APPRAISAL REPORT

WATER RESOURCES APPRAISAL FOR HYDROELECTRIC LICENSING

ELWHA RIVER BASIN

WASHINGTON

FEDERAL ENERGY REGULATORY COMMISSION

OFFICE OF ELECTRIC POWER REGULATION
SAN FRANCISCO REGIONAL OFFICE

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PREFACE

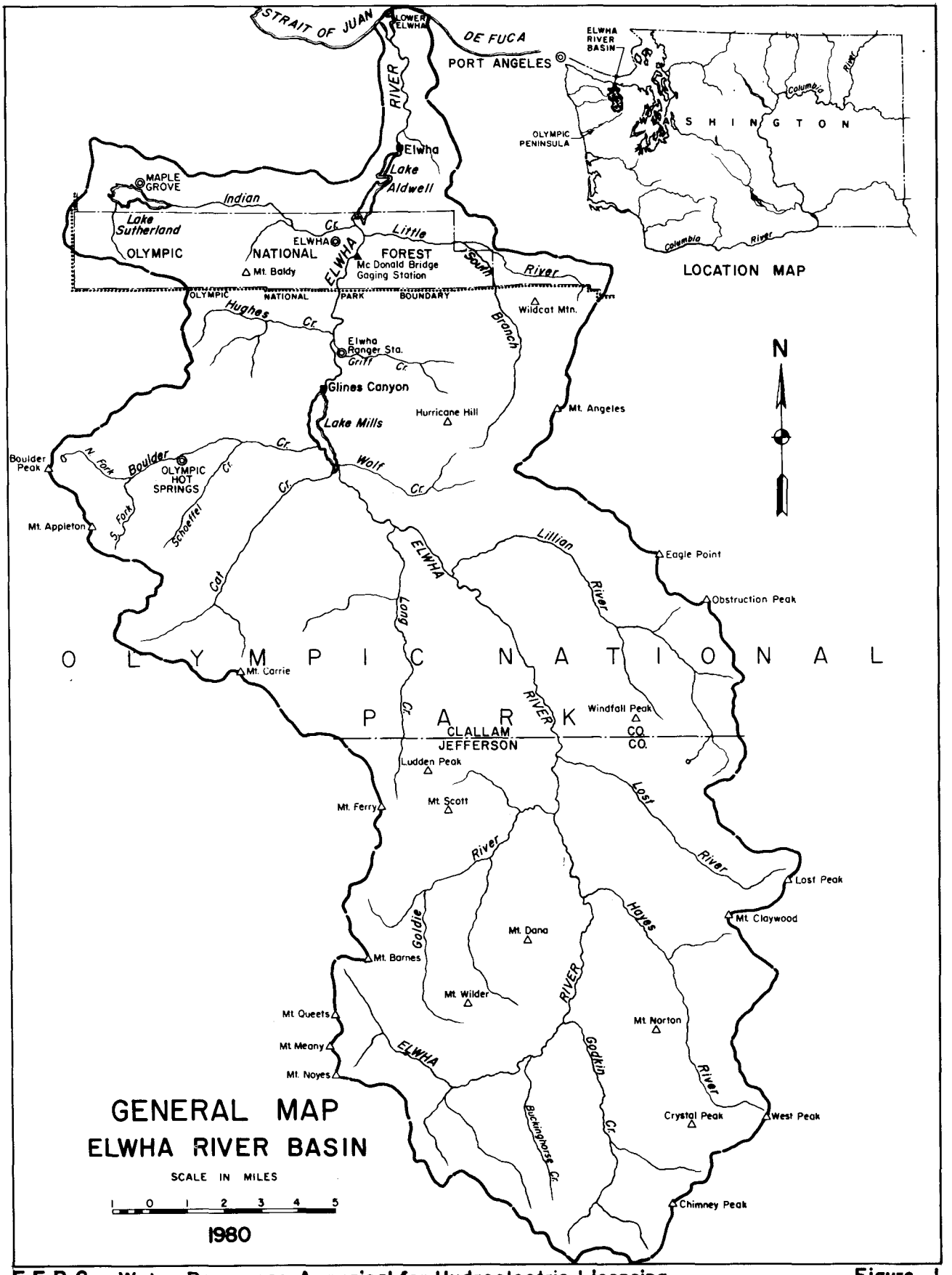
The Federal Power Act, as amended, authorized the Federal Power Commission to undertake investigations of the water resources of any region to be developed; to cooperate with the executive departments and other agencies of Federal and State Goverments in water resources planning; and to issue licenses to non-Federal interests for the construction, operation, and maintenance of dams, powerhouses, and appurtenances for hydroelectric power development and other purposes. The Act reserves to the United States the right to take over a non-publicly owned project upon expiration of license after paying the licensee's net investment in the project, not to exceed fair value of property taken, plus severance damages, if any. Projects to be licensed or relicensed must, in the judgment of the Commission, be best adapted to a comprehensive plan for improving waterways for the benefit of interstate commerce, for water power development, and for other beneficial public uses, including recreation.

On October 1, 1977, pursuant to the provisions of the Department of Energy Organization Act (DOE Act), Public Law 95-91 Stat. 565 (August 4, 1977) the Executive Order No. 12009, 42 Fed. Reg. 46267 (September 15, 1977), the Federal Power Commission ceased to exist and its functions and regulatory responsibilities were transferred to the Secretary of Energy and the Federal Energy Regulatory Commission which, as an independent commission within the Department of Energy, was activated on October 1, 1977. On December 23, 1977, the Secretary issued an order amending DOE delegation Order No. 0204-1 further delegating to the FERC the authority, under section 4(a) of the Federal Power Act, to continue its activities as they relate to river basin appraisals.

For purposes of this report, all references to the "Commission" when used in the context of an action taken prior to October 1, 1977, refer to the Federal Power Commission; when used otherwise, the reference is to the Federal Energy Regulatory Commission.

This report on the Elwha River basin, Washington, has been prepared by the staff of the Federal Energy Regulatory Commission as part of a program of Water Resources Appraisals for Hydroelectric Licensing. Bernard Smith of the Commission's San Francisco Regional Office is primarily responsible for the conduct of studies and for the overall preparation of the report. It is intended primarily to provide information which the Commission and its staff may use or build upon, as appropriate, when considering matters related to hydroelectric licensing, relicensing or recommendation for Federal takeover. The report has been prepared to correlate and, when possible, to supplement available information and thus, enable the staff and the Commission to act expeditiously on matters pertaining to the development of the hydroelectric power potential of the Elwha River basin within the limitations of other desirable water uses and environmental concerns. The report is a staff study which was not prepared for adoption or approval by the Commission, and does not commit or prejudge later Commission actions.

Much of the material in the report is based on reconnaissance-type information, but more precise data have been used where available. The basic material used in preparing this report has largely been abstracted from previous reports of Federal, State, and local entities. Several agencies and individuals have participated in discussions pertaining to the information in the report and have provided useful background data or suggestions. The plans presented however, do not necessarily carry the endorsement of any agency or group.



F E R C – Water Resources Appraisal for Hydroelectric Licensing **Figure 1**

SUMMARY

The drainage area of the Elwha River basin is about 321 square miles and forms one of the largest river basins in the Olympic Peninsula in the Western portion of Washington. The basin, located in Clallam and Jefferson Counties, is approximately 10 miles wide in an east-west direction and 30 miles long. Most of the basin lies within the Olympic National Park. Topography ranges from the gentle slopes of the narrow coastal plain near Port Angeles to the rugged glacial peaks of the Bailey Range. Elevations range from sea level at the Elwha mouth to more more than 6,000 feet along the mountain ridges which form the basin divide. Except for the cultivated fields and pastures of the coastal plain, most of the area is densely forested up to the timberline (about the 5,000-foot elevation).

The climate is predominantly a marine-type with summers being cool and relatively dry and the winters being mild, wet, and cloudy. Widely diverse variations have been recorded as a result of the Olympic Mountains and maritime air masses from the Pacific Ocean. Topography is the most controlling factor governing precipitation. The higher, glaciated elevations receive as much as 200 inches, mostly as snow; whereas the coastal plain has an annual precipitation of 25 inches. The flows of the Elwha River are minimum during the summer when precipitation is least and snow packs have been depleted.

Almost 99 percent of the total area in the Elwha River watershed is in forest, with the bulk of that being either national forest or national park. Farming and urban areas are almost nonexistent. Potential use probably will be the continued development of forested lands. Electric power is supplied to the northern portion of the Elwha River basin by Clallam County Public Utility District No. 1. All power is purchased from the Bonneville Power Administration. Due to the presence of Olympic National Park, recreation is very important to the local economy. In 1977, over 500,000 visits were made to the portion of the national park in or bordering the Elwha River basin.

The water resources of the basin have been developed to provide for water supply, flood control, recreation, and hydropower. Additionally, there is an active program for fishery management. Two hydroelectric generating facilities in the basin, both owned by the Crown Zellerbach Corporation, are used to supply power to its industries in Port Angeles. None of the generated power is sold to other users. The two projects are named Elwha and Glines Canyon. The Elwha project is located 4.9 miles above the river's mouth at the Strait of Juan De Fuca. The dam was constructed in 1911-13 along with a powerhouse containing 10.8 megawatts of installed capacity. The project (FERC Project No. 2683) has never been licensed by the Commission but an application for license is pending.

The Glines Canyon Project No. 588 is located on the Elwha River about 13.5 miles upstream from its mouth. The 14,850-kilowatt project consists primarily of a dam, reservoir, water conduits, surge tank, powerhouse, substation, and transmission lines. Average annual generation is 118 million kilowatt-hours. The project is classed as an industrial project by the State of Washington rather than a public utility. On June 3, 1976, the original license expired and subsequent to that date, an annual license for continued operation and maintenance of the Glines Canyon project has been issued to the licensee, Crown Zellerbach Corporation. An application for new major license was filed with the Commission on June 1, 1973, and was supplemented April 1, 1976, June 1, 1976, June 15, 1976,

and March 30, 1977. Since the project was licensed as a major project, it is subject to the takeover provisions of section 14 of the Federal Power Act.

With basically little usable water storage capacity, the Glines Canyon Dam is operated essentially as a run-of-river powerplant. Generation is directly proportional to streamflow up to the plant's hydraulic capacity of 1,200 cubic feet per second except for the small regulatory effect of the reservoir. Continued operation of the Glines Canyon plant appears to be economically attractive. The project is well maintained and appears capable of providing both an economical source of power and recreational activities for many years after the expiration of the original license.

There are adequate water and related land resources to meet present and future requirements in the Elwha basin. It should also be recognized that Congressional restraints imposed upon developments inside a national park limits the range of opportunities. Future water resource developments, if any, will probably be for the purpose of fishery enhancement or water supply.

Five potential conventional hydroelectric and one potential pumped storage site in the basin have been considered for development. However, all of the projects except for one of the conventional hydroelectric projects are located within the Olympic National Park. None of the projects is, at this time, being given further consideration for development.

As is done at the Glines Canyon project, consideration should be given to regulating the Elwha project for minor flood control. The Puget Sound Task Force recommended that a fish passage facility be constructed at the Elwha Dam and that Lake Aldwell be regulated in the future to provide water supply and streamflow regulation for fish.

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CHAPTER I

DESCRIPTION OF THE ELWHA RIVER BASIN

Location and Drainage Area

The Elwha River drains an area of about 321 square miles in Clallam and Jefferson Counties, Washington. The drainage area, which forms one of the largest river basins on the Olympic Peninsula, is about 10 miles wide and 30 miles long as shown on figure 1. Most of the Elwha River basin lies within Olympic National Park.

The Elwha River rises in a glacial field on the southeastern slopes of Mount Olympus (the peak of which is located outside of the Elwha River basin). From its source, the Elwha River flows in a southerly direction, making a sweep eastward, then flows northerly about 30 miles to the Strait of Juan de Fuca. The Elwha River has no major tributaries but is joined by numerous small streams.

Physiography and Geology

Topography ranges from the gentle slopes of the narrow coastal plain near Port Angeles, Washington, to the rugged glacial peaks of the Bailey Range. Elevations range from sea level at the Elwha River mouth to more than 6,000 feet along the mountain ridges which form the basin divide. Except for the cultivated fields and pastures of the coastal plain, most of the area is densely forested to timberline near the 5,000-foot elevation. Summer retention of snow on a site governs the upward limits of the forest.

