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COVER SHEET

- a. **Title:** South Fork Tolt River Hydroelectric Project (adopted portions of the 1987 Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement (FEIS), Snohomish River Basin, Washington, Seven Hydroelectric Projects, Docket No. EL85-19-101, for application for FERC license to construct, operate, and maintain the project)
- b. **Adopted Portions of the 1987 FERC Final Environmental Impact Statement**
- c. **Agency:** Bonneville Power Administration (BPA)
- d. **Abstract:** The South Fork Tolt River Hydroelectric Project that would produce 6.55 average megawatts of firm energy per year and would be sited in the Snohomish River Basin, Washington, was evaluated by the Federal Energy Regulatory Commission (FERC) along with six other proposed projects for environmental effects and economic feasibility. Based on its economic analysis and environmental evaluation of the project, the FERC staff found that the South Fork Tolt River Project would be economically feasible and would result in insignificant impacts if sedimentation issues could be resolved. Upon review, the BPA is adopting portions of the 1987 FERC FEIS that concern the South Fork Tolt River Hydroelectric Project and updating specific sections in an Attachment. Asterisks identify all inserts by BPA.
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1. PROPOSED ACTION

* The proposed action of the Federal Energy Regulatory Commission (FERC) was to issue or deny licenses for seven hydroelectric projects, of which the South Fork Tolt River Project was one. BPA's proposed action is to grant a billing credit to the developer of the South Fork Tolt River Project. *

1.1 South Fork Tolt River Project (FERC No. 2959)

* The Federal Energy Regulatory Commission issued a license for the South Fork Tolt River Project on March 29, 1984 (FERC, 1984b), but petitions for rehearing were filed by a number of intervenors, as well as the licensee. Subsequently, an order staying the license was issued. The license was reissued in 1989. * * The BPA Attachment updates license information. *

1.1.1 Project Description

* The following description reflects the project planning stage in the FERC Final Environmental Impact Statement. The BPA Attachment includes the project description as of March 1992. *

Location

The proposed project would be located on the South Fork Tolt River, at the existing South Fork Tolt Dam, near the town of Carnation, in King County, Washington.

Facilities

A map showing the layout of project features is provided in figure 1-1.

- Dam and Reservoir--The existing South Fork Tolt Dam, located at river mile (RM) 10 of the South Fork Tolt River, is an earthfill structure 200 feet high, with a gross storage capacity of 57,900 acre-feet and surface area of 1,030 acres at the normal maximum water surface elevation of 1,765.0 feet.^{1/} The dam has a crest length of 980 feet and a crest elevation of 1,775.0 feet. The dam has a morning-glory-type spillway with a ring gate, sluiceways, and a multiple-level water supply intake. Water from the South Fork Tolt Reservoir flows through a pressure pipeline approximately 4.7 miles long and is discharged to an existing regulation basin approximately 5 miles downstream. Water from the South Fork Tolt reservoir pipeline is discharged into the regulation basin by a spillway adjacent to the south dam. The regulating basin holds approximately 882 acre-feet at a normal water surface elevation of 766.05 feet. The regulation basin is created by two earthfill dams. The south dam is 35 feet high with a crest length of 320 feet. The west dam is 30 feet high with a crest length of 250 feet. Both dams have a crest elevation of 771.1 feet. Overflow from the regulation basin is discharged by a spillway through the west dam.

- Penstock--A 69[slc]-inch-diameter steel pipe approximately 4.7 miles long, would tap the existing 54-inch-diameter stub and would be installed parallel to the existing water supply pipeline. The pipeline would extend from the 54-inch-diameter stub to the powerhouse and would be buried over most of its length.

- Powerhouse--The powerhouse, which would be located southeast of the existing regulating basin, would be an indoor structure housing a 15,030-kilowatt (kW) generator connected to a vertical shaft impulse turbine, rated 23,000 horsepower (hp) at a net head of 930 feet. The turbine would discharge into an enclosed tailrace, where a weir and motor-operated gate system would divert Seattle's water requirements to the regulating basin and return releases directly to the river.

^{1/} All elevations refer to mean sea level (msl), unless otherwise indicated.

Figure Detailed map of South Fork Tolt River Project (FERC No. 2959) features
(Source: modified from City of Seattle, 1981).

- **Transmission Facilities**--The switchyard would be located adjacent to the powerhouse and contain a 115-kV, three-phase circuit breaker; a 115-kV, three-phase, gang-operated disconnect switch; current and potential transformers for metering and protection; buswork and a step-up transformer rated at 13.8/115 kV. Power generated by the project would be transmitted 8.4 miles to the point of interconnection with the Puget system. Four miles of the transmission line is existing and 4.4 miles is proposed. Power from the project would be wheeled through the Puget system to a point where Seattle Interconnects with Puget.

- **Access Facilities**--Access to the existing South Fork Tolt Dam and regulating basin would be by existing roads. To gain access to the powerhouse, one 300-foot-long road would be constructed between the access road for the regulating basin and the powerhouse site.

Construction and Operation

- **Construction Schedule**--Seattle City Light estimates that it would take two years to construct the project.

- **Operation and Maintenance**--The control system for the South Fork Tolt River Project would be designed for fully automatic operation from the Seattle City Light Department's power control center. The project would generate power with water released for the city's water supply needs. Power from the project would be used by the city to meet its own demand. The project would have an average annual generation of about 75.3 gigawatt hours (GWh), with the minimum flows proposed by the licensee on September 27, 1985, as measured at the downstream gauge.

* Updated in Settlement Agreement discussion in the Attachment. *

- **Project Safety**--This is a licensed project and would be considered safe when in compliance with the terms and conditions of the license.

1.1.2 Mitigative Measures Proposed by Seattle City Light

Land Features and Water Quality

- Construction adjacent to the river would be carried out during low-flow periods.
- Water would be diverted around construction areas or routed through them in culverts during pipeline construction.
- Erosion, surface runoff, and moving sediment would be contained during construction by use of interception, diversion, and disposal structures; mulches and nettings; and sediment control structures.
- Vehicular activity and parking would be confined to defined and cleared areas.
- Slash would be removed before excavation was begun to avoid mixing slash with soil used for backfill.
- Road would be sloped to the inside of hills, and vegetative buffer strips would be retained on the downhill side of roads to aid in retention of sediments.
- Holding ponds would be used where needed to contain storm waters until sediments settled out.
- Disturbed streambank areas of the South Fork Tolt River near the return flow structure would be stabilized to prevent scouring.
- Appropriate water temperatures for water released from the reservoir would be maintained by blending releases from the multiple-level intake structure.

- The return flow intake would be placed below the water level of the tailrace to avoid entrainment of air in the pipeline.

Fishery Resources

- An energy-dissipating structure would be constructed on the project outfall to preclude attraction of migrating fish.
- Ramping rates would be regulated at about 1 foot per hour to reduce impacts from fluctuating water levels.
- Existing minimum release flows from the dam would continue or would be improved for the existing fishery.

Terrestrial Resources

- Damage to vegetation would be minimized to the extent possible, and disturbed areas would be mulched and revegetated.
- Cuts into second-growth forest along widened portions of the pipeline right-of-way would be staggered to decrease the unnatural effect of the linear swath.
- The transmission line would conform with the criteria of Oldendorf et al. (1981) to prevent raptor electrocution.
- The transmission line would use the existing water pipeline right-of-way.
- Pipelines and conduits would be buried and the soil surface would be revegetated.
- A wildlife habitat vegetation and management plan would be developed and implemented.

Recreational and Visual Resources

- The powerhouse would be designed to incorporate provisions for guided tours.
- Development of an offsite trail in cooperating with federal and state agencies would be considered.
- Project facilities would be of high visual quality and blended with the landscape to the extent possible.
- Wooden poles would be used for the transmission line to reduce contrast with the forest landscape.

Cultural Resources

- If archeological or historical materials were found during construction, activities would stop and the state historical preservation officer would be notified so that the material could be evaluated.

1.2 No-Action Alternative

*** The no-action alternative of FERC was to deny issuing seven hydroelectric licenses in the Snohomish River Basin, of which the South Fork Tolt River Project is one. BPA's no-action alternative is to deny a Billing Credit for the South Fork Tolt River Project. ***

The no action alternative for each proposed site would preserve the existing fish, wildlife, vegetation, recreational, aesthetic, archeological, and socioeconomic values of the sites as described in section 3.1 but would not preclude the impacts on these resources associated with land and water use from commercial and recreational activities in and outside the Snohomish River Basin.

*** The "Background and Need for Action" section of the BPA Attachment updates Federal power needs in the region. ***

2. AFFECTED ENVIRONMENT

2.1 GENERAL SETTING ^{1/}

The Snohomish River Basin is just north and east of Seattle, Washington, and lies in parts of King and Snohomish Counties. The approximately 1,800-square-mile basin is relatively undeveloped, but is being influenced by the growing Seattle-Bellevue areas. The main urban center is Everett, with a 1980 population of 54,413 (Bureau of the Census, 1983), or about 40 percent of the basin's total population.

The climate of the basin is maritime-influenced and varies dramatically along a gradient from the sea-level estuary to the high (7,000 feet) Cascade Mountains forming the eastern rim of the basin. The lowlands receive about 35 inches of precipitation per year, while the mountainous eastern portion of the basin often receives 180 inches. The lowland area has hot, dry summers and mild winters, while the mountainous areas have cool summers and cold winters with a deep snowpack.

The 20.5-mile long Snohomish River begins at the confluence of its two major tributaries, the Skykomish River to the northeast and the Snoqualmie River to the southeast. These subbasins drain about 850 and 700 square miles, respectively. The Snohomish River Basin has more than 2,700 linear miles of streams and an annual runoff of about 7 million acre-feet. The average annual discharge into Puget Sound is about 10,000 cubic feet per second (cfs), but this varies dramatically on a seasonal basis from 1,140 cfs in late summer to 136,000 cfs in late winter.

Soils of the eastern, mountainous part of the basin consist of a thin mantle of glacial debris with deeper glacial drift on gentler slopes and valley bottoms. Soils derive from glacial action on the granitic, volcanic, and sedimentary rocks of the Cascade Mountains. Soils of the western, lowland areas consist of gravelly, sandy loams with silty clays in the lowest areas.

The basin is largely forested, with the conifers Douglas fir, western hemlock, and red cedar dominating other species. A large portion of the lowlands in the western third of the basin is open, grassy, floodplain area.

^{1/}

Much of the background information presented in this section was derived from the Snohomish River Basin Resource Management Program (Pacific Northwest River Basins Commission, 1981) and A Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound (Williams et al., 1975).

While much of the lowland area is available for pasture and cultivation, forestry and wood products are the leading land uses and industries in the basin. Much of the employment of the basin's population is found in the Seattle-Bellevue areas. Other important land uses are dispersed recreation (such as boating, hiking, mountain climbing, fishing, and hunting), urban and rural development, and transportation. The basin's large, natural populations of anadromous fish contribute substantially to commercial and sport fisheries, an important economy of western Washington. These natural populations are augmented by hatchery-reared fish.

Land ownership in the basin is about 50 percent public and 50 percent private. Two-thirds of the public ownership is federal, primarily under the management of the Mt. Baker-Snoqualmie National Forest.

A number of land and water issues have been identified in the basin. The Environmental Protection Agency (Jones and Stokes Associates, Inc., 1983, 1984a, 1984b) and the Washington Department of Ecology (1985a) are addressing water quality and quantity issues. Flooding problems are being addressed by the Corps of Engineers (1979, 1982).

The Washington Department of Ecology (1981b) has listed 48 dams in the basin. Most are small domestic or industrial water storage projects. Four projects are notably large: Spada Lake, Lake Stevens, and the Tolt and Spada reservoirs. Only one project was listed as generating electricity in 1981: the licensed (41.7 MW) Snoqualmie Falls Project (FERC No. 2493), built in 1898 at the 270-foot-high falls. Two other projects are now generating electricity: the licensed (112 MW) Sultan River Project (FERC No. 2157) (now called the Henry M. Jackson Dam and Reservoir) and the small, exempted (0.65 MW) Woods Creek Project (FERC No. 3602). Two other projects (Twin Falls Project, FERC No. 4885, 20 MW; and Weeks Falls, FERC No. 7563, 3.4 MW), both on the South Fork Snoqualmie River, have been licensed but are not yet constructed. More than 100 potential project sites have been identified or proposed for the basin (Washington Department of Ecology, 1981b; Washington Water Research Center, 1980). Two of the proposed projects (South Fork Tolt River and Tokul Creek) were recently licensed, but those licenses have been stayed pending the outcome of the Cluster Impact Assessment Procedure (CIAP) for the basin. * See update in Attachment. *

Examples of other issues and management plans or programs relevant to the basin are the Tulalip's Tribal treaty rights; the Mt. Baker-Snoqualmie National Forest Plan (in draft form); the Northwest Power Planning Act; the U.S.-Canada Pacific Salmon Treaty (1985) and other anadromous fisheries plans; aquatic and riparian management plans; the Snohomish River Basin Instream Resources Protection Program Plan; the Snohomish County Shoreline Master Program; and the Washington

Statewide Comprehensive Outdoor Recreation Plan. Other programs, such as the National Wilderness System and state and federal Wild and Scenic River Systems, have a bearing on land use in the basin.

2.2 TARGET RESOURCES

2.2.1 Selection of Target Resources

The FERC staff proposed the Cluster Impact Assessment Procedure (CIAP) to assess cumulative adverse impacts on environmental resources from multiple hydroelectric project development (FERC, 1985c). The Council on Environmental Quality (CEQ) stated that cumulative impacts are: "...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

A key element of the CIAP is the selection of target resources. Target resources are important environmental resources that have a high potential of being impacted in a cumulative manner by multiple hydroelectric development within a given river basin. "Importance" is attributed for reasons of economics, sensitivity to hydroelectric development, special status (such as federally designated endangered species), vital role in an ecosystem, Native American treaty rights, and similar factors.

Target resources were selected through a process involving public and agency scoping meetings, site visits, and review of pertinent published and unpublished literature. More information on target resources and their selection is provided in FERC 1985b and 1985c.

The target resources selected for cumulative impact analysis in the Snohomish River Basin are salmon (chinook, Oncorhynchus tshawytscha; coho, O. kisutch; pink, O. gorbusche; chum, O. keta), steelhead trout (Salmo gairdneri), sea-run trout (cutthroat, S. clarki; Dolly Varden, Salvelinus malma, resident fish (rainbow trout, cutthroat trout, brook trout (Salvelinus fontinalis), and Dolly Varden [sic]), black-tailed deer Odocoileus hemionus columbianus), and bald eagles (Haliaeetus leucocephalus). Other species, habitats, and resources recommended to the staff for cumulative impact evaluation by the public or agency personnel included black bear (Ursus americanus), "small game," water ouzel (Cinclus mexicanus), bobcat (Felis rufus), beaver (Castor canadensis), spotted owl (Strix occidentalis), mountain lion (Felis concolor), whitewater recreation, roadless areas, and potable water supply. The FERC staff analyzes impacts to these resources on a site-specific basis, as appropriate.

Descriptions, distributions, and relationships of each target resource to the proposed projects are given in the following subsections.

2.2.2 Fisheries Target Resources

2.2.2.1 Salmon

Snohomish River salmon are a major commercial and game resource. The four species present are all anadromous, beginning life in freshwater, migrating to the salt water to mature, and returning to freshwater to spawn. Adult salmon die after spawning. Most aspects of the life histories of the four species--chinook, coho, pink, and chum--are basically the same, with some differences in the timing of migration and spawning (table 2-1). One major life history difference occurs in the duration of juvenile rearing in freshwater and estuarine environments. Habitat requirements also have basic similarities of clear, clean, cold waters and gravel substrate free of fine sediments for spawning. Migration is an integral part of the life cycle and depends on access both to the marine environment and to suitable upstream spawning areas.

Distribution and Abundance

Distribution of salmon within the Snohomish River Basin depends on species, with pink, chinook, and chum regarded as mainstem and large tributary spawners, and coho using smaller tributaries to a greater extent. All four species are present in the two major tributaries of the Snohomish River--the Skykomish and Snoqualmie Rivers. Salmon use all accessible reaches of the major rivers and tributaries in the basin, as well as many of the smaller tributaries, up to impassable barriers (figure 2-1). The total length of stream accessible to salmon varies by species. The Washington Department of Fisheries (WDF) catalog cites more than 200 miles as being accessible and utilized by all four species (Williams et al., 1975). The WDF uses an accessible length of 655 miles in estimating coho salmon smolt production (Zillges, 1977). Major natural barriers are Sunset Falls on the South Fork Skykomish (RM 51.5) and Snoqualmie Falls on the Snoqualmie River (RM 40.4). A ladder and trapping facility at Sunset Falls, operated by WDF, provides access to the upper South Fork Skykomish River. The WDF also operates a limited artificial propagation program in the Snohomish River Basin, although the major management emphasis is now on natural production of wild stocks. Unless otherwise stated, all values given in this document for salmon production, harvest, and escapement include both wild and hatchery fish.

Figure . Anadromous fish zones within the Snohomish River Basin (Source: staff).

Table . Timing of salmon and sea-run trout freshwater life phases in the Snohomish River Basin. (Source: Pacific Northwest River Basins Commission, 1970).

Species	Fresh-water Life Phase	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Spring chinook	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing												
	Juv. out migration												
Summer-Fall chinook	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing												
	Juv. out migration												
Coho	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing												
	Juv. out migration												
Pink	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing												
	Juv. out migration												
Chum	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing												
	Juv. out migration												
Summer steelhead	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing ^{1/}												
	Juv. out migration												
Winter steelhead	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing ^{1/}												
	Juv. out migration												
Searun cutthroat	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing ^{1/}												
	Juv. out migration												
Searun Dolly Varden	Upstream migration												
	Spawning												
	Intragravel development												
	Juvenile rearing ^{1/}												
	Juv. out migration												

^{1/} Normally extends over a two-year period

Total salmon production from the basin has been variable over the past 10 years, and clear trends cannot be identified from the recent production, harvest, and escapement data for each of the four species (table 2-2). Accounting methods have changed since the mid-1970's, making comparison of present population statistics to historical statistics difficult.

Coho salmon are the most abundant salmon species in the system, with adult fish from different age classes returning each year to spawn. Total production from 1976 to 1984 averaged 413,003, a harvest-to-escapement ratio of 4:2:1. Hatchery production contributed about 10.9 percent to total production. Coho spawn in and use virtually all accessible tributaries in the basin (table 2-3) (Williams et al., 1975; Pacific Northwest River Basins Commission, 1980). Some spawning also occurs in the mainstem Skykomish and Snoqualmie Rivers.

Pink salmon are the most abundant salmon species in the system, with adult fish from different age classes returning each year; however, the principal runs occur in odd-numbered years. The even year run is very small and is not quantified. Total production average 325,846 during odd-numbered years over the period 1977 to 1983 (table 2-2). Escapement of pink salmon averaged 148,773 during the same period, and the harvest averaged 176,713. The harvest-to-escapement ratio averaged 1:2:1. Hatchery production contributes about 0.36 percent of the total. Pink salmon spawn primarily in the mainstem Snohomish, Skykomish, and Snoqualmie Rivers and in several larger tributaries (table 2-3). They spawn in nearly all mainstem Skykomish tributaries up to the North Fork Skykomish (Pacific Northwest River Basins Commission, 1980).

Chinook salmon are a highly prized species with three distinct races in the Snohomish River Basin: spring, summer, and fall runs. Total production of all three runs averaged 89,984 (escapement averaged 6,974 and catch averaged 83,010) from 1979 to 1985 (table 2-2). The harvest-to-escapement ratio averaged 12:1 during that period. Hatchery production contributed about 28.8 percent of the total. Habits and timing of the spring chinook run differ from the summer and fall runs. Runs are so low that there is no officially recognized production from spring chinook in the basin (personal communication, D. Haring, Fish Biologist, Washington Department of Fisheries, Olympia, Washington, May 30, 1986). Habits and timing of summer and fall run chinook are sufficiently similar that they are managed as a single population of fall chinook. Fall chinook generally spawn in the lower reaches of main tributaries and in the mainstem Snohomish, Skykomish, and Snoqualmie Rivers (Williams et al., 1975; Pacific Northwest River Basins Commission, 1980).

