

CHIEF JOSEPH DAM & RESERVOIR COLUMBIA RIVER, WASHINGTON



**US Army Corps
of Engineers** ®

SEPTEMBER 2009

CHIEF JOSEPH DAM COLUMBIA RIVER, WASHINGTON

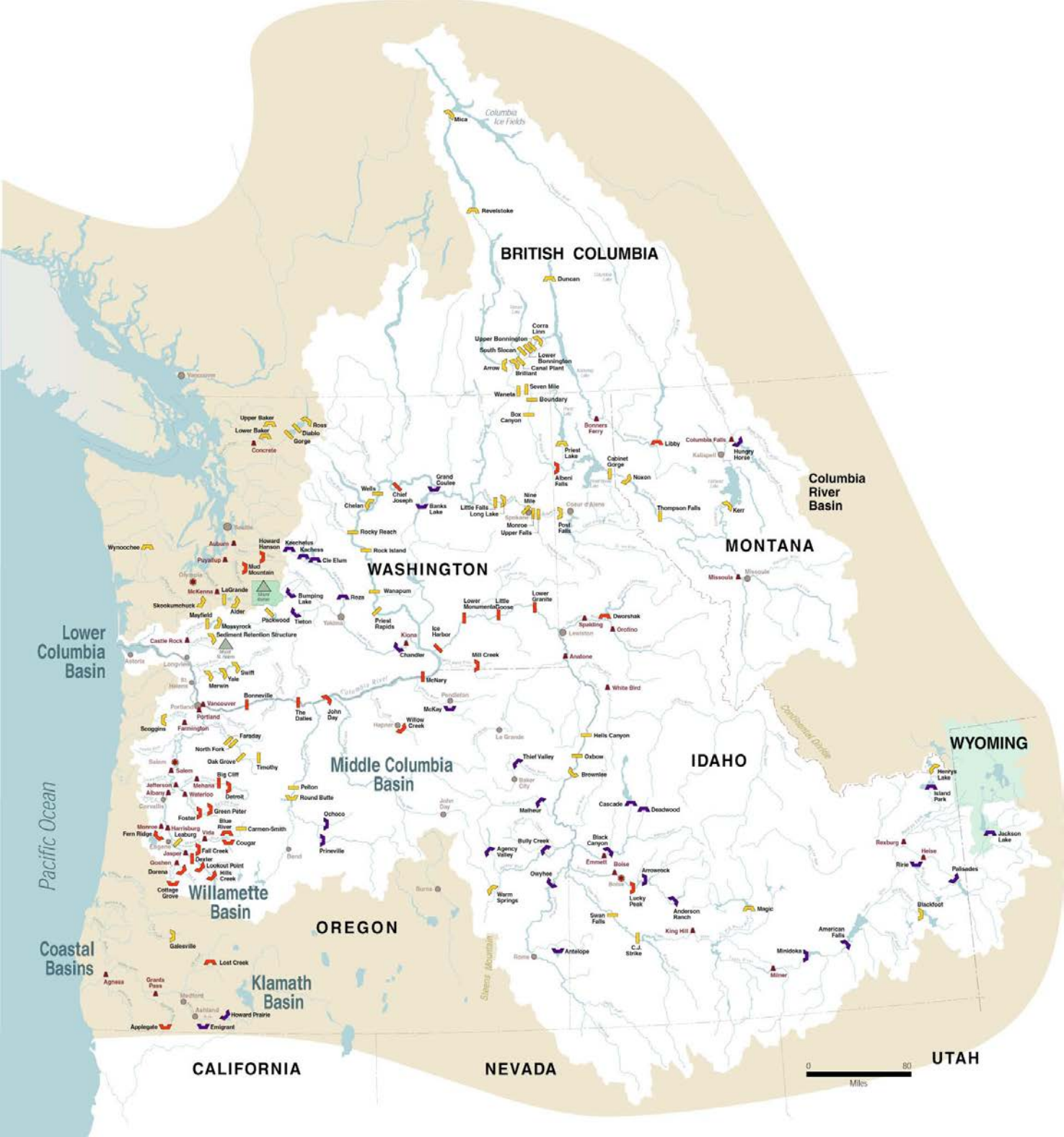
WATER CONTROL MANUAL

SEPTEMBER 2009



**US Army Corps
of Engineers** ®





BRITISH COLUMBIA

Columbia River Basin

MONTANA

WASHINGTON

Middle Columbia Basin

IDAHO

WYOMING

Willamette Basin

OREGON

Klamath Basin

CALIFORNIA

NEVADA

UTAH



Lower Columbia Basin

Pacific Ocean

Coastal Basins

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this water control manual be published in loose-leaf form and only those sections or parts thereof requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that insertions can be made to keep the manual current.

REVISIONS TO THIS MANUAL

As a continuing program, portions of this manual may occasionally be revised and updated. Pertinent data, rating tables, and general information will be revised when changes become evident; likewise, changes in the plan of operation or in the project development will be reported. Whenever revisions are made, new pages containing the revised material will be issued to holders of the manual.

WATER CONTROL ASSISTANCE PERSONNEL

In the event that unusual conditions arise during duty or non-duty hours, contact can be made by telephone using the following numbers:

United States Army Corps of Engineers, Northwestern Division Reservoir Control Center,
Portland, OR, (CENWD-PDW-R)

REDACTED CONTENT

REDACTED CONTENT

EMERGENCY INSTRUCTIONS FOR CHIEF JOSEPH DAM

For instructions in case of emergency situations at Chief Joseph Dam, refer to the 2008 Flood Emergency Action Plans (Section 7); copies are located at the NWD and NWS RCC and at the CHJ Project control room.

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**CHIEF JOSEPH DAM
PERTINENT DATA**

LOCATION

State Washington
 County Douglas County (left bank), Okanogan County (right bank)
 River Columbia River
 Distance above Mouth of Columbia River 877.9 km (545.5 RM)
 Distance downstream from Grand Coulee Dam 82.7 km (51.4 RM)
 Distance ENE of Seattle (roadmiles) 365 km (227 mi)
 Distance W of Spokane (roadmiles) 209 km (130 mi)
 Dam Coordinates Sec 24, T29N, R25E and Sec 19, T29N, R26E, WM

PROJECT AUTHORIZATION

River and Harbor Act of 1946 (Public Law 525 dated July 24, 1946)

HYDROLOGIC DATA

Drainage Area 195,285 km² (75,400 mi²)
 Average Annual Discharge (1953-2003, 51 years) 3,106 m³/s (109,700 cfs)
 Minimum Observed Discharge (3/22/66), regulated 119.5 m³/s (4,220 cfs)
 Minimum Daily Discharge, regulated (11/11/73)¹ 631.5 m³/s (22,300 cfs)
 Maximum Regulated Peak Discharge (6/11/61) 14,039 m³/s (495,800 cfs)
 Maximum Historical Flood at Grand Coulee (June 1894) 20,530 m³/s (725,000 cfs)

HYDRAULIC DATA

Spillway Design Discharge 33,980 m³/s (1,200,000 cfs)
 Probable Maximum Flood (PMF) Inflow & Outflow 33,980 m³/s (1,200,000 cfs)
 PMF Maximum Reservoir Elevation El 292.24 m (El 958.8 ft)
 Standard Project Flood 13,479 m³/s (476,000 cfs)

RESERVOIR OPERATING DATA

Normal Full Pool Elevation El 291.39 m (El 956 ft)
 Minimum Normal Operating Pool Elevation El 289.56 m (El 950 ft)
 Authorized Minimum Pool Elevation² El 283.46 m (El 930 ft)
 Maximum Powerhouse Ramp-Up and Ramp-Down Rates No Limit

<u>RESERVOIR</u>	<u>ELEVATION</u>	<u>GROSS STORAGE</u>
<u>POOL NAME</u>	<u>m (ft)</u>	<u>ha-m (KAF)</u>
Normal Full Pool (NFP).....	291.39 (956).....	73,158 (593.1)
Minimum Normal Pool	289.56 (950).....	67,422 (546.6)
Minimum Pool	283.46 (930).....	49,438 (400.8)
Normal Operating Pool	289.56–291.39 (950–956)	5,736 (46.5)

Notes:

¹ Minimum discharges listed above are the lowest during the time since the initial filling of the reservoir. Lower discharges and elevations during the initial reservoir filling are not reported because they are not representative of the project's present operation.