The predominant geological feature of the north Olympic Peninsula is the Olympic Mountains. Unlike most mountain features, they do not exist as a range. Rather, they radiate out in all directions from the 7,965-foot Mount Olympus. The mountains were formed in the late Pliocene era, about two million years ago, when they were uplifted from the sea. The materials from which they are formed are much older. Subsequently, alterations have been made on the landform by glaciation and avalanche activity. Glaciers are still present in the higher elevations but are receding. Evidence of recent avalanche activity exists as the landform continues to change. Materials present in the mountains are conglomerates, sandstones, siltstone, and volcanics. Sedimentary rocks of early Tertiary age predominate throughout the southern three-quarters of the basin. In the vicinity of Lake Mills and Glines Canyon, two belts of volcanic rocks with an intervening sedimentary belt trend northwesterly across the Elwha basin. The steep walls of Glines Canyon are a result of the relative durability of resistance to weathering and erosion of these rocks. The steeply dipping to vertical attitude of the volcanic-sedimentary belt has also been a determining influence in the development of Glines Canyon. North of Glines Canyon, the outer or younger volcanic belt is bounded by still younger or later Eocene rocks consisting of a complexly-interbedded sequence of marine sandstone, conglomorate, siltstone and shale. These younger sedimentary rocks are less intensely folded and metamorphosed than rocks in the southern portion of the basin. Their somewhat less consolidated nature renders them more susceptible to erosion and to the ultimate development of the gentle hills and ridges adjacent to the narrow coastal plain.

The Elwha River is a tortuous and turbulent stream, winding between high and precipitous mountains, cutting its way through narrow valleys from a quarter of a mile to a mile in width and of various lengths. The bed of Elwha River is from 50 to 200 feet wide and is covered with boulders and large rocks which have rolled down from the mountain sides. The banks are high and the channel of the river is not susceptible to appreciable change at any place except in the low lands near its mouth, where it has shifted course several times causing extensive damage to the farms in the vicinity.

Climate and Hydrology

Because most of the air masses that reach the basin originate over the Pacific Ocean, the climate of the basin is predominately a marine-type which is characterized by relatively dry and cool summers and wet and mild winters.

The barriers formed by the Olympic Mountains have a direct bearing on the precipitation in the basin. Average precipitation exceeds 220 inches a year in the upper reaches of the Elwha watershed, and decreases to about 30 inches along the coastal region.

The normal monthly and annual temperatures and precipitation for two weather stations in the area are shown in table 1. Elwha Ranger Station is located in the basin, and the other, Port Angeles, with a longer period of record, is located just outside of the basin.

Although records of streamflow in the mountains are nonexistent, average annual runoff is estimated to exceed 160 inches in the upper reaches of the Elwha River. There is one U.S. Geological Survey streamflow gaging station in the basin, McDonald Bridge, located at mile 8.6 on the Elwha River in the Olympic National Forest. The gage drainage area is 269 square miles.

The period of record for the gage is 64 years, from October 1897 to December 1901 and from 1918 to the present. The maximum flow recorded was 41,600 cubic feet per second in November 1897. Minimum daily discharge recorded was 10 cubic feet per second in October 1938. The average discharge for the period of record (through October 1978) is 1,511 cubic feet per second. River flow is partially regulated by the Lake Mills Reservoir, about five miles upstream from the gage.

Table 1

Normal Monthly and Annual Temperatures and Precipitation
Elwha River Basin Area

	Elwha Ranger Station (El. 360 feet msl)		Port Angeles Station (El. 100 feet msl)	
	Temperature (degrees F.)	Precipitation (inches)	Temperature (degrees F.)	Precipitation (inches)
January	36.1	8.98	38.5	4.01
February	36.1	6.97	41.4	2.93
March	40.4	5.54	42.9	2.04
April	44.2	3.28	47.1	1.33
May	52.0	1.68	52.1	.94
June	56.6	1.29	56.3	.91
July	63.2	.74	59.4	.49
August	58.7	1.02	59.0	.73
September	57.7	2.01	56.6	1.20
October	48.1	5.68	50.2	2.68
November	41.4	8.71	43.9	3.79
December	38.0	9.74	40.6	3.97
Annual	47.7	55.64	49.0	25.02
Years of Record	30	33	73	99

Source: Annual Summary 1976, Climatological Data, U.S. Department of Commerce.

CHAPTER II

PRIOR REPORTS AND CURRENT INVESTIGATIONS

Prior Reports

Much of the information used in this report was obtained from several other reports having a direct and important bearing on matters pertaining to the water and related land resources of the Elwha River basin. The more significant reports are briefly described below.

A comprehensive Water and Sewerage Plan for Clallam County, Washington, was published in March 1970 by Stevens, Thompson & Runyan, Inc., Engineers/Planners, Seattle, Washington. The plan projects the water and sewage improvements required in Clallam County to properly serve its residents during the next 20-year period.

The Comprehensive Study of Water and Related Land Resources, Puget Sound and adjacent waters, State of Washington, completed in 1971, was prepared by the State of Washington and concerned Federal agencies as members of the Puget Sound Task Force under the aegis of the Pacific Northwest River Basins Commission. The report presents a comprehensive plan for meeting the expected needs of the Puget Sound area projected to the year 2020. The comprehensive plan contains a number of proposed projects in the Elwha River basin, including fish passage facilities around Elwha and Glines Canyon Dams, diversion facilities from Elwha River to Port Angeles, and outlet works and reservoir operation modification of the Elwha project for the purpose of industrial water supply. Although the power appendix of the report identifies a number of potential conventional hydroelectric development sites and one potential pumped-storage development site in the Elwha River basin, the comprehensive plan for the Elwha basin includes no additional power facilities.

In November 1971, the State of Washington Department of Fisheries reported on Elwha River Fisheries. The study was financed by Crown Zellerbach Corporation and was undertaken to evaluate the impact of Crown Zellerbach's Elwha-Glines Canyon hydroelectric projects on the fishery resources of the Elwha River.

The Columbia-North Pacific Region Comprehensive Framework study of Water and Related Lands, completed in 1972, presents broad framework plans and programs for the development and management of water and related land resources of the Columbia-North Pacific region, which includes the entire Elwha River basin. The report was prepared by State and Federal agencies under the aegis of the Pacific Northwest River Basins Commission. No specific projects in the Elwha River basin were included in the study's framework plans.

A study of the Municipal Water System of Port Angeles, Washington, was documented in October 1973 by CH2M Hill, Bellevue, Washington. The Elwha River was considered as one of the two sources to supply future water needs of Port Angeles.

The Final Environmental Statement for the Proposed Olympic Wilderness in Olympic National Park, Washington, was prepared by the National Park Service in July 1974.

The statement, in response to the Commission's comments (dated November 1973), indicates that Glines Canyon Dam and Lake Mills lay outside the proposed wilderness boundaries.

A Water Quality Management Plan for North Olympic Coastal Basin was prepared in 1974 by ENCON, Environmental consultants, Vancouver, Washington. The plan represents a major effort towards developing a comprehensive water quality management program for Jefferson and Clallam counties, Washington, and their incorporated towns and cities.

In January 1976, the North Pacific Division of the Corps of Engineers published "Pumped Storage in the Pacific Northwest, an Inventory." The inventory includes one potential pumped storage site in the Elwha basin.

In January 1976, the Public Utility District No. 1 of Clallam County, Washington, and the City of Port Angeles, Washington, prepared appendices IV and XVIII, respectively, of the Draft Environmental Impact Statement Supplement for Furtherance of Washington Public Power Supply System Nuclear Projects Nos. 4 and 5. These appendices describe electric utility systems and water resources in the Port Angeles - Clallam County area.

The Corps of Engineers, Seattle District, prepared a report, published August 1978, entitled "Phase 1 Inspection Report, National Dam Safety Program, Elwha Dam, Port Angeles, Washington." The report states that the dam does not meet inspection criteria and recommends improvements for dam safety.

Current Investigations

Officials of Clallam County requested the Corps of Engineers to conduct a study of flood problems along the lower 2 miles of the Elwha River. The study was deferred until safety of the upstream Elwha Dam has been determined.

The Corps of Engineers is currently conducting a detailed assessment of the nation's hydroelectric resources as part of the national Hydroelectric Power Study. The study is designed to provide a current and comprehensive estimate of the potential for incremental or new generation at existing dams and other water resource projects, as well as for undeveloped sites in the United States. When completed in 1981, the effort will provide a more detailed evaluation of the nation's hydroelectric resources, and will serve as a framework for future planning and development of this important renewable energy source. The national Hydropower Study addresses all conventional hydroelectric power potential at Federal and non-Federal installations, and considers both large and small scale dams and other water resource projects.

CHAPTER III

THE ECONOMY OF THE BASIN

Ninety-eight percent of the Elwha River basin consists of mountainous, heavily forested, national park or national forest land. Moreover, most of the privately owned property within the basin is subject to periodic flooding and, therefore, unable to support urban development. Consequently, economic activity and population within the basin are negligible.

Population

Adjacent to the basin is the City of Port Angeles in Clallam County, a major pulp and paper manufacturing center and a focal point for tourists visiting the Olympic National Park and Victoria, British Columbia. In 1975, Port Angeles had an estimated population of 16,236 persons. Significantly, during the 1960's, the city accounted for almost 80 percent of Clallam County's population growth. Recently, most of the county's population gains have occurred within unincorporated areas east of the city. Past and projected population changes within Clallam County and Jefferson County, the other county in which the Elwha basin is situated, are shown in table 2.

Table 2

Past and Projected Population Growth
near the Elwha River Basin, 1950-2000

Year	City of Port Angeles	Clallam County	Jefferson County
1950 1/	11,233	26,396	11,618
1960 1/	12,653	30,022	9,639
1970 1/	16,367	34,770	10,661
1975 2/	16,236	40,100	11,800
1980 3/	na	44,100	13,500
1990 3/	na	52,000	16,700
2000 3/	na	55,900	18,400

na- Population projections for areas smaller than counties are unavailable.

1/ U.S. Department of Commerce, Bureau of the Census, Census of Population, 1950, 1960, and 1970.

2/ U.S. Department of Commerce, Bureau of the Census, Estimates of the Population of Washington Counties and Metropolitan Areas: July 1, 1975 and 1976, Current Population Reports, Series P-25, No. 707, August 1977.

3/ Washington State Office of Financial Management, Population, Enrollment, and Economic Studies Division, Washington State County Population Forecasts by Age and Sex, 1970-2005, December 1977.

Employment and Income

In 1975, the latest year for which complete data are available, 15,843 persons were employed in Clallam County (table 3). These persons earned wages, salaries, and proprietors income totalling $149,680,000. As shown in table 4, the county's manufacturing establishments generated about one-third of this amount. Wood products -- primarily logs, lumber, and plywood -- and pulp and paper are this sector's most important products.

Table 3

Employment Growth by Major Industry Group
Clallum County, 1967-1975

Industry Group	Average Yearly Employment 1/		Change in Employment
	1967	1975	1967-75
Agriculture	674	628	-46
Manufacturing	3,202	3,631	429
Contract construction	330	590	260
Contract construction	330	590	260
Transportation, communications, and Public utilities	517	578	61
Wholesale and retail trade	1,675	2,596	921
Finance, insurance, and real estate	254	405	151
Personal, repair, business, medical, legal, educational, and tourist services	1,416	1,841	425
Federal civilian government	293	388	95
Federal military personnel	463	611	148
State and local government	1,625	2,707	1,082
Non-farm proprietors	1,459	1,761	302
Other 3/	84	107	23
Total employment 4/	11,992	15,843	3,851

1/ Includes both full- and part-time workers.
2/ Includes farm proprietors and employees.
3/ Includes mining, fishing, and household employees.
4/ Excludes unpaid family workers.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economics Information System, table 25, unpublished data, 1978.

Agriculture

Agriculture is very limited within the confines of the basin. Small amounts of cultivated farmland lie along the lower 4 miles of the Elwha River, in the Indian Creek valley, and some small areas upstream from Lake Aldwell and below Lake Mills. The cultivated land above Lake Aldwell is primarily in hay and pasture, while that lying downstream from Lake Aldwell is cultivated in close-growing crops and hay and pasture. There are 752 acres of cultivated land in this watershed. This amount represents only 0.4 percent of the total basin land area.

Table 4

Labor and Proprietors Income by Major Industry,
Clallum County, 1975

Industry Group	Income ($1,000)	Percentage
Agriculture	2,843	1.9
Manufacturing	50,425	33.7
Contract construction	8,781	5.9
Transportation, communications, and public utilities	7,702	5.2
public utilities	7,702	5.2
Wholesale and retail trade	23,884	16.0
Finance, insurance and real estate	4,040	2.7
Services	15,548	10.4
Federal civilian government	6,057	4.1
Federal military	6,990	4.6
State and local government	21,875	14.5
Other	1,535	1.0
Total	149,680	100.0

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economics Information System, table 5, unpublished data, 1978.