Table . Harvest and escapement of Snohomish River Basin salmon stocks. 1/

Species	Year	Harvest			Escapement	Total
		Puget Sound	All others	Sport		
Chinook	1985	5,507	34,421	18,358	7,278	65,564
	1984	8,288	35,603	18,988	4,936	67,815
	1983	8,990	39,607	21,123	5,721	75,441
	1982	7,589	38,427	20,495	6,684	73,195
	1981	14,701	58,501	31,201	7,028	111,431
	1980	18,568	76,803	40,962	9,959	146,292
	1979	10,364	48,328	25,242	7,215	90,149
	Mean	10,572	47,241	25,196	6,974	89,984
Coho	1984	36,671	269,736	28,962	96,900	432,269
	1983	50,634	412,232	44,262	153,500	660,628
	1982	34,088	188,589	20,249	59,300	302,226
	1981	53,285	194,238	20,856	42,900	311,279
	1980	130,441	480,300	51,571	107,400	769,712
	1979	42,744	368,229	39,537	139,600	590,110
	1978	70,928	279,948	30,058	67,700	448,634
	1977	75,532	416,965	44,770	125,600	662,867
	1976	36,615	266,795	28,795	95,500	427,705
	Mean	58,993	319,670	34,340	98,711	511,714
Pink	1983	29,901	195,163	-	198,283	423,347
	1981	30,705	103,320	-	90,096	224,121
	1979	39,831	188,638	-	180,724	409,193
	1977	6,994	113,740	-	125,990	246,724
	Mean	26,858	150,215	-	148,773	325,846
Chum	1984	4,939	1,737	-	39,032	45,708
	1983	9,278	628	-	6,610	16,516
	1982	93,138	6,610	-	74,208	173,956
	1981	23,792	1,475	-	13,550	38,817
	1980	17,684	1,841	-	28,932	48,457
	1979	393	188	-	4,357	4,938
	1978	6,231	1,271	-	25,938	33,440
	1977	4,729	869	-	17,260	22,858
	1976	15,100	1,220	-	15,100	31,420
	Mean	19,476	1,760	-	24,999	46,234

1/ Source: Washington Department of Fisheries, unpublished data, 1986.

Table . Priority anadromous and resident fish streams in the Snohomish River Basin and relative fish use of each. 1/, 2/

Stream	Salmon				Steelhead		Sea-run trout	Resident trout
	Chinook	Coho	Pink	Chum	Winter	Summer		
Snohomish River	X	O	*	*	X	*	O	
Quilceda Creek	O	X		*	O		X	*
Pilchuck River	*	X	*		X		O	O
Worthy Creek		X			X		O	O
Kelly Creek		*			X		O	O
French Creek		X			O		X	O
Snoqualmie River	X	O	*	*	X	*	O	
Cherry Creek	*	X	*	O	X		O	O
Tuck Creek		X		O			X	X
Harris Creek		X		O	X		O	O
Stossel Creek		X					X	X
S.F. Tolt River	X	*			X		O	O
Griffin Creek	*	X	*	O	X		O	O
Patterson Creek		X			X		O	O
Raging River		X			X		O	O
Deep Creek	O	X			X		O	*
Tokol Creek	*	*	*	O	X		*	*
S.F. Snoqualmie River								X
N.F. Snoqualmie River								X
M.F. Snoqualmie River								X
Skykomish River	X	O	X	X	X	*	O	
Sultan River 3/	X	*	X	*	X		O	O
Woods Creek	*	X	*	O			X	O
W.F. Woods Creek	O	X	O	O	X		O	O
Carpenter Creek		X			O		X	O
Elwell Creek	*	X	X	O	*		O	O
Youngs Creek		X					X	O
Wallace River	*	X	X	*	X		O	O
May Creek	*	X	X	*	X		X	O
Olney Creek	*	X	X	*			*	O
Procter Creek	*	X	X	O			O	X
N.F. Skykomish River	X	*	*	O	X	X	*	O
Troublesome Creek	O	X	O		O	O	*	O
S.F. Skykomish River	X	*	*				O	X
Index Creek	O	X	O				X	O
Money Creek		X					O	X
Miller River	X	*	O		X		O	O
Malony Creek		X					*	O
Beckler River	X	*	O				O	X
Tye River	X	*						X

1/ Source: Modified from Pacific Northwest River Basins Commission (1980) except as noted.

2/ Legend: X Principal run
 * Major use
 O Minor use

3/ Based on personal communication, Mary McCrea, Fisheries Biologist, Washington Department of Fisheries, Olympia, Washington, November 21, 1986.

Chum salmon return annually, although the principal runs occur in even-numbered years. Total production averaged 66,596 in even-numbered years and 20,782 in odd-numbered years for the period 1976 through 1984 (table 2-2). Even-year escapement averaged 36,642, and odd-year 8,355 for the same period; catch averaged 29,954 in even years and 12,427 in odd years. Hatchery production accounted for 1.4 percent of total production. Most spawning occurs in the mainstem Snohomish, Skykomish, and Snoqualmie Rivers. Chum also spawn in a number of Skykomish River tributaries, but there is relatively little use of Snoqualmie River tributaries (Williams et al., 1975).

Life History

Pink salmon return to spawn primarily in odd-numbered years, with upstream migration occurring from July through October. Spawning occurs in September and October. Fry begin their seaward migration immediately or soon after emerging from the gravel in the spring. Rearing and feeding take place in the lower mainstem Snohomish, Skykomish, and Snoqualmie Rivers enroute to Puget Sound. Fry rear extensively in estuarine and Puget Sound marine waters. These areas are vital links in the life cycle. Adults return to spawn at age two.

Coho salmon enter the Snohomish system from July through December, spawning from October through January. Fry emerge in March and April. Early emergence gives fry an advantage in competition for food. Juveniles rear in fresh water for more than a year, and generally emigrate from April through July during peak spring runoff. Summer-fall chinook enter fresh water from July through October and spawn from August through November. Fry rear for a short period following emergence from the gravel and begin downstream migration in the spring, coincident with peak spring runoff, April through July. Adults of all three races spend 1 to 5 years at sea before returning to spawn.

Chum salmon migrate upstream from late August to January, spawning from November through January. Fry emergence occurs in March and April. Emigration occurs soon after emergence, following a brief rearing period. Adults return in even-numbered years at age three or four.

Habitats

Naturally reproducing salmon are extremely dependent on the freshwater environment. Runs of all species are subject to impacts from a variety of sources, such as reduction of streamflow, sedimentation, loss of riparian vegetation, and migration blockage; however, low adult return rates have only rarely been attributable to adverse marine survival other than harvest.

Habitat requirements of the four salmon species have basic similarities, particularly for spawning and egg incubation. There is some difference among the four species in preferred substrate size, depth, and velocity of water for spawning. The greatest difference in habitat requirements is in the duration of freshwater rearing. Salmon spawn in gravel riffles that are relatively free of sediments and fine particulate material and that have an adequate intragravel flow of water. Eggs incubate in the gravel until ready for emergence. Chinook salmon generally spawn in larger tributaries and mainstem riffles with larger substrates and deeper, faster water. Coho salmon use smaller tributaries and spring-fed side channels. Chum salmon use lower gradient, lower velocity mainstem riffles and sloughs and tributaries. Pink salmon use broad riffles, smaller substrates in main rivers and tributaries (personal communication, Mary McCrea, Fisheries Biologist, Washington Department of Fisheries, Olympia, Washington, November 21, 1986). Pink and chum juveniles migrate to sea soon after emergence and do not require summer rearing habitat in the streams. Chinook juveniles may spend several months feeding and growing in the river before migrating.

Estuarine habitats are a critical link in the life cycle of these species. Chinook also spawn in mainstem channel riffles, while coho use riffles in smaller tributary streams extensively. The quantity of sediment and other fine particulate material in spawning gravels is correlated to spawning success (Bjornn, 1979) due to reduced intragravel water movement and blockage of fry emergence. Streamflow and temperature are important factors for salmon spawning and egg incubation. Fry that do survive incubation and in-gravel rearing under higher sediment concentrations may emerge in weaker condition and have a reduced chance of survival. Adults must have adequate water depths and velocities for redd digging and spawning, and egg incubation is dependent on intragravel flow to supply oxygen and remove metabolic wastes. Dewatering of redds during winter can result in freezing of the eggs, causing mortality or reduced egg and fry survival. Excessively low incubation temperatures can extend incubation time and delay emergence, which can be a detriment through reduced competitiveness of fry for food and rearing space, and other adverse results of altered life-stage timing.

Riffles where spawning occurs experience significant changes in flow conditions throughout the annual hydrological cycle. High discharges during major storm events and spring snowmelt transport sediments and bedload through the system, cleaning and redistributing spawning gravels. This natural process is necessary to maintain usable spawning grounds in most streams. Low discharges carry less sediment and do not transport bedload, which can lead to armoring of spawning beds, increased sedimentation, and reduced intragravel flows, all of which can result in lower spawning success of all salmonids. Low discharges can also result in delayed or blocked upstream passage by adults over shallow gravel bars, and in increased difficulty of passage over cascades and waterfalls.

The mainstem Snohomish, Skykomish, and Snoqualmie Rivers contain notable spawning areas for pink, chum, and chinook salmon (Pacific Northwest River Basins Commission, 1980). Spawning also occurs in tributaries with broad riffle areas such as the Wallace, Sultan, Pilchuck, Tolt, Raging, and North Fork Skykomish Rivers and in other, smaller tributaries (table 2-3).

Coho and spring chinook juveniles rear in streams for more than a year and have the most critical freshwater rearing habitat requirements. Coho is the major stream-rearing species in the Snohomish Basin. Coho spawn and rear throughout the basin (table 2-3), up to impassable barriers in most streams. Low-flow conditions in summer may be the most constraining influence on coho and spring chinook production in the basin. Overwintering habitat may also be a constraining influence on smolt production, particularly when sedimentation has filled interstitial spaces in the gravels used for cover during winter. Key habitat factors are food supply, cover, space, and water temperature. All these factors depend heavily on streamflow; thus, maintenance of adequate flows for rearing is a critical issue in maintaining coho populations, as well as other stream-rearing salmonids. Watershed disturbances, such as road construction and logging, also influence instream habitat quality by removal of riparian vegetation (cover and food supply), increased sedimentation due to surface disturbance and erosion (space, cover, food supply, and temperature), and alteration of surface runoff patterns (temperature, and streamflow). Increased sedimentation of stream substrates results in loss of overwintering habitat due to the filling of interstitial spaces, loss of rearing habitat and cover due to reduced pool depths, and loss of food base by reducing benthic invertebrate production.

Habitat conditions in the Snohomish River Basin, especially at the higher elevations accessible to salmon, are generally good to excellent. A general description of the larger streams in the Snohomish River Basin is contained in a catalog of streams and salmon use issued by the Washington Department of Fisheries (Williams et al., 1975). All but one (Black Creek) of the seven proposed projects are located within the anadromous fish zone on tributary streams, near the upstream extent of salmon access.

Habitat conditions in the streams where hydroelectric development is proposed generally consist of steep-gradient, narrow channels of large boulders and rubble, with limited areas of spawning-sized gravels. Rearing habitat for juveniles is generally excellent. In some cases the principal habitat for salmon is confined to adult holding areas in pools. For the six proposed projects located in the anadromous fish zone, spawning habitat is generally very limited within the proposed bypass reaches, although suitable spawning habitat is often available downstream. Descriptions of salmon habitats in specific project bypass reaches are given in section 2.2.2.5.

Management

The Snohomish River Basin is one of three basins in the state of Washington managed for wild populations by natural production of all salmon species (Washington Department of Fisheries, 1983). Managing agencies and Tribes are the Washington Department of Fisheries (WDF), the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), and the Tulalip Tribes. The Forest Service also manages fish habitat on National Forest lands.

The rights and role of treaty Indian Tribes in management and harvest of anadromous fish resources in Puget Sound have been established through several court decisions in recent years based on the Treaty of Point Elliot. The Tulalip Tribes have taken a major role in comanagement of Snohomish River anadromous fish stocks. The court decisions ordered that treaty Indian Tribes have the right to take up to 50 percent of the allowable harvest on salmon stocks originating from the Snohomish River, and the right to prevent environmental degradation of the fishery and the habitat upon which the fishery is dependent. The Tribes also have the responsibility to manage the resources, including participation in establishment of escapement goals, hatchery production levels, harvest allocations, and other management activities. The Puget Sound Salmon Management Plan, adopted by the Ninth District Court on November 15, 1985, defines the framework and implementation for management, allocation, and dispute resolution of salmon harvest in the Puget Sound region. (This was discussed in section 3.1.3.9.3 in the FERC FEIS).

The management goal of resource agencies is to maintain existing salmon populations and to regain full natural production from the Snohomish River Basin. To accomplish this goal, the agencies have adopted the policy of allowing no long-term loss of existing or potential habitat within the basin. Habitat protection is a key element achieved through prevention of losses in streamflow, physical habitat, and direct loss of fish. Mitigative measures are required of developers to eliminate adverse impacts or reduce them to insignificant levels. A collective expression of basin management is contained in the Snohomish Guidelines (U.S. Fish and Wildlife Service et al., 1983) developed to direct collection of data and assess the potential for impacts due to individual development projects proposed in the basin. The Snohomish Guidelines were employed by the applicant for the Twin Falls and Weeks Falls Projects (FERC Nos. 4885 and 7563), resulting in the licensing of those two projects in 1985.

Anadromous fish resources are subject to a multitude of harvest management problems deriving from biological, legal, institutional, economic, and social factors (Washington Department of Fisheries, 1982). Biological factors included problems of overlap in run timing and location, differential exploitation on each run, intermixing of hatchery stocks in the already mixed-stock fishery, and

maintenance of freshwater rearing habitats. The major legal factor is the Boldt decision, which ordered that treaty Indian Tribes must be provided with the opportunity to take up to 50 percent of the allowable harvest of salmon runs originating from the Snohomish River Basin. Institutional factors include the conflicting goals and jurisdiction of various agencies involved in salmon resource management (Washington Department of Fisheries, Tulalip Tribes, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Bureau of Indian Affairs, North Pacific Fisheries Management Council, International Pacific Salmon Fisheries Commission, and the Fisheries Service of Canada). Social and economic factors include market price; consumer preferences; fishery participants' varying with time, area and species; strong social and cultural ties to fisheries; and conflicts between commercial and sport fishery goals. In addition, the actions of numerous federal, state, and local nonfishery agencies can have substantial effects on fishery resources and their management.

Harvest of salmon in marine waters is managed as much as possible to achieve escapement goals, but uncertainties of prerun projections, harvest regulation and enforcement, and other factors often result in the goals not being met. In-season harvest is actively monitored and regulated in an attempt to attain desired escapement goals so as to maintain required population levels. Artificial propagation in the basin is being de-emphasized. Hatchery production still is used in several locations in the basin, but hatchery production is no longer considered by agencies as an acceptable mitigative measure for development projects. Replacement of wild salmon populations with hatchery stocks results in severe management conflicts by causing either underharvest and a surplus of hatchery fish, or overharvest and depletion of wild stocks. The WDF operates a trap and haul facility at the series of impassable falls (known as Sunset Falls) in the lower South Fork Skykomish River to provide salmon with access to upstream spawning and rearing habitat not historically available. Outplants of some hatchery stocks are made above natural barriers in some tributary streams, such as Olney Creek.

2.2.2.2 Steelhead

Steelhead are an anadromous form of rainbow trout. Steelhead trout are a major game resource in the Snohomish River Basin. Steelhead are also an important commercial resource to the Tulalip Tribes. Their life cycle is similar to that of coho salmon except that steelhead do not die after spawning and may spawn more than once. Two races of steelhead are present in the Snohomish: winter-run and summer-run. Life histories of the two populations are similar, differing primarily in timing of upstream migration (table 2-1) and distribution within the system (table 2-3). Steelhead are noted for their preference for tributaries and headwater reaches, migrating upstream to impassable barriers in most systems. Winter-run steelhead are currently more abundant, although historically summer steelhead were probably the most abundant (Pacific Northwest River Basins Commission, 1980). Both

populations have been heavily supplemented with hatchery production in the Snohomish (table 2-4), although management and regulations for the sport fishery and Tulalip Tribes commercial fishery are based on maintaining wild populations (Washington Department of Game, 1984; Washington Department of Game, unpublished data base, Olympia, Washington, 1986).

Distribution

The Snohomish River Basin contains approximately 433 miles of stream accessible to steelhead--154 miles in the Snoqualmie River and 279 miles in the Skykomish River (figure 2-1) (Washington Department of Game, unpublished data base, Olympia, Washington, 1986).

Summaries of sport and commercial steelhead catches indicate that total winter-run adult harvests have been at least 8,759 to 31,792 since 1972 (table 2-4). Recent catch and escapement data indicate that total returns of Snohomish River steelhead have been at least 20,111 to 37,181 (table 2-4). These data are incomplete for all but a few years. Escapement estimates for wild winter-run steelhead suggest that WDG management practices are permitting a rebuilding of an apparently depressed stock. It is also apparent that the winter-run hatchery programs at Tokul Creek and Skykomish Hatcheries are supporting the majority of sport and commercial harvest in the Snohomish River Basin. Overall, harvest of winter steelhead has declined about 34 percent since the mid-1960's, but is more variable than in the past. The wild winter run has not met escapement goals in recent years (Washington Department of Game, unpublished data base, Olympia, Washington, 1986).

Summer-run steelhead are more limited in distribution and abundance in the Snohomish River Basin (Pacific Northwest River Basins Commission, 1980; Washington Department of Game, unpublished data base, Olympia, Washington, 1986). The North Fork Skykomish River and its tributaries support one of the few visible, wild, summer-run populations in the Puget Sound (Pacific Northwest River Basins Commission, 1980). Escapement estimates are not made for summer-run steelhead; the condition of wild summer-run steelhead stocks in the Snohomish River Basin is not known. Summer-run steelhead are planted in several Snohomish River tributaries, including the Pilchuk, North Fork, and South Fork Skykomish, Snoqualmie, Wallace, Tolt, and Raging Rivers, and Tokul Creek (Pacific Northwest River Basins Commission, 1980). Harvest of summer-run steelhead in the Snohomish River Basin was between 308 and 1,509, in an increasing trend (91 percent) from 1964 to 1976. The WDG Skykomish Steelhead Hatchery near Gold Bar began planting summer-run steelhead in 1975, with the first hatchery returns harvested in 1977.

Table . Snohomish River Basin adult winter-run steelhead trout population data. 1/

Year	Harvest						Total Harvest		
	Wild			Hatchery					
	Sport	Indian	Total	Sport	Indian	Total	Sport	Indian	Total
1971-1972	-2/	-	-	-	-	-	-	-	16,775
1972-1973	-	-	-	-	-	-	-	-	9,647
1973-1974	-	-	-	-	-	-	13,887	-	-
1974-1975	-	-	-	-	-	-	16,225	1,680	17,905
1975-1976	-	-	-	-	-	-	8,643	2,498	11,141
1976-1977	-	-	-	-	-	-	7,136	1,623	8,759
1977-1978	-	-	-	-	-	-	26,047	5,745	31,792
1978-1979	-	-	-	-	-	-	14,288	5,423	19,711
1979-1980	-	-	-	-	-	-	15,368	10,402	25,770
1980-1981	1,004	1,930	2,934	6,268	7,595	13,863	7,272	9,525	16,797
1981-1982	1,086	1,776	2,862	4,076	6,152	10,228	5,162	7,928	13,090
1982-1983	1,627	1,596	3,223	4,648	5,162	9,810	6,275	6,758	13,033
1983-1984	423	-	423	8,756	-	8,756	9,175	5,511	14,686
1984-1985	149	-	149	10,957	-	10,957	11,106	15,175	26,281
1985-1986	-	-	-	-	-	-	-	-	-

Year	Escapement			Total run size					
	Hatchery	Wild	Total	Hatchery	Wild	Total			
1971-1980	-	-	-	-	-	-	-	-	-
1980-1981	-	2,954	-	-	5,888	-	-	-	-
1981-1982	-	4,160	-	-	7,022	-	-	-	-
1982-1983	-	5,158	-	-	8,381	-	-	-	-
1983-1984	-	6,432	-	-	-	-	-	-	-
1984-1985	4,392	6,508	10,900	-	-	-	-	-	-
1985-1986	-	-	-	-	-	-	-	-	-

1/ Sources: 1971-1972 to 1975-1976, Pacific Northwest Basins Commission, 1980; 1976-1977 to 1984-1985, Washington Department of Game, 1986; 1984-1985 personal communication, Dave Somers, Fisheries Biologist, Tulalip Tribes, Marysville, Washington, January 9, 1987.

2/ A dash (-) indicates data not available.

Harvest of summer-run steelhead rose dramatically in 1978 in response to the hatchery returns and has been more than 2,800 fish per year in all but one year since 1978. It appears from catch data reported by WDG that the current summer-run steelhead harvests is heavily supported by the hatchery program based at the Skykomish Steelhead Hatchery near Gold Bar.