² Authorized Minimum Pool Elevation El 283.46 m (El 930 ft) is used for emergencies or special maintenance only.

All elevations in this manual are referenced to National Geodetic Datum (NGVD) of 1929.

CHIEF JOSEPH DAM
PERTINENT DATA (CONTINUED)

RESERVOIR SURFACE AREA..... 3,399 ha (8,400 ac)
RESERVOIR LENGTH AT NFP82 km (51 mi)

DAM

Type Concrete Gravity
Total Length¹ 1.82 km (5,962 ft)
 Right Embankment (earth and rockfill) 76.2 m (250 ft)
 Right Non-Overflow Monoliths 59.7 m (196 ft)
 Spillway Structure 298.7 m (980 ft)
 Center Non-Overflow Monoliths 331.74 m (1,088.4 ft)
 Powerhouse Intake Structure 620.6 m (2,036 ft)
 Closure Monoliths 159.96 m (524.8 ft)
 Left Embankment (earth and rockfill) 145.1 m (476 ft)
 Buried Core 126.8 m (416 ft)
Top Elevation El 295.7 m (El 970 ft)
Height from Bedrock (bottom of concrete foundation) to Top of Dam variable:
 Spillway 70.1 m (230 ft)
 Intake Section 51.8 m (170 ft)
 Powerhouse Roof to base of Draft Tubes 41.5 m (136 ft)
Width at Top of Dam (9.1 m (29.85 ft) roadway plus 2 sidewalks) 11.89 m (39.0 ft)
Maximum Base Width 108.2 m (355 ft)

Spillway

Type Concrete Gravity “Ogee” Section
Location Straddles original river channel
Length 342.9 m (1,125 ft)
Crest elevation 274.78 m (901.5 ft)
Gate Top Elevation (closed condition) El 292.0 m (El 958 ft)
Number of Spillway Bays 19
Gate Type Tainter
Size of Spillway Gates 10.97 m wide by 17.74 m high (36.0 ft wide by 58.2 ft high)
Total Discharge:
 Initial freeflow–El 289.9 m (El 951 ft)(all gates full open) 26,363 m³/s (931,000 cfs)
 Spillway Design Discharge–El 292.24 m (El 958.8 ft) 33,980 m³/s (1,200,000 cfs)

SPILLWAY STILLING BASIN

Length 64.3 m (211 ft)
Width 278.9 m (915 ft)

SLUICES None

Notes:

¹ Total length of the dam is not equal to the sum of its individual sections because of the angle of intersection of the intake and closure monoliths

All elevations in this manual are referenced to National Geodetic Datum (NGVD) of 1929

CHIEF JOSEPH DAM
PERTINENT DATA (CONTINUED)

POWERHOUSE

Location Along the left bank, generally parallel to the original river channel
Length 621.5 m (2,039 ft)
Inside Width of Generator Room..... 20.7 m (68 ft)

POWERHOUSE (CONTINUED)

Height from bedrock to Powerhouse Roof 41.5 m (136 ft)
Maximum Output (27 units at NFP) 2,440,000 kW
Full Gate Discharge (27 units at NFP)..... 6,088 m³/s (215,000 cfs)

PENSTOCKS

Number 27
Length 78.6 m (258 ft)
Maximum Diameter 7.62 m (25 ft)
Construction..... steel plate, 1.59 cm to 3.18 cm (5/8 in to 1-1/4 in) thick
Penstock Angle with Horizontal 17 degrees
Intake Bell Center Line Elevation El 273.56 m (El 897.5 ft)
Penstock Control Normal Operation and Emergency Closure–Intake Stoplogs

TURBINES

Number (main units) 27
Type Francis (vertical shaft)
Manufactured By:
 Units #1-4, 15-16..... S. Morgan Smith Company
 Units #5-14..... Newport News Shipbuilding & Dry Dock Company
 Units #17-27..... Hitachi America, Ltd.
Output at Rated Net Head:
 Units #1-4, 15-16 117,700 hp @ 50.3 m (165 ft)
 Units #5-14..... 115,100 hp @ 50.3 m (165 ft)
 Units #17-27..... 136,000 hp @ 49.7 m (163 ft)
Discharge at Rated Net Head:
 Units # 1-4, 15-16 206.7 m³/s (7,300 cfs)
 Units #5-14..... 200.0 m³/s (7,064 cfs)
 Units #17-27..... 271.4 m³/s (9,586 cfs)

GENERATORS

Number 27
Manufactured By:
 Units 1-16 Westinghouse Electric Company
 Units 17-27 General Electric Manufacturing Company
Rated Nameplate Capacity:
 Units 1-16 (13.8 kV, 60-cycle 3-phase)..... 92,920 kVA at 0.95 pf (88,274 kW)
 Units 17-27 (13.8 kV, 60-cycle 3-phase)..... 100,000 kVA at 0.95 pf (95,000 kW)
Total Nameplate Capacity 2,457,380 kW
Maximum Capacity @ 0.95 pf:

All elevations in this manual are referenced to National Geodetic Datum (NGVD) of 1929

CHIEF JOSEPH DAM
PERTINENT DATA (CONTINUED)

Units 1-16 @ 0.95 pf 92,920 kVA at 0.95 pf (88,274 kW)
 Units 17-27 @ 115% Nameplate & 0.95 pf 115,000 kVA at 0.95 pf (109,250 kW)
 Total Capacity at 0.95 pf.....2,614,000 kW

Maximum Unit Output:

Units #1-4, 15-16(87,680 kW per unit).....526,610 kW
 Units #5-14(85,830 kW per unit).....858,300 kW
 Units 17-27(101,415 kW per unit).....1,222,100 kW
 Total2,607,000 kW

Maximum Output (based on recent Gibson tests and historical models)2,440,000 kW

Notes:

- ¹ Unit (#1-4, 15-16) output limited by turbine to 87,280 kW
- ² Unit (#5-14) output limited by turbine to 85,755 kW

Station Service Units:

Number2

Penstocks:

Number2
 Diameter..... 1.83 m (6 ft)
 Controls..... Same type as main unit penstocks

Turbines:

Type Francis (vertical shaft)
 Manufactured By Pelton Waterwheel Company
 Rating..... 3,500 hp (equivalent to 2,611 kW) at 50.3 m (165 ft)

Generators:

Number2
 Manufactured By Elliott Company
 Rating (4,160 V, 60-cycle 3-phase) 3,000 kVA at 0.8 pf (2,400 kW)

TRANSFORMERS

Number22 plus 2 extra
 Manufactured by General Electric Company
 Rating..... Single Phase

All elevations in this manual are referenced to National Geodetic Datum (NGVD) of 1929

SECTION 1. INTRODUCTION

1.01 Authorization. This manual is prepared in accordance with the following regulations:

- ER 1110-2-240, Water Control Management, dated 8 October 1982, prescribes policies and procedures to be followed by the US Army Corps of Engineers (Corps) in carrying out water control management activities, including establishment of water control plans for Corps and non-Corps projects, as required by federal laws and directives. Chapter 7 of ER 1110-2-240 assigns to District Engineers the responsibility for development of plans and manuals for operation of reservoirs.
- NPDR 1165-2-2, “Water Resource Policies and Authorities, Water Management Responsibilities,” CENPD-EN-WM, dated 2 January 1990. This regulation pertains to the management of the Columbia River reservoir system through the regulation and operation of Corps of Engineers dams and those owned by other agencies. The purpose of this regulation is to clarify the organizational structure of and define specific responsibilities for the Division, districts, and project offices engaged in this activity. See Exhibit 1-1.
- EM 1110-2-3600, Management of Water Control Systems, dated 30 November 1987, provides guidance to field offices for the management of water control projects or systems authorized by Congress and constructed and operated by the Corps of Engineers. It also applies to certain water control projects constructed by other agencies or entities.