Mineral Resources

Mining and mineral processing have not, historically, been important in the economy of the Elwha basin. With the dedication of most of the area to the National Park System, further mineral exploration and development is unlikely.

Production of small amounts of sand, gravel and crushed stone for construction purposes and road maintenance are the main mineral activities in the Elwha basin. Although production is small, the industry is, nevertheless, important to the area's continuing economic growth. North of Olympic National Park, the basin contains abundant resources of these materials in the form of glacial outwash, alluvium, and isolated remnants of basalt flows. Demands on these resources have been modest but increasing. In 1964, the combined production of crushed stone, and sand and gravel in Clallam County was 264,000 short tons with a total value of $231,000. By 1974, production had increased to 548,000 short tons with a total value of nearly $600,000. Less than 20 percent of the total production quoted for Clallam County is derived from the Elwha basin. No mineral production is derived from the Jefferson County portion of the basin, which lies entirely within the Olympic National Park.

Since 1968, a small clay industry has been developing in Clallam County. The end use of the clay product is presumed to be paper filler and ceramics. Production data for this industry is proprietary information and not available for publication. Part of the reserves supporting this industry occur in the

northern portion of the Elwha basin. The area's manganese resources are currently uneconomic with little likelihood of development in the foreseeable future, except in a national emergency.

The sedimentary rocks of Tertiary Age which form the coastal plan adjacent to the Strait of Juan de Fuca have been the focus for recent petroleum exploration. No discoveries have been reported and the petroleum potential of the area remains undemonstrated.

The volcanic and adjacent sedimentary belts of the basin are areas of anomalous geothermal gradient and heat flow. A surface manifestation of this broad geothermal anomaly occurs at Olympic Hot Springs. Exploration and development of the geothermal potential is unlikely because most of the geothermal anomaly lies within the Olympic National Park.

Transportation

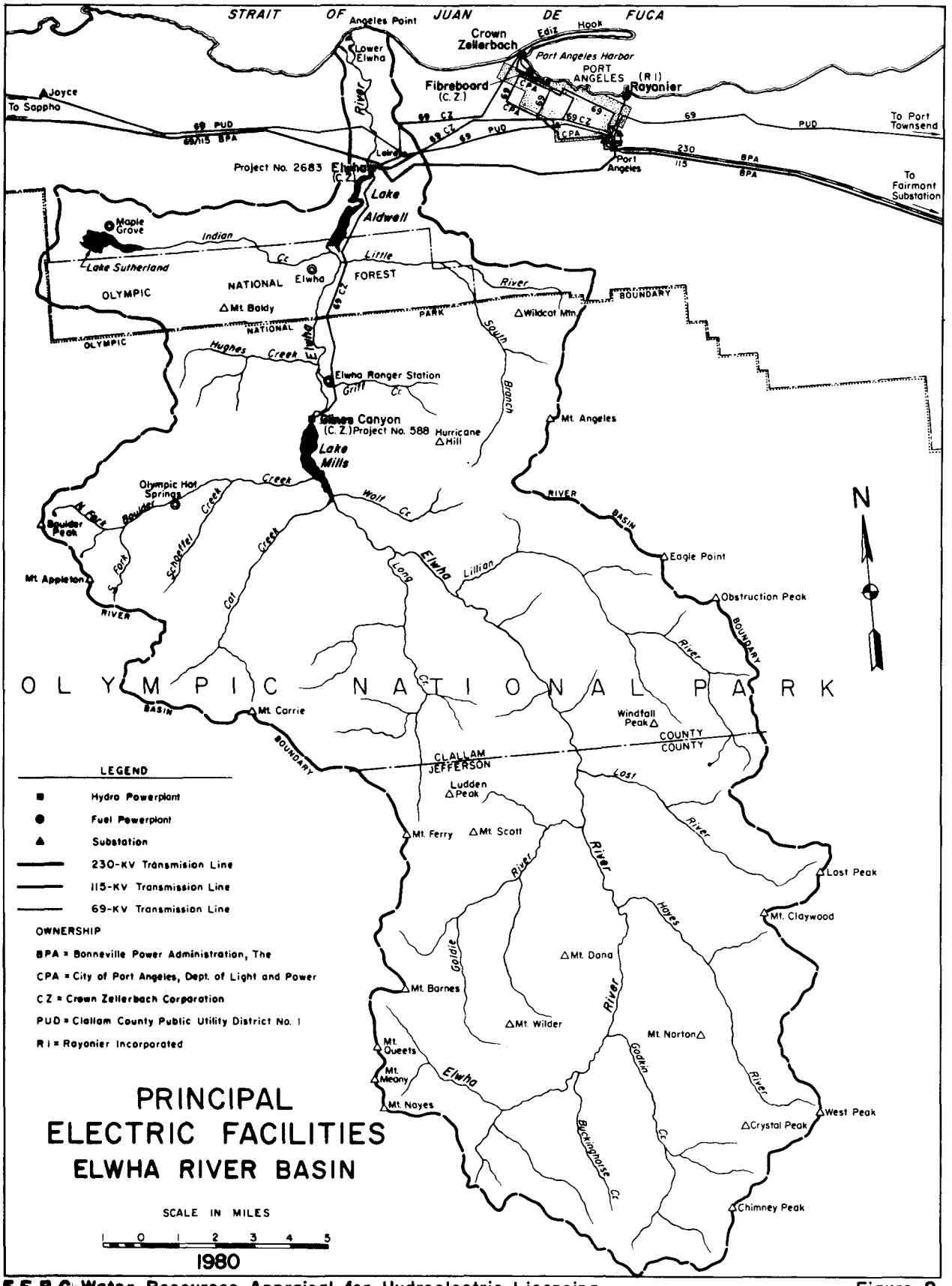
The system of roads is the primary means of transportation within this area. The basin's road network centers around the U.S. Highway 101 loop connecting the major cities of the Olympic Peninsula. State Highway 112 follows the coast in an eastwest direction. A secondary road provides limited access south into Olympic National Park and Olympic National Forest.

The only commercial air service on the Olympic Peninsula is at nearby Port Angeles. The heavy industries located at Port Angeles are best served by ship because of the products' bulky nature. Port facilities at Port Angeles accommodate ocean-going ships as well as sport and commercial fishing boats. Regular ferry service is provided for freight and passengers to Victoria, British Columbia. Rail service is available via the Chicago, Townsend, where railroad cars are then transported by barges across Puget Sound to Seattle.

Electric Utility Systems

Electric power is supplied to the northern portion of the Elwha River basin by Clallam County Public Utility District No. 1. The District has no generation facilities and purchases all electric power for resale from Bonneville Power Administration. The principal electric facilities in the Elwha River basin vicinity are shown on figure 2. There are two hydroelectric projects located in the basin, both owned by Crown Zellerbach Corporation. The two plants, the 10,800-kilowatt Elwha project (FERC Project No. 2683) and the 14,850-kilowatt Glines Canyon project (FERC Project No. 588) are used by the Company to serve part of its load at the Port Angeles mill. The power output from the Elwha project is combined with the Glines Canyon project output and is delivered to the Company's Port Angeles mill by two 69-kilovolt transmission lines. The output of the two projects plus supplemental purchased power from Bonneville Power Administration supplies the mill's total requirements.

As shown on figure 2, Clallam County PUD No. 1 owns and operates a 69-kilovolt transmission line that extends from Port Angeles through the basin to Sappho. Loads in the basin are supplied by this line through the 10,000-kilovolt-ampere Laird substation. Bonneville Power Administration also owns and operates a 69-kilovolt (115-kilovolt design) transmission line from Port Angeles to Sappho which passes through the north basin.



F E R C-Water Resources Appraisal for Hydroelectric Licensing **Figure 2**

Recreation

Visitors come from throughout the United States to enjoy the natural beauty and to utilize the many recreation facilities available on the Olympic Peninsula. The principal recreation attraction on the Peninsula is Olympic National Park. Since the Peninsula is less than a two-hour drive from the Seattle-Tacoma metropolitan area, it is heavily used by urban residents.

Olympic National Park covers most of the peninsula and includes 89 percent of the Elwha River basin. Another eight percent of the basin is within the boundaries of Olympic National Forest. Lands held in trust by the Bureau of Indian Affairs for the Lower Elwha Band of Clallam Indians comprise one percent of the basin. The remaining two percent is in private ownership.

The National Park Service reported 2,659,000 visits to Olympic National Park in 1977. The National Park Service defines a visit as the entry of a vehicle into the park when the passengers use the services or facilities provided by the Park Service. Thus, commercial traffic entering the park and recreation traffic passing through the park but not stopping are excluded from the visitor count.

During 1977, 36,000 visits were attributable to the portion of the Elwha basin within the national park. Additionally, Hurricane Ridge, the divide between the Elwha River and Morse Creek drainages, attracted 436,000 visits. Recreation use within the basin, but outside the park boundaries, occurs at Lake Sutherland and Lake Aldwell. No use figures are available for these recreation areas.

In 1968, the National Park Service contracted with the University of Washington to study the economic impact of Mt. Ranier and Olympic National Parks. Using this study, which provides recreation expenditures of visitors per trip per vehicle, it is possible to estimate the contribution to the local economy of the Elwha River basin portion of Olympic National Park. By taking the weighted average of recreation expenditures in and near Olympic National Park, each visit was worth about $25 to the local economy in 1968 dollars. Adjusting for inflation using the Consumer Price Index relevant to recreation, each visit was worth $32 to the local economy in 1977 dollars. The adjusted unit value multiplied by the number of visits provides an approximate value of recreation to the basin. Therefore, it is estimated that in 1977 the national park portion of the Elwha River basin contributed $1,150,000 to the local economy.

CHAPTER IV

EXISTING WATER AND RELATED LAND RESOURCES DEVELOPMENT

General

Almost 99 percent of the total area in the Elwha River watershed is in forest, with the bulk of that being either national forest or national park. Farming and urban areas are almost nonexistent. Development of forested lands will probably continue.

The production of salmon from the Elwha basin provides an important segment of the harvest of the commercial and sport fisheries of Puget Sound, Strait of Juan de Fuca and the Pacific Ocean coastal waters. There is a wide variety of wildlife present as the Elwha River originates in the rugged Olympic Range and traverses all the life zones of western Washington on its route to the Strait of Juan de Fuca. The varied climate greatly influences wildlife abundance and distribution.

The water resources of the basin have been developed to provide for water supply, flood control, recreation, and hydroelectric power. Additionally, there is an active management program for fishery enhancement. Existing water resource developments which provide the foundation for future resource planning are discussed in the following paragraphs.

Water Supply

The city of Port Angeles obtains water for its municipal supply from Morse Creek. This is a small coastal basin immediately east of the Elwha basin with a drainage area of about 50 square miles. The system consists of a simple diversion dam, which currently supplies the city with 3.80 million gallons per day, but is capable of supplying a peak demand of 8.10 million gallons per day. It serves a population of 15,700 and periodically, one industry. The water is disinfected for domestic use.

A 70-inch industrial water line constructed by the city of Port Angeles in 1929 to divert water from the Elwha River furnishes 59 million gallons per day to the Crown Zellerbach Fibreboard Corporation, and I.T.T. Rayonier Incorporated pulp mills. The water line is owned by the city of Port Angeles but is operated and maintained by the industries. Although the line was constructed to relieve industrial demands on the municipal system, the Fibreboard Corporation pulp mill draws an average of 500,000 gallons per day from the municipal system. Although the average annual demand by this industry is 0.50 million gallons per day, most of the water is used during the winter months when waters of the Elwha are turbid and unsatisfactory for use, which reflects a somewhat higher municipal use during December and January than would be expected for purely municipal consumption.

Flood Control

The 750-acre floodplain of the Elwha River extends from Lake Mills to the river mouth interrupted by Lake Aldwell. Overbank flooding occurs when flows exceed 9,000 cubic feet per second. Flows of this magnitude have a recurrence interval

of about 1.4 years. Improvements in the floodplain are scattered along the lower 13 miles of the river and consist primarily of recreation-oriented developments. The lower delta is utilized for agriculture. Major flood discharges on the Elwha River do not seriously disrupt the economy of the basin because the principal transportation systems are not affected, very few homes are within the floodplain, and damaged facilities can be restored rapidly. Flood damage is sustained by agricultural lands, campgrounds, flood protective works, and a water supply diversion structure.

The existing flood control system consists of flood control storage provided by voluntary drawdown of the Lake Mills Reservoir by the Crown Zellerbach Corporation, two levees, and a channel improvement project. One of the levees was constructed by Clallam County, 10 feet high on the left bank of the Elwha River extending about 1,000 feet upstream from the river mouth. The other levee project protects the control channel for the Port Angeles industrial water supply system. The channel improvement has been made approximately 1.5 miles upstream from the river mouth.