Life History

Adult winter steelhead migrate into the Snohomish River system from November through June, with peak movement February through April (table 2-1). Spawning occurs from December through June, with peak activity in May (Pacific Northwest River Basins Commission, 1980). Egg incubation extends into July. Fry seek shallow, protected areas during their first summer in the stream. Juveniles prefer deeper, swifter areas of the streams for better access to food and cover. Juveniles typically rear in freshwater for two years before migrating to the sea (Washington Department of Game, 1984). Outmigration of smolts begins in March, peaks in May, and continues into July (table 2-1). Adults spend two to four years at sea, generally returning to spawn at age four (Pacific Northwest River Basins Commission, 1980).

Upstream migration of summer-run adults begins and ends sooner than winter runs (table 2-1); spawning of summer-run adults generally occurs over a narrower time period as well. Juvenile rearing and migration habits of summer-run steelhead are similar to those of the winter-run fish.

Habitats

Habitat requirements of steelhead trout are substantially similar to those of other stream rearing anadromous salmonids, such as coho and chinook salmon. Steelhead spawn on gravel riffles in mainstem and tributary streams when these are available, or in smaller pockets of gravel in tributary streams when this is the only gravel available (personal communication, Gary Fenton, Washington Department of Game, Olympia, Washington, February 15, 1986). As is the case for salmon, the gravel must be clean of sediments and have adequate surface and intragravel water flow to be suitable for spawning. Steelhead typically seek and spawn in tributaries, up to impassable barriers. Adult steelhead often enter fresh water when their eggs are immature and must "hold" until ready to spawn. This is particularly true of summer-run steelhead, which often hold over for an entire summer before spawning. Deep, cold water is required for this holding. Therefore, deep pools, especially in tributary streams, are a critical habitat to the maintenance of steelhead populations.

Juvenile steelhead typically rear in fresh water for two summers. For steelhead, as for coho salmon, summer low-flow rearing or overwintering habitat conditions are probably the major limiting influences on smolt production in the Snohomish River Basin. Habitats occupied by juvenile steelhead are essentially the same as for coho juveniles and are subject to the same factors for survival: food, cover, space, and water temperature.

Limited information is available to characterize steelhead habitat conditions in the Snohomish River Basin. Descriptions of habitats (section 2.2.2.5 below) in the anadromous reaches of the proposed project areas for salmon apply to habitats for steelhead trout.

Management

Snohomish River steelhead trout are managed as wild populations with natural production. The management "goal" established for steelhead by the WDG emphasizes maintenance, or increases in wild populations of steelhead, yet recognizes the need to increase sport fishing opportunities at the same time (Washington Department of Game, 1982). The Tulalip Tribes have the same treaty-secured rights for steelhead as for salmon (see section 2.2.2.1, Management). The Tribes actively comanage Snohomish River steelhead as a commercial fishery. Both the Washington Department of Game and the Tribes operate steelhead hatcheries. Hatchery production is being used to meet demand for increased fishing opportunity on winter steelhead. Hatchery stocks have been selectively bred for early return timing, with most hatchery-origin adults returning in December and January (Washington Department of Game, unpublished data base, Olympia, Washington, 1986). Fishing for steelhead is closed during the peak return period for wild fish (Pacific Northwest River Basins Commission, 1980).

The WDG has identified a number of problems in meeting its goals. Depletion of spawning and rearing habitat, streamflow reductions, migration blockage, and overharvest of wild stocks in a mixed-stock fishery are perhaps the most relevant to the assessment of the proposed projects. The Tulalip Tribes have identified the following as the problems: competition with artificially introduced stocks, genetic dilution, poaching by non-Indians, and overharvests in the extreme terminal areas.

The current hatchery stock used for planting the Snohomish River system originated and is maintained at Chambers Creek hatchery in southern Puget Sound. Most juveniles are reared from fry to smolt at the WDG Tokul Creek and Skykomish Rearing Pond facilities. Hatchery stock from other Puget Sound rivers are occasionally used to supplement the Chambers Creek stock (Washington Department of Game, unpublished data base, Olympia, Washington, 1986).

2.2.2.3 Sea-run Trout--Cutthroat and Dolly Varden

Distribution

Sea-run cutthroat trout are an important game fish in the Snohomish River Basin (Kraemer, 1980; Pfeifer, 1980). They prefer small tributaries and are present in virtually all accessible tributaries (table 2-3). Sea-run Dolly Varden are probably not as widely distributed in the system as sea-run cutthroat, since Dolly Varden prefer larger tributaries for spawning, such as the North Fork Skykomish, Snohomish, Wallace, and Sultan Rivers (Pacific Northwest River Basins Commission, 1980; Davis, 1980). The importance of tributaries to sea-run Dolly Varden is uncertain, however, because a group of Dolly Varden were observed in pools in West Cady Creek (Hosey & Associates, meeting record, October 13, 1985). These fish could not be found in the creek after the initial sighting, and no evidence of spawning could be found.

Life History

Sea-run cutthroat trout enter estuarine waters late in June and delay there until upstream migration begins during November and December (table 2-1). Except for the delay in the estuary, sea-run cutthroat have a life history similar to that of winter steelhead (Pacific Northwest River Basins Commission 1980). Peak spawning, however, is slightly earlier than for steelhead. Juvenile cutthroat may rear from 1 to 5 years in fresh water before migrating to sea, although the average smolt age is 3 to 4 years (Pacific Northwest River Basins Commission, 1980). Migration occurs from March through July, peaking in mid-May. Larger fish migrate earlier within this period; smaller, presmolt fish migrate later and remain in the estuary longer. Smolts may remain in the estuary for up to 6 months. Sea-run cutthroat return to spawn after 1 year at sea (Pacific Northwest River Basins Commission, 1980).

Sea-run Dolly Varden migrate upstream from mid-June through December and spawn from mid-October to December (table 2-1). Juveniles usually rear in the streams for 2 to 3 years before migrating to sea. Downstream migration occurs from March to July; smolts may remain in the estuary for 6 months (Pacific Northwest River Basins Commission, 1980). Sea-run Dolly Varden spend 1 year at sea, returning to spawn at age 3 to 4 years.

Habitats

Habitat requirements of sea-run cutthroat trout and Dolly Varden are similar to those of other stream-rearing salmonids. As with steelhead and rainbow trout, it generally is not possible to distinguish between juveniles of sea-run versus resident races of cutthroat or Dolly Varden trout. This factor, the tendency for residualization, and the extended stream rearing phase of juveniles have led many biologists to regard any wild population of cutthroat trout to be anadromous, or at least partially anadromous (Pflefer, 1980; Pacific Northwest River Basins Commission, 1980). In the same sense, populations of wild, resident cutthroat trout that are located upstream of anadromous fish barriers may contribute to sea-run populations (Pflefer, 1980; Pacific Northwest River Basins Commission, 1980). Project-specific habitats are discussed in section 2.2.2.5.

Management

Sea-run cutthroat trout have received very little management other than fishing regulation, and very little is known about the status of these runs in the Snohomish River Basin (Kraemer, 1980; Pflefer, 1980). Creel census and electrofishing surveys have been fragmentary and inconsistent and provide little quantitative information useful in assessing population status and formulating management strategies. Generally, current sea-run cutthroat trout populations are believed to be substantially smaller than historical populations. Habitat degradation and loss in streams and in estuaries, increased angling pressure, and the cutthroat trout's greater susceptibility to angling are most often cited as the probable causes of the declines (Kraemer, 1980; Pflefer, 1980; Pacific Northwest River Basins Commission, 1980; Washington Department of Game, 1984a). Population status in the Snohomish River Basin is rated as moderate, with the population trend unknown (Washington Department of Game, 1984a).

Management of sea-run cutthroat trout has paralleled that of steelhead and resident trout (DeShazo, 1980). Regulations have usually been non-species-specific and are designed to protect all species of trout in a stream. The WDG has adopted new management policies that identify sea-run cutthroat and sea-run Dolly Varden trout as a distinct management group and has recommended regulations to protect these runs (Washington Department of Game, 1984a).

2.2.2.4 Resident Trout

Resident trout (including rainbow, cutthroat, Dolly Varden, and brook trout) are present in the Snohomish River Basin both above and below anadromous fish barriers. Rainbow, cutthroat, and Dolly

Varden trout are widely distributed throughout the basin, but distribution of brook trout is uncertain. Life histories of resident rainbow, cutthroat, and Dolly Varden trout are similar to those of their sea-run counterparts, except that the entire life cycle is completed in fresh water, often within relatively small areas (Washington Department of Game, 1984a). Resident trout are characteristically smaller and require smaller gravels for spawning. Project-specific habitats are discussed in section 2.2.2.5.

2.2.2.5 Project-specific Fish Habitats

Existing Projects

Site-specific fish habitats and project features that may affect those habitats are discussed below for the four existing, licensed or exempted hydroelectric projects authorized since 1981.

- Sultan River Project (FERC No. 2157)--The Sultan River Project is the second phase of an existing water supply project. The hydroelectric project diverts water from Culmback Dam at RM 16.2 on the Sultan River and returns it through a powerhouse at RM 4.3. Up to 1,300 cfs are diverted from 11.9 miles of the Sultan River. Anadromous fish have access to the lower 5.4 miles of the bypass reach, up to RM 9.7, where the city of Everett has a water supply diversion dam. This diversion dam was installed in the early 1900's and blocked anadromous fish from further upstream migration.

The Sultan River bypass reach is characterized as a steep ravine, with a confined channel 15 to 45 feet wide, averaging about 35 feet wide. The gradient is steep, from 250 feet per mile near Culmback Dam, to 56 feet per mile near the powerhouse. Substrates consist of large rocks and boulders, some bedrock, and only a few patches of gravel. Habitats are primarily cascades and rapids, separated by short pool and riffle sections.

Anadromous fish in the lower Sultan River include chinook, coho, pink, and chum salmon, steelhead trout, sea-run cutthroat trout, and Dolly Varden. Resident species include rainbow and cutthroat trout (FERC, 1981). Resident species present above the city of Everett diversion dam are rainbow and cutthroat trout. This section of river is in a deep canyon with dams at both ends and is virtually inaccessible to people. The fish populations are self-sustaining, and fish are of small size. Steelhead spawn in the entire river up to the Everett diversion dam, although the majority of spawning occurs below RM 4.5 (Washington Department of Game and Snohomish County Public Utility District No.1, 1982). Some reds have been observed up to the diversion dam, but most are seen below RM 3.5 (FERC, 1981). One- and two-year-old steelhead juveniles have been observed in abundance up to RM 9.7. Steelhead found in the lower river are mostly of hatchery origin, while the steelhead found in

the upper river are from wild stocks (Washington Department of Game and Snohomish County Public Utility District No.1, 1982). The WDG estimates that the canyon area (RM 3.5 to 9.7) has the potential to produce 8,000 to 10,000 steelhead smolts (FERC, 1981). Chinook salmon utilize the river up to the city of Everett diversion dam at RM 9.7. Historically, the majority of spawning occurred above RM 4.5. Spawning ground surveys show a statistically significant decline in chinook spawning use above RM 4.5 since the Sultan River Project was constructed (memorandum from Ken Bruya, Fisheries Biologist, Washington Department of Fisheries, Olympia, Washington, November 12, 1986). Coho and pink also spawn in the Sultan River. A few adults have been observed up to the Everett diversion dam; juvenile coho have been observed up to RM 7.4 (FERC, 1981). The WDF has estimated the Sultan River has the potential to support a run of 2,588 coho (FERC, 1981). Pink salmon spawn in the lower Sultan River. In 1979 the WDF estimated that the total escapement of pink salmon to the Sultan River was 4,000 fish and a total run size of 8,000 fish. A small run of chum salmon is believed to spawn in the lower Sultan River, but there is limited information available on the size or distribution of the run (FERC, 1981).

Impacts of the Phase II hydroelectric project are expected to include: reduced resident fish production between Culmback Dam and the city of Everett diversion dam from lower flows and water temperatures, reduced extremes of water temperature and flow downstream of the city of Everett's diversion dam, and disruption of spawning and upstream passage of steelhead and salmon due to fluctuation of flow from the powerhouse and attraction to the powerhouse return flow (FERC, 1981). Post operational fish mitigation studies include investigation of steelhead fishability, sediment analysis, gravel quantity, ramping rates, fish passage, and river temperatures.

- Woods Creek Project (FERC No. 3602)--The Woods Creek Project is located at RM 7.5 on the East Fork Woods Creek, tributary to Woods Creek and the Skykomish River near Monroe. The project diverts up to 144 cfs from about one-eighth mile of the creek. The powerhouse is located downstream at Coho Falls, a 60-foot impassible barrier to anadromous fish.

Woods Creek flows in a well-defined channel in the bypass reach. The creek averages about 18 feet wide and has a gradient of about 35 feet per miles. Above the falls the channel is wider and meanders more than it does below the falls, where the channel is confined by steep sidewalls. Substrate consists mostly of small gravel upstream of Coho Falls. Bedrock and boulders predominate immediately below the falls with patches of gravel intermixed. The substrate becomes progressively smaller downstream.

Habitat quality is very good throughout Woods Creek (Williams et al., 1975). There is good cover and a good pool/riffle/glide balance above the falls. Steelhead trout and all four species of salmon occur in Woods Creek downstream of Coho Falls. Steelhead and coho spawn immediately downstream of the falls in the tailrace of the plunge pool; chinook, pink, and chum salmon spawn farther downstream. Resident cutthroat trout are present upstream of the falls. The WDF plants coho fry above the falls.

The project releases a minimum instream flow of 6 cfs. The diversion intake is screened to minimize and avoid entrainment of resident fish and coho fry and smolts, and the tailrace discharge is racked to prevent entry of adult fish.

- Twin Falls Project (FERC No. 4885)--The Twin Falls Project is located between RM 10.0 and 11.4 on the South Fork Snoqualmie River, upstream of Snoqualmie Falls. During operation, the project will divert 120 to 600 cfs from approximately 1.3 miles of stream and release a minimum streamflow of 75 cfs at the diversion site. Project operation will cease during the summer low-flow period.

The project site is in a transition zone between mountainous terrain and lowland valleys. The 1.3-mile bypass reach is characterized by run, riffle, cascade, and fall habitat types. The stream gradient is quite variable, ranging from 2 to 10 percent throughout most of the reach, with gradients of 1 percent and 15 percent occurring in lower and upper reaches, respectively. Channel width varies from 20 to 90 feet. Substrate is composed of rubble and large boulders, with some areas of sand and gravel, depending on gradient. Barriers to upstream fish migration include falls within the bypass reach of 30, 40, and 100 feet in height. Snoqualmie Falls, located about 13.5 miles downstream, is a complete barrier to upstream migration of anadromous species.

The South Fork Snoqualmie River is well suited for rainbow trout production; the WDG presently manages the river as a self-sustaining rainbow trout stream. Riffles, runs, and pools in the lower and upper reaches of the bypass reach provide isolated patches of gravel, good cover, feeding areas, and deep runs for trout spawning, rearing, and holding. Results of electrofishing and snorkel surveys indicate, however, few to no trout in the area of the diversion structure and a larger population of rainbow and cutthroat trout in the area of the powerhouse (South Fork Resources, 1982). The limited size of trout populations in the project reach is believed to result from river channelization in the early 1970's when highway I-90 was realigned (South Fork Resources, 1982). Brook trout also occur in the project area.

- Weeks Falls Project (FERC No. 7563)--The Weeks Falls Project is located at RM 13.6 on the South Fork Snoqualmie River, about 17 miles upstream of Snoqualmie Falls, a complete anadromous fish barrier. The project will divert 69 to 579 cfs from about 850 feet of the river. A minimum flow of 38 cfs will be released at the diversion site.

In the bypass reach, the Snoqualmie River is in mountainous terrain and consists of falls, cascades, deep plunge pools, and limited riffles. The gradient is high in the lower 650 feet of the bypass reach. Substrates consist primarily of bedrock and boulders. Stream width ranges from 30 to 98 feet. Pools in this reach have good cover and feeding areas for the rearing of resident trout. The upper 200 feet of the bypass reach is of lower gradient (0.5 to 1.5 percent) and has suitable gravels and flow conditions for spawning.

Resident salmonids in the project vicinity are rainbow, brook, and cutthroat trout. The principal gamefish is the rainbow trout (South Fork II, Inc., 1983). The bypass reach is managed as a self-sustaining population. Recruitment of fish to the bypass reach is from upstream.

Proposed Project

The South Fork Tolt River Project (FERC No. 2959) is located on the South Fork Tolt River. The main Tolt River is a tributary to the lower Snoqualmie River at RM 24.8. The licensee proposes to divert water from approximately 5.9 miles of the South Fork Tolt River, returning the water at RM 2.5. About 5.4 miles of this reach is accessible to anadromous species; upstream migration is locked by a large falls at RM 7.9. A habitat survey of the South Fork Tolt River conducted by the Washington Department of Fisheries and Seattle City Light personnel found a series of steep cascades/falls near RM 3.0 which would be difficult for all salmon to negotiate (memorandum from Larry Cowan, Fisheries Biologist, Washington Department of Fisheries, Olympia, Washington, October 22, 1986).

The diverted reach is generally a steep, narrow channel with 90 percent cascades and rapids, 5 percent steep chutes, and 5 percent well-defined pools in the lower miles, and slightly broader channel in the upper river (City of Seattle, 1981). Average gradient of the diverted reach is 2.8 percent. Rubble and boulder substrate predominate, with limited patches of gravel in the lower reach. A major landslide occurred in the upper reach in 1976, and continues to contribute to fine sediments and gravels to the river. Substrate analysis showed an average of 12 percent fines in the gravels, a higher amount than in other Washington rivers (Stober et al., 1983). The quantity of spawning gravels is limited to a few riffles and to pockets of gravel located behind boulders, although the quality appeared to be good to excellent (City of Seattle, 1981). Rearing habitat appeared to be of good quality and

abundant, formed mainly by instream structure (boulders and logs), with vegetative cover along the banks.

Steelhead trout are the most abundant anadromous species present in the South Fork Tolt River. Winter-run steelhead dominate, but the river also has a small population of summer-run steelhead. Coho are the most abundant salmon, with occasional use by chinook probable. Coho, chinook, pink, and chum salmon spawn extensively in the main Tolt River downstream of the confluence of the South Fork and North Fork Tolt Rivers. Within the Tolt River system, coho salmon are most abundant in Stossel Creek. Resident species are rainbow and cutthroat trout, mountain whitefish, longnose dace, sculpin, and brook trout.

2.2.3 Black-tailed Deer

Black-tailed deer are the most common and most economically important big game animal of the Snohomish River Basin. These deer are forest-dwelling mammals that live as individuals or small family groups. Deer forage while in the forest, but mainly feed in grass-shrub-sapling openings, whether natural or man-made. Primary foods in the Snohomish River Basin are various woody and nonwoody plants such as blackberry, salal, red alder, vine maple, and grasses (Pacific Northwest River Basins Commission, 1980). Deer seek cover for protection from inclement weather or to evade potential predators (human and nonhuman). Mature or old-growth forest cover is important during periods of deep snow when deer are prevented from using openings and must seek shelter and food within the forest. While deer in the Snohomish River Basin are not dependent on old-growth forest, they use it when such habitat is available (Sweeney et al., 1981).

Deer occur throughout the Snohomish Basin except on the highest, rocky slopes. Seasonal home range size is variable, but usually is about 1/2 to 1 square mile (Witmer et al., 1985). Many deer living below about 2,000 feet in elevation are resident deer, occupying the same area year-round. Other deer spend summers above 2,000 feet elevation, but migrate to other areas, usually below 2,000 feet in elevation, for the winter period (Pacific Northwest River Basins Commission, 1980; letter from Richard Dearsley, Wildlife Biologist, Mt. Baker-Snoqualmie National Forest, Seattle, Washington, August 9, 1985). This lower elevation area, known as winter range (figure 2-2), is often the limiting habitat of deer range (Pacific Northwest River Basins Commission, 1980). Areas to the west of the western winter range boundary line shown in figure 2-2 support resident deer. Migration lengths are variable, but most migratory deer use traditional areas and routes in the same drainage basin or subbasin, moving about 3 miles between winter and summer ranges. Deer occasionally cross saddles or ridges and move along adjacent drainages, or swim across large rivers (Sweeney et al., 1981).

Mature does have one, or commonly two, fawns in spring. Areas used for fawning are variable and dispersed, unlike elk, which at times have fairly well-defined calving areas. Fawning areas are often shrubby areas characterized by being fairly flat, wet areas or near water, with a mixture of good forage and nearby cover. Deer are not particularly dependent on riparian habitat (Hanley, 1984; Washington Department of Ecology, 1985b), although they occasionally use such habitat for fawning and during hot, dry summer weather (Witmer et al., 1985).