- ER 1110-2-8156, Preparation of Water Control Manuals (WCM), dated 31 August 1995, provides specification on WCM content and format.
- ER 1110-2-1450, Engineering and Design, Hydrologic Frequency Estimates, dated 31 August 1994, requires that, “Reference to the frequency of specific events should use the phrase ‘[x] percent chance exceedance flood.’ If the phrase is used several times in the text, it may be shortened to ‘[x] percent flood.’ Information for public dissemination may use the shorter term provided the full definition is included as a footnote. The [x] percent flood has one chance in [100/x] of being exceeded in any given year. Uses of the terms ‘[x]-year flood,’ ‘recurrence interval,’ ‘exceedance interval,’ and ‘return period’ are no longer acceptable in Corps reports.”
- SD-10 Guide for Identification and Development of Metric Standards, Department of Defense, Office of the Under Secretary of Defense, Acquisition, Technology, & Logistics. December 2003. Section 4, Pages 3-4 provides guidance for the use of SI units in Department of Defense documents. The following paragraph is relevant to this Water Control Manual:

“4.1 Where Soft Conversion Should Be Used. If the purpose is simply to put the requirements in metric language, a soft conversion is the only needed change. The soft conversion can be in the form of stating only the converted metric units in the requirements as substitutions for the inch-pound units; stating the metric units in parenthesis after the inch-pound units in the requirements or vice versa; or giving a table of conversions and/or conversion factors and giving the requirements in only one system.

- In this manual, the inch-pound units are stated in parenthesis after the metric units.
- A glossary and table with standard-to-metric conversion factors are provided in Exhibits 1-2 and 1-3, respectively

1.02 Purpose and Scope. This manual presents the reservoir regulation plan for Chief Joseph Dam (CHJ or CJD) for use as a reference document for higher authority and as a guidance manual for Corps staff involved in project activities. Detailed information describing local sub-basins, project features, data collection facilities, forecasting procedures, reservoir regulation plans, and the effects of regulation are provided in this manual.

1.03 Related Manuals and Reports.

a. Chief Joseph Dam, Columbia River, Washington, Reservoir Regulation Manual, dated October 1960 is hereby superseded by this September 2009 manual.

b. “The Columbia River Basin Master Water Control Manual,” prepared by the Corps’ North Pacific Division (NPD), now the Northwestern Division (NWD), dated December 1984, provides an overview of the operation and regulation of water resource projects in the Columbia Basin including CHJ.

c. The Project Master Plan, Design Memorandum 60, US Army Corps of Engineers, dated September 2002, also describes the project’s facilities and resources.

d. The January 2008 Emergency Action and Notification Subplan for Chief Joseph Dam is located at the project and in the Northwest Division and Seattle District Reservoir Control Centers.

e. Fifty-seven numbered Design Memorandums and supplements totaling 129 reports describe the development and construction of primary project features. These memoranda are listed in Exhibit 1-4.

f. NWDR 1110-2-6, Deviation Requests For Approved Water Control Manuals, dated 9 November 2005, provides guidelines concerning deviations from approved WCMs and delegates deviation approval authority to the chief, Columbia Basin Water Management Division (CBWMD) (Exhibit 1-5).

Other operating reports and bulletins of interest concerning the project are available in the Seattle District office in the Engineering Records and Information Section. Some reports and data are also available in the Technical Section at CHJ at speed dial number 723-2255 or the project's commercial number (509) 686-5501.

1.04 Project Owner and Operating Agency. CHJ is owned by the United States Government and operated by the U.S. Army Corps of Engineers (Corps) for the authorized purpose of hydropower and secondary uses including recreation, irrigation, fish and wildlife enhancement, and streamflow regulation. The dam is attended continuously.

1.05 Regulating Agency. Primary responsibility for regulation of CHJ is assigned to the Division Engineer, Northwestern Division, who directs day-to-day operations through the Division Reservoir Control Branch (CENWD-PDW-R). Seattle District Water Management Section (CENWS-EC-TB-WM) supports the Division by conducting engineering investigations and coordinating with the public on matters concerning the project operation, regulation, and public affairs. Each office contains a reservoir control center to help accomplish its water resource regulation mission. The Corps'

Northwestern Division and Seattle District reservoir control centers are referred to as the NWD-RCC and NWS-RCC, respectively.

The Corps authority for regulation of CHJ is provided in Regulation NPDR 1165-2-2, “Water Resource Policies and Authorities, Water Management Responsibilities,” CENPD-EN-WM, dated 2 January 1990, see Exhibit 1-1.

SECTION 2. DESCRIPTION OF PROJECT

2.01 Location. Chief Joseph Dam (CHJ) is located in north central Washington on the Columbia River 877.9 river kilometers (RK) (545.5 river miles (RM)) upstream from the mouth of the Columbia River. The dam is 82.7 RK (51.4 RM) downstream from Grand Coulee Dam (GCL) at RK 960.6 (RM 596.9) and approximately 1.6 km (1 mi) upstream from the city of Bridgeport. The project is approximately 365 km (227 mi) (road miles) east of Seattle, Washington, see Plate 2-1. Corps of Engineers' project jurisdiction extends from a point about 0.3 km (1,000 ft) downstream from the dam upstream 72 km (45 mi) to Seaton's Grove boat ramp at RK 950 (RM 590). The 9.7 km (6 mi) reach between Seaton's Grove boat ramp and GCL is administered by the U.S. Bureau of Reclamation. The powerhouse and administrative facilities at CHJ are located on the left bank (south side of the river) in Douglas County, in Sec 24, T29N, R25E and Sec 19, T29N, R26E, WM.

2.02 Purpose. CHJ is a major unit of the comprehensive water resource development of the Columbia River Basin. The project is a single-purpose project authorized for hydropower with a number of other beneficial uses associated with its operation; namely, fish and wildlife conservation, in-stream flow regulation, recreation, and irrigation.

a. Authorized Purpose. Chief Joseph Dam (CHJ) was initially authorized as Foster Creek Dam and Powerhouse by Public Law 79-525, dated July 24, 1946, under the River and Harbor Act of 1946.

b. Incidental Benefits. As a run-of-river project, CHJ has a limited reservoir

storage capacity used primarily for power pondage, but is available for re-regulation of flood flows. Although Rufus Woods Lake provides no authorized irrigation storage or reservoir releases for at-site or downstream irrigation, water from the reservoir is an important water supply for irrigation of local farmlands surrounding the reservoir.

c. Purposes Contained in or Derived from Congressional Acts. The Endangered Species Act and the Clean Water Act provide additional authorized purposes for the projects in the Columbia River Basin. The objectives of these acts overlap with respect to ecosystem and the quality of habitat directly affecting the fish that live in the rivers. The Columbia River contains fish species that are listed as endangered species and are protected under federal law. Federal law requires States to list impacted waters that fail to meet state water quality standards, and to develop Water Quality Improvement Reports to address those pollutants. Washington State has listed the Columbia River from the Canadian border to the Snake River confluence on its federal Clean Water Act Section 303(d) list due to temperature and total dissolved gas levels exceeding state water quality standards (Washington State Water Quality Standards (old) 173-201A(060)(4); (new)173-201A-200(1)(f) and the Confederated Colville Tribal Water Quality Standards).