The low degree of protection provided by these facilities limits use of floodplain lands to agricultural uses such as hay production or pasture. Recreational development in the upper reaches is also limited by flooding. When a flood is expected, the Lake Mills Reservoir is drawndown 5 feet which corresponds to a storage capacity of 2,500 acre-feet. This reduces peak discharges of moderate floods but has little effect during major floods. Small tributaries of the Elwha River have no significant flood, drainage, or erosion problems because of the lack of development and excellent vegetative cover.

Hydroelectric Power

There are two hydroelectric developments in the Elwha River basin, the Elwha project (FERC Project No. 2683) and the Glines Canyon project (FERC Project No. 588). Both projects are owned and operated by Crown Zellerbach Corporation for the purpose of providing electric power to their Port Angeles mill. The total installed capacity for the 2 plants is 25,650 kilowatts. The average annual generation of the 2 hydroelectric projects for the period 1955 through 1967 was 160,544 megawatt-hours. In 1977, the 2 plants generated a total of 146,869 megawatt-hours, as reported to the Federal Energy Regulatory Commission 1/. Of this total, 96,386 megawatt-hours was accountable to the Glines Canyon project 2/ and 50,483 to the Elwha project.

The original license for the Glines Canyon development expired on June 3, 1976, and since that time the project has been operating under annual licenses. Glines Canyon is presently being considered for relicensing and is described in detail in chapter V.

The Elwha Dam, which was constructed in 1911-13, is located 4.9 miles above the river's mouth at the Strait of Juan de Fuca. The 3,300-acre-foot reservoir created by the dam is known as Lake Aldwell. The Elwha project has a total

1/ *FPC Industrial Form No. 4, January-December 1978.*
2/ *Correspondence, January 17, 1978, Crown Zellerbach to FERC, Subject-Project No. 588.*

installed capacity of 10,800 kilowatts and consists of a dam with two spillways, a penstock intake section and a powerhouse. The powerplant has four Francis-type turbines: two horizontal units installed in 1912 and two vertical units installed in 1922. The Elwha project is under consideration for licensing and is described in detail in chapter V.

The questionable safety of the Elwha Dam has been the subject of continuing concern to interested parties and agencies. Independent engineering contractors retained by Crown Zellerbach, the U.S. Army Corps of Engineers, the Washington State Department of Ecology, and the staff of the FERC have all found the dam to be unsafe for probable maximum flows. The U.S. Department of Housing and Urban Development has refused to appropriate monies, otherwise earmarked, to the Lower Elwha Indian Tribe for housing developments until the safety of the dam is improved.

The Elwha development has never been licensed by the FERC or the FPC. Following the decision of the United States Supreme Court in the Taum Sauk case, Union Electric Company vs. FPC, 381 U.S. 90 (1965), Crown Zellerbach, on July 22, 1968, filed an application for a major license to operate and maintain the Elwha development. Supplements to the application have been filed on November 2, 1968, February 14, 1969, and April 13, 1973. On March 24, 1976, Crown Zellerbach filed another supplement to the application, requesting that the FPC issue a declaratory order that Crown Zellerbach was not required to file an application for a license for the Elwha development and could withdraw its application without violating the Federal Power Act and that the FPC was without authority to issue a license for the Elwha development. On December 11, 1978, a FERC administrative law judge ordered that the Commission does have jurisdiction over the Elwha project and that the Crown Zellerbach Corporation should refile its license application.

Navigation

Other than the above mentioned order, there are no previous Commission orders that have determined Elwha River to be navigable. However, most navigation on the river has been historical. There is evidence of pre-dam Clallam Indian river traffic, a brief period of history of use by white settlers, and some use of the river downstream of the dam for travel and commerce to this day primarily for guided fishing trips.

Recreation

The Elwha River basin is comprised primarily of public lands under the jurisdiction of the National Park Service and U.S. Forest Service. Private lands open for public recreation are at Lake Aldwell and Lake Sutherland.

The most popular basin recreation area in Hurricane Ridge situated in Olympic National Park 20 miles south of Port Angeles and forming the eastern boundary of the Elwha River basin. The road leading to Hurricane Ridge is outside the basin, but the day use facilities are situated in the basin. Recreation facilities consist of a visitor center, restaurant, picnic area and a ski run operated during the winter. Over 436,000 visits to Hurricane Ridge were reported in 1977 by the National Park Service.

The National Park Service operates three campgrounds in the basin. Elwha Campground, the only campground in the basin open all year, has 52 campsites. It is located 8 miles west of Port Angeles and 3 miles south of U.S. Highway 101 adjacent to the Elwha River. Altaire Campground has 29 campsites and is located 1 mile south of Elwha Campground. Boulder Creek Campground is located 7 miles southwest of Elwha Campground at the end of Boulder Creek Road and contains 20 campsites.

Outside of the national park, recreation developments are located at Lake Aldwell, the Elwha project reservoir and Lake Sutherland. A small campground resort and a county boat launching ramp are situated on Lake Aldwell. At Lake Sutherland, there are several private resorts and a public boat launching ramp has been provided by the Washington Department of Game. Crown Zellerbach Corporation constructed a free boat launching ramp on Lake Mills adjacent to its Glines Canyon Dam. The basin also contains over 40 miles of trails, most of which are within Olympic National Park.

Fish and Wildlife

The development of hydroelectric power generation facilities on the Elwha River is the most significant factor limiting fish and wildlife production. The Elwha Dam precludes anadromous fish from using all but the lower 4.9 miles of the Elwha River for spawning and rearing.

Anadromous fish utilize all spawning gravels below Elwha Dam; however, widely fluctuating river flows limit chinook, coho, pink and chum salmon use of the Elwha River. Other anadromous fish using the river include searun cutthroat trout and searun Dolly Varden. The Washington Department of Fisheries supplements the natural production of chinook salmon by releasing an additional 20,000 fingerlings during each out migration.

Resident fish inhabiting the Elwha River system include rainbow, cutthroat, and brook trout; mountain whitefish; threespine stickleback; sucker; and sculpine. The Washington Department of Game stocks Lake Sutherland with 20,000 catchable (over 10 inches) cutthroat trout annually. Redside shinners inhabit Lake Sutherland, its outlet, Indian Creek, and Lake Aldwell. Kokanee have been successfully introduced into Lake Aldwell, Lake Mills, and Lake Sutherland.

Below Elwha Dam, the Washington Department of Fisheries operates the Elwha Fish Rearing Facility. The facility was opened in 1975 to produce coho and chinook salmon to mitigate the loss of fish habitat caused by the construction of Crown Zellerbach's hydroelectric power projects. Crown Zellerbach pays the cost of rearing fish which are released in the basin. Additional fish are raised for release throughout Washington State. Planned fish production for the 1977-78 fiscal year was 150,000 coho and 180,000 chinook.

Many species of wildlife are present throughout the basin. Blacktail deer, Roosevelt elk, black bear, and mountain goat are present in significant numbers. During the summer, these species inhabit the higher elevations and in winter they move to the lower elevations of the basin. In winter, Roosevelt elk and blacktail deer concentrate around Lake Mills. Populations of these two species are limited by food available during the winter. Lands flooded by Lake Mills and Lake Aldwell contained areas of winter habitat.

Mountain goats were introduced on the Olympic Peninsula in 1924 and 1929. They now thrive on several mountains including Mount Angeles which separates the Elwha and Morse Creek watersheds. Black bear are found throughout the forested areas of the basin. Mountain lion also inhabit the basin.

Upland game species include ruffed and blue grouse, ring-necked pheasant, California quail, Hungarian partridge, and band-tailed pigeon. Beaver, muskrat, mink, marten, river otter, raccoon, and weasel are resident furbearers. Waterfowl include eider, bufflehead, scaup, pintail, green-winged teal, widgeon, mallard, black brant, and coot. Most waterfowl are migrants, but a few winter in the basin. Numerous other species of wildlife not classified as game animals inhabit the basin. These include songbirds, birds of prey, shorebirds, forest rodents and amphibians and reptiles.

There are not threatened species in the basin. However, the status of the fisher, pine marten, spotted owl, and American osprey has not been determined due to insufficient data. All have been seen in the basin.

Water Quality

The Elwha River flows for the greater part of its length through a natural sanctuary, Olympic National Park, where outdoor recreation is the primary use. Hence, wasteloading is light, and minimum flows for other purposes such as fish are sufficient to maintain desirable water quality.

A potential pollution problem exists in the heavily forested areas of the upper Elwha River watershed where new methods of pest control call for chemical spraying applied by aircraft. Such application in this steep, fast run-off watershed tends to shorten the time interval and increase the intensity of toxic chemicals leaching into the stream and rivers.

It is expected that at certain times of the year, extreme water fluctuations from the Elwha power dams create unnaturally wide temperature ranges in the river below. Such conditions could be very damaging to fish life and to the production of natural fish food, depending on the extent and rate of the temperature change.

As the water is used for water supply by the pulp and paper industries in Port Angeles, turbidity problems occurring in the river during winter months force the industries to rely on the Port-Angeles municipal system for additional water.

CHAPTER V

THE GLINES CANYON AND ELWHA PROJECTS

History of the Glines Canyon Project

Construction of the Glines Canyon development was initiated in May 1926 by Northwestern Power and Light Company. The site for the powerplant facility was acquired in March 1916 by the Company's predecessor, Northwestern Power and Manufacturing Company. Energy has been produced continuously subsequent to April 30, 1927, although the construction of the dam was not completed until about June 15, 1927. A Federal Power Commission license was issued on June 4, 1926, to Northwestern Power and Light Company for a period of 50 years. The Commission designated the development as Project No. 588. On May 8, 1934, the license was transferred to Washington Pulp and Paper Corporation. Crown Zellerbach Corporation acquired title to the property and license on July 31, 1936.

On June 1, 1973, the licensee filed an application for a new license to become effective after expiration of the original license. The application was supplemented April 1, 1976, June 1, 1976, June 15, 1976, and March 31, 1978. Crown Zellerbach has been issued annual licenses for continued operation and maintenance of the Glines Canyon project since the original license expired on June 3, 1976. The project is being considered by the Commission for relicensing or recommendation for Federal takeover. Since the project was licensed as a major project, it is subject to the takeover provision of section 14 of the Federal Power Act.

The project is not classed as a public utility by the State of Washington, but as an industrial project. Power from the project is delivered to the licensee's pulp and paper manufacturing plant located on Ediz Hook, Port Angeles, Washington.

Description of the Glines Canyon Project

The Glines Canyon hydroelectric project is located on the Elwha River approximately 13.5 miles above its confluence with the Strait of Juan de Fuca. The project consists primarily of a dam, reservoir, water conduits, surge tank, powerhouse, substation, and transmission lines. Figures 3, 4, and 5 show project configuration. Project data are summarized in table 5.

The dam is constructed in five distinct sections: the 185-foot-long earthfill embankment on the east (right) abutment; the 120-foot-long concrete gravity section; the 155-foot-long, 200-foot-high, concrete arch section and related thrust block; the gated spillway section approximately 145 feet long; and the 260-foot-long earthfill embankment on the left abutment. The arch dam was contructed with an ungated spillway, with crest at elevation 590 mean sea level (msl) and was originally divided into eight 16-foot-wide bays by bridge support piers. The bridge and piers forming these bays were removed during modifications in 1969. The gated spillway section is equipped with five tainter gates each 20 feet wide by 20 feet high. A cross section of the dam and tainter gates is shown on figure 6.