Deer are somewhat sensitive to disturbance, especially while wintering, but less so than are elk. Deer become accustomed to human development and activities, and often occur in residential areas near forest (Happe, 1982). Increased densities of roads in remote deer habitat can lead to increased legal and illegal harvest of deer (Witmer et al., 1985).

Deer densities in the Snohomish River Basin vary greatly. Densities are lower in the northern part of the basin (8.8 deer per square mile) than in the southern part (23 deer per square mile) (Washington Department of Game, 1982). Deer congregate in some areas, especially in winter, so higher densities occur. Sweeney et al. (1981) reported 157 deer per square mile in a portion of the North Fork Snoqualmie River subbasin. Although not well documented, selected winter concentration areas were identified by the Pacific Northwest River Basins Commission (1980) and are shown in figure 2-2. Areas of higher deer densities were also mapped by the Puget Sound Task Force (Pacific Northwest River Basins Commission, 1970); these areas correspond fairly closely to the areas identified in figure 2-2 as winter range. The variability in densities was confirmed by Erland (1985), who estimated densities from about 25 to more than 100 deer per square mile in southern portions of the Snohomish River Basin.

The two main Game Management Units (GMU) in the Snohomish River Basin are characterized in table 2-5. The 2,640 deer harvested in King and Snohomish Counties in 1980 represented about 9 percent of the state's total black-tailed deer harvest of 30,730 and about 5 percent of the state's total deer harvest of 57,970. The net economic value of the 1979 deer harvest in the Snohomish River Basin was estimated to be \$1,884,800. It is expected that recreational demand for this and other resources of the basin will increase as the Seattle-Bellevue-Everett areas grow (Pacific Northwest River Basins Commission, 1980). Additionally, the Tulalip Tribe has treaty rights to hunt deer in the basin.

Figure . Black-tailed deer use of the Snohomish River Basin (Source: staff).

The Region 4 general deer management goal is to maintain populations, habitat, and harvests at 1970-1979 levels (Washington Department of Game, 1984b). Other, more specific goals for GMU's 448 and 460 are:

- Map critical (winter) habitat;
- Encourage major landowners to protect habitat;
- Identify and seek mitigation and compensation for impacts to deer from various land use activities, including dams, through review of EIS's and resource permits;
- Cooperate with Mt. Baker-Snoqualmie National Forest personnel in development of their forest plan;
- Ensure high compliance rate with cooperative road management program; and
- Expand road management program (GMU 460).

Table 2-5. Characteristics of deer populations in the two main game management units in the Snohomish River Basin.

Table 2-5. Characteristics of deer populations in the two main game management units (GMU) in the Snohomish River Basin. ^{1/}

Characteristics	GMU 448	GMU 460
	Stillaguemish ^{2/}	Snoqualmie ^{3/}
Population	9,800	6,900
Density	8.8/mi ²	23/mi ²
Population trend	Slight decrease	Stable
1982 harvest	663 bucks	516 bucks
Harvest per mi ²	0.6	1.7

^{1/} Source: Washington Department of Game, 1982.

^{2/} GMU 448 is located in the northeastern part of the basin and covers 1,100 square miles.

^{3/} GMU 460 is located in the southeastern part of the basin and covers 300 square miles.

Deer can be affected both directly and indirectly by hydroelectric development (Kie et al., 1982; Oregon Department of Energy, 1983). Major impacts are most likely to occur from impoundments, unburied structures such as penstocks, or open canals. These features cause direct loss of deer habitat and can also affect movement of deer between habitats or seasonal ranges. Three of the four existing, licensed, or exempted projects in the basin authorized since 1981 (the Woods Creek, Twin Falls, and Weeks Falls Projects) have had and probably will continue to have little impact on deer populations. These projects have no impoundments or structural features that could impede deer movement. Additionally, they are also very small projects, so that only small amounts of deer habitat are permanently lost to project features. The fourth project, the Sultan River Project (now called the Henry M. Jackson Dam and Reservoir), has had an impact on deer populations primarily through loss of habitat due to inundation. The initial Culmback Dam inundated about 770 acres of deer habitat; the alteration of the dam for hydroelectric power production inundated an additional 1,100 acres (FERC 1981; Washington Department of Game, 1980). The impact was even more significant because of the presence of a deer winter concentration area along the Sultan River near Spada Lake.

All seven of the proposed projects occur within deer habitat and, consequently, have the potential to impact deer. Three projects (Storm Ridge, Excelsior Mountain, and Black Creek) occur near the boundary of summer and winter range; the others are within the year-round resident deer range and the winter range of migratory deer (except Tokul Creek) (figure 2-2). Projects with features in deer winter concentration areas are South Fork Tolt River, Storm Ridge, Excelsior Mountain, and Barclay Creek.

2.2.4 Bald Eagles

The federally designated threatened bald eagle nests and winters in the Snohomish River Basin (see section 2.3.6 below). In recent years, nesting (Grubb et al., 1983) and adult wintering (Dobler, 1983) populations have appeared fairly stable in western Washington. Washington has the largest wintering population (1,100-1,600 bald eagles) in the contiguous United States, with the highest concentrations occurring in the Nooksack and Skagit River drainages (Dobler, 1983). About 70 eagles winter in the Snohomish River Basin (Steenhof et al., 1984), with heaviest use along portions of the mainstem and South Fork Skykomish River (Hansen, 1978; Washington Natural Heritage Data System, 1985) (figure 2-3). The results of winter surveys conducted over the last several years are presented in table 2-6.

Nesting distribution is more restricted than wintering distribution. In Washington, nesting usually occurs along coastal or lowland areas. Only 16 of 244 nesting territories in Washington are in the

Cascades (Steenhof et al., 1984). Grubb et al. (1975) reported that only 2 of 221 active nests in western Washington in 1975 were along inland lakes and rivers. Two active bald eagle nests have been observed in the Snohomish River Basin in recent years; both are in the lower basin--one near the main stem Snohomish and one in the estuary area (Washington Natural Heritage Data System, 1985). Bald eagles have nested inland in the Skykomish River Basin in the past, and suitable nest groves are apparently still available for use (Hansen, 1978).

Nesting requirements of bald eagles are described by Stalmaster et al. (1985), Steenhof et al. (1984), and Anthony et al. (1982). In general, nests are located in uneven-aged conifer-dominated stands with large old-growth trees near water bodies that support an adequate food supply. The large nest trees are often reused, and one or two alternative nest trees are located nearby. Large Douglas-fir and sitka spruce are preferred as nest trees. The nesting period begins with courtship and nest site selection (mid-January) and ends with the young being fledged, i.e., leaving the nest (mid-August) (U.S. Fish and Wildlife Service, 1981). Territories of breeding adults are usually 1 to 1.5 miles in radius. Bald eagles are particularly intolerant of human disturbance during the breeding season, with their sensitivity decreasing as the young develop (Steenhof et al., 1984).

Wintering eagle habitat use is described by Steenhof et al. (1984), Stalmaster et al. (1985), and Steenhof (1978). Wintering eagles key in on areas along streams that provide abundant spawned out salmon carcasses. Several studies have documented a linear relationship between the numbers (and availability) of spawning salmon and the numbers of eagles wintering along the stream (Servheen, 1975; Knight and Knight, 1983; Stalmaster et al., 1979). In addition, wintering eagles require large perching

Figure . Bald eagle use of the Snohomish River Basin (source: staff).

Table . Results of Washington state midwinter bald eagle surveys for the Snohomish River Basin, 1982-85. 1/, 2/

Location (10' lat/long)	Drainage	1982	1983	1984	1985
<u>KING COUNTY</u>					
474-1212	South Fork Skykomish, Miller main, Beckler mouth	7A	5A,2I	2A,4I	3A
473-1212	Miller Forks	NS	NS	NS	NS
474-1211	Tye River	10A	0	4A,1I	1A,2I
474-1215	Snoqualmie River, Tolt River	0	3A	2A	2A
474-1220	Snoqualmie River, Sammam. R.	NS	NS	NS	0
474-1214	Tolt River	NS	NS	NS	NS
473-1215	Snoqualmie River	1A	0	0	2A
473-1214	Snoqualmie River, Snoqualmie Forks, Tokul Creek	0	0	0	0
472-1214	Snoqualmie Middle Fork and South Fork	<u>0</u>	<u>0</u>	<u>1I</u>	<u>0</u>
	Subtotal:	18	10	14	10
<u>SNOHOMISH COUNTY</u>					
474-1211	Beckler R., Rapid R.	1A	4A,1U	1A	0
475-1211	Beckler R.	NS	NS	NS	NS
475-1212	N.Fk. Skykomish R.	2A	0	3A,2I	1A
474-1212	S.Fk. Skykomish R., Barclay Crk.	0	0	0	0
474-1213	South Fork, North Fork, and main Skykomish River	1A	2A	0	2A 4I
475-1213	North Fork & main Skykomish River, Sultan River	0	0	0	0
475-1214	Main Skykomish River, Sultan River	17A,31I	2I	12A,10I	6A,12I,11U
475-1215	Main Skykomish River	0	4A,14I	3A	3A,1I
474-1215	Main Snoqualmie River	0	0	0	0
474-1220	Snoqualmie/Skykomish River confluence	0	NS	NS	1I
475-1220	Snohomish River	<u>NS</u>	<u>0</u>	<u>1A</u>	<u>1I</u>
	Subtotal	52	27	32	42
	Basin total	70	37	46	52

1/ Source: Washington Natural Heritage Data System, 1985.

2/ Key to letter code: A = adult bald eagle, I = immature bald eagle, U = bald eagle of unknown age, NS = cell not surveyed.

trees along streams, where they spend up to 90 percent of the daylight hours (Stalmaster et al., 1985). Preferred perching trees are large, often dead, bigleaf maple, red alder, cottonwood, or sitka spruce trees that provide a good view of the surrounding area (Stalmaster and Newman, 1979). Most perching trees are along or within 50 meters of the river.

A third important habitat component for wintering eagles is roosting sites. Roosts are used communally by eagles primarily at night, but also during the day during severe, inclement weather. Roosting sites have been described by Keister (1981), Anthony et al. (1982), Allen and Young (1982), Hansen et al. (1980), Stalmaster et al. (1985), and Steenhof et al. (1984). Roosts are usually in uneven-aged, old-growth conifer stands in a protective landform setting. They may be several miles from feeding areas. Roost sizes vary from 4 to 20 acres in western Washington, but may be much larger where large numbers of eagles congregate, as in the Klamath Basin. Roosts usually have a clear line of sight to the surrounding area, a favorable microclimate, stout perches high off the ground, and freedom from human activity (Hansen et al., 1980). Roosts are usually in remote areas and may be abandoned if human activity increases in the area (Hansen et al., 1980).

As with nesting and roosting, feeding eagles are sensitive to disturbance by humans. Eagles are more sensitive to human activities on the river (e.g., boating or fishing) or on foot along the river's edge than to activities farther inland, cars along paved roads, airplane activity, or where a screen of vegetation is between the humans and eagles (Stalmaster and Newman, 1978; Knight and Knight, 1984; Steenhof et al., 1984; Servheen, 1975; Skagen, 1980; Stalmaster, 1980). Eagles can become somewhat acclimated to some human activities (Russell, 1980; Stalmaster and Newman, 1978; Biosystems Analysis, Inc., 1980). Bald eagles may also be more tolerant of human activities where habitat is optimum and food abundant (Steenhof, 1978).

Steenhof et al. (1984) and Gerrard (1983) have documented the history of declines in eagle populations in the Pacific Northwest and other parts of the country. The effects of serious impacts of the past (shooting, pesticides) seem to have declined. Although eagle populations appear to have stabilized in the Pacific Northwest, threats to the full recovery of the species still could occur. In the west Cascade Mountains, these threats are from logging, increases in human development and recreational use (especially on shorelines), elimination of salmon runs, and overexploitation of fish resources (Steenhof et al., 1984). Furthermore, they suggest that the cumulative, long-term effects of individual and small actions poses the single most important threat to the recovery of eagles in the Pacific states. All these types of impacts have occurred, or have the potential to occur, in the Snohomish River Basin (Pacific Northwest River Basins Commission, 1980; Hansen 1978, 1979; Hansen and Bartelme, 1980). The factors limiting bald eagle populations in the Snohomish River Basin are

probably food supply (Stalmaster and Gessaman, 1984) and, secondarily, availability of perching trees along rivers (Hansen, 1978). The loss of communal roost sites is also an important factor (Hansen et al., 1980).

The Pacific States Bald Eagle Recovery Plan (Steenhof et al, 1984) presents a detailed outline of actions needed for the recovery plans to be successful. Portions of this outline especially relevant to an analysis of possible hydroelectric development in the basin are presented below (those items with an asterisk are highest-priority items):

1. PROVIDE SECURE HABITAT

1.23 INCORPORATE EAGLE HABITAT GUIDELINES IN AGENCY LAND USE PLANS

1.311 MANAGE INLAND AND ANADROMOUS FISH POPULATIONS AND HABITATS TO MAINTAIN AND ENHANCE ADEQUATE FOOD FOR EAGLES

1.3111 MANAGE WATER LEVELS TO MAINTAIN AND ENHANCE EAGLE FOOD SOURCES

1.3117 PROTECT AND ENHANCE NATURAL SPAWNING POPULATIONS AND SPAWNING GROUNDS OF SALMON AND OTHER IMPORTANT FISH SPAWNERS TO INCREASE AVAILABILITY TO EAGLES

1.3118 MAINTAIN AND IMPROVE HABITAT FOR FISH BY REDUCING SILTATION FROM LOGGING, ROADS, AND OVERGRAZING

*** 1.321 MAINTAIN FORESTED HABITAT THAT IS PRESENTLY USED BY EAGLES**

1.3211 PROHIBIT LOGGING OF KNOWN NEST TREES, PERCH TREES, AND WINTER ROOST TREES

1.3213 WHERE SUITABLE, STABILIZE SOIL AND STREAMBANKS TO PROTECT NESTING, PERCHING, AND ROOSTING TREES

*** 1.33 RESTRICT HUMAN DISTURBANCE AT EAGLE USE AREAS**

1.331 ESTABLISH BUFFER ZONES AROUND NEST SITES

1.332 EXCLUDE LOGGING, CONSTRUCTION, HABITAT IMPROVEMENT, AND OTHER ACTIVITIES DURING CRITICAL PERIODS OF EAGLE USE

1.333 PROHIBIT BUILDING CONSTRUCTION NEAR KEY BALD EAGLE NESTING AND WINTERING HABITATS

1.334 PROHIBIT VEHICLE TRAFFIC AT SENSITIVE KEY AREAS DURING PERIODS OF EAGLE USE

2. INVENTORY, MONITOR, AND RESEARCH BALD EAGLE HABITAT AND POPULATIONS TO OBTAIN ADEQUATE KNOWLEDGE FOR DEVELOPING AND EVALUATING MANAGEMENT PROGRAMS

2.11 MONITOR THREATS AND CHANGES TO HABITAT

2.113 MONITOR THREATS AND CHANGES TO COMMUNAL ROOSTS AND ASSOCIATED WINTER HABITAT

4.1 REDUCE BALD EAGLE MORTALITY

4.132 RESTRICT POWER LINE CONSTRUCTION WITHIN IDENTIFIED FLIGHT LANES NEAR WINTER ROOSTS AND NESTING SITES

Management concerns and guidelines are also presented in documents prepared by the U.S. Fish and Wildlife Service (1981) and the Mt. Baker-Snoqualmie National Forest (Hansen, 1979). The management goals for bald eagles expressed in those documents relate primarily to the protection of existing nesting, roosting, and feeding areas. This is to be accomplished by restricting some human activities in time and space, and by providing adequate buffer strips of vegetation around eagle use areas.

Three of the four existing, licensed, or exempted hydroelectric facilities in the basin authorized since 1981 (the Woods Creek, Twin Falls, and Weeks Falls Projects) probably had and will continue to have little effect on bald eagles. This is primarily because these projects are at or above natural anadromous fish barriers so that historical eagle use of the areas was probably always very limited (see figure 2-3; also Washington Natural Heritage Data System records for eagle surveys). The fourth project, the Sultan River Project (now called the Henry M. Jackson Dam and Reservoir), would probably have adversely impacted eagles except that earlier structures (i.e., the diversion dam for domestic water supply at RM 9.7) had already caused a significant impact on eagle use of the Sultan River. This impact probably occurred indirectly, through a reduction in spawning salmonid populations (Washington Department of Game, 1980). Fitting hydroelectric facilities at the existing structures was expected to cause insignificant impacts to spawning salmonids and, consequently, to bald eagles (FERC, 1981). Eagles continue to use the lower Sultan River somewhat and (much more heavily) the mainstem Skykomish River near the mouth of the Sultan River (figure 2-3) (Washington Natural Heritage Data System, 1985).

Five of the seven proposed projects (South Fork Tolt River, Storm Ridge, Excelsior Mountain, Olney Creek Falls, and Barclay Creek) have features within or adjacent to the eagle use areas shown in figure 2-3. These projects have at least the potential to affect bald eagles either directly (by altering or removing habitat elements such as nesting, perching, and roosting sites or by the placement of

foreign structures such as transmission lines) or indirectly (by adversely affecting the eagles' main food supply, spawning salmon, or by affecting eagle habitat use patterns through increased human activity and associated noise). The other two proposed projects (Tokul Creek and Black Creek) could affect eagles only through a substantial impact to water quality or to anadromous fish populations.

2.3 OTHER RESOURCES

2.3.1 Topography, Geology, and Soils

Elevation in the South Fork Tolt River watershed ranges from 1,600 feet near the Tolt Dam to 5,535 feet at McLain Park [sic; Peak], with a basin average of 3,200 feet above sea level. The wooded, mountainous terrain becomes increasingly rugged, with rock outcrops and talus slopes, toward the watershed's eastern edge. U-shaped valleys with long, steep sidewalls extend toward the western edge of the watershed, where continental glaciation smoothed off land forms and left deep deposits of till. The South Fork Tolt flows westerly in a bedrock channel along the southern side of one of these valleys. The existing South Fork Tolt Dam is located near the point where the river drops out of its bedrock valley and enters the Puget lowland. Bedrock is predominantly a sequence of layered volcanic flows with subordinate interbeds of volcanic breccias and sediments. Locally, bedrock is mantled by Pleistocene age glacial and glacial-related sediments consisting of till and outwash. These sediments are generally stable, but can become unstable under some disturbed or saturated conditions.

A large landslide is located about 3,300 feet downstream of the South Fork Tolt Dam. The landslide has exhibited major movements, blocking and moving the course of the river and adding considerable amounts of sediment to the stream. Although the region has had a history of naturally occurring landslides, and slide mechanisms predate construction of the Tolt reservoir, local residents and some governmental fisheries agencies contend that the dam is aggravating the problem and was largely responsible for a major slide in 1976. Early studies by the Corps of Engineers (1978) and by Shannon and Wilson (1976) indicate a possible correlation between reservoir level and at least one spring discharge in the slide area, indicating a possible hydraulic connection between the reservoir and landslide scarp. For the last two years, however, the slide has shown signs of stabilization. The angle of repose is greatly improved; the slide surface has extensively revegetated; and there is little evidence of the river eroding the toe of the slide. Currently, turbidity levels from the slide are generally undetectable. * Updated in Attachment. *

Dominant soils in the area are of a gravelly sandy loam texture that are well drained and relatively stable. The soils were mapped as Skykomish, Barnstone, and Klaus series on glacial outwash and glacial drift plains (Webster and Steinbrenner, 1974). Soil depth varies extensively across the

watersheds, with the deeper soils (5 to 10 feet) occurring in the valley bottom. Organic matter on the forest floor varies markedly in depth. Soils along the proposed pipeline route were described in detail during construction of the existing Tolt water project. Data indicate that overburden materials are mostly of glacial origin. Generally, overburden from the dam site to the river crossing are predominantly till, which is a dense, silty, gravelly fine sand. Beyond the river crossing site, overburden is commonly outwash--medium dense to dense, coarse sand, gravel, and cobbles. Construction records indicate that groundwater was encountered within the overburden in a number of areas during previous construction (Converse Consultants, 1982).

Several slides and erosional scarps are present in the proposed project area. Slides from the eroding scarps are present mainly in the sidewall area of the proposed project downstream of the South Fork Tolt Dam. Most of the scarps resulted from the steep slopes of consolidated glacial till remaining after construction of the South Fork Tolt Dam in 1960 to 1963. Some of the erosional scarps are active because of the typical winter freeze-thaw cycle, annual washing by approximately 100 inches of precipitation, and their proximity to the existing pipeline right-of-way. Clay particles dislodged from these scarps contribute to surface drainage turbidity. Most of the slides resulted from construction of the existing water supply pipeline, but are currently stable.