(1) Fish and Wildlife Conservation. CHJ is authorized under Public Law (PL) 85-624 Fish and Wildlife Coordination Act of 1958 and PL-93-205 Endangered Species Act of 1973 (ESA) as Amended to conserve the ecosystems upon which endangered and threatened species depend. The NOAA FECRP 2008 and the 200x USFWS Biological Opinions require actions to achieve this objective. CHJ is operated to fulfill the obligations in the biological opinions.

(2) Water Quality. The objective of PL 92-500 Federal Water Pollution Control Act of 1972 (Clean Water Act (CWA)) as Amended is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters to assure protection of public health, public water supplies, agricultural and industrial uses, and the protection and propagation of a balanced population of shellfish, fish and wildlife, and allow recreational activities in and on the water.

i. Total Dissolved Gas (TDG). Under the CWA, the U.S. Environmental Protection Agency (EPA) has issued a TDG TMDL that includes all waters above Grand Coulee Dam and tribal waters from GCL downstream to the Snake River, referred to as the Mid-Columbia River Basin. Also under the CWA, Washington State Department of Ecology (WDOE) has issued TMDL standards for TDG for the Mid-Columbia River Basin. The TMDLs were developed in coordination with the Colville Confederated Tribes and the Spokane Tribe of Indians.

ii. Temperature. At the time of publication, the US Environmental Protection Agency (EPA), in coordination with Washington, Oregon, Idaho, the Colville Confederated Tribes, the Spokane Tribe of Indians and other federal and local agencies and interested parties, has completed a DRAFT TMDL for temperature for the Columbia and Snake Rivers. Issuance has been delayed. WA Ecology anticipates that EPA will issue a temperature TMDL for the Columbia River at some future date. Until that time, Ecology will address any temperature exceedances as may be necessary to meet state water quality standards for temperature.

(3) Recreation. Recreation is provided through PL 89-72 Federal Water Project Recreation Act of July 9, 1965 (see section 2.06 for description of projects).

2.03 Physical Components. Major components at CHJ include Rufus Woods Lake, a concrete gravity dam (composed of the spillway, powerhouse water intake section, non-overflow concrete and rockfill sections), and the powerhouse. The project also includes recreation facilities available to the public, significant environmental mitigation wildlife sites, and other miscellaneous facilities. A general layout of the project structures is shown in Plate 2-2. Details are provided below:

a. Reservoir. Rufus Woods Lake formed by CHJ contains total active storage of 23,720 ha-m (192,300 AF) between minimum pool El 283.46 m (El 930 ft) and Normal Full Pool (NFP) El 291.39 m (El 956 ft). The top 1.83 m (6 ft) of the reservoir between El 289.56 m (El 950 ft) and NFP contains 5,736 ha-m (46,500 AF) of storage used for normal daily-weekly pondage-type hydropower operations. Immediately upstream of the dam, at NFP, the reservoir is about 53.3 m (175 ft) deep. The length of the reservoir is approximately 72 km (45 mi) and ends about 9.7 RK (6 RM) downstream from the GCL tailrace. As a result of this close proximity, GCL tailwater elevations are increased by backwater encroachment from Rufus Woods Lake. The surface area at NFP is about 3,399 ha (8,400 ac). Storage tables for Rufus Woods Lake are provided in acre feet (AF) and hectare meters (ha-m) in Tables 2-1 and 2-2, respectively, in the table section. The table in acre feet is based on a January 10, 1955 storage table prepared by the USGS. A reservoir area capacity curve is shown in Chart 2-1.

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c. Wildlife Mitigation Sites (WMS). A wildlife mitigation program for CHJ was approved on January 5, 1981, to preserve habitat for threatened species and to mitigate wildlife losses resulting from the February 1981 3.05 m (10 ft) reservoir raise. See Plate 2-9 for the WMS locations. Details of the WMS are listed in Tables 2-5 and 2-6.

TABLE 2-5. CHJ WILDLIFE MITIGATION SITES

CHIEF JOSEPH DAM MITIGATION ACREAGE (Hectares)							
Site No.	River Kilometer KM	Total Site Area	Area Above and Below Full Pool			Fee, Public Domain, and Easement Land	
			Fee	Public Domain (non-fee)	Flowage Easement (non-fee)	Above Full Pool	Fenced
1	887.85	49.19		49.19		14.63	4.15
2	881.73	0.004	0.004 (all above)			0.004	
3	881.41	79.87			78.87	26.29	15.66
5	890.10	97.96			97.96	25.99	14.10
6	891.39	63.98		63.09		39.15	
7	895.41	192.11	49.31 (14.63 above)	142.80		128.27 [14.63 in fee]	79.28
8, 9	898.14	101.81			101.81	87.30	6.69
10	899.91	105.09		105.09		53.76	3.43
11	904.26	48.38		28.42	19.96	32.66	24.67
12	909.09	32.38			32.38	13.96	11.93
15	923.57	36.58			36.58	22.82	7.96
16	925.18	27.10			27.10	6.75	5.14
18	941.27	170.43			170.43	160.75	160.75
19	945.29	37.08			37.08	≈ 8.09	
20	948.51	72.26			72.26	64.24	
Total Acreage (Hectares)		1,114.23	49.31 [14.63 above full pool]	389.48	675.44	684.69	333.75

Wildlife mitigation acreage by site. Sites 2 and 19 are islands; sites 10 and 16 are upland habitat with a manmade island for goose nesting. Total acreage is higher than what is actively managed due to land below the 291.39-meter surface water elevation.

TABLE 2-6. CHJ WILDLIFE MITIGATION SITES

CHIEF JOSEPH DAM MITIGATION ACREAGE (Acres)							
Site No.	River Mile RM	Total Acreage	Area Above and Below Full Pool			Fee, Public Domain, and Easement Land	
			Fee	Public Domain (non-fee)	Flowage Easement (non-fee)	Above Full Pool	Fenced
1	551.8	121.55		121.55		36.15	10.25
2	548	0.01	0.01 (all above)			0.01	
3	547.8	197.37			197.37	64.97	38.70
5	553.2	242.07			242.07	64.23	34.83
6	554	158.10		158.10		96.75	
7	556.5	474.70	121.84 (36.14 above)	352.86		316.95 [36.14 in fee]	195.90
8, 9	557.3, 558.2	251.57			251.57	215.72	16.52
10	559.3	259.68		259.68		132.85	8.48
11	562	119.56		70.23	49.33	80.71	60.95
12	565	80.02			80.02	34.50	29.49
15	574	90.38			90.38	56.40	19.67
16	575	66.96			66.96	16.69	12.70
18	585	421.13			421.13	397.22	397.22
19	587.8	91.63			91.63	≈ 20.00	
20	589.5	178.56			178.56	158.73	
Total Acreage		2,753.29	121.85 [36.15 above full pool]	962.42	1,669.02	1,691.88	824.71

Wildlife mitigation acreage by site. Sites 2 and 19 are islands; sites 10 and 16 are upland habitat with a manmade island for goose nesting. Total acreage is higher than what is actively managed due to land below the 956-foot surface water elevation.

d. Archeological Resources. Nearly 300 prehistoric and historic cultural resource sites are located within the CHJ project boundary.

2.05 Real Estate Acquisition. Lands along the reservoir right bank are property of the Colville Confederated Tribe (CCT) and lands along the left bank are mostly private property. Tables 2-7 and 2-8 provide land classifications, management units, and acreage for CHJ project lands.