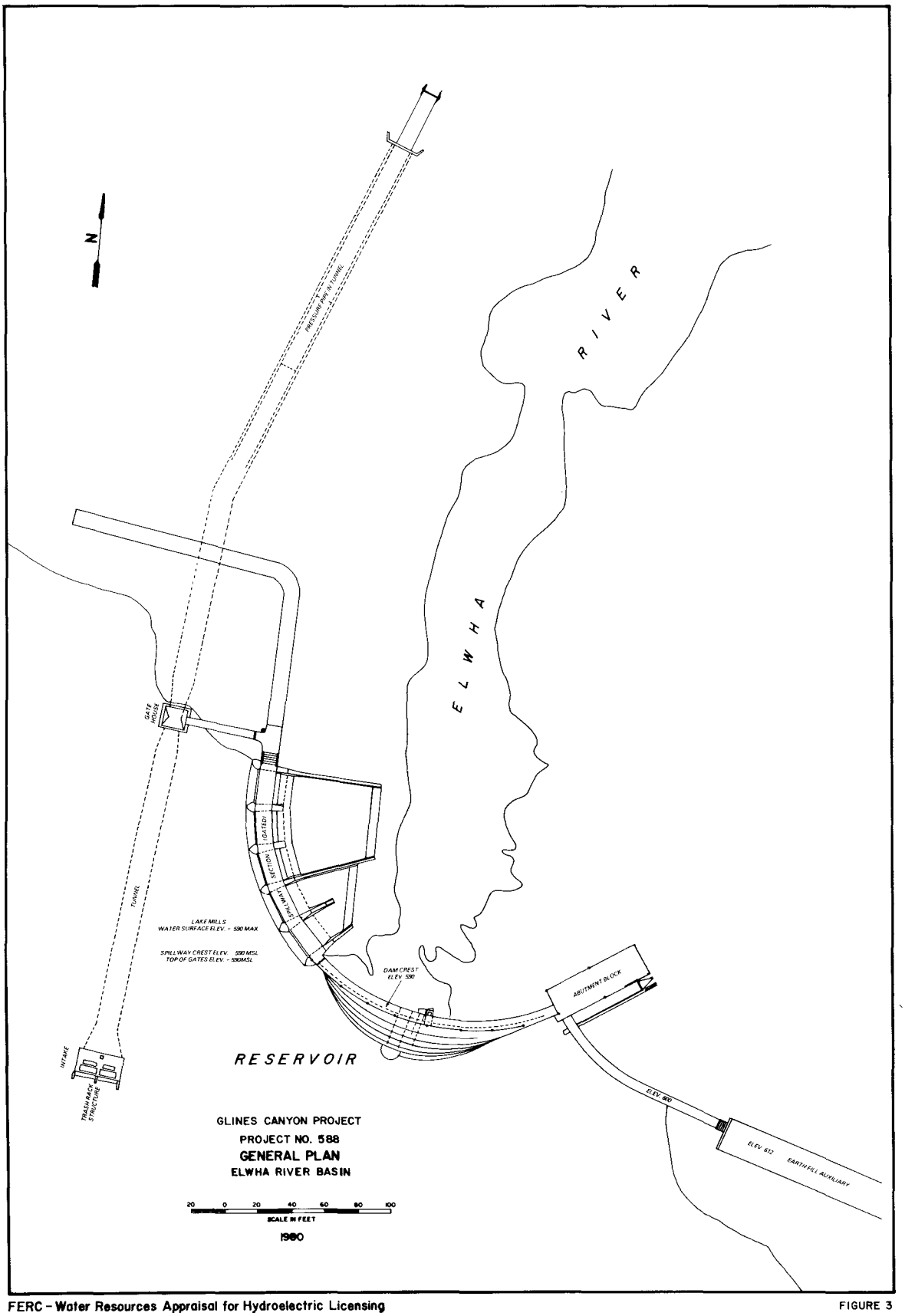


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FIGURE 3

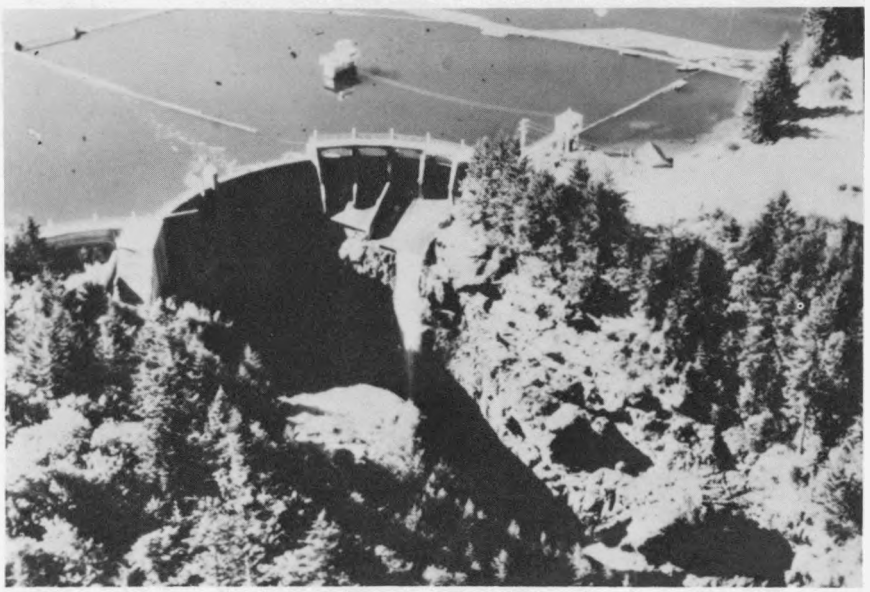


Figure 4. Glines Canyon Dam looking southwest.

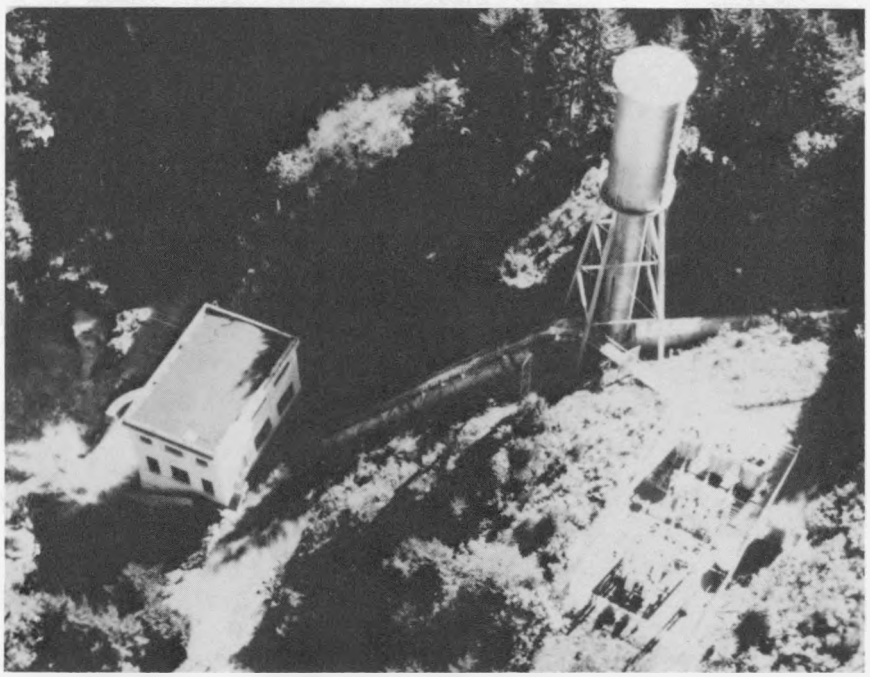


Figure 5. Glines Canyon powerhouse, surge tower, and switchyard.

Table 5

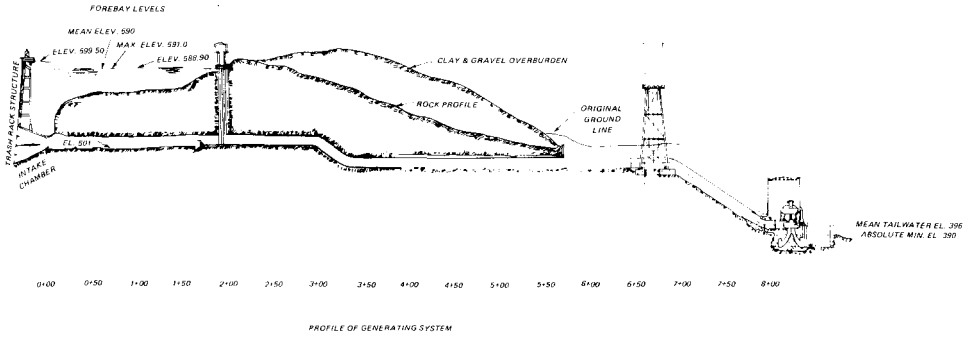
Pertinent Data
Glines Canyon Project

Project name	Glines Canyon
Project number	588
Date license expired	June 3, 1976
Owner	Crown Zellerbach Corporation
State	Washington
River	Elwha
River miles	13.5
Drainage area, square miles	245
Mean flow, cfs	1,511
Dam	
Height, feet	200
Length, feet	860
Type	Concrete arch, concrete gravity and earthfill embankments
Reservoir	
Normal maximum pool, feet (msl)	590
Crest of spillway, feet (msl)	570
Normal drawdown, feet	5.0
Usable storage capacity for normal drawdown, acre-feet	2,500
Area at normal maximum pool, acres	440
Powerplant	
Installed capacity, kW	14,850
Gross static head, feet	197
Hydraulic capacity, cfs	1,200
Average annual generation, MWh	118,000
Construction date	1927

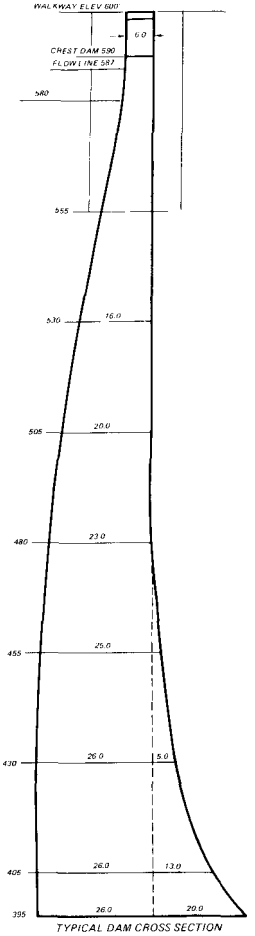
Note: Elevation in this table are set to mean sea level. Licensee has submitted information using a project datum 20 feet higher than mean sea level.

The reservoir (Lake Mills) (see figure 7) has an approximate area of 440 acres at normal maximum pool elevation of 590 feet, msl and 430 acres at normal minimum pool elevation of 585 feet, msl. Gross storage capacity at normal maximum pool is 39,000 acre-feet with a usable storage capacity of 2,500 acre feet.

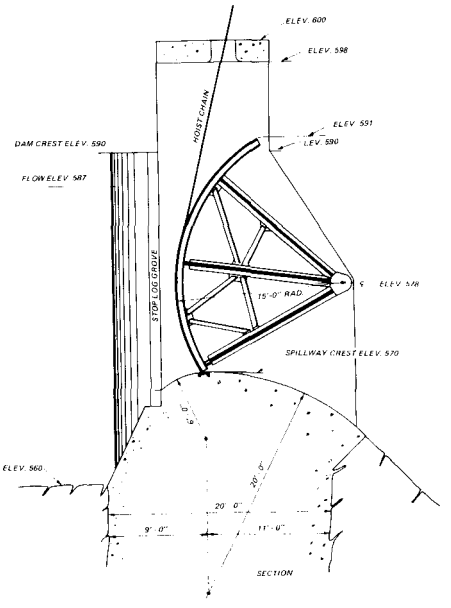
The intake structure for the power tunnel, located in the left abutment connects to a 12-foot-diameter gunite-lined tunnel which extends 350 feet downstream from the intake structure to the gate structure containing a caterpiller-type intake gate. An 11-foot, 7-inch outside diameter riveted steel penstock 450 feet long extends from the tunnel to the powerhouse. The upper 225 feet of the penstock is located in a rock tunnel. A 140-foot-high riveted steel surge tank is located approximately 100 feet downstream from the tunnel adit. Figure 6 includes a profile of the generating system.



PROFILE OF GENERATING SYSTEM



TYPICAL DAM CROSS SECTION



SECTION OF SPILLWAY AND TAINTER GATES

GLINES CANYON PROJECT
PROJECT NO. 588
PROFILE OF GENERATING SYSTEM
CROSS SECTIONS OF DAM
SPILLWAY AND TAINTER GATES

GLINES CANYON DAM

ELWHA RIVER BASIN
1980

FERC – Water Resources Appraisal for Hydroelectric Licensing

FIGURE 6

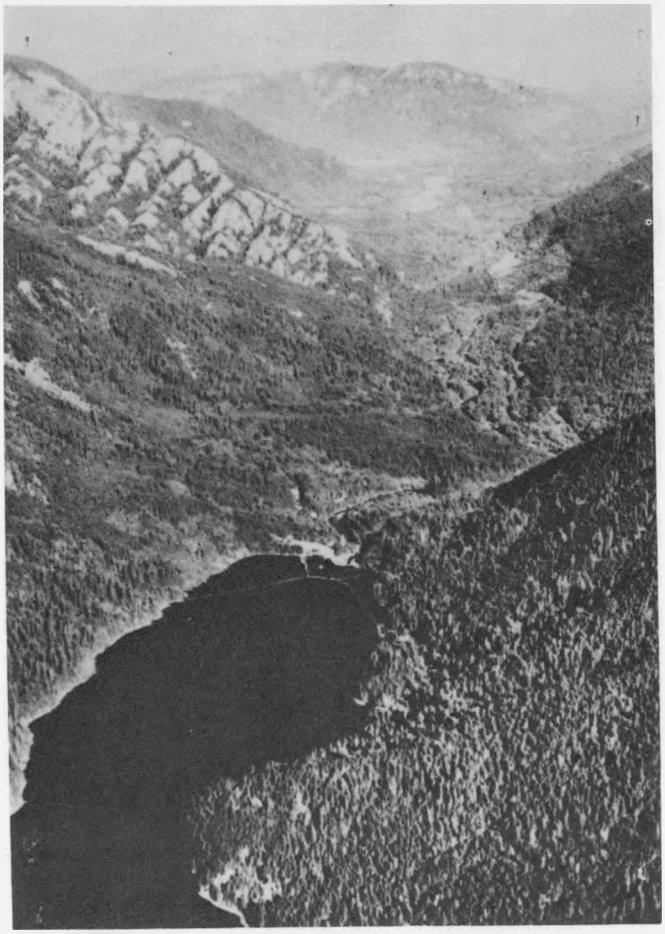


Figure 7. Lake Mills and Glines Canyon Dam looking north.