Landslides and erosion can lead to sedimentation in the Tolt River system. The percentage of fine sediment in the Tolt River drainage was determined by sampling in July, September, and February of 1981-1982 (Stober et al, 1983). North Fork Tolt River suspended sediment concentrations were generally higher than South Fork Tolt River concentrations on all dates sampled. Sediment at the mainstem stations did not necessarily reflect the combined contribution of sediment from the South and North Forks, suggesting that processes of deposition and scouring are active within the system. The highest instantaneous sediment discharges were measured at the lower mainstem stations due to the observed increase in the volume of water conveyed through these reaches. Of the 63 samples analyzed, a maximum average percent fine sediments (<0.841 mm diameter) of 16.1 percent (dry weight) was recorded in the mainstem in February. The minimum average percentage of 5.5 was recorded in the North Fork in July. The average percentages for the South Fork were 9.5 in July, 8.1 in September, and 11.8 in February.

2.3.2 Meteorology

* Climate, air quality, and noise subsections in Meteorology (section 3.1.3.2 in 1987 FERC FEIS) are descriptive, do not indicate any environmental impacts from the South Fork Tolt River Project, and are incorporated by reference. Global Warming and Pollution Control are discussed in the Attachment. *

2.3.3 Water Quantity and Quality

* The subsection on groundwater resources (3.1.3.3.1 in 1987 FERC FEIS) as it refers to South Fork Tolt River Project indicates studies had failed to provide any conclusive evidence on water-resource potential of springs below the existing Tolt River Dam. The surface water resources subsection (3.1.3.3 in 1987 FERC FEIS) as it applies to South Fork Tolt River Project is incorporated by reference. Seattle City Light is completing a Water Quality and Erosion Control Plan. *

2.3.4 Nontarget Fishery and Aquatic Resources

* This section in 1987 FERC FEIS (section 3.1.3.4) identifies nontarget fish species, specifies habitat requirements are similar to anadromous fish, and indicates habitats and populations of nontarget fish are assumed to be protected by the same management of Snohomish River Basin streams as target species. Section is incorporated by reference. Additional information can be found in the Attachment. *

2.3.5 Nontarget Terrestrial Resources

* This section in 1987 FERC FEIS (section 3.1.3.5) describes the general setting, and discusses wetlands, riparian habitat, old growth forest, and threatened and endangered species. Subsection on threatened and endangered species included below. Updates on all topics appear in the Attachment. *

2.3.6 Threatened and Endangered Species

Four federally listed wildlife species either do or may occur in the Snohomish River Basin: the bald eagle (Haliaeetus leucocephalus) (threatened), peregrine falcon (Falco peregrinus anatum) (endangered), gray wolf (Canis lupus) (endangered), and grizzly bear (Ursus arctos horribilis) (threatened) (U.S. Fish and Wildlife Service, Undated[a]; Washington Department of Game, Undated[b]). The peregrine falcon, gray wolf, and grizzly bear probably do not occur in the basin at all, or occur only erratically as individuals passing through the area (Washington Department of Game, Undated[b]; Washington Natural Heritage Data System, 1985). No federally listed plant or fish species occur in the basin (U.S. Fish and Wildlife Service, 1986). (The distribution and habitat requirements of bald eagles are described in section 2.2.4.)

The federally listed species are also state-listed. Additional state-listed wildlife species that do or may occur in the basin are the spotted owl (Strix occidentalis) (threatened), snowy plover (Charadrius alexandrinus) (endangered), and western pond turtle (Clemmys marmorata) (threatened). The spotted owl and snowy plover are also federally listed as sensitive species (U.S. Fish and Wildlife Service, 1982). The spotted owl and western pond turtle are known to occur in the basin, whereas the

snowy plover probably does not, or occurs only along Puget Sound (Washington Natural Heritage Data System, 1985; Washington Department of Game, Undated[b]). Spotted owls require large tracts of old-growth forest. A pair of spotted owls requires an area of at least 1,000 acres of forest for its home range territory, but not all of that area needs to be old-growth forest (Forsman et al., 1984). Spotted owls are not particularly sensitive to human disturbance if good habitat is available (Forsman et al., 1984). Western pond turtles prefer fairly slow-moving waters with muddy or rocky bottoms. They also need abundant aquatic vegetation such as cattails, watercress, and lilies.

Four state-listed plant species may occur in Snohomish or King Counties, and, consequently, in the basin: few-flowered sedge (Carex pauciflora) (threatened), choriso bog orchid (Platanthera chorisiana) (threatened), fringed pinesap (Pleuricospora fimbriolata) (threatened), and golden Indian-paintbrush (Castilleja levisecta) (endangered), (Washington Natural Heritage Data System, 1985; Washington Natural Heritage Program, 1984). The few-flowered sedge occurs in and near sphagnum bogs. Choriso bog orchids occur in wet meadows and bogs. Fringed pinesap occurs in deep, shady woods at mid- to low elevations. They prefer the drift and humus of old forests. The golden Indian paintbrush occurs in moist, lowland areas (both meadows and prairies) of the Puget Trough. A large number of state-listed sensitive plant species also may occur in the Snohomish River Basin (table 3-19).

2.3.7 Cultural Resources

* Subsections 3.1.3.7.1 - 3.1.3.7.4 in the 1987 FERC FEIS, which describe the archaeological and ethnographic setting, the historic period, and recorded cultural resources of the Snohomish River Basin as a whole, are incorporated by reference. *

2.3.7.5 Project-Specific Cultural Resources

Based on field reconnaissance and consultation with the Washington State Historic Preservation Office (SHPO), the applicants for three of the proposed projects (Storm Ridge, Excelsior Mountain, and Barclay Creek) identified no archeological sites within the project areas. Cultural resources were identified within (or very near) the South Fork Tolt River and Tokul Creek project areas.

Table . Sensitive plant species that may occur in the Snohomish River Basin. 1/

Common name	Scientific name
Swamp sandwort	<u>Arenaria paludicola</u>
Northern grapefern	<u>Botrychium boreale</u>
Lance-leaved grapefern	<u>Botrychium lanceolatum</u>
Moonwort	<u>Botrychium lunaria</u> var. <u>onondagense</u>
Alaska harebell	<u>Campanula lasiocarpa</u>
Bristly sedge	<u>Carex comosa</u>
Large-arm sedge	<u>Carex macrochasta</u>
Long-styled sedge	<u>Carex stylosa</u>
Tall bugbane	<u>Cimicifuga elata</u>
Spleenwort-leveled goldthread	<u>Coptis aspekanifolia</u>
Few-flowered shooting star	<u>Dodecatheon pulchellum</u> var. <u>watsonii</u>
Yellow mountain-avens	<u>Dryas drummondii</u>
Black lilly	<u>Fritillaria camschatcensis</u>
Swamp gentian	<u>Gentiana douglasiana</u>
Water lobelia	<u>Lobelia dortmanna</u>
Bog clubmoss	<u>Lycopodium inundatum</u>
White meconella	<u>Meconella oregana</u>
Branching montia	<u>Montia diffusa</u>
Alaska plantain	<u>Plantago macrocarpa</u>
Alaska alkaligrass	<u>Puccinella nutkaensis</u>
Cooley's buttercup	<u>Ranunculus cooleyae</u>
Pygmy saxifrage	<u>Saxifraga debilis</u>
Swamp saxifrage	<u>Saxifraga integrifolia</u> var. <u>apetala</u>
Flat-leaved bladderwort	<u>Utricularia intermedia</u>

1/ Source: Washington Natural Heritage Data System, 1983, 1985.

The field reconnaissance for the South Fork Tolt River Project located six prehistoric stone tools within the project area. All these tools had been transported into the project area with gravels deposited during previous construction activities. Archeological testing did not reveal additional cultural materials within the area. A log foot bridge spanning the North Fork Tolt River and a small deteriorated cabin were located by the field reconnaissance, but both are well outside the project area....

Both the Tulalip Tribes and the Snoqualmie Tribe have been contacted regarding known religious and ceremonial sites and areas of cultural value in the general project area. In addition, the Forest Archeologist for the Mt. Baker-Snoqualmie National Forest was contacted regarding the confidential locations of religious and ceremonial sites in the forest that might be in the general area of specific project sites. The archeologist indicated that the Barclay Creek, the Tokul Creek, and Black Creek Projects are in the general vicinity of identified religious use areas (letter from Madonna Moss, Forest Archeologist, Mt. Baker-Snoqualmie National Forest, Seattle, Washington, February 4, 1986).

* Additional information can be found in the Attachment. *

2.3.8 Recreational and Visual Resources

* Section 3.1.3.8 of the 1987 FERC FEIS, which describes recreational resources in the Snohomish River Basin and discusses the Wild and Scenic Rivers Act, is incorporated by reference. Additional information is provided in the Attachment. *

2.3.9 Socioeconomics, Land Use, and Institutional Factors

2.3.9.1 Socioeconomics

* This section, 3.1.3.9.1 of the 1987 FERC FEIS, which describes population growth trends for King and Snohomish Counties, and the economic value of the fishery resources in the Snohomish River Basin at the time of the 1987 FERC FEIS, is incorporated by reference. *

2.3.9.2 Land Use

....Land in the vicinity of the South Fork Tolt River Project (FERC No. 2959) is used primarily for commercial forestry, with parcels of old-growth forest and regrowth from recent logging activity nearby. Weyerhaeuser Company is the primary landholder, although the Forest Service owns land on the eastern part of the Tolt watershed, and the city of Seattle owns land within the South Fork Tolt watershed. Lands within the watershed area are managed together by the city of Seattle and

Weyerhaeuser in order to sustain timber production and to protect municipal and industrial water supply. Because of the extensive private ownership of land and the desire to maintain water quality within the watershed, recreational access is limited--the area is usually open only to daytime use, and access roads are closed during periods of logging activity.

2.3.9.3 Institutional Factors

* Section 3.1.3.9.3 of the 1987 FERC FEIS, which describes Indian Fishing Treaty rights and the Federal trust responsibility, fishery resources management, and the Public Utilities Regulatory Act (PURPA), is incorporated by reference. Updated information is in the Attachment. *

3. ANALYSIS OF ENVIRONMENTAL IMPACTS

3.1 FORMAT AND INTERPRETATION OF ANALYSES

Section 4.1 in 1987 FERC FEIS, which describes the format and interpretation of analyses in the FERC FEIS, is incorporated by reference as it applies to the South Fork Tolt River Project.

3.2 ANALYSIS OF PROPOSED PROJECTS

3.2.1 Geology and Soils

Environmental Consequences of Project as Proposed

This project is designed to minimize soil and geological disturbances by using several existing features developed as part of an existing water supply project. The current access road is adequate for most construction of the 66-inch [sic] pipeline that would closely parallel an existing pipeline. Two areas of moderate concern associated with this project are erosion and mass-wasting. Erosion concerns are mostly related to pipeline construction, where erosion could result in sedimentation to the river; several areas of concern have been identified in a geotechnical investigation (Converse Consultants, 1982) and an Erosion and Sedimentation Control Report (Symonds, 1984). An erosional scarp is located at station 170+00 below the intake and could be aggravated by construction-related activities and slope undercutting. This scarp is in an active state of erosion and because of its proximity to the pipeline right-of-way, continued erosional progression of the scarp represents a hazard to the existing pipeline, as well as to the proposed pipeline (Converse Consultants, 1982). Improper placement of excavated materials could cause an excessive load in unstable areas, presenting moderate structural concerns. An additional area that could impact sedimentation is associated with construction around the powerhouse and tailrace areas. Humus-rich soil and the presence of excessive moisture in these areas could pose minor problems of siltation and interfere with stabilization. Overall, sedimentation potential for the project as proposed would be moderate to minor.

The other issue, mass wasting, has been identified and documented in a geotechnical report (Converse Consultants, 1982). That report states that there are two main slide areas along the penstock route; other slump areas also exist. Disturbance of these areas during construction of the proposed pipeline would require special considerations since most of these slides occurred as a result of previous construction. Since that construction period, several of the over-steepened slopes have stabilized, but they could become unstable with additional construction, especially during periods of

high rainfall. Steep, sandy faces of the slide areas have been hard to revegetate, and this condition could result in extended erosion from proposed project construction.

The Erosion and Sediment Control Plan developed for this project at the request of the licensee to protect the municipal water supply (Symonds, 1984) mainly addresses construction concerns around the powerhouse. Erosional stability and mass wasting along the penstock route need to be addressed in more detail to protect the stream from minor sedimentation and to ensure structural safety of the penstock. Update in Attachment.

Reduced flows in the bypass reach could result in some increased sedimentation. However, because of high gradient in this section of the stream, most materials would be transported through the reach, especially with periodic flushing flows. If unusual or adverse environmental conditions should exist, moderate sedimentation could occur in the bypass reach. Such an event might result from a severe storm in conjunction with a landslide. Because of reduced flows in the bypass reach, excess sediment could not be transported downstream. Consequently, flushing flows are needed periodically to maintain the morphology of the river and to maintain the quality of spawning gravels. The methodologies of Wesche et al. (1985) and Williams (1984) provide information for setting appropriate flushing flows.

The additional effects of the project on gravel recruitment in the South Fork Tolt River drainage would be low because the existing reservoir directly above the project site already prevents gravel recruitment from upstream reaches of the drainage.

The average amount of fine sediments (> 0.84 mm) present in the South Fork Tolt River is about 12.2 percent, with an average of 10.4 percent for the North Fork Tolt River and 15.6 percent for the mainstem Tolt River (Stober et al., 1983). Measurement of the particle-size distribution of spawning bed materials is a method commonly used to evaluate the quality of the intragravel environment for developing salmonid eggs and embryos (Stober et al., 1983).

Relative to differences in percent fine sediment between stations, the North Fork station consistently ranks lower than South Fork and mainstem Tolt River stations, implying that the quality of spawning gravel is better in the unregulated stream. The level of fine sediments in spawning gravel in the South Fork increased in a downstream direction, indicating an accumulation of sediment from erosional sources. Much of the fine material derives from previous construction, with a major contribution coming from runoff through fill material adjacent to the existing regulating basin. The

proposed project would reduce this problem by implementing erosion controls for drainage around the proposed powerhouse.

Another source of fine material in the South Fork drainage is the unvegetated banks along the road below the right abutment of the dam. These banks are over-steepened as a result of previous road construction and are a chronic source of erosion. During a visit to the site, the FERC staff observed several sedimentation basins that were trapping most of the fines during average rainfall events. These basins did not, however, appear adequate to handle runoff during high-intensity events and would allow some fine sediments to enter the South Fork Tolt River.

State and federal resource management agencies have suggested a sediment threshold of ~ 10 percent fine sediment in spawning riffles. This value is based on research that suggests there is a decrease in fishery production with increased sedimentation. A more detailed evaluation of some of this research (Cederholm et al., 1982) indicates that relationships for percent fine sediments versus percent survival to emergence can be established under controlled conditions, but these relationships did not hold for natural conditions.

The South Fork Tolt River value of 12.2 percent fine sediments in 1981-1982 exceeds the value of 10 percent suggested by the agencies. However, the data used to derive the 10 percent value were for basins unaffected by logging roads, which translates to 0 percent disturbance in the basin (Cederholm et al., 1982). The data do point out that a value in excess of about 12 percent is for a disturbed (i.e., logged) basin. Thus, spawning in the basin could be affected by additional development. The 12.2 percent fine sediments value for the South Fork Tolt River was obtained in 1981-1982 and might have been affected by a large natural slide that occurred a short distance below the dam in March 1976 and December 1977 and by logging activity in the basin. Thus, the percent fine sediments in the river during 1981-1982 was probably influenced by the slide, erosion from around the regulating basin, and the fact that the basin is regulated against flushing flows by the dam.

The existing sediment load entering the South Fork Tolt River above the project site is about 5,000 to 6,000 tons per year (table S-2). Additional input to the system from the project as proposed would be about 1,400 to 2,200 tons per year (table S-5).

Environmental Consequences with Staff-Recommended Mitigation

To reduce impacts to soils and geologic resources, the FERC staff determined that the following measures should be implemented.

- The erosion, slope stability, and sedimentation control plan should be further developed in consultation with the resource agencies and Tulalip Tribes to reduce the potential for significant sedimentation impacts along the penstock route. Details such as those presented by Symonds (1984) should be provided for all areas affected by construction to help ensure that state-of-the-art control measures are used. Furthermore, because of the potential for erosion and sedimentation, the FERC staff recommends that the licensee's plan be bonded to ensure implementation. These plans should be developed to address all stability concerns discussed in the Converse Consultant's (1982) geotechnical investigation.
- Road subgrade underlain by geotechnical fabrics should be considered to control siltation from the powerhouse access road.
- Differential settlement values need to be assessed for the drainage channel (see Converse Consultants, Inc., 1982, pg. 17) where peat is located during construction.
- Temporary and long-term seepage control measures must be incorporated into the slope stability plan where groundwater is encountered to control water that would cause erosional scarps and mass wasting.
- Flushing flows need to be set for the South Fork Tolt River in consultation with the agencies and Tribes to maintain spawning gravel, scour fine sediments, and minimize bank cutting. Two-year flood event flows can probably be used initially to establish flushing flows, lacking study results.
- Specific geotechnical field observations should be planned before, during, and after construction to monitor slide areas located along the penstock route.

If these recommendations are followed in conjunction with agency and Tribal consultation, the project should have a low level of sedimentation and moderate to low potential mass-wasting impacts. These

* Erosion and sedimentation issues responded to in Attachment, as needed.

recommendations do not, however, end with the construction phase, but instead require geotechnical monitoring throughout the life of the project to assess slope stability and recommend remedial action

Unavoidable Adverse Impacts

Activities during the construction period would lead to low to moderate increases in sedimentation in the vicinity of the proposed project and low to negligible impacts downstream in the Tolt River drainage. Fine sediments and silts would be deposited in fish spawning areas and could temporarily reduce the suitability of these areas for egg deposition and incubation (City of Seattle, 1981 FERC, 1984a). Temporary impacts to spawning areas can result in long-term impacts to fish populations. However, if appropriate erosion and slope stability measures are implemented; if these measures, along with flushing flows, are developed in consultation with the agencies and Tulalip Tribes; and if the measures are bonded, then the proposed project should result in only a low increase in the sediment load to the South Fork Tolt River during the construction and stabilization period under average conditions. Long-term impacts would probably not be measurable, and with a proper flushing program, quality spawning gravels should be maintained. The conservative estimate of net sedimentation from mass wasting (not mitigated) and project-related erosion would be 700 to 1,100 tons per year of fines entering the South Fork Tolt River. This is about a 12 to 19 percent increase over background levels. Under a conservative analysis, a minor to moderate increase could be expected in sediment entering the South Fork Tolt River.

3.2.2 Streamflow and Water Quality

Environmental Consequences with Project as Proposed

The proposed project is designed to minimize impacts to the streamflow conditions and water quality by implementing a number of mitigative measures. Construction activities at the powerhouse and tailrace area could result in the addition of suspended soil and organic material, but given the fact that the South Fork Tolt River is used as a municipal water supply, some very stringent controls have been placed on construction and operation of this project. These controls, detailed in the Water Quality and Erosion Control Plan (Economic and Engineering Services, Inc.; 1984), are designed to protect the Tolt regulating basin and stream. These plans include the appointment of an independent consultant to monitor water quality during construction and operation of the project. In addition, appendices to the plan deal with outlines for a quarterly report and an emergency action plan for spill prevention, but these appendices need further development. The outlines contain the main components for water quality protection.

The plan mentioned above discusses controls for the amount of turbid water and chemical or petroleum products that could enter the drinking water supply. As long as the developers stress the same degree of protection for the stream that they desire for the municipal water supply, impacts should be short term and low.

The construction for the project is divided into seven water quality construction zones, and flow shutdowns, access roads, and river return are addressed. The work in the river return area would cause some disturbance to the streambed and discharge of turbid water to the South Fork Tolt River.