TABLE 2-7. LAND CLASSIFICATIONS, MANAGEMENT UNITS, AND ACREAGE OF PROJECT LANDS

Metric Units

REAL ESTATE LAND (above & below full pool)	HECTARES	NOTE	CHJ\acreages.doc 9/3/02 B. Ecker
Fee title	683.05.....	All allocated to Operations (see Land Allocation below).* 474.38 ha above full pool. Includes 0.15 ha acquired in cure of dispute resolution.	
Public Domain (non-fee)	981.18.....	684.69 ha above full pool. Gov't-owned land administered by BLM that has been withdrawn from the public for Corps use in connection with the operation of CHJ. 16.19 ha proposed to be disposed of.	
Held by Easement (non-fee)	4,858.99	0.27 ha utility easement, 2.03 ha power line easements, 0.16 ha boundary easements, 0.30 ha bank protection sites from BIA, 1.09 ha access roads from BIA to protection sites, 31.57 ha access along SR 97 Br over Okanogan River, 675.44 ha mitigation land, RR siding at Brewster, 15.96 ha SR 17 Br over Columbia River at Bridgeport for hwy access on left bank (above full pool), 2.59 ha SR 17 Bridge over Col River at Bridgeport (above full pool), 0.86 ha downstream cableway crossing.	
Held by Permit (lesser interest)	0.98.....	transfer from Dept. of Interior's BOR to Corps of Engineers in 1958.	
Held by Lease (lesser interest)	0.99.....	0.98 ha to cross private property for RR/Hwy access to deliver turbines/equip to dam—DACW67-5-97-5, 0.004 ha for Total Dissolved Gas monitoring station—DACW67-5-97-10.	
Held by License (lesser interest)	0		
Riverbed	_____0	CCT owns river bottom from midline (of original Col River before dam was constructed) to Okanogan Co side. WSDNR owns river bottom from midline to Douglas Co side.	
TOTAL REAL ESTATE INTEREST	<u>6,525.18</u>	Land reported excess to Corps needs in 1988 master plan has been surplus and removed from this total. ¹ Total realty interests (6,525.18 ha of fee, easement, public domain, and lesser interests) acquired by the Corps also includes land below elevation 170.00 m; for example, land that historically extended to the high ordinary water level of the Columbia River in 1945.	
¹ 75.61 fee ha SR17 land—Douglas Co, 31.57 fee ha SR97 land—Okanogan Co (Br structure conveyed to WSDOT 1992), 35.53 fee ha BPA substation/buffer—Douglas Co, 5.80 fee ha Lf Bk Wlf Mgt Area—Douglas Co, 1.42 ha easement (SR97 Br over Okanogan Rv & assoc land.)			
*LAND ALLOCATION (breakdown of fee title land)			

TABLE 2-8. LAND CLASSIFICATIONS, MANAGEMENT UNITS, AND ACREAGE OF PROJECT LANDS

(standard inch-pound units)

REAL ESTATE LAND (above & below full pool)	ACRES	NOTE	CHJ\acreages.doc 9/3/02 B. Ecker
Fee title	1,687.83 All allocated to Operations (see Land Allocation below). [*] 1,172.2 ac above full pool. Includes 0.36 ac acquired in cure of dispute resolution.	
Public Domain (non-fee)	2,424.52 1,691.88 ac above full pool. Gov't-owned land administered by BLM that has been withdrawn from the public for Corps use in connection with the operation of CHJ. 40 ac proposed to be disposed of.	
Held by Easement (non-fee)	12,006.70 0.67 ac utility easement, 5.01 ac power line easements, 0.39 ac boundary easements, 0.95 ac bank protection sites from BIA, 2.70 ac access roads from BIA to protection sites, 78.02 ac access along SR 97 Br over Okanogan River, 1,669.02 ac mitigation land, RR siding at Brewster, 39.44 ac SR 17 Br over Columbia River at Bridgeport for hwy access on left bank (above full pool), 6.4 ac SR 17 Bridge over Col River at Bridgeport (above full pool), 2.12 ac downstream cableway crossing.	
Held by Permit (lesser interest)	2.41 Transfer from Dept. of Interior's BOR to Corps of Engineers in 1958.	
Held by Lease (lesser interest)	2.44 2.43 ac to cross private property for RR/Hwy access to deliver turbines/equip to dam—DACW67-5-97-5, 0.01 ac for Total Dissolved Gas monitoring station—DACW67-5-97-10.	
Held by License (lesser interest)	0		
Riverbed	<u>0</u> CCT owns river bottom from midline (of original Col River before dam was constructed) to Okanogan Co side. WSDNR owns river bottom from midline to Douglas Co side.	
TOTAL REAL ESTATE INTEREST	<u>16,123.90</u> Land reported excess to Corps needs in 1988 master plan has been surplused and removed from this total. ¹ Total realty interests (16,123.90 acres of fee, easement, public domain, and lesser interests) acquired by the Corps also includes land below elevation 955 feet; for example, land that historically extended to the high ordinary water level of the Columbia River in 1945.	
¹ 186.83 fee ac SR17 land—Douglas Co, 78.02 fee ac SR97 land—Okanogan Co (Br structure conveyed to WSDOT 1992), 87.8 fee ac BPA substation/buffer—Douglas Co, 14.53 fee ac Lf Bk Wlf Mgt Area—Douglas Co, 3.5 ac easement (SR97 Br over Okanogan Rv & assoc land.)			
[*] LAND ALLOCATION (breakdown of fee title land)			

2.06 Public Facilities. Recreation facilities operated in conjunction with the project include Bridgeport State Park, a visitor orientation area, three project viewpoints, a boat ramp downstream from the dam, and a right-bank fishing area. Fishing in the reservoir is popular and the Corps has developed recreation sites along the reservoir including fishing docks and general access to the reservoir. The locations of project recreation sites and facilities are shown on Plate 2-9 (*copied from Plate 4-1 in the Chief Joseph Master Plan report dated September 2002*). Hazards to recreational boating in the reservoir and immediately downstream of the dam are posted with warning signs and related information. Refer to Plate 2-10 for hazard locations.

SECTION 3. HISTORY OF PROJECT

3.01 Authorization. Chief Joseph Dam (CHJ) was initially authorized as Foster Creek Dam and Powerhouse by Public Law 79-525, dated July 24, 1946, under the River and Harbor Act of 1946, in accordance with the survey report dated April 9, 1946, submitted by the Chief of Engineers in House Document 693, 79th Congress, 2d Session, July 3, 1946. Foster Creek Dam was renamed Chief Joseph Dam by Public Law 80-858, dated June 30, 1948, under the River and Harbor Act of 1948. The reservoir created by CHJ was designated Rufus Woods Lake on July 9, 1952, by PL 82-469, 82d Congress, 2d Session.

3.02 Planning and Design. The history of comprehensive planning of multiple water resource projects in the Columbia River Basin began in the early 1900's. The Foster Creek Dam project (later named Chief Joseph Dam) was among various sites being studied for further development. The Corps together with other Federal agencies such as the Bureau of Reclamation, the Federal Power Commission, Federal and state fishery agencies, and related resource agencies have been leaders in Columbia Basin water resource development throughout much of the 20th century.

a. Columbia River. Under the River and Harbor Act of March 3, 1925, Congress authorized the Federal Power Commission and the Corps to conduct surveys of navigable streams with potential power sites. The surveys were published in House Document 308, Sixty-ninth Congress, 1st session, which called for detailed studies of many rivers, including the Columbia. The Corps began a detailed investigation of the Columbia River. The Bureau of Reclamation also presented their investigation for irrigation. In 1932,

Congress published the Report of the Columbia River and Tributaries as House Document No. 103, 73rd Congress. It resulted in a comprehensive plan for the entire Columbia River for hydropower, navigation, irrigation and flood control.