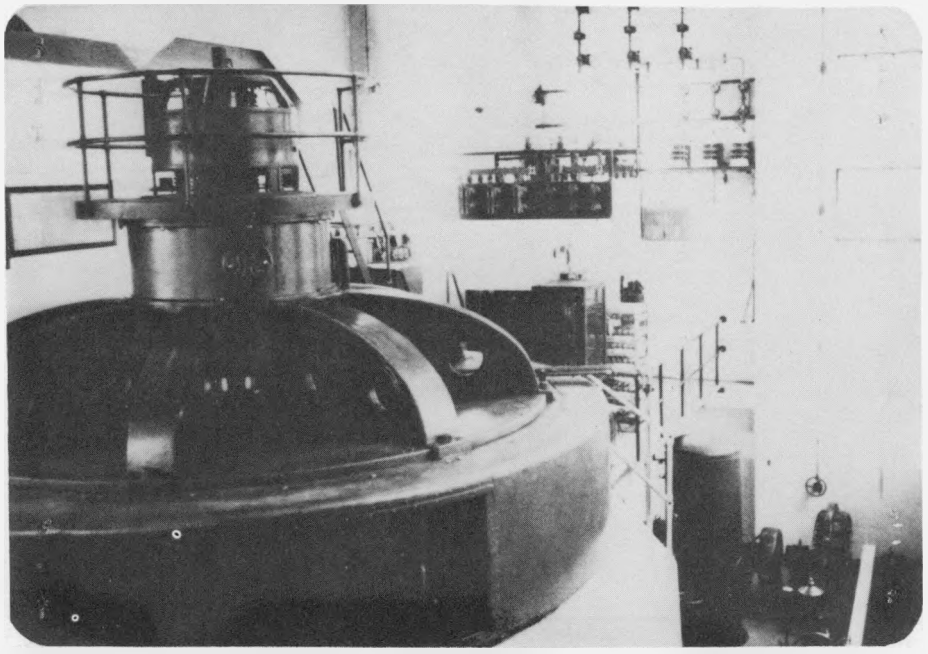


Figure 8. View of Glines Canyon powerhouse interior.

The reinforced-concrete powerhouse, located on the bank of the Elwha River, contains one rewound 16,500-kilovolt-ampere, 6.6-kilovolt generator connected to a 17,500-horsepower, 225-revolutions per minute, Francis turbine operating under a gross static head of 197 feet. A hydraulically operated butterfly valve is installed ahead of the turbine to serve as a shutoff valve. Installed capacity is 14,850-kilowatts with a power factor of 0.9. There is also one 50-kilowatt, 80-horsepower, 320-volt auxiliary turbine generator for use as a house set.

The substation located south of the powerhouse in a fenced year includes three transformers, each 4,500 kilovolt-amperes, 6,000 volts stepped up to 66,000 volts, and one oil circuit breaker, 66-kilovolts, 600 amps, 1,000 megavolt-amperes. There are 8 miles of transmission lines which connect with the licensee's Elwha powerhouse on the lower Elwha River.

Operation of the Glines Canyon Project

The power generated by the Glines Canyon project is utilized by the licensee's pulp and paper mill at Port Angeles, Washington, as a primary source of power for production machinery. This is supplemented by power generated by the licensee's Elwha plant on the lower Elwha River and by power purchased from Bonneville Power Administration.

With basically no water storage, the Glines Canyon Dam is operated as a run-of-river project. Generation is directly proportional to streamflow up to the plant's hydraulic capacity except for the small regulatory effect of the reservoir. Approximately 1,200 cubic feet per second are required for maximum generation of 16,000-kilowatts. During low flow periods, generation is cut back to the extent of the streamflow with a minimum change in the forebay. Full generation or streamflow capacity is utilized for operation. Surplus water is discharged through spillway gates. The forebay elevation does not normally vary more than 5 feet. In anticipation of a flood, the forebay is drawn down in advance 5 feet which corresponds to 2,500 acre-feet of storage capacity. During the flood, the forebay level is held and allowed to rise slowly until the flood is passed. Overspill is avoided, if possible.

Condition of the Glines Canyon Powerplant

The project facilities are satisfactorily maintained and are in good working condition. The structures appear to be sound and stable.

Glines Canyon Dam was inspected by an independent engineering consultant in 1967, 1972, and in 1977, in compliance with part 12 of the Commission's regulations. The consultant concluded that all sections of the dam were stable for reservoir levels up to an elevation of 600 feet msl, the crest of the non-overflow concrete gravity wall at the east abutment. The maximum spillway capacity with the reservoir at elevation 600 feet is about 63,000 cubic feet per second. This compares to the estimated 100-year flood of 45,000 cubic feet per second.

The consultant estimated the probable maximum flood at the Glines Canyon Dam would have an instantaneous peak of about 149,000 cubic feet per second. At the time of peak inflow, 149,000 cubic feet per second, the reservoir would surcharge to about an elevation of 611.2 feet msl, approximately 11 feet over the top of the gravity dam section and to the top of the earthfill embankment

section. Under this extreme loading condition, the nonoverflow section would probably fail.

History of the Elwha Project

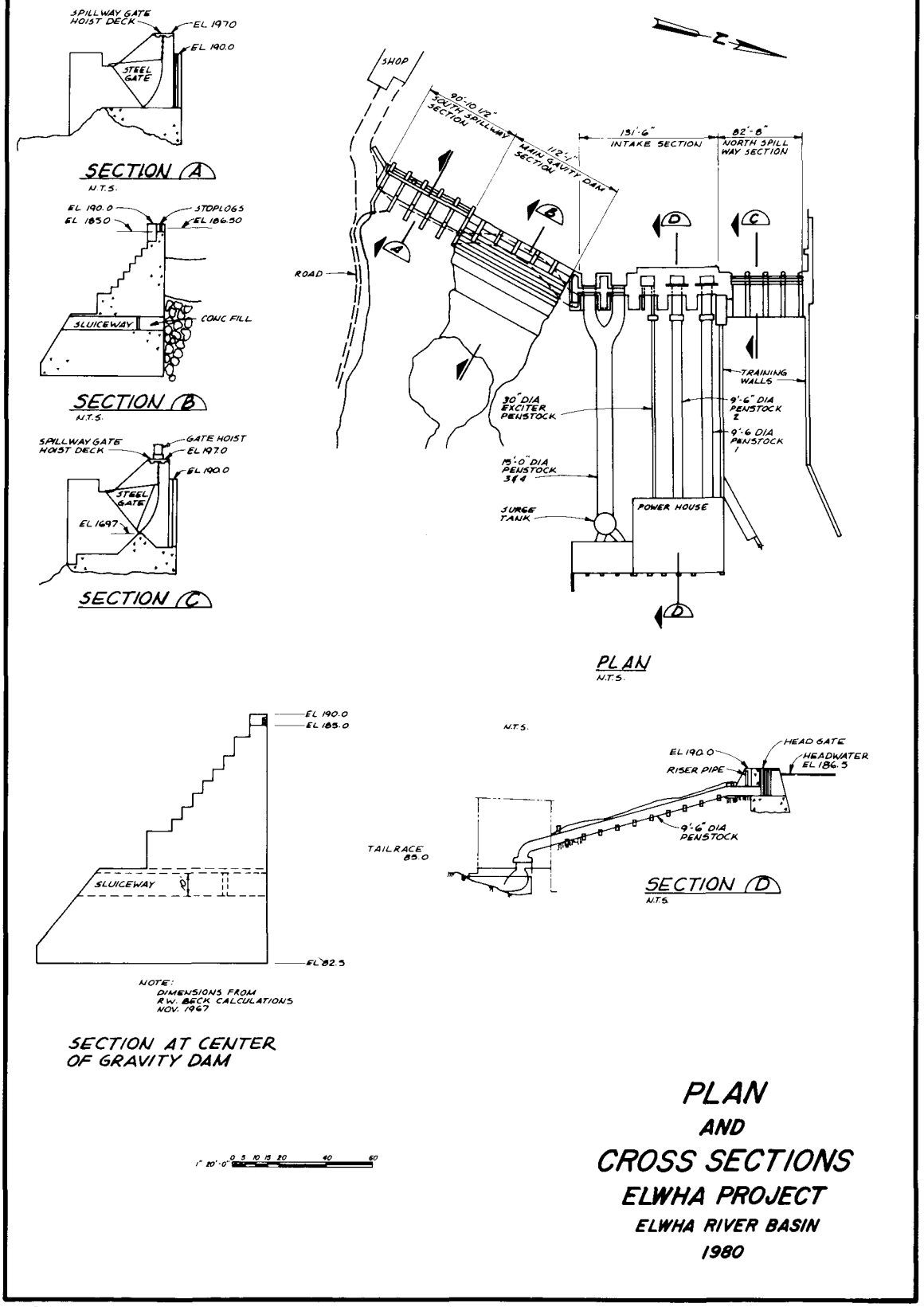
The Elwha Dam, which was constructed in 1911-13, has two horizontal generating units installed in 1912 and two vertical units installed in 1922. The Elwha development has never been licensed by the FERC or the FPC. Following the decision of the United States Supreme Court in the Taum Sauk case, Union Electric Company vs. FPC, 381 U.S. 90 (1965), Crown Zellerbach, on July 22, 1968, February 14,1969, and April 13, 1973. On March 24, 1976, Crown Zellerbach filed another supplement to the application, requesting that the FPC issue a declaratory order that Crown Zellerbach was not required to file an application for a license for the Elwha development and could withdraw its application without violating the Federal Power Act and that the FPC was without authority to issue a license for the Elwha development. On December 11, 1978, a FERC administrative law judge ordered that the Commission does have jurisdiction over the Elwha project and that the Crown Zellerbach Corporation should refile its license application.

Description of the Elwha Project

The Elwha project is located in Clallam County, Washington, near the town of Port Angeles on the Olympic peninsula on the Elwha River, 4.9 miles upstream from the mouth of the river. Crown Zellerbach's licensed Glines Canyon Project No. 588 is located 7.4 miles upstream from Elwha Dam. The project consists primarily of a dam, reservoir, penstocks, surge tank, powerhouse, and transmission lines. A plan and cross-sections of the project are shown on figure 9 and pertinent data are given in table 6.

The right (south) spillway, a gravity and buttress structure 90.9 feet long, is about 30 feet high (top at elevation 190 feet) and is founded on rock. There are five 13.75-foot-wide by 19-foot-high tainter gates with a flat-floored spillway crest at elevation 169.7 feet. The main gravity structure, 112 feet long and 100 feet high, (crest at elevation 190 feet) has six spillway bays, five 17 feet wide and one 12.1 feet wide, all with crests at elevation 185. These bays are controlled by 3-foot-high stoplogs. The intake structure, founded on rock, is a gravity and buttress-type structure, 131.5 feet long and about 30 feet high, and has trashrack protected intakes for two 9.5-foot-diameter penstocks which converge into a single 15-foot-diameter penstock, two 30-inch-diameter penstocks, and two 9.5-foot-diameter penstocks. Hydraulically operated slide gates are located at the intakes to each of these penstocks. The intakes all have inverts at elevation 165 feet. There is an 80-foot-long concrete cofferdam 25 feet in front of the intake partially obstructing the approach channel. Its top is at elevation 186 feet. There is a two-foot-high wall (top at elevation 192 feet) to reduce the frequency of overpour into the penstock and powerhouse area. The left (north) spillway, 82.7 feet long, is about 30 feet high (top at elevation 190 feet) and is founded on rock. There are four 13.75-foot-wide by 19-foot-high tainter gates with a triangular-shaped spillway crest at elevation 169.7 feet.