In addition to the plan discussed above, the licensee describes various measures that should provide substantial protection against increasing turbidity from sediment in the stream (City of Seattle, 1981). In general, construction of the pipeline, powerhouse, return flow conduit, and dissipating structure would result in temporary, localized increases in turbidity and suspended solids in the regulating basin, the South Fork Tolt River, and small streams in the area. Heavy equipment would operate adjacent to the stream, and particulates from blasting, earth-moving, and dust could be added to the water. No construction equipment would be allowed in the streambed; however, a road would be built in the sidehill to provide access to the energy dissipating structure and return flow conduit. Soil erosion caused by surface runoff from construction areas could contribute to sediment in the river. Construction of the powerhouse and return flow conduit could also cause turbidity in surface waters or shallow groundwater leaving the area. For example, construction in the gully would intercept existing groundwater and result in increased overload flow and erosive capacity. Increased sediment loads could be incorporated in the groundwater, discharging into the Tolt River or in storm water runoff from the site.

Because of the possible connection between reservoir levels and spring discharges, which may play a role in landslide activity below the Tolt Dam, the slide's effects on suspended solids in the river would need to be monitored along with other impacts of the existing project. The landslide has largely stabilized, and the sediment contribution is minimal except during periods of extremely high river flow and surface water runoff.

The temperature of the water released into the river through the powerhouse would not be raised, mainly because the intake levels are well below the reservoir surface and the water is colder. During the warm summer period, flows would normally not be discharged into the South Fork Tolt River,

* Seattle City Light is currently working on a Sedimentation Plan, required by the FERC license. The Attachment includes information on the Sedimentation Plan.

because the powerhouse would be using only municipal supply water. In the wettest years, return flow into the river is projected to begin as early as October and continue through July. The wet years typically result in cooler water temperatures in the reservoir and less drawdown due to smaller water demand in the municipal and industrial system. In fact, water discharged from the powerhouse into the South Fork Tolt River during summer might be colder than the river water due to the effect of solar insolation on the stream reach above the outfall structure. By selection of water withdrawal depth, the differences would be mitigated.

Entrainment of air and dissolved gas supersaturation are unlikely to occur in water flowing into the powerplant; this water should be in equilibrium with the air. Water flowing into the river through the return flow conduit might, however, become supersaturated under certain conditions. For this to occur, there must be entrainment of air and plunging or turbulence in lower, high-pressure portions of the conduit (Baxter and Claude, 1980). Effective measures to avoid gas entrainment and supersaturation have been developed and should be adequate to prevent this condition.

No contaminants would be discharged from the powerhouse during project operation; no fluids containing PCB's would be used in the electrical equipment.

The Seattle Water Department is required, in its water right permit and in an existing agreement with the Washington Departments of Game and Fisheries, to maintain an established minimum flow level in the South Fork Tolt River for the protection of fish and other wildlife downstream of the dam during periods of low natural flow. Water is released to meet the required minimum flow of 54 cfs (at USGS gauge 12-1480) from September 15 through May 31, and 35 cfs from June 1 to September 15. During dry years, however, release requirements can be reduced by 30 percent, when so authorized by the Director of the Washington Department of Ecology. This situation would not change under operation of the proposed project.

The FERC staff's assessment of potential impacts on water quality indicate the following:

- Groundwater: The project would have no anticipated major impacts on groundwater in the area. The only possible effect would occur during excavation for the pipeline, powerhouse, and outfall structure--such excavation might cut into unknown local springs or aquifers and disrupt the flow for a short time.
- Surface Water: During construction of the proposed pipeline from the reservoir to the regulating basin, there could be short-term disruption of water flows in crossed streams. Operation of the project would alter the flow of surface waters but would not change the overall annual yield of basin runoff.

Environmental Consequences with Staff-Recommended Mitigation

Most environmental concerns relative to streamflow and water quality have been addressed in plans developed by the licensee to protect the municipal water source (Economic and Engineering Services, Inc., 1984). However, the FERC staff recommends the following concerns also be addressed:

- The licensee should revise the water quality control plan (Economic and Engineering Services, Inc., 1984) and ensure that the South Fork Tolt River receives the same level of protection that is detailed for the water supply system. These revisions should be submitted to the FERC for approval and would minimize impacts during construction and make long-term impact almost unmeasurable.
- Water temperatures to ensure that gases do not become entrained during operation should be developed and detailed in consultation with the resource agencies and Tribes.
- Specific measures to ensure that gases do not become entrained during operation should be developed and detailed in consultation with the resource agencies and Tribes.

Following the above recommendations, impacts to the South Fork Tolt River should be low under average conditions. The effectiveness of the mitigative measures is considered in appendix S.

Unavoidable Adverse Impacts

The project should have only low impacts on the South Fork Tolt River for construction and operation under average conditions. If, however, severe rainfall events occur or unstable geological conditions are encountered during operation, water quality could be impacted by excessive turbidity. But with the concern over domestic water supply associated with the project, stringent requirements would be in place that should handle most average and emergency conditions.

During the initial start-up period, the powerhouse could release a minimal amount of turbid water into the South Fork Tolt River. Fluctuations in streamflow induced by plant operation could cause changes in the stream hydrograph and initiate downstream transport of bed sediments. The probability of bedload instability during flow fluctuation should be low as long as the rate of change remains at or near natural flow levels. Operation of the project should not change the existing levels of asbestos, nutrients, and organic materials in the regulating basin or the river.

3.2.3 Fishery and Aquatic Resources

Environmental Consequences of the Project as Proposed

The South Fork Tolt River Project would divert up to 166 cfs from 5.9 miles of river. This would amount to an additional 33 to 100 cfs average withdrawal over the current water supply withdrawal. The project would require construction of a new pipeline, penstock, powerhouse, and return flow structure. The major impacts to fishery and aquatic resources identified for the project are:

- Reduced sediment transport capacity within the bypass reach,
- Fishery and aquatic habitat reduction due to flow reduction in the bypass,
- Temperature fluctuation in the bypass reach,
- Interference with upstream migration of adult salmonids, and
- Potential stranding of fish downstream of the powerhouse.

- Sediment Transport--Diversion of flow from the bypass reach would reduce the sediment flushing capacity of the stream, which might result in increased sedimentation of the streambed. If this occurred, there would be a significant adverse impact on anadromous fish populations in the bypass reach. Diversion of water during hydroelectric project operation would reduce the frequency and magnitude of peak discharges in the bypass reach. These peak discharge events are the principal sediment-flushing mechanism, and thus appropriate flushing flows would need to be set. Erosional scarps in the upper area of the bypass are the major source of bedload and sediments to the reach, with some minor contributions from road construction and logging. Measurements of streambed composition in 1981-1982 showed an average of about 12 percent fine sediments (> 0.84 mm in diameter) in the bypass reach (Stober et al., 1983), which is above the 10 percent sediment threshold established for the Snohomish River Basin by state and federal agencies. Assuming that at least some sediment flushing is occurring under the current flow regime, the present level of fine sediment may be slightly less than in 1981-1982 and may be continuing to decline. It is clear, however, that the spawning gravels in the bypass reach have been adversely affected by sedimentation from human-related activities and natural processes in the South Fork Tolt River. A shift in the sediment input-transport balance toward low sediment removal or higher sediment input would adversely affect spawning gravel quality. This in turn could adversely affect anadromous salmonid spawning success and could lead to reduction of the steelhead runs in the bypass reach. The FERC staff concluded that the project-induced sedimentation potential of the project as proposed would be moderate to low,

increasing about 50 percent over existing conditions (table S-2). The staff also identified the need for appropriate flushing flows to ensure that sediments would be transported out of the bypass reach, and recommended that flushing flows be set. Given the present condition of the South Fork Tolt River streambed composition and the increase in sediment input and reduction in flushing capacity likely to occur from the proposed project, it appears to the staff that significant adverse impacts are likely to occur to salmonid spawning habitats as a result of construction and operation of the project as proposed.

- Fisheries Habitat--The South Fork Tolt River flow regime was substantially reduced by the existing water supply storage and diversion project. The proposed hydroelectric project would further reduce flow conditions in the bypass reach. The original license application projected average reductions of 33 to 100 cfs on an annual basis. This flow reduction probably would be slightly less than originally expected, based on minimum flow regimes proposed and tentatively agreed to in recent negotiation sessions. Fishery resource agencies believe that substantial reductions in anadromous fish runs occurred in the Tolt River coincident with construction of the water supply project. The city of Seattle staff, however, say that the decline in Tolt River anadromous fish runs occurred coincident with the increase in hatchery planting by the resource agencies. Resource agencies have substantially curtailed hatchery planting in a basinwide move toward management of wild, self-sustaining populations of salmon and steelhead. The magnitude and cause of anadromous fish run declines in the Tolt River drainage has not been determined.

Concerns over the impact of the proposed flow regime to fishery resources led to a study of fish populations, habitat quality and quantity, fish food base (macroinvertebrates), and water temperature in the Tolt River (Stober et al., 1983). Steward and Stober (1984) issued a supplemental report that reanalyzed the Instream Flow Incremental Methodology (IFIM) portion of the original study. The habitat versus discharge relationship from this supplement formed the basis of habitat analysis undertaken in all subsequent discussion and negotiation on the proposed South Fork Tolt River Project.

A license issued March 19, 1984, established an interim flow schedule and directed the licensee to consult with state and federal fisheries agencies and the Tulalip Tribes to establish a final instream flow schedule for the South Fork Tolt bypass reach within 6 months after license issuance (FERC, 1984b). The Tolt River Fisheries Advisory Committee (Advisory Committee) was formed to develop the flow schedule. Included on the committee were representatives of the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fisheries, Washington Department of Game, Washington Department of Ecology, the Tulalip Tribes, the Seattle City Light Department, and the Seattle City Water Department. The Advisory Committee was unable to reach agreement with the

designated time and has obtained extensions from the Commission to conduct further negotiations. The Advisory Committee has conducted extensive examination of steelhead trout and chinook and coho salmon habitat for a variety of flow schedules, flow accretion conditions, measurement locations, and related matters. Preliminary agreement was reached on minimum flows, measuring points, switching criteria, and gauging stations in June 1983 (typical letter of agreement and conditions is included in appendix R). These flows as measured at USGS gauging station 12-1480 are listed in table 3-1.

Implementation of the preliminary agreement began June 1, 1986. Since then, the Advisory Committee has been working on resolution of remaining issues, including monitoring studies (fish populations and flow conditions, dissolved gases and water temperature, and construction-phase erosion and sedimentation), restoration programs (sedimentation control, gravel recruitment and supply), and enhancement opportunities (structural habitat modification, temporary outplant to reestablish fish runs, and incubation boxes).

The consensus of the Advisory Committee on which the preliminary flow agreement is based is that:

- The South Fork Tolt River, upstream of the proposed powerhouse, should be managed for steelhead trout;
- The quantity and quality of steelhead rearing habitat would be improved by the negotiated higher summer minimum flows;
- Steelhead spawning would not be significantly affected by the negotiated lower winter minimum flows; and
- Restricting steelhead spawning to lower, more stable flows avoids risks of redd dewatering and resultant mortality that might otherwise occur at higher, more variable flows.

Table Preliminary minimum flow agreements
for the South Fork Tolt River
Project. 1/

Period	Flows (cfs)	
	Normal year	Critical Year
January	45	30
February	50	36
March	53	36
April	53	36
May	53	36
June	53	36
July		
1-15	53	36
16-31	53	30
August	53	30
September	53	30
October	53	30
November	45	30
December	45	30

1/ Source: appendix R.

The FERC staff reviewed the South Fork Tolt River documents, data, and Advisory Committee meeting minutes; visited the proposed project area; and discussed the fishery issues with some of the Advisory Committee members. As a result, the staff concurred with the consensus of the Advisory Committee. The staff believed that the steelhead trout population in the South Fork Tolt River bypass reach would not be adversely affected by operation of the proposed South Fork Tolt River Project under the preliminary flow agreement conditions.

- Water Temperature--Summer water temperature is not considered a problem in the South Fork Tolt River, and it is unlikely that the proposed project would alter the summer temperature regime in the bypass. Summer flows are presently held at the minimum release level. The slight increase in summer minimum flow for the proposed project would not be likely to reduce significantly summer water temperatures. No adverse impacts due to the proposed summer flow release schedule are anticipated.

- Upstream Migration--Return of up to 166 cfs would not delay or disrupt upstream migration at the powerhouse discharge. The licensee has proposed a flow dissipation structure of gravel-filled gabions through which the diverted water would be returned to the river. This structure would disperse the return flow through the gabions, over a length of bank, at velocities at least 0.5 feet per second slower than velocities in the stream. The structure would effectively mitigate for potential false attraction to the discharge, prevent entry to the tailrace and powerhouse, and result in no adverse effect on upstream migration.

- Ramping Rate--Adult and juvenile fish might be stranded in the channel downstream of the powerhouse by rapid reduction of discharge during routine and emergency shutdowns. Stranding can lead to injury and death of the fish and to increased predation and poaching. Fry are most susceptible, potentially leading to extensive mortalities and significant impacts to anadromous populations. Adults may be prevented from migrating, and spawning fish can be driven from redds, resulting in reduced spawning success. The licensee originally proposed a ramping rate of 1.0 foot per hour, which has been questioned by resource agencies. The agencies believe that the rate should be established on the basis of site-specific testing after the facility is constructed, before operation. Article 27 of the Order Issuing License dated March 29, 1984, later stayed, established interim ramping rates and requires the licensee to consult with fisheries agencies and the Tulalip Tribes and to conduct an investigation to determine appropriate ramping rates for the project prior to operation (FERC, 1984b). The staff believes that the ramping rates established in Article 27 will adequately protect fishery resources in the South Fork Tolt River and mainstem Tolt River pending results of the required site-specific ramping rate studies.

Environmental Consequences with Staff-Recommended Mitigation

The FERC staff has identified the need to set flushing flows in the South Fork Tolt River to maintain spawning gravels, scour fine sediments, and minimize bank cutting. Because the information necessary to determine the appropriate flushing flows is not presently available, the staff also has recommended that studies be performed to obtain the information. The Fisheries Advisory Committee has been considering restoration and enhancement options for sedimentation, gravel recruitment, and other problems in the South Fork Tolt River as part of its ongoing negotiations (Seattle City Light, 1986), including a gravel supply study to examine gravel sources, flushing flows, and other concerns relating to gravel recruitment. These data could be used to set appropriate flushing flows. * Reference to Erosion and Sediment Control Plan in section 3.2.1 above and update in Attachment. *

Unavoidable Adverse Impacts

The licensed South Fork Tolt Project, as conditioned by the preliminary agreement (appendix R) and staff recommendations for flushing flows, is not expected to result in any adverse impacts to fishery resources. Some improvement might occur in the fishery resource as a result of habitat restoration and enhancement activities, if implemented as part of the final agreement between the licensee and the fishery resource agencies and Tribes.

3.2.4 Terrestrial Resources

Environmental Consequences of Project as Proposed

- Black-tailed Deer--Impacts to deer would occur from the loss of 5.2 acres of permanent habitat. The 5.2 acres are also winter range. There would be no blockage of animal movement, and forest cover is not limiting in the area. In part, impacts overall would be low because most project features already exist. Disturbed areas would be revegetated. The loss of 5.2 acres is considered a low impact to deer (appendix N). * Update in Attachment. *

- Bald Eagles--Bald eagle use of the Tolt River and Reservoir is very low (figure 2-3 and table 2-6). The FWS did not express concern about the proposed project and bald eagles (letter from J.R. Blum, Area Manager, Fish and Wildlife Service, Olympia, Washington, March 5, 1981). The project could affect the eagles' food supply (spawning salmon), but the minimum flows established for fisheries purposes would keep this impact to a very low level (appendix O). The loss of about 1.5 acres of mature riparian forest in the powerhouse area is a loss of a potential roost or nest site, but because the

area is small and eagle use very low, the impact is considered very low. The project could cause some disturbance to eagles that might occasionally use the area, but since most project features already exist, the additional amount of impact would be very low. The licensee proposes to design the transmission line so as to pose little hazard of electrocution to eagles or other raptors. * Wintering Bald Eagle Study included in Attachment. *

- Riparian Habitat and Wetlands--The diversion length (28,512 feet) is 35 percent of the South Fork Tolt River and considered long. The stream is moderately wide (38 feet) in this reach. The gradient (averaging 2.8 percent) is low, and small alder stands occur along the river. Consequently, there is potential for moderately good furbearer habitat. Because flows would not change substantially over those maintained artificially now, there should be only small changes in riparian habitat or furbearer habitat. A very short length (about 150 feet) of vegetation-water interface would be permanently affected by project structures. There are no special [sic] wetland areas that would be affected by the project. * Update in Attachment. *

- Old-growth Forest Habitat--About 2 acres of old-growth forest would be removed along the pipeline right-of-way and in the area of the powerhouse. There are no special management areas for spotted owls, pine marten, pileated woodpeckers, or mountain goat winter range in the project area. Two mountain goat winter range areas managed by the Forest Service are located about 2 miles east of the eastern end of the Tolt Reservoir. The proposed project would not affect those areas. The project area is at a relatively low elevation so that potential pine marten habitat is limited. Little potential habitat for spotted owls and pileated woodpeckers exists around the reservoir because of recent and extensive logging. There is some potential habitat downstream of the reservoir, although cover is mostly second-growth forest, not old-growth. Project impacts to old-growth and associated wildlife are considered low. * Update in Attachment.*

Environmental Consequences with Staff-recommended Mitigation

The staff recommends that the applicant develop a wildlife mitigation plan that includes, but is not necessarily limited to, (1) revegetation of disturbed areas with native plant species as described by Juelson (1980), (2) use of nonchemical means for controlling vegetation in rights-of-way, (3) restriction of public access to the site to reduce disturbance of wildlife, and (4) replacement of any old-growth forest removed by project development by purchasing a comparable tract of forestland that is in jeopardy of harvest and transferring management responsibility of the tract to the Washington Department of Game (see, for example, FERC, 1985d, license article 39). Implementation of this plan should reduce wildlife impacts to an insignificant level.

Unavoidable Adverse Impacts

About 5.2 acres of deer and other wildlife habitat would be permanently excluded from use. About 2 acres of old-growth forest would be removed. There would be a very low unavoidable impact to eagles due to disturbance and loss of potential habitat. Additional information on bald eagles is in the Attachment.

3.2.5 Threatened and Endangered Species

The only federally listed species using the project area is the bald eagle. Low impact to bald eagles could occur (see section 3.2.4), mainly because the area receives only very low use by eagles and most project features already exist.

No state-listed species are known to occur in the project area, but habitat suitable for the fringed pinesap may occur in the project area. Although the potential to impact fringed pinesap is low because the amount of mature forest that would be removed is low (about 2 acres), the licensee should survey the project area for this species and contact the Washington Department of Game regarding appropriate mitigation if any individuals of the species are encountered.

Sections 4.2.1.1.6 - 4.2.1.1.8 of the 1987 FERC FEIS, which describe cultural resources, recreational and visual resources, and socioeconomics and land use, are incorporated by reference. Updated information on recreational resources is in the Attachment.

3.2.6 Summary of Impacts

The potential site-specific impacts of the seven proposed projects are summarized in table 3-5. Impacts are quite variable, depending on the project and the resource category. No project is entirely benign across all resource categories, nor is any harmful across all resource categories. The proposed South Fork Tolt River Project is not entirely benign across all resource categories, nor is it harmful across all resource categories.

3.3 IMPACT SUMMARY

3.3.1 Unavoidable Adverse Impacts

Construction of any of the proposed projects would result in the following generalized unavoidable adverse impacts:

- Localized and temporary generation of noise and dust during construction of project facilities;

- Dedication of a small amount (up to 10 acres) of forestland and wildlife habitat to project facilities for the life of the project;
- Short-term increases in turbidity and sedimentation during and for a short period following project construction and possibly during project operation;
- Temporary and localized disruption of fish habitat during construction;
- Disruption of 150-600 feet of vegetation-water interface during the operational life of the project;
- Reduced flows between the proposed dam and powerhouse sites, with attendant adverse impacts on anadromous fish and/or resident trout spawning and rearing habitat during project operation; Update in Attachment.
- Restricted recreational use of the project area during construction.

Additional unavoidable adverse impacts would occur with specific projects. These impacts, and the projects associated with each, are as follows:

- Aggravation of mass-wasting and landslide hazard (Storm Ridge, Excelsior Mountain, Olney Creek Falls, and Tokul Creek);
- Removal of 1-5 acres of old-growth forest (Tolt River, Storm Ridge, Excelsior Mountain, Olney Creek Falls, and Barclay Creek) -- update in Attachment;
- Disruption of recreational use/and or visual quality of important use areas during the operational life of the project (Storm Ridge and Excelsior Mountain).