Examples of the effectiveness of their planning are reflected in the following reports:

- Review Reports of 1931 and 1937
- Columbia River Review Report of 1948
- Columbia River Review Report of 1958
- Supplement to the Review Report of 1958
- Columbia River and Tributaries Study, House Document 103, completed in March 1932

In addition to the planning studies cited above which set the framework for development of the present Columbia River system, the following treaties and agreements have involved the Columbia River operation:

- Review Reports of 1931 and 1937
- Treaty of June 15, 1846. This treaty between the United States and United Kingdom settled the northern boundary of the United States west of the Rocky Mountains and provided Canada with open navigation on the Columbia River in the United States.
- Boundary Waters Treaty of January 11, 1909. This treaty established agreements with respect to the boundary waters between the United States and Canada which include the Columbia River. Major elements of this treaty are:

(1) Defines the treaty boundary waters between the two nations.

(2) Established an International Joint Commission (IJC) and gave the Commission, along with Canada and the United States, jurisdiction in certain cases involving uses, obstructions, and diversions of boundary waters.

(3) Requires approval of the IJC to construct or maintain any remedial or protective work that results in raising the natural levels of waters on the other side of the boundary.

(4) Provides that boundary waters and waters flowing across the boundary shall not be polluted on either side which would result in injury or loss of health or property of the others, and

(5) Gives the IJC jurisdiction over certain disputes between the parties to the Treaty.

- Columbia River Treaty. This treaty between the United States and Canada was signed in 1961 and ratified on September 16, 1964. It provided that Canada construct three dams, Mica, Arrow, and Duncan, to provide 15,500,000 AF (1,911,897 ha-m) of storage space for hydropower and 8,450,000 AF (1,042,292 ha-m) of primary storage space for flood control, together with an additional 12,000,000 AF (1,480,178 ha-m) of secondary storage space for flood control. This storage is beneficial for flood control and hydropower generation in both the United States and Canada by reducing floods and regulating streamflows for increased hydropower generation. Details of this treaty are presented in the Corps of Engineers, Columbia River Basin, Master Water Control Manual, dated December 1984, on page 3-9.

- Interstate Compacts. Three compacts between States within the Columbia River Basin involving waters of the Columbia River provide guidelines for administering its waters, and for equitable division and apportionment of the waters of the Columbia River and its tributaries. Refer to the Columbia River Basin Master Water Control Manual, pages 3-9 and 3-10 for details of these compacts.

b. Chief Joseph Dam. Based on the Report of the Columbia River and Tributaries, House Document No. 103, 73rd Congress, several dam sites were investigated for further development. Differences in engineering problems, estimated costs, present power capabilities, and potentials for ultimate expansion decisively favored the location studied farthest downstream, one-quarter mile upstream from Foster Creek. Production of electric power would be the primary function of the proposed Foster Creek Dam project. Navigation on the Columbia River would be blocked at Grand Coulee Dam, so slack-water navigation upstream to Grand Coulee would be provided on the reservoir behind Foster Creek Dam. Irrigation would be accomplished by canals from the Foster Creek Reservoir and by direct pumping from the Okanogan River, or from the Columbia River below Foster Creek without construction of a canal. Flood control was not an issue as the proposed reservoir would be too small to have any noticeable effect during damaging floods. Sport fishing and recreation would benefit by the creation of a lake behind the dam.

Plans were made for a concrete gravity dam, intake, powerhouse and appurtenant generating facilities for 27 generating units. The project was designed for a NFP at EL 286.5 m (940 ft) with spillways, intake structure, and non-over flow sections constructed

to a top elevation at EL 292.6 m (960 ft). In 1953, the NFP elevation changed to EL 288.3 m (946 ft). The plan called for the powerhouse to be designed for only the first sixteen units (1-16), with the additional 11 units (17-27) added at later date.

Design Memorandum 35 provides the planning and design for units 17-27. The planning included consideration for optimizing power production at CHJ. This would have required require additional units beyond 27 and an increase in NFP to EL 295.7 m (970 feet). Raising the NFP to EL 295.7 m (970 ft) would have required raising the top elevation of the dam. The existing configuration would allow an increase in NFP to EL 291.39 m (El 956 ft) feet providing optimum use the planned 27 unit power plant with the current head between CHJ and Grand Coulee. The decision was made to incorporate features in the current design so that if the plan for raising the NFP to 970 feet were to go forward, little modification would be required. This included designing the additional units 17 – 27 for generation at EL 295.7 m (970 feet) as well as structural features to allow future raising the top elevation of the dam by 3.05 m (10 ft) to EL 295.7 m (970 feet).

In the 1990's, studies began to improve Total Dissolved Gas (TDG) conditions throughout the Columbia River migration corridor during all times that required spill. The 2000 and 2004 FCRPS Biological Opinions required changes that resulted in the Chief Joseph Dam Dissolved Gas Abatement project. The planning and design called for construction of flow deflectors in all 19 bays of the spillway at CHJ and operational changes for shifting spill and power generation between CHJ and GCL.

During testing of the flow deflectors, Seattle District determined that an extensive monolith joint repair was required to prevent the transmission of high surface pressures

through the joints to the foundation. An upgraded seal system was designed in 2006, consisting of an injection grout seal under the existing bituminous cement seal and a new elastomeric surface seal. Additional features to prevent the deflectors from transmitting high pressures included a redundant drain and waterstop system. The rehabilitation will be completed in the fall of 2009. Once complete, the final analysis of the hydraulic effects of the flow deflectors will be completed.

3.03 Construction History. The project was authorized for 27 generating units in 1946, construction began in 1949, and the dam was completed in 1981. The CHJ project was constructed in two phases as described below. Additional construction for the spillway flow deflectors was completed in 2008 and the joint repair is expected to be completed in summer 2009.

Phase I. Construction of the initial 471.2 m- (1,546 ft-) long powerhouse and dam with 16 main generating units, and 2 service units was initiated in 1949 with work on a planned El 286.51 m (El 940 ft) pool which was revised in 1953 to El 288.34 m (El 946 ft). The pool raise was completed in 1955 with its filling to NFP. Phase I construction generally occurred during the period from 1949 to 1958.

Phase II. Construction was initiated on July 11, 1969, in response to a recommendation to raise the pool 3.05 m (10 ft) to El 291.39 m (El 956 ft) and to complete the 11 additional units included under the original authorization. This work included raising the dam as well as completion of the powerhouse to accommodate the additional turbines, generators, and auxiliary equipment. Raising the dam to EL 295.7 m (970 feet) included raising the heights of all monoliths, rebuilding the spillway, and raising the intake structure. The additional 11 units were installed from March 1975 to

August 1978 and put on line from June 1977 to May 1979. The construction to raise the dam 3.05 m (10 ft) was completed and the pool was raised to El 291.39 m (El 956 ft) in February 1981. Phase II construction generally occurred during the 1969-1981 period.

Construction began on the spillway flow deflectors in 2006. The contractor was allowed a year round work window and completed the construction in 2008, ahead of schedule. A spill test was conducted in May 2009 and preliminary data indicate that the flow deflectors are performing as designed. The repair of the seal system was started in 2006, and will be completed during the summer of 2009.

A list of the primary contracts for the CHJ Phase I development (from the 1960 Reservoir Regulation Manual) is shown in Table 3-1.

TABLE 3-1. PHASE I DAM AND POWERHOUSE CONSTRUCTION CONTRACTS

Phase I #	CONTRACTOR	WORK ITEM	AMOUNT (\$)
205	General Construction Co.	Forebay Excavation	2,279,000
437	Peter Kiewit Co.	Dam Excavation & Cofferdam	3,109,000
651	Chief Joseph Builders	Dam El 288.34 m (El 946 ft)	27,290,000
1398	Columbia River Construction	Powerhouse & Intake	46,210,000
260	Newport News	Turbines (10)	7,339,300
2253	S. Morgan Smith	Turbines (6)	4,633,500
1835	Allis-Chalmers	Governors (10)	464,100
3207	Woodward	Governors (6)	253,300
313	Westinghouse	Generators (4)	5,120,700
2285	Westinghouse	Generators (4)	4,874,000
2750	Westinghouse	Generators (2)	2,347,500
56-13	Westinghouse	Generators (6)	6,999,900
2384	Gunther, Shirley	Install Powerhouse Equipment	3,599,300
2286	English Electric Co.	Transformers (10)	1,780,000
56-25	Pennsylvania Transformer Co.	Transformers (3)	624,200

Contract vendor names for the Phase II development of CHJ are not readily available.