The two 9.5-foot-diameter penstocks and the single 30-inch-diameter penstock, all 190 feet long, were constructed in 1913. In 1933, the 15-foot-diameter penstock and related surge tank (from which two short penstocks project into the new powerhouse) were added.



FERC-Water Resources Appraisal for Hydroelectric Licensing — Figure 9

Table 6

Pertinent Data
Elwha Project

Project name	Elwha
Project No.	2683
License status	major application pending
Owner	Crown Zellerbach Corporation
State	Washington
River	Elwha
River mile	4.9
Drainage, square miles	315
Dam	
Height (structural), feet	100
Length, feet	417
Type	concrete gravity
Reservoir	
Normal maximum pool, feet (msl)	188.0
Crest of spillway, feet (msl)	169.7
Area at normal maximum pool, acres	580
Total storage capacity, acre-feet	3,300
Powerhouse	
Installed capacity, kilowatts	10,800
Gross static head, feet	104
Average annual generation, megawatt-hours	50,483

The original indoor powerhouse constructed in 1913, contains turbine-generator Units 1 and 2 and one D.C. house unit. Units 1 and 2 are two Wellman-Seaver-Morgan horizontal shaft-reaction turbines, each connected to a 9.5-foot penstock, and each rated at 4,800 horsepower at 100-foot head at 360 revolutions per minute. The two Westinghouse generators are each rated at 2,400-kilovolt-amperes (3,000 kVA @ 80 percent PF). The D.C. house unit is connected to the 30-inch penstock with a 200-kilowatt generator rating at 860 revolutions per minute.

The new indoor powerhouse, constructed in 1922, contains units 3 and 4. These are two vertical shaft Francis-type reaction turbines, each connected to a short penstock from the surge tank and rated at 5,000 horsepower at 1-foot head at 300 revolutions per minute. The manufacturer is unknown. The two generators, each rated at 3,330-kilowatts (3,330 kVA unity power factor), were manufactured by Westinghouse. There are no butterfly or other type of turbine protection valves. Tailwater is at elevation 85 feet.

Two 69-kilovolt transmission lines serve the project and the Glines Canyon project: Line No. 1, 7 miles long to Crown Zellerbach's Port Angeles Mill, and Line No. 2, 9.75 miles to the Port Angeles Mill and thence on to the Bonneville Power Admiminstration substation. The transmission line from Glines Canyon to Elwha, 8 miles long, is included in the Glines Canyon project.

The reservoir formed by the dam is referred to as Lake Aldwell. At normal full-pool elevation of 188.0 feet, the lake has a total storage capacity of full-pool elevation of 188.0 feet, the lake has a total storage capacity of 3,300 acre-feet, an area of 580 acres, and a length of 2.2 miles. Only about a third of the storage is used for pondage during normal streamflows, since the forebay elevation does not vary more than 2 feet during these periods. Because of its limited capacity, the reservoir has negligible value for flood control. However, it does provide facilities for boating, fishing, and other recreational pursuits.

The Elwha and Glines Canyon projects are owned and operated by Crown Zellerbach Corporation for the purpose of providing electric power to their Port Angeles mill. The power output from the Elwha project is combined with the Glines Canyon project output and is delivered to the Company's Port Angeles mill by two 69-kilovolt transmission lines. The output of the two projects plus supplemental purchased power from Bonneville Power Administration supplies the mill's total requirements.

Condition of the Elwha Project

The Elwha Project was inspected in June 1979 by a FERC engineer from the San Francisco Regional Office. Little leakage was noted through or around the dam but spillway flows were masking most areas, particularly the underseepage below the main gravity structure. The powerplant was inspected and generally everything appeared to be in order except that the end of one draft tube pier was gone and another was leaning. It appeared that the tailrace was either being eroded or that the structure was being damaged. Unit No. 1 was operating at a reduced capacity of 2,900 kilowatts due to a crack in the bronze water wheel.

The maximum continuous generator capacity is 3,250-kilowatts. The generators nameplate rating is 2,400 kilowatts (3,000 kilovolts at 80 percent power factor).

It was noted that repair work to the concrete structure had been completed. The area downstream of the dam has a potential for loss of life, particularly at the fish hatchery and various residence in the Indian Reservation. The licensee has a plan before FERC for review and approval to modify the dam to meet the maximum probable flood by strengthening the gravity structure through post tensioning. During the interim, the licensee has developed contingency plans for any flood problems if any dam failure occurred. The questionable safety of the Elwha Dam has been the subject of continuing concern to interested parties and agencies. Independent engineering contractors retained by Crown Zellerbach, the U.S. Army Corps of Engineers, the Washington State Department of Ecology, and the staff of the FERC have all found the dam to be unsafe for probable maximum flows. The U.S. Department of Housing and Urban Development has refused to appropriate monies, otherwise earmarked, to the Lower Elwha Indian Tribe for housing developments until the safety of the dam is improved.

CHAPTER VI

NEEDS FOR FURTHER DEVELOPMENT OF WATER AND RELATED LAND RESOURCES

General

The needs for further development of water and related land resources of the Elwha River basin are somewhat restrained, due to the influence of the Olympic National Park. Only a small portion of the total land area is available for residential, commercial, and industrial development.

At the present time, area needs for further water resource development are primarily for purposes of electric power supply, water supply, and flood control.

Electric Power Needs

The Elwha River basin is located in northwest Washington in the area designated by the Federal Energy Regulatory Commission as Power Supply Area (PSA) 43. Power requirements in the basin make up only a very small portion of the total requirements of PSA 43. The Elwha basin hydroelectric projects supply a portion of Crown Zellerbach Corporation's Port Angeles mill load requirements. The balance of the mill's load is supplied by Bonneville Power Administration.

Electric loads in PSA 43 are served by members of the Northwest Power Pool, West Group Area. A forecast of loads and resources for the West Group Area is made annually by the Pacific Northwest Utilities Conference Committee. The forecast dated March 1, 1978, indicates the total average annual load growth of the West Group Area during the 10-year period through June 1989 will be approximately 4.4 percent for peak demand and 4.2 percent for energy requirements. The estimated total area peak load is forecast to increase from 24,617 megawatts in 1978-79 to 37,739 megawatts in 1988-89. The region's estimated energy requirements will increase from 140,800 gigawatt hours in 1978-79 to 212,600 gigawatt-hours in the 1988-89 year. Based on existing resources and including those plants scheduled for installation during the period, the report states that there is a 88.4 percent probability that the total energy load cannot be met in all periods through 1983-84, and a 48.9 percent probability of not meeting all firm energy loads through that date. Reduced loads estimates appearing are projected in this year's PNUCC West Group Forecast. However, energy deficiencies are still projected for every year through 1988-89.

Water Supply

Principal factors that will determine water demand in the Elwha River basin are growth in the pulp and paper industry, population growth, and further industrial expansion. Demand will increase also as a result of increased tourism and summer home development.

The Elwha River, from which the self-supplied industries presently take their water, is projected to be a satisfactory source to meet industrial demands through 2020. There is a basic need, however, for planned development of the area. This is necessary to coordinate the competing industrial uses and to

insure surface water supply adequacy if the Port Angeles municipal system should go to the Elwha River for increased supply instead of developing this supply from groundwater.

A shallow groundwater source at the Elwha River for future Port Angeles municipal water supply is a feasible alternative to Morse Creek, subject to exploratory data. The source could be developed by a series of shallow infiltration wells. The number of wells would depend upon the capacity of the aquifer and the total supply needed.

Flood Control

Recently, attention has been focused on flood damage reduction along the lower 3 miles of the Elwha River. Part of the problem which has concerned local interests for several years is the possibility of a channel change which could have a severe impact on the community. Much of the support for a study is from the Lower Elwha Band of Clallam Indians, who are unable to obtain Federal loans to improve tribal facilities. The Department of Housing and Urban Development suspended processing of a development program for a 25-unit mutual help program for the tribe when the State of Washington's Department of Ecology established that the land was located in a flood control zone.

Officials of Clallam County requested the Corps of Engineers to study flood problems along the lower 2 miles of the Elwha River. The study has been deferred until safety of the upstream Elwha Dam has been determined by the State of Washington.

Nearly a third of the flood plain is held in trust by the United States for use by the Lower Elwha Tribe. Although state law may not be applicable to Indian property, Federal institutions are bound by regulations to withhold loans in a flood hazard area. Rather than exchanging its land for other Federal land, the lower Elwha Tribe firmly insists on remaining in the Elwha River delta which it claims to be the tribe's ancestral home.

CHAPTER VII

FUTURE DEVELOPMENT AND UTILIZATION OF WATER RESOURCES IN THE ELWHA RIVER BASIN

General

The Federal Energy Regulatory Commission license for the Glines Canyon hydroelectric development (FERC Project No. 588) expired on June 3, 1976. The licensee has filed an application for a new 50-year license. In the interim, the project is operating under annual licenses. Under the provisions of the Federal Power Act, the Commission may issue a new license to the licensee, or may recommend takeover of project by the Federal Government. A license application is also pending for the Elwha project (FERC Project No. 2683) which has never been licensed before by the Commission. The intent of this chapter is to provide information on the possible future development and utilization of the water resources in the area of the Glines Canyon and Elwha projects that would be useful in Commission consideration of the projects.

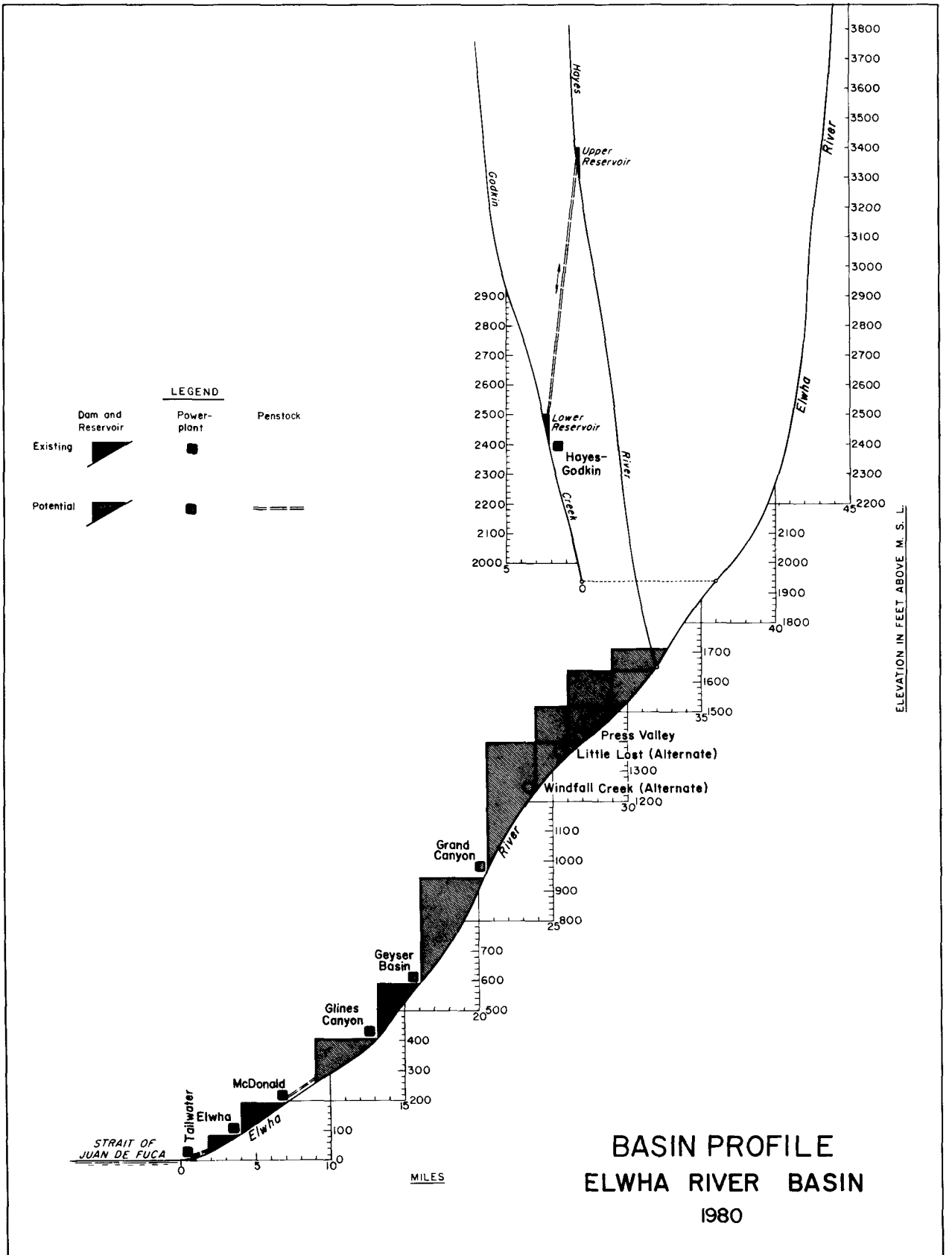
Potential Basin Development

There are adequate water and related land resources to meet present and future requirements in the Elwha basin. It is recognized, however, that Congressional restraints imposed upon developments inside a national park limits the range of opportunities.