3.3.2 Irreversible and Irretrievable Commitment of Resources

The proposed diversion dam 5, small reservoirs, powerhouses, transmission lines, and access roads would occupy terrestrial and aquatic habitats for the life of any of the proposed projects (assumed to be at least 50 years). Therefore, these resources would be committed for that period; however, because the project facilities could be removed after the useful life of the project had ended, the commitment of local natural resources would not be irreversible or irretrievable. Although not commonly done, these diversion structures could be breached upon license expiration. It is likely that the habitats occupied by project facilities could be reclaimed to preproject functions, but there would almost certainly be some minor but permanent alteration in the physical character of the resources.

4. LITERATURE CITED

See Federal Energy Regulatory Commission Final Environmental Impact Statement for a complete listing of all referenced material, including the particular references cited within the adopted portions.

APPENDIX L. DESCRIPTION OF IMPACT LEVEL CRITERIA FOR SEDIMENTATION
AND WATER QUALITY RESOURCE COMPONENTS

Table L-1. Description of impact criteria for the fisheries target resource component sedimentation/transport. 1/

Impact rating	Amount of project basin disturbance <u>2/</u>	Sedimentation potential <u>3/</u>	Mass-wasting potential <u>4/</u>
4	>M	ANY	ANY
	M	≥M	≥M
	≥Ru	E	H
3	M	≥M	L
	M	L	≥M
	Mi	M	H
	Mi	H	M
	Mi	M	M
	Ru	≥M	H
2	M	L	L
	Mi	L	M
	Mi	M	L
	Ru	M	H
	Ru	M	M
	Ru	L	H
1	Mi	L	L
	Ru	L	M
	Ru	M	L
0	Ru	L	L

1/ Source: staff; terms are defined in table L-6.

2/ Basin disturbance ranges >M = greater than moderate (>5%)
M = moderate (2.6 - 4.9%)
Mi = minor (1.0 - 2.5%)
Ru = relatively undisturbed (<1.0%)

3/ Sedimentation potential E = excessive erosion potential
H = high erosion potential
M = moderate erosion potential
L = low erosion potential

4/ Mass wasting potential H = high
M = moderate
L = low

Table L-2. Interactive matrix criteria for sedimentation. 1/

Value	Criterion
0.0	No potential interaction between projects
0.1	Low potential for interaction of a suspended material
0.2	Minor potential for interaction of fines, no interaction with bedload <u>2/</u>
0.3	No interaction of fines, low measurable interaction with bedload <u>2/</u>
0.4	Low potential for measurable interaction of fines, no interaction with bedload <u>2/</u>
0.5	Low potential interaction of fines and bedload <u>2/</u>
0.6	Low potential interaction of fines, low measurable interaction with bedload <u>2/</u>
0.7	Low measurable interaction of fines, low potential interaction with bedload <u>2/</u>
0.8	Low potential interaction of fines, moderate potential for measurable interaction with bedload <u>2/</u>
0.9	Moderate potential for measurable interaction of fines, low potential interaction with bedload <u>2/</u>
1.0	Moderate or greater potential for measurable interaction of fines and bedload <u>2/</u>

1/ Source: staff.

2/ Refers to an interaction which could have a negative increase or decrease in bedload between projects (note: some increase in bedload could have a positive effect). "Potential" implies that fine sediments may interact, but at levels that cannot be measured. "Measurable" interaction of fine sediments implies a change sufficient to be measured with state-of-the-art techniques.

Table L-3. Project interaction coefficients for the sedimentation/transport component. 1/

Proposed project (FERC No.)	Proposed project (FERC No.)						
	S. Fork Toit River (2959)	Storm Ridge (5305)	Excelsior Mtn. (5338)	Olney Cr. (5853)	Tokul Cr. (6220)	Black Cr. (6221)	Barclay Cr. (6310)
S. Fork Toit River (2959)	0	0.1	0.1	0.1	0.1	0.2	0.1
Storm Ridge (5305)	0.1	0	0.9	0.1	0.1	0.1	0.2
Excelsior Mtn. (5338)	0.1	0.9	0	0.1	0.1	0.1	0.5
Olney Creek Falls (5853)	0.1	0.1	0.1	0	0.1	0.1	0.2
Tokul Creek (6220)	0.1	0.1	0.1	0.1	0	0.2	0.1
Black Creek (6221)	0.2	0.1	0.1	0.1	0.2	0	0.1
Barclay Creek (6310)	0.1	0.2	0.5	0.2	0.1	0.1	0

1/ Source: staff; see tables S-6 and S-7 for additional documentation.

Table L-4. Categories of sedimentation potential, mass-wasting potential, and sedimentation/transport impact levels for the proposed projects with and without staff mitigation. ^{1/}

Proposed project (FERC no.)	Percent basin disturbance	Sedimentation potential		Mass-wasting potential		Sedimentation/transport impact level	
		Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation
S. Fork Tolt River (2959)	1.5	M ^{2/}	L	H	M	3	2
Storm Ridge (5305)	<1	H	M	H	H	3	3
Excelsior Mtn. (5338)	<1	E	E	H	H	4	4
Olney Creek Falls (5853)	<1	M	M-L	M	M	2	2
Tokul Creek (6220)	1.6	M	L	M	M	3	2
Black Creek (6221)	1.4	M	L	M	M	resident 3, anadromous 1	resident 2, anadromous 0
Barclay Creek (6310)	<1	M	L	M	M-L	2	1

^{1/} Source: staff.

^{2/} L = low; M = moderate; M-L = moderate to low; H = high; E = excessive.

Table L-5. Definition of terms used in the description of impact rating. 1/, 2/

Term	Definition
Project basin	Drainage area upstream from the initial point where project-related construction would occur.
Low sedimentation potential	The potential for surface erosion is insignificant; potential erosion would be minimal; <u>3/</u> low (<10% probability) susceptibility to mass wasting.
Moderate sedimentation potential	The potential for surface erosion is significant. Extensive erosion can occasionally occur from disturbed areas, but it can be reduced or limited by careful implementation of an erosion and sediment control plan and by avoiding unnecessary surface disturbances. <u>3/</u>
High sedimentation potential	The potential for surface erosion is significant. Extensive erosion can frequently occur on all bare surfaces; erosion cannot be avoided unless construction practices that minimize surface disturbances are applied. <u>3/</u>
Excessive sedimentation potential	The potential for surface erosion is very significant. Extensive erosion can be expected to occur on all bare surfaces; surface erosion can frequently lead to rill and gully erosion; erosion will still be a potential concern even using the most stringent construction practices.
Greater-than-moderate baseline disturbance	Greater than 10% of the basin disturbed by other activity (e.g., timber harvest, fire, hydroelectric).
Moderate baseline disturbance	Between 5% and 10% of the basin disturbed by other activity (e.g., timber harvest, fire, hydroelectric).
Minor baseline disturbance	Between 2.5% and 4.9% of the basin disturbed by other activity (e.g., timber harvest, fire, hydroelectric).
Relatively undisturbed	Less than 2.5% of the basin disturbed by other activity (e.g., timber harvest, fire, hydroelectric).
Known habitat	Habitat where current or historical use by the target resource species has been documented.
Possible habitat	Habitat where current or historical use by the target resource species has not been documented but use is not precluded by a physical barrier or some other factor.
Potential habitat	Habitat where current and historical use by the target resource species is limited by a physical barrier or some other factor, and elimination or removal of the limiting factor is included in federal, state, or Tribal management plans.
Average conditions	Refers to average environmental conditions for the area as detailed in section 3.1.3.2.1.

Table L-5. Continued

Term	Definition
Adverse conditions	Refers to conditions that can occur on an infrequent basis that exceed average values for the area (e.g., high-intensity, long-duration rainfall events, or high-intensity rainfall events over snowpack).
Conservative analysis	Refers to those conditions assumed to be roughly a worst-case situation that would result in increased sediment yield from a specific project. In most cases, conservative refers to a 100-year flood event at a site with no erosion controls in place.

1/ Source: staff.

2/ Additional terms are defined in table L-6.

3/ Soil erosion potential modified from Washington Department of Natural Resources (1983).

Table L-6. Definitions for soil interpretations and water quality. 1/

- TYPE - refers to the Department of Agriculture Soil Classification System.

- SLOPE STABILITY

- Natural Slope Stability--The Natural Slope Stability Rating refers to the stability of a soil and its underlying material in an undisturbed state and under normal climatic circumstances.

Ratings are based on:

- (1) the physical characteristics and behavior of soil
- (2) the behavior of the underlying material
- (3) drainage: the presence of and depth to a water table, perched water or seeps
- (4) observations of natural slope failures (e.g., slumps, earthflows and landslides).

Definitions of the ratings:

Stable: No significant slope stability problems related to soil or underlying material occur under normal circumstances.

Unstable: Significant slope stability problems related to soil and underlying material occur under normal circumstances. Slope stability needs to be a major consideration when selecting road locations, designing roads, and developing construction plans.

- Disturbed Slope Stability--The Disturbed Slope Stability Rating refers to the stability of a soil and its underlying material after they have been disturbed by the construction of pipelines, roads, and landings. Slope problems expected from road and landing construction are mainly massive slides and sluice-outs initiated from road fill failures, road backslope failures, and failures due to concentrations of road drainage water. Land disturbances can aggravate these problems and increase the chance of setting in motion old creeps, slumps, and earthflows, or of causing new ones on slopes without roads.

Ratings are based on:

- (1) the physical characteristics and behavior of the soil
- (2) the behavior of the underlying material
- (3) drainage: the presence of and depth to a water table, perched water, or seeps
- (4) observations of natural slope failures (e.g., slumps, earthflows, and landslides)
- (5) observations of slope failures on disturbed forest lands.

Definitions of the ratings:

Stable: No significant slope stability problems related to soil or underlying material occur when careful construction techniques are applied.

Unstable: Slope stability problems related to soil and underlying material can occur, but they can be overcome or minimized by applying current road construction technology and practicing good road maintenance, or by accepting practical alternatives that would avoid problems.

Table L-6. Continued.

Very Unstable: Slope stability problems related to soil and underlying material can occur, and they cannot be entirely overcome by using current construction technology. Alternative project locations and construction methods should be considered.

• ROAD, CUT, FILL, AND MASS WASTING HAZARD

The Cut, Fill, and Sidecast Hazard Rating refers to the hazard of (1) cut slopes to erode, slough, or collapse; (2) fills to erode or fail; and (3) sidecast to erode, slide, or flow down slope.

Ratings are based on:

- (1) the physical characteristics and behavior of soil
- (2) the behavior of the underlying material
- (3) steepness of slope
- (4) soil drainage (e.g., the presence of a water table or seeps)
- (5) seasonal wetness.

• DEFINITIONS OF THE RATINGS FOR MASS WASTING POTENTIAL

Low: The hazard can be overcome with standard road and penstock construction methods, including careful cutting and filling; <10 percent probability (susceptibility) of mass wasting.

Moderate: The impacts of the hazard can be reduced or minimized by standard road and penstock construction methods, including carefully planned cutting and filling. When possible, these areas should be avoided; 10-20 percent probability (susceptibility) of mass wasting.

High: The impacts of the hazard can only be reduced by special road and penstock construction methods, including carefully planned excavating and end-hauling. Best mitigation is avoidance of the area; >20 percent probability (susceptibility) of mass wasting.

• EROSION POTENTIAL

- Natural Erosion--The erosion potential of the soil on and around the construction area in its natural undisturbed state.

Low: The potential for surface erosion is insignificant. Erosion would be minimal over the near future (20-30 years).

Medium: The types of soils and related erosional factors in the area could result in sheet erosion under undisturbed conditions.

High: The types of soils and related erosional factors could result in advanced sheet, rill, or gully erosion under undisturbed conditions.

Table L-6. Continued.

- Accelerated Erosion Potential--Erosion much more rapid than natural erosion, mainly as a result of the activities of man or of a catastrophe in nature (e.g., fire that exposes the surface).
- Erosion Potential Ratings--The Erosion Potential Ratings refer to the susceptibility of a soil surface to erode from bare slopes as a result of water action. Bare soil areas include all construction areas. The types of water erosion that occur are sheet, rill, and gully erosion.

The Erosion Potential Ratings are based on the interaction of:

- (1) certain soil properties, including texture, structure, and porosity
- (2) rainfall and storm intensity
- (3) slope.

- Definitions of the Ratings for Erosion Potentials

- Low: The potential for surface erosion is insignificant. Erosion will be minimal.
- Medium: The potential for surface erosion is insignificant. Extensive erosion can occasionally occur on disturbed areas, but it can be reduced or limited by careful construction practices by avoiding unnecessary surface disturbance.
- High: The potential for surface erosion is significant. Extensive erosion can frequently be expected to occur on all bare surfaces. Widespread erosion cannot be avoided unless construction practices that minimize surface disturbance are applied.
- Excessive: The potential for measurable amounts of erosion is 1.0. Widespread erosion cannot be avoided even with state-of-the art erosion controls.

• SITE PREPARATION SCARIFICATION

The Scarification Damage Rating refers to the negative impact on the soil and duff as a result of the clearing and piling of debris by wheeled and tracked equipment during and following construction. Scarification is assumed to be a management practice only on slopes of less than 30 percent. Scarification is performed in forest management to reduce a site's fire hazard and to prepare the site for seedlings.

Scarification often hinders or limits revegetation and stabilization efforts by:

- (1) removing the duff layers that protects the surface soil from erosion and provides it with nutrients
- (2) removing part or all of the nutrient-rich surface soil in some areas
- (3) altering the physical properties of the surface soil and, in doing this, reducing aeration, permeability, and water holding capacity.

Table L-6. Continued

Ratings are based on:

- (1) the potential for a soil to compact, displace, and/or puddle
- (2) soil drainage (e.g., presence of and depth to a water table)
- (3) organic matter content of the surface soil.

Definitions of the ratings:

N.A.: A rating is not applicable on this unit. The unit is mainly over 30 percent in slope.

Moderate: Disturbance of the duff and surface soil layers will occur, but careful on-ground operations during dry months of the year may limit the impact of this damage. However, there is no way to avoid some soil damage and the resultant productivity loss.

Severe: Extreme damage to the surface soil layer and subsoil will occur as a result of on-ground operations. Although soil damage may be less in the driest months, a significant long-term loss in productivity will result.

• WATER QUALITY IMPACT DEFINITIONS

Low: Project disturbances would not change any single Class AA water quality parameter by more than 50 percent over existing conditions and no standards would be exceeded.

Moderate: Project disturbances change one or more Class AA water quality parameters by more than 50 percent but less than 99 percent over existing conditions, and no standards would be exceeded.

High: Project disturbances would cause changes in Class AA water quality parameters that would exceed one or more standards.

• ADDITIONAL DEFINITIONS

- Mass Wasting--A general term for the dislodgement and downslope transport of soil and rock material under the direct application of gravitational body stresses. Mass wasting may be the result of two types of mass movements: (1) surficial movements of relatively small deposits (e.g., debris slides, debris flows, and sluice-outs); and (2) deeper or more widely encompassing movements (e.g., soil creep, slumps, earthflows, and landslides).

- Slope Phase--A subdivision of soil series separated on the basis of slope. Each slope phase of a series should have some differences that affect its use and management.

1/ Modified from Washington Department of Natural Resources (1983).

Table L-7. Sample data sheet for sedimentation and land disturbance information and interpretation. ^{1/}

Project _____

Percent Disturbance Since Present Time Due To:

<u>Timber Harvest (%)</u> ^{2/}	<u>Area (ft²)</u> ^{3/}	<u>Factor</u> ^{4/}	<u>Total Area (ft²)</u>
0 - 2		0.25	
3 - 4		0.15	
5 - 6		0.05	
>6		0.0	

Roads - Permanent, abandoned and RV type with landings

<u>No Treatment (%)</u>	<u>Length (ft)</u>	<u>Area (ft²)</u> ^{3/}	<u>Factor</u> ^{4/}	<u>Total Area (ft²)</u>
0 - 3			0.95	
4 - 6			0.80	
7 - 15			0.60	
15 - 20			0.40	

Control Treatment (%)

0 - 2	0.8
3 - 4	0.35
5 - 8	0.13
>8	0.05

<u>Fire and Recreation Areas (%)</u>	<u>Area (ft²)</u> ^{3/}	<u>Factor</u> ^{4/}	<u>Total Area (ft²)</u>
0 - 2		0.65	
3 - 4		0.45	
5 - 7		0.20	
7 - 10		0.05	

Project Construction

	<u>Length (ft)</u>	<u>Area (ft²)</u> ^{3/}	<u>Factor</u> ^{5/}	<u>Total Area (ft²)</u>
Road			1.0	
Pipeline, Powerhouse			0.8	
Transmission Line			0.35	

TOTAL BASIN DISTURBANCE _____ (ft²)TOTAL AREA OF BASIN _____ (ft²)

% OF BASIN DISTURBED _____

Rainfall: ^{6/} _____

Table L-7. Continued.

	For Basin Soils:	1	2	3	4
<u>Soil Properties</u>					
<u>% of Project Area</u>					
<u>Soil Survey #</u>					
<u>Type</u>					
Composition %					
Sand					
Silt					
Clay					
Rock Fragments					
<u>Slope Phase %</u>					
<u>Profile</u>					
Organic Layer (in)					
Top Soil (Typical)					
Underlying Soil (average)					
Depth (in)					
<u>Slope Stability</u>					
Natural					
Disturbed					
<u>Road Cut Fill and Sidecut Hazard</u>					
<u>Erosion Potential</u>					
Natural erosion					
Accelerated erosion					
<u>Site Preparation Scarification</u>					
<u>Project Erosion Impact</u>					
Potential		_____	_____	_____	_____
Mean Potential		_____	_____	_____	_____
Mass Wasting Potential		_____	_____	_____	_____
Mean Potential		_____	_____	_____	_____

1/ Source: staff.

2/ Assume cable logging, 5-year forest timber sales included under 0-2 year period.

3/ Length x 16-foot-wide average road.

4/ Factors from Klock (1985).

5/ These factors were developed by the staff using professional judgment.

6/ This is required for the calculation of sediment yield from roadways and penstocks. See table S-1 for an example of the use of rainfall values.

REFERENCES

- Klock, G.O. 1985. An approach to modeling the cumulative effects of forest practices in downstream aquatic ecosystems. *Journal of Soil and Water Conservation*. 40(2):237-241.
- Washington Department of Natural Resources. 1983. State soil survey, report for northwest region. Forest Land Management Division, Olympia, Washington.

APPENDIX N. DESCRIPTION OF IMPACT LEVEL CRITERIA FOR BLACK-TAILED
DEER TARGET RESOURCE COMPONENTS

Table N-1. Description of impact level criteria for black-tailed deer target resource components. 1/

Impact level <u>2/</u>	Components			
	Permanent habitat loss (acres) <u>3/</u>	Wintering area loss (acres) <u>4/</u>	Cover loss (where limiting) <u>5/</u>	Migration blockage
4	>320 acres	>160 acres	Forest cover in project area drops to <10%.	Major blockage likely due to position of unburied penstock or inundated area over large area or in a narrow canyon.
3	>32 acres, but <320	>16 acres, but <160	Forest cover in project area drops to 10-20%.	Major blockage possible because of unburied penstock or inundated area over large area or in a narrow canyon.
2	>5 acres, but <32	>2.5 acres, but <16	Forest cover in project area drops to 21-30%.	Partial blockage likely because of position of some project features, but over a limited area or low-gradient area.
1	Some loss, but <5 acres	Some loss, but <2.5 acres	Forest cover in project area drops to 31-40%.	Partial blockage possible because of position of some project features, but over a limited area or low-gradient area.
0	No permanent loss of habitat	No permanent loss of wintering area	Forest cover in project area remains >40%; or no loss of forest cover.	No blockage of deer movement anticipated.

1/ Source: staff.

2/ Impact level: 0 = no impact, 1 = very low impact, 2 = low impact, 3 = moderate impact, 4 = high impact.

3/ Based on an average home range size of 320 acres for black-tailed deer.

4/ Wintering area loss analysis applied where wintering areas are within 3 miles of the mapped winter range/summer range boundary.

5/ Cover is considered limiting whenever an area about the size of a deer home range (320 acres) has less than 40 percent forest cover.