Table 3-2 lists the costs of primary features for both phases of CHJ development. These costs were furnished by the Seattle District Finance and Accounting Branch. Costs are based on the latest cost certification dated 26 Sep 1995.

TABLE 3-2 CHJ TOTAL COST OF PRIMARY FEATURES (PHASE I AND II)

#	FEATURE	<u>PHASE I</u> FB 288.34 m (946 ft)	<u>PHASE II</u> 3.05 m (10 ft) pool raise	TOTAL (\$)
1	Lands & Damages	9,905,869	819,309	10,725,178
2	Relocations	3,538,591	870,607	4,409,198
3	Reservoir	1,736,856	259,599	1,996,455
4	Dam and Water Collecting	158,707,911	64,330,701	223,038,613
6	Fish & Wildlife	5,854,965	0	5,854,965
7	Powerplant	232,262,369	85,417,245	317,679,615
8	Roads & Bridges	3,264,769	576,421	3,841,190
9	Channels and Canals	0	608,118	608,118
14	Recreation Facilities	3,779,920	1,472,103	5,252,023
18	Cultural Resources Preservation	4,976,609	0	4,976,609
19	Buildings, Grounds and Utilities	14,555,106	707,491	15,262,597
			Total	593,644,561

3.04 Related Projects. There are 14 dams on the main stem of the Columbia River (see Chapter 4 for list). CHJ is downstream of GCL and upstream of Wells Dam and the Mid-Columbia dams.

a. Grand Coulee Dam (GCL). GCL is the largest hydropower producer in the United States. Lake Roosevelt storage capacity is 5.1 million-acre-feet; hydraulic capacity is approximately 430, 000 cfs; generating capacity is approximately 6809 Mega Watts. The project is owned by the Federal Government and operated by the U. S. Bureau of Reclamation (Reclamation).

Grand Coulee Dam (GCL) Operating Constraints. The 9.7 km (6 mi) tailwater reach below GCL is subject to backwater effects from Lake Rufus Woods and erosion damage due to the high powerhouse discharges at GCL. Reclamation operating order No. 152 for GCL, dated 08 August 2006, provides tailwater criteria for discharge operations at GCL. The order lists limits on hourly tailwater drawdown in feet, criteria for emergency slide occurrence, criteria to set minimum GCL tailwater elevations, and operating procedures in case of failure of the RBMS system, see Exhibit 3-1. No mitigation is involved in the CHJ backwater encroachment on the GCL tailwater because both projects are federally owned. Order No. 152 is implemented using tailwater stages measured at the road bridge about 1.6 km (1 mi) downstream from GCL dam. Tailwater stage-discharge rating curves for GCL previously provided in the Chief Joseph Dam Reservoir Regulation Manual, dated 1960, are no longer used because of extreme fluctuations in the tailrace and river immediately downstream of the three GCL powerplants.

b. Lake Pateros (Wells Dam reservoir) extends 29.5 miles upstream of Wells Dam on the Columbia River, resulting in encroachment on the CHJ tailwater. It is operated by Douglas County, Washington Public Utility District (PUD), and Okanogan County,

Washington Public Utility District (PUD). The Okanogan River enters the Columbia River between Wells Dam and CHJ. This operation results in a powerloss for CHJ.

3.05 Modifications to Regulations. Although no formal changes have been made to the original WCM and water control plan, changes in regulation have occurred due to raising the height of the dam and lake level in 1981, restricting reservoir operations to within a 6 foot range, and limiting drawdown rates. With completion of major headwater reservoirs upstream of CHJ in British Columbia and the United States by the early 1970's, Columbia River seasonal streamflow patterns at CHJ changed in response to the major effect of the seasonal storage regulation at these projects. This upstream storage operation includes a spring reservoir refill for flood control and subsequent drawdown to provide water supply for hydropower, fish and wildlife conservation, recreation, and other secondary purposes such as irrigation and navigation. As a run-of-the-river project, CHJ is still operated as a "re-regulating" dam to basically pass the seasonal flows downstream.

3.06 Principal Regulation Problems. Regulation problems at CHJ are associated with dissolved gas supersaturation conditions resulting from spillway operations at CHJ, Grand Coulee Dam (GCL) and dams in Canada and encroachment of Lake Pateros on the CHJ tailwater.

a. Grand Coulee Dam (GCL). Because of its large storage and generating capacity, BPA uses GCL as a peaking facility to provide dynamic functions and ancillary benefits as part of the day-to-day operation of the power system. When GCL discharges during peak load periods, water is held in the Chief Joseph reservoir and released later in a controlled way so that downstream water flow requirements are satisfied.

When GCL releases water through the drumgates, total dissolved gas levels are in

excess of the water quality standards. These high TDG levels are seen downstream, where the effects can be detrimental in the lower Columbia River. Once the CHJ Gas Abatement Project is complete, a new operating policy for the CHJ will address the benefits of the spillway flow deflectors in minimizing the TDG in the downstream Columbia River Basin. When final, the Water Control Plan will be updated.

b. Lake Pateros (Wells Dam reservoir). Wells Project was constructed after completion and filling of the Phase I CHJ dam to El 288.34 m (El 946 ft) in 1955. Recognizing that Wells Reservoir (Lake Pateros) would encroach on the CHJ tailwater and reduce the hydraulic head and power generation, an agreement was completed to reimburse the Federal Government for the losses resulting from the encroachment on original units #1-16. To account for this hydraulic head loss, a lower rated head was provided for the CHJ turbines. See Section 9.04 b for details.

SECTION 4. WATERSHED CHARACTERISTICS

4.01 General Characteristics. The Columbia River is one of the largest rivers in North America and together with its tributaries forms the dominant water system in the Pacific Northwest Region. Its total length is approximately 1,954 km (1,214 mi), with 740 km (460 mi) in British Columbia, Canada and 1,213 km (754 mi) in the United States. The Columbia River begins in Columbia Lake on the west slope of the Rocky Mountain Range in British Columbia and enters the United States in the northeastern corner of the State of Washington. The river then flows south and west through GCL and CHJ, then southeasterly to its confluence with the Snake River near Richland, Washington. It turns westward for 515 km (320 mi) forming the Washington-Oregon border before flowing into the Pacific Ocean near Astoria, Oregon.

The river drains approximately 567,207 km² (219,000 mi²) mostly in the states of Washington, Oregon, Idaho, Montana and southern British Columbia, with small areas in Wyoming, Nevada, and Utah. Of this total, 195,285 km² (75,400 mi²) are located upstream from CHJ, with 76,866 km² (29,678 mi²) located in Canada. The Kootenai (Kootenay in Canada) River rises in British Columbia, flows into the United States, flows back into British Columbia, then joins the Columbia River north of the International Boundary before crossing into Washington State. The N. F. Flathead River, a tributary of Flathead River, rises in British Columbia, flows into the Flathead River, which joins with the Clark Fork River, which rises in Montana. The Clark Fork River becomes the Pend Oreille River in Idaho where it flows into Lake Pend Oreille. The Pend Oreille River flows back into British Columbia, then joins the Columbia River north of the International Boundary before crossing into Washington State. Columbia

Basin drainage areas, both in the United States and British Columbia, located upstream of CHJ are listed in Table 4-1.

TABLE 4-1. COLUMBIA RIVER BASIN-DRAINAGE AREAS.

Subdivision	United States		Canada	
	km ²	mi ²	km ²	mi ²
Clark Fork –Pend Oreille	64,162	24,773	1,106*	427*
Kootenai	13,597	5,250	22,093**	8,530**

Location	km ²	mi ²
Columbia River at the International Boundary***	154,622	59,700
Columbia River at Grand Coulee Dam (USGS gage)	193,472	74,700
Columbia River at Bridgeport (USGS gage below CHJ) ****	196,062	75,700

Notes: * this area is located in the upper N.F. Flathead River

** this area is located in the upper Kootenay River (above Libby Dam) and the upper Yaak and upper Moyie Rivers

*** includes 77,759 km² (30,023 mi²) from the Clark Fork-Pend Oreille and Kootenai Rivers in the United States and 76,863 km² (29,677 mi²) from sources in British Columbia

**** gage located 2.57 km (1.6 mi) downstream from CHJ. Because of the backwater effect caused by Lake Pateros reservoir behind Wells Dam, Columbia River streamflows for this station are computed at CHJ using flow through the turbines and spillway discharge when it occurs.

4.02 Topography. Chief Joseph Dam and Rufus Woods Lake lie in a steep-sided canyon of the Columbia River valley. The right bank (north side) of the valley rises sharply to the Okanogan Highlands, 1,000 feet or more above the Columbia River. The left bank (south side) of the valley rises in a series of terraces and benches climbing to the Columbia Plateau surface. The majority of the shoreline is treeless with a dry land shrub-steppe cover. Numerous canyons and deep draws support isolated stands of pine

and deciduous trees and shrubs. Irrigated orchards on upland benches and six irrigated wildlife mitigation sites are situated along the lakeshore.

4.03 Geology. The Columbia Basin upstream of CHJ is in the northern Rocky Mountain physiographic province, a region characterized by rugged highlands and intermontane basins. Rocks are mainly ancient argillitic and quartzitic materials, but a portion of the basin contains slightly younger metamorphosed sedimentary rocks and granite. These rocks have been folded and faulted in later mountain-building movements that formed the Rocky Mountains.

The granitic Okanogan Highlands occupy the area north of the Columbia River valley. This is an area characterized by moderately steep, forested slopes and broad rounded summits up to 7,000 feet in elevation. Present configurations of the highlands are the result of Tertiary erosion and Pleistocene glaciation. To the south of the Columbia River valley lies the Columbia Plateau which is composed of Miocene basaltic lava flows with an aggregate thickness up to about 1,830 m (6,000 ft). In the contact zone between the basaltic plateau and the granitic highlands, the Columbia River has cut a canyon 3.2 to 6.4 km (2 to 4 mi) wide with a maximum depth of about 460 m (1,500 ft).

Glacial advances and retreats have filled the Columbia River valley with outwash, lake deposits, glacial till, and other related deposits. Post-glacial fluvial cutting of these deposits produced a complex array of terraces at elevations ranging from about 240 to 570 m (800 to 1,880 ft) mean sea level. Major land surfaces within the valley include: sands and gravels; glacial till composed of compact sand, gravel, silt, and clay; and glacial lake deposits consisting of silt, clay, fine sand, and old landslide deposits. Most of the arable soils are located on level or gently curving terrace surfaces, are alluvial in

origin, and overlie either bedrock or some variety of glacial deposits. Locally extensive fields of erratics are found on both sides of the valley at virtually all elevations. These basalt blocks were “let down” as the Columbia River re-excavated its valley following de-glaciation.

4.04 Sediment. Sediment surveys of Rufus Woods Lake are not conducted because of the absence of any noticeable accumulation in the reservoir since the construction of CHJ. There are no major-sediment bearing tributaries entering the lake and Lake Roosevelt, the deep reservoir behind Grand Coulee Dam, effectively traps and stops the movement of sediments downstream. Landslide, eroision and sloughing of the steep banks surrounding the reservoir occur primarily due to the steep terrain and reservoir fluctuations. Raising the dam and lake level, restricting reservoir operations to within 6 feet range, establishing drawdown rates have reduced these activities.

The banks are subject to erosion because of their mostly fine-grain soil composition. Moderate slumping tends to occur on glacial till slopes undercut by wave action as well as in deposits vulnerable to high ground water levels. Several major prehistoric and historic landslides have occurred in the dam and lake area. Impoundment of Rufus Woods Lake caused sloughing near Bridgeport State Park and upstream from China Creek at RK 925 (RM 575) on the left bank (south shore). Many areas are sloughing to a lesser degree along the reservoir periphery, some due to reservoir operation and some a result of upland irrigation. Of particular importance is the post-glacial Bridgeport Slide that occurred just upstream from the dam on the left bank. This land is presently administered by the Corps and is monitored by the project. Slides along the upstream portion of Rufus Woods Lake downstream from Elmer City were active

during the middle and late 1940's as a result of rapid tailwater fluctuations at Grand Coulee Dam, but have decreased in recent years as a result of the raising of Rufus Woods Lake. In 1970, construction for the third powerplant at Grand Coulee Dam precipitated additional sliding so riprap was added to control these slides.

4.05 Climate. The Columbia River Basin is influenced by a modified west coast marine and continental climate which varies with elevation and proximity to mountain ranges. In the mountainous regions, the influence of the Continental Divide is greater than the maritime influence, and heavy showers and occasional cloudbursts occur in May, June, and July. Marine influences are strongest during the winter and cause most of the winter snowfall when warm moist air from the Pacific Ocean is cooled by orographic lifting over the mountains in the upper basin or by frontal contact with Arctic air masses.

The climate in the CHJ locality is semi-arid and typical of a temperate desert climate. Summers are typically warm and very sunny with an average high temperature of 30.1° C (86.2° F) and average low temperatures of 13.3° C (55.9° F), while winters are relatively mild with average high temperatures of 2.3° C (36.1° F) and average low temperatures of -5.2° C (22.7° F). Average annual precipitation is about 26.0 cm (10.24 in) per year.

Weather data are collected at CHJ and furnished to the National Weather Service for publication. Weather data at CHJ for the 1949-2005 period of record include monthly temperature data (averages and extremes) and daily temperature data (extremes by month) and are provided in Tables 4-2 and 4-3. Tables 4-4 and 4-5 include precipitation values including snowfall. Monthly climate summaries are provided in Tables 4-6 and 4-7. Data for these tables are obtained from the Washington Climate Summaries internet

web site at <http://www.wrcc.dri.edu>. After entering the database, select Chief Joseph from the list of available climate stations.

Evaporation values for the reservoir and immediate vicinity of the project are estimated from nearby weather and agriculture research stations since pan measurements are not recorded at the project. Average monthly evaporation values (Class A evaporation pan) at the Spokane Airport, located on the eastern edge of the Columbia plateau, are 11.8 cm, 18.5 cm, 21.8 cm, 28.7 cm, 26.0 cm, and 16.3 cm (4.66 in, 7.27 in, 8.57 in, 11.28 in, 10.22 in, and 6.41 in) for April, May, June, July, August, and September, respectively. Pan evaporation values should be multiplied by 0.70 to 0.80 to estimate evaporation from naturally existing surfaces such as lakes. The 2000 Level Modified Streamflow Record (1928-1999) by BPA, dated May 2004, uses the following average monthly evaporation amounts from CHJ reservoir in their runoff depletion studies: April, May, and June - 0.28 m³/s (10 cfs); July - 0.57 m³/s (20 cfs); and August and September - 0.28 m³/s (10 cfs).

**TABLE 4-2. CHIEF JOSEPH DAM—TEMPERATURE SUMMARY (1949–2005)
AVERAGE MONTHLY AND MAXIMUM/ DAILY EXTREMES– °C**

	Monthly Average			Daily