The Puget Sound Task Force of the Pacific Northwest River Basins Commission in 1970 prepared a comprehensive plan of development for the Elwha basin. Early actions recommended for implementation by 1980 are the establishment of flood plain regulations to reduce existing and potential flood damages and permit optimum agricultural use of the Elwha River flood plain; the construction of fish passage facilities at Elwha Dam; the provision of a spawning channel; and the development of a fish hatchery with capabilities for expansion.

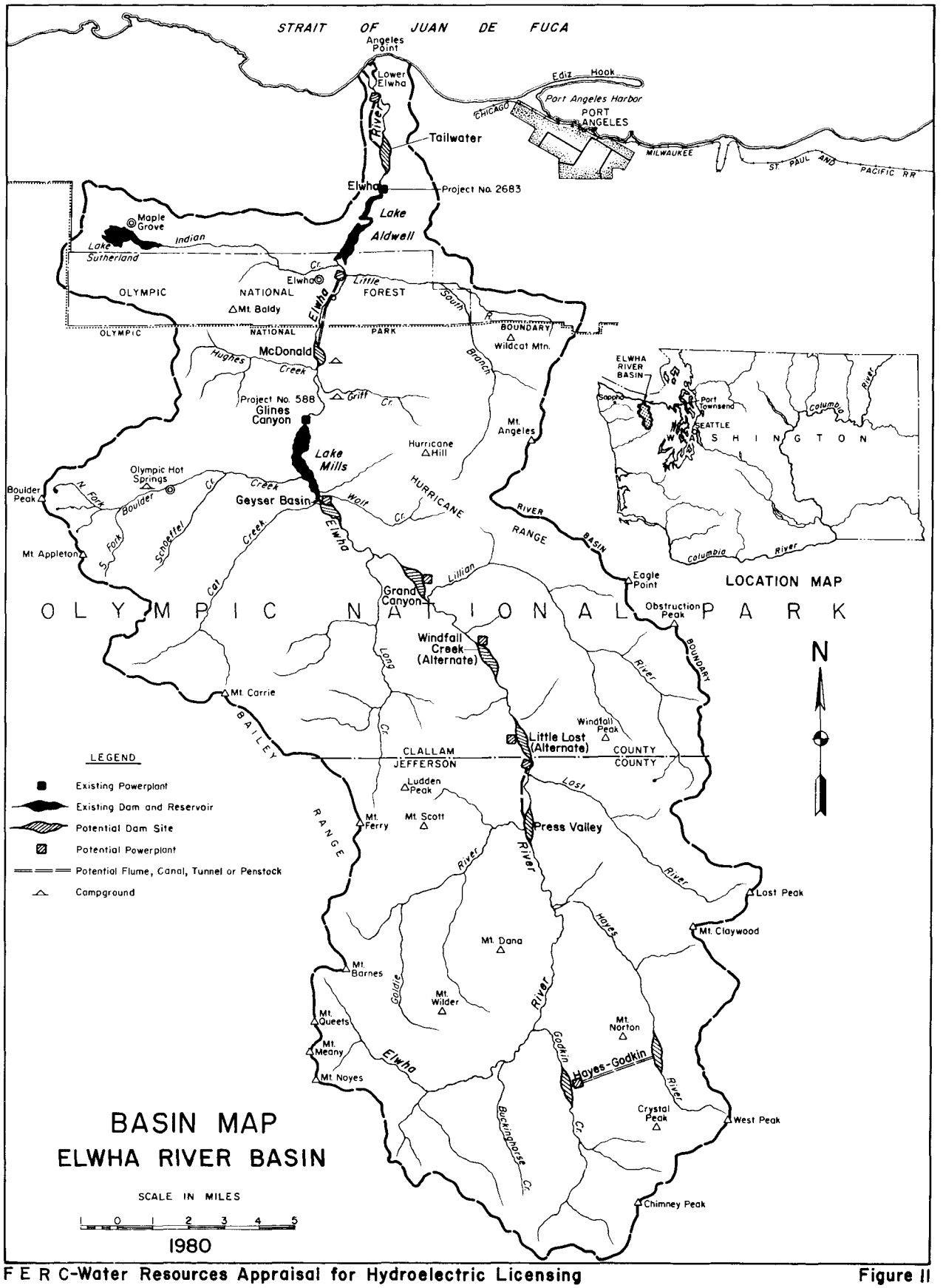
For the long-range period 1980-2020, additional water supplies for industry and streamflow for fish in the Elwha River would be obtained by modifying the use of the 3,300-acre-foot Lake Aldwell formed by Elwha Dam.

The comprehensive study of water and related land resources of the Puget Sound and adjacent waters indicates that there are five potential conventional hydroelectric projects in the Elwha River basin that total nearly 200,000 kilowatts. There is also one potential pumped storage project in the Elwha River basin. The locations of these projects are shown on the basin profile, figure 10 and the basin map, figure 11. Data on the six potential hydroelectric projects in the basin are given in table 7. Water resource development of the main stem of the Elwha River would not only provide a substantial and an apparently economic source of hydroelectric power that would contribute to meeting the rapidly growing power loads of the Northwest, but would also provide future water supply for Port Angeles and flood control for the area near the mouth. However, all of the projects except for the Tailwater conventional hydroelectric project, are located within the Olympic National Park. New development is prohibited within the limits of national parks without specific authorization by the Congress.



FERC-Water Resources Appraisal for Hydroelectric Licensing

Figure 10



F E R C-Water Resources Appraisal for Hydroelectric Licensing

Figure II

Table 7

Potential Hydroelectric Developments
Elwha River Basin

Project	Power Pool Elevation (feet)	Usable Power Storage Capacity (1,000 ac-ft)	Gross Static Head (feet)	Installed Capacity (kW)	Average Annual Generation (MWh)	Total Annual Power Benefits ($1,000)	Benefit to Cost Ratio
Hayes-Godkin	NA	NA	1,530	1,000,000	NA	NA	NA
Press Valley	1,710	40	310	25,000	110,000	8,596	1.6
Grand Canyon	1,400	NA	430	53,600	235,000	18,444	4.7
Geyser Basin	970	87	362	54,000	236,000	18,583	4.5
McDonald	410	NA	210	40,000	174,000	13,772	1.1
Tailwater	84	NA	84	20,000	88,000	6,877	1.2
		Totals		1,192,600	843,000		
Alternate Sites 1/							
Little Lost	1,640	NA	290	28,300	124,000	9,734	1.1
Windfall Creek	1,520	NA	290	30,000	132,000	10,334	1.1

NA - Not available.
1/ Little Lost and Windfall Creek are alternate to Grand Canyon and to each other.

Reconnaissance-type cost estimates of specific power facilities were developed from Corps of Engineers, North Pacific Division, cost data and adjusted to January 1980 price levels by means of the Engineering News Record cost indexes. The annual costs used in the benefit-cost analyses include fixed charges, operation and maintenance expenses, and administration and general expenses. In assuming private financing, the fixed charges included interest and amortization using an interest rate of 12.5 percent and 50-year life, interim replacements, and insurance.

Annual power benefits are based on private financing with the cost of alternative capacity consisting of a coal-fired, steam-electric generating plant. The at-site power values for the Pacific Northwest region are based on July 1980 cost levels and were developed for the National Hydropower Study. The annual value for dependable capacity would be $256.78 per kilowatt-year and the value of energy would be 18.14 mills per kilowatt-hour. Operation at an annual plant factor of 50 percent was assumed for the hydroelectric projects. Approximate benefit-cost ratios for the potential conventional hydroelectric projects are given in table 7. Public non-Federal financing would not change the benefit-cost ratios significantly.

Data for the Hayes Godkin pumped storage project was obtained from the North Pacific Division Corps of Engineers report, "Pumped-Storage Inventory of the Pacific Northwest," dated January 1976. It would be hydraulically independent of any conventional hydropower development. The 1,000-megawatt project would develop about 1,530 feet of head between reservoirs in Hayes River and Godwin Creek. The Corps of Engineers report provides an estimated unit cost of $225 per kilowatt based on July 1975 cost data and a project annual cost of $15.3 per kilowatt. These pumped storage project costs do not include the cost of pumping energy, and therefore should not be compared with alternative peaking costs without the addition of pumping energy cost. However, the cost of pumping

energy is not site-related but is determined by the part of the peak load to be carried by the pumped storage project and by the source of the pumping energy. This project is also located within the Olympic National Park.

The Glines Canyon Development

The physical condition of the existing project is good. There are no known major deficiencies in the structures or equipment. Structural modifications recommended by the licensee's consultant engineer who inspected the project were completed in 1977. The purpose of the modifications were to increase the dam's structural integrity during a probable maximum flood of 149,000 cubic feet per second. The project appears capable of continued operation for many years.

The licensee does not propose any additions, future modification or redevelopment of the project. However, this run-of-river plant installed capacity is undersized for the mean conditions of the Elwha River. Modification of the project to develop the full potential of the site would not be feasible under present economic criteria. Since the project is located within the boundaries of the Olympic National Park, the National Park Service has final approval and control over any access or changes that would affect the dam site and reservoir as well as the surrounding project area.

Federal jurisdiction was originally based on the project's occupancy of lands of the United States within the Olympic National Forest. Since the issuance of the original license, however, the national forest lands in the project area were converted to national park lands (Olympic National Park) by an Act of Congress on June 29, 1938 (Ch. 812, 52 State. 1241).

The FERC is prohibited from granting licenses within certain national parks by the Act of March 3, 1921 (41 Stat. 1353) which provided, in part, that no license for dams, conduits, reservoirs, powerhouses, transmission lines, or other works for the storage or carriage of water, or for the development, transmission, or utilization of power, within the limits as now constituted, of any national park shall be granted without the specific authority of Congress.

The Elwha Development

The physical condition of the existing project is good. Major deficiencies have been corrected by the licensee. The licensee has a plan before the FERC to modify the dam to meet the maximum probable flood by strengthening the gravity structure through post tensioning. Continued operation of the Elwha project appears to be economically attractive. The economical source of power for the foreseeable future.

As is done at the Glines Canyon project, the Elwha project could be regulated for minor flood control by drawing down the reservoir in advance of the flood peak. The Puget Sound Task Force recommended that a fish passage facility be constructed at the Elwha Dam and that Lake Aldwell be regulated to provide future water supply and streamflow augmentation for fish.

Fish and Wildlife

Future plans for fish and wildlife management will be determined by several factors. Hunting, fishing, and non-destructive endeavors such as photography and bird watching will encourage the management of wildlife resources. However, future construction in the basin may pose new conflicts for fish and wildlife. The U.S. Army Corps of Engineers has considered a flood control and drainage program for the Elwha River which would alter river flows and destroy riparian habitat. If the Corps' project is under taken, the Elwha Band of the Clallam Indians plan to build a housing project near the mouth of the Elwha River and thereby remove additional lands from wildlife habitat.

The Fish and Wildlife Technical Committee of the Pacific Northwest River Basins Commission has proposed streambed improvement projects below Elwha Dam which if effective would stabilize the streambed gradient and control gravel movements. These improvements, along with the regulation of releases from Elwha Dam, could increase natural fish production.

The U.S. Forest Service and the National Park Service have proposed several wildlife studies in the basin. The Forest Service plans range studies for deer, elk, and upland game. Based on the study results, wildlife enhancement areas would be established in Olympic National Forest. The National Park Service plans studies to determine the status of plants and animals within the park and the possible reintroduction of the wolf.

Conclusions

There are no reservoirs under construction or being seriously considered in the basin which would have a significant effect on the Glines Canyon or Elwha developments.

There are potential conventional and pumped storage hydroelectric projects in the basin that appear economically feasible; however, development of all but the smallest of these plants is not considered feasible due to restrictions on the national park lands.

Continued operation of the Glines Canyon and Elwha projects appears to be economically attractive. The projects are satisfactorily maintained and appear capable of providing an economical source of power.

As is done at the Glines Canyon project, consideration should be given to regulating the Elwha project for minor flood control by drawing down the reservoir in advance of the flood peak. The Puget Sound Task Force recommended that a fish passage facility be constructed at the Elwha Dam and that Lake Aldwell be regulated in the future to provide water supply and streamflow augmentation for fish.

* United States Government Printing Office:1981--343-662/8223