APPENDIX O. DESCRIPTION OF IMPACT LEVEL CRITERIA FOR BALD EAGLE RESOURCE COMPONENTS

Table 0-1. Description of impact level criteria for bald eagle resource components. 1/

Impact level <u>2/</u>	Components			
	Salmon food supply and availability <u>3/</u>	Impacts to roost or nest sites <u>4/</u>	Loss of mature riparian forest (acres) <u>5/</u>	Disturbance factor <u>6/</u>
4	A projected impact level of 4 to the anadromous fish resource.	Project area includes or physically disturbs a current use nest or roost site.	Loss of ≥ 31 acres	Some project features in moderate or high eagle use area; or winter access by developer may be a problem; or river activity by developer expected.
3	A projected impact level of 3 to the anadromous fish resource.	Project area includes or physically disturbs a past use or potential nest or roost site.	Loss of 21-30 acres	Some project features in low or moderate eagle use area; but no river activity by developer anticipated, and winter access by developer not expected to be a problem.
2	A projected impact level of 2 to the anadromous fish resource.	Project area does not include or physically disturb but is within 330 feet of a roost or nest site.	Loss of 11-20 acres	Some project features within 300 m of eagle use area; or area is already developed for other human uses.
1	A projected impact level of 1 to the anadromous fish resource.	Project area does not include or physically disturb but is within 660 feet of a roost or nest site.	Loss of ≤ 10 acres	No project features within 300 m of eagle use areas, but access to site goes through eagle use areas via routes not normally used in winter, i.e., not thoroughfares.

Table 0-1. Continued.

Impact level <u>2/</u>	Components			
	Salmon food supply and availability <u>3/</u>	Impacts to roost or nest sites <u>4/</u>	Loss of mature riparian forest (acres) <u>5/</u>	Disturbance factor <u>6/</u>
0	No projected impact to the anadromous fish resource.	No project features within 660 feet of a current or past use roost or nest site.	No loss of mature riparian forest acres.	No project features within 300 m of eagle use areas, and access to site does not pass through eagle use areas except along existing thoroughfare routes.

1/ Source: staff.

2/ Impact level: 0 = no impact, 1 = very low impact, 2 = low impact, 3 = moderate impact, 4 = high impact.

3/ Based on the results of the anadromous fish resource analysis, impact must occur in or near eagle use area.

4/ Buffer zones of 330 and 660 feet derived from U.S. Fish and Wildlife Service Bald Eagle Guidelines.

5/ Mature riparian forest are forest stands within 300 feet of a stream that contain some trees at least 100 feet tall and are generally more than 100 years old; 30-acre area based on average bald eagle roost size.

6/ Eagle use areas are mapped as: high = 10 or more eagles usually seen in the area each winter, moderate = 3-9 eagles usually seen in the area each winter, low = 1-2 eagles seen in the area, but usually not every winter; 300 m zone derived from the literature as the minimum buffer needed to avoid disturbing feeding or river perching eagles.

**APPENDIX R. EXAMPLE OF INSTREAM FLOW AGREEMENT BETWEEN
AN APPLICANT AND A RESOURCE AGENCY**

STATE OF WASHINGTON

DEPARTMENT OF GAME

Region Four Office, 16018 Mill Creek Boulevard, Mill Creek 98012 - Telephone, 775-1311

June 25, 1986

Randall W. Hardy, Superintendent
 Seattle City Light
 1015 Third Avenue
 Seattle, Washington 98104

South Fork Tolt River - Minimum Instream Flows

Dear Mr. Hardy:

The negotiations on new minimum instream flows have progressed to a point that preliminary agreement on the flows, measuring point, switching criteria, and gaging locations has been reached. The agreed-upon points are as follows:

1. The measuring point for the instream flow regime will be the USGS gage number 12.148000;
2. The minimum monthly Normal and Critical flows (in cubic feet per second) are shown below. A Critical flow occurrence is defined as any time when flows are reduced below the Normal levels.

	Jan	Feb	Mar	Apr	May	Jun	July (1-15)	July (16-31)	Aug	Sep	Oct	Nov	Dec
Normal	45	50	53	53	53	53	53	53	53	53	53	45	45
Critical	30	36	36	36	36	36	36	30	30	30	30	30	30

Randall W. Hardy
June 25, 1986
Page 2

3. The flows can be switched from Normal to Critical (or some point in between) only when all the following criteria have been met:
 - a. The reservoir storage is below the critical storage rule curve as shown in Exhibit A;
 - b. The reservoir inflow for the antecedent 30-day period is less than the 90 percent exceedence flow as shown in Exhibit B;
 - c. The Seattle Water Department has previously implemented appropriate stages of the Conservation Plan that are consistent with the final Comprehensive Regional Water Plan (COMPLAN) and that are at least as stringent as Stage III of the draft plan, and
 - d. Switching from Normal to Critical flows will only occur after consultation with the fishery agencies at least one week, and preferably two weeks, before switching occurs. Consultation will include discussion of alternatives such as scheduling, additional conservation measures, and intermediate flows.
4. The instream flow requirements will not be changed from Critical (or agreed upon intermediate flows) to Normal until the City has consulted the agencies and the reservoir storage rises above the critical storage rule curve;
5. The releases from the fish valve will not fall below 25 cfs between November 1 and January 31 and below 30 cfs between February 1 and October 31. During critical conditions the minimum flow from the fish valve will be 20 cfs;
6. A flow meter will be installed in the fish valve at the earliest possible date. Daily records will be kept of flows at the fish valve meter, USGS gage 12.148000, USGS gage 12.148300, and of the daily water supply demand.
7. The USGS gage 12.148000 will be equipped with instrumentation to allow for real-time data acquisition.
8. The new minimum flow regime will be implemented beginning June 1, 1986.

Final language of the above items will be included in an agreement which will be cooperatively developed among all parties. The agreement will also include other fishery-related considerations, such as habitat restoration or other enhancement opportunities, which are subject to further specific discussion among all parties.

Randall W. Hardy
June 25, 1986
Page 3

We would appreciate a response acknowledging your concurrence with the points discussed in this letter. Thank you for your continuing cooperation.

Sincerely,

THE DEPARTMENT OF GAME

A handwritten signature in dark ink, appearing to read "R. Gary Engman", with a long horizontal flourish extending to the right.

R. Gary Engman
Program Manager
Habitat Management Division

RGE:td

cc: Kenneth M. Lowthian, Superintendent
Seattle Water Department

Exhibit A

Critical Storage Rule Curve

<u>Month</u>	<u>Elevation (feet)</u>	<u>Total Storage (acre-feet)</u>
January	1735.7	31,000
February	1741.0	35,300
March	1741.0	35,300
April	1748.2	43,600
May	1748.6	42,000
June	1755.0	47,900
July	1752.0	45,450
August	1748.0	41,400
September	1740.1	34,500
October	1739.2	33,000
November	1735.7	31,000
December	1735.7	31,000

Values are for first day of month.

EXHIBIT B

NINETY PERCENT EXCEEDANCE FLOWS

<u>Month</u>	<u>90% Exceedance (CFS)</u>
January	101
February	93
March	115
April	115
May	155
June	86
July	36
August	21
September	29
October	57
November	102
December	147

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

2 of 2

**APPENDIX S. DOCUMENTATION AND VERIFICATION OF
SEDIMENTATION MATRIX ASSESSMENT**

APPENDIX S. DOCUMENTATION AND VERIFICATION OF SEDIMENTATION MATRIX ASSESSMENT

This appendix provides documentation and verification for the sedimentation analyses presented in the main text and appendix L. This appendix is a compilation of material used by the staff to assess impacts from disturbances to soil and geologic resources for the proposed projects. Most of this material was developed by the staff before publication of the DEIS and was used to check or verify the matrix analysis presented in chapter 4. The appendix is not presented as a detailed assessment of sedimentation issues in the Snohomish River Basin, but it does provide details of the materials that were used to document conclusions regarding the effects of sedimentation and mass wasting.

It is important to note that most of the values presented in this appendix should be considered representative of a range of values and not a specific value. This is due to the variable conditions that affect sedimentation yield and mitigation effectiveness, as well as the variability in the data used in the calculation. To determine usefulness and limitations of the data and results, the analyses presented in this appendix must be considered in the light of the following assumptions made by the staff:

- Data generated by the Geological Survey (Nelson, 1971) are assumed to be representative of flow/sediment conditions associated with the Snohomish River Basin today (personal communication, L.N. Nelson, Geologist, Geological Survey, Seattle, Washington, January 16, 1986);
- The sediment discharge recorded by Nelson (1971) at the station closest to a proposed project is assumed to be uniformly representative of the conditions associated with a proposed project site;
- The velocities of water for the selected portions of the Snohomish River Basin are assumed to be uniform;
- The distribution of grain size at Nelson's (1971) sampling station is assumed consistent with distribution of grain size at the closest proposed project location;
- Materials <6.4 mm are considered fine sediments and represent the material of most concern relative to evaluation of the fishery resource impacts of the proposed projects;
- "Calculated background conditions" are assumed to be representative of "actual conditions" present at the proposed project sites;
- Most sediment discharge is assumed to occur at or near peak streamflows;
- Materials, once suspended, are assumed to remain in suspension within the Snohomish River;
- Bedload (tons/year) is assumed equivalent to 7 percent of the total load carried by the Snohomish River;
- The entire suspended load is assumed to be fine sediments (<6.4 mm);
- Sediment contributed from roadways is assumed equal to that contributed by penstock rights-of-way;

- It is assumed that the following formula developed by Reid (1981) for the Clearwater River Basin, Washington, can be used to calculate sediment yield from a roadway or penstock during project construction and operation:

$$\text{Sediment Yield (tons/year)} = \left(\frac{\text{ave. precip.}}{140 \text{ inches/year}} \right)^{0.8} \times 700 \text{ tons/mile} \times \text{miles (roadway and penstock)}$$

- A 5 percent contingency is assumed for calculated sediment yield resulting from a proposed action because of uncertainty in the calculation of sediment sources in the project area;
- A mass wasting event or landslide resulting from some aspect of the project is assumed to occur annually (one event);
- A mass wasting event or landslide is assumed to have a volume of 900 yd³ of material and increase the material load to the stream by 7,047 mg/L during a 15-minute, 100-year storm event (Dunne, 1984);
- It is assumed that 70 percent of the mass wasting material (by weight) will occur as bedload and 30 percent as suspended sediments (by weight) (Nelson, 1971);
- The percent increase in sedimentation over natural conditions is assumed to be represented by "background plus project impacts" divided by "background levels"; and
- The proximity of a road or penstock to the stream is assumed to be related to the likelihood of sediments entering the stream (i.e., sediment delivery) as described by the following coefficients:

	<u>Coefficient</u>
within <250 feet of stream:	1.00
within 250-499 feet of stream:	0.75
within 500-1,000 feet of stream:	0.50
>1,000 feet from stream:	0.25

Additional assumptions for tables S-6 and S-7:

- The range of fine sediment loads calculated for each proposed project is assumed to include the actual level that would occur with project development;
- The sediment resulting from development of proposed projects is assumed to move through the system uniformly (to allow comparison with Nelson's (1971) measured levels); and
- The transport system is assumed to reach equilibrium immediately and the sediment input is assumed to occur in 1-year increments (i.e., during a 1-year construction period).

Table S-1. Sample calculations of the baseline sediment yield and the incremental contribution resulting from development of a proposed project, Black Creek, FERC No. 6221. ^{1/}

A. Determination of Baseline Sediment Yield

- Evaluate background sediment load (<2.0 mm) (suspended)
 - Data from Nelson (1971), Report Station 1430 (North Fork Snoqualmie River near North Bend)
 - For a conservative estimate, assume 50 percent of average suspended sediments noted in report (mean = 40,000 tons/year/96 mi²):
 hence: $(0.50) \times (40,000 \text{ tons/year/96 mi}^2) = 20,000 \text{ tons/year/96 mi}^2$ or about 210 tons/mi²
 - Determine size of drainage area above project (from license application) = 4 mi²
 hence: $(4 \text{ mi}^2) \times (210 \text{ ton/mi}^2) = 840 \text{ tons/year}$
- Evaluate background bedload (>2.0 mm)
 - Extrapolate suspended load data to quantify bedload
 - Assume 93 percent of total load is suspended (i.e., 7 percent is bedload) (Nelson, 1971):

$$\frac{840}{93} = \frac{z}{7} \quad \text{where } z = \text{tons/yr of bedload}$$
 hence: $z = 60 \text{ tons/year}$
- Total load in stream at powerhouse site
 - Total Load = (Suspended Load) + (Bedload)
 $= 840 \text{ tons/year} + 60 \text{ tons/year}$
 $= 900 \text{ tons/year}$
- Total fine sediments in system (<6.4 mm)
 - Determine quantity of fine sediments present in bedload that are not quantified in the suspended load
 - Use Nelson (1971) data from Station 1, Snoqualmie near Tokul Creek: about 13 percent fine sediments by weight in total bedload
 hence: $(0.13) \times (60 \text{ tons/year}) = 8 \text{ tons/year}$
 - Determine total weight of fine sediments (<6.4 mm)
 Total fine sediments = (suspended) + (fine sediments in bedload)
 (tons/year) = $(840 \text{ tons/year}) + (8 \text{ tons/year})$
 $= 848 \text{ tons/year}$

B. Determination of Incremental Effects Resulting From Development

- Use hydraulic and precipitation data from license application or other sources for average annual precipitation and flow level of a 100-year flood event
- Roadway/penstock construction:
 - Roadway to powerhouse 800 feet
 - Roadway to diversion structure 0 feet
 - Penstock 6,340 feet
 - Total roadway and penstock construction = 7,150 feet = 1.35 miles

Table S-1. Continued

- Evaluate sediment contributed from roadway and penstock during project construction and operation

- Use equation developed by Reid (1981), and normalize for 61 inches per year average precipitation with the following formula to calculate sediment contribution:

$$\text{tons/year} = \left(\frac{\text{average ppt/year}}{140 \text{ inches/year}} \right)^{0.8} \times 700 \text{ tons/mile} \times \text{mile(s) of roadway}$$

- Assume that all sediments contributed are fines (<0.6 mm)
- For Black Creek:

$$\left(\frac{61 \text{ inches/year}}{140 \text{ inches/year}} \right)^{0.8} \times 700 \text{ tons/mile} \times 1.35 \text{ mile}$$

$$= 486 \text{ tons/year}$$

- Adjustment for effect of proximity of roads and penstocks to stream on amount of sedimentation entering stream:

-- with 3,170 feet of roads or penstock rated at 1.00; 3,170 feet rated at 0.50;
800 feet rated at 0.25

-- sediment yield from roads and penstocks =

$$216 \text{ tons/year} + 54 \text{ tons/year} + 14 \text{ tons/year} = 284 \text{ tons/year}$$

- Add 5 percent contingency for other potential sediment sources within the project area
(0.05) x (284 tons/year) = 14 tons/year

- Additional impact from mass wasting during 100-year storm event of 15-minute duration

- Assume 900 yd³ of material in the mass failure and an increase sediment concentration over background of 7,047 mg/L (from Dunne, 1984)

- Calculate the flow of a 100-year event

(previous peak flow observed at Black Creek was about 140 cfs)

Given 25-year record and no 100-year event observed at Black Creek, for conservatism - assume that a 100-year storm event would be four times the peak observed:

$$(4) \times (140 \text{ cfs}) = 560 \text{ cfs}$$

(this is approximately 40 percent of the flow observed at a 100-year event for Barclay Creek, a much larger stream).

- Conversion factor

$$= \frac{7,047 \text{ mg}}{\text{L}} \times \frac{1 \text{ g}}{1,000 \text{ mg}} \times \frac{1 \text{ ton}}{9.072 \times 10^5 \text{ g}} \times \frac{560 \text{ ft}^3}{\text{s}} \times \frac{28.32 \text{ L/s}}{1 \text{ ft}^3/\text{s}}$$

$$= 0.12 \text{ tons/second}$$

For a 15-minute duration (= 900 seconds):

$$(900 \text{ seconds}) \times (0.12 \text{ tons/second}) = 108 \text{ tons/year/event}$$

Table S-1. Continued

- Assume
 - Total amount of fine sediments added to stream would be based on assumption that 70 percent of tonnage will be bedload and 30 percent suspended
 - All suspended sediments are fine sediments
 - From Nelson (1971) data from Station 1, Snoqualmie near Tokul Creek: 13 percent fine sediments by weight in bedload
- Determine weight of fine sediments in mass failure event
 - Suspended load = $(0.30) \times (108 \text{ tons/year}) = 32 \text{ tons/year}$
 - Bedload = $(0.13) \times (0.70) \times (108 \text{ tons/year}) = 10 \text{ tons/year}$
 - Total = 42 tons/year

C. Project Summary Sheet

	<u>Project induced (tons/year)</u>	<u>Background (tons/year)</u>
FINE SEDIMENTS FROM:		
Background load		848
Weighted load, roads and penstock:	284	
Load, 5 percent contingency:	14	
Load, mass failure:	42	
	Total = 340	

PERCENT INCREASE OVER BACKGROUND CONDITIONS

$$\frac{\text{Project induced sediment level}}{\text{background sediment level}} \times 100 =$$

$$\frac{340 \text{ tons/yr}}{848 \text{ tons/yr}} \times 100 = 41 \text{ percent}$$

1/ Source: staff. These sample calculations were done for each of the proposed projects and the results are presented in tables S-2 and S-5. See the introduction to this appendix for other assumptions used in the analysis.

Table S-2. Summary of estimated sediment load calculations for the seven proposed projects without staff-recommended mitigation. ^{1/}

Project (FERC no.)	Snohomish River Basin fine sediment yields				Increase over background (percent) (b/a)
	Background sediment load (tons/yr) (a)	Project-induced sediments		Total sediments from projects (tons/yr) (b)	
		Sediments from roads and penstocks ^{2/} (tons/yr)	Sediments from mass failure (tons/yr)		
South Fork Tolt River (2959)	5,806	2,710	305	3,015	52
Storm Ridge (5305)	1,510	1,071	460	1,531	101
Excelsior Mountain (5338)	1,053	923	270	1,193	113
Olney Creek Falls (5853)					
(as proposed)	700	160	280	440	63
(as modified)	700	119	280	339	57
Tokul Creek (6220)	6,785	291	235	526	8
Black Creek (6221)	848	298	42	340	41
Barclay Creek (6310)	995	535	93	628	63

^{1/} Source: staff. See table S-1 for an example of the actual calculations and the introduction to this appendix for assumptions.

^{2/} With a 5 percent contingency adjustment and an adjustment for proximity of roads and penstocks to streams.

Table S-3. Mitigative factors for state-of-the-art erosion-control practices for various control measures following construction disturbances. ^{1/}

Condition of site	Soil loss reduction (%) ^{2/}
<u>1. Bare soil conditions</u>	
Freshly disked to 6-8 inches	0
After one rain	11
Loose to 12 inches smooth	10
Loose to 12 inches rough	20
Compacted bulldozer scraped up and down	-30
same except root raked	-20
Compacted bulldozer scraped across slope	-20
same except root raked across	10
Rough irregular tracked all directions	10
Seed and fertilize, fresh	56
same after six months	46
Seed, fertilizer, and 12 months chemical	62
Not tilled algae crusted	99
Tilled algae crusted	98
Compacted fill	-24 to -71
Undisturbed except scraped	34 to -30
Scarified only	24 to -31
Sawdust 2 inches deep, disked in	39
<u>2. Asphalt emulsion on bare soil</u>	
1,250 gallons/acre	98
1,210 gallons/acre	99
605 gallons/acre	43-86
302 gallons/acre	40-72
151 gallons/acre	30-35
<u>3. Dust binder</u>	
605 gallons/acre	-5
1,210 gallons/acre	30-80
<u>4. Other chemicals</u>	
1,000 lb fiber Glass Roving with 60-150 gallons asphalt emulsion/acre	95-99
Aquatain	42
Aerospray 70, 10 percent cover	6
Curasol AE	52-70
Petroset SB	34-60
PVA	10-29
Terra-Tack	34
Wood fiber slurry, 1,000 pounds/acre fresh	27-95
Wood fiber slurry, 1,400 pounds/acre fresh	74-99
Wood fiber slurry, 3,500 pounds/acre fresh	90-99

Table S-3. Continued

Condition of site	Soil loss reduction (%) ^{2/}
Portland cement + Latex	
1,000 pounds/acre + 8 gallons/acre	87
1,500 pounds/acre + 12 gallons/acre	99
5. <u>Seedings</u>	
Temporary, 0 to 60 days	60
Temporary, after 60 days	95
Permanent, 0 to 60 days	60
Permanent, 2 to 12 months	95
Permanent, after 12 months	99
6. <u>Brush</u>	65
7. <u>Excelsior blanket with plastic net</u> ^{3/}	
(slopes 2:1)	90-96
8. <u>Mulch</u> (slopes 2:1) ^{3/}	
1.5 tons/acre tacked down	80
4 tons/acre tacked down	95
Wood fiber 3/4 ton/acre, with seed	50

^{1/} Source: Israelsen et al. (1980).

^{2/} Reduction is in the amount of soil that will leave a construction site from rill and sheet erosion; negative values indicate an increase in percent erosion that will occur if the measure is used.

^{3/} Source: Goldman et al., 1986.

**DATE
FILMED**

6/15/94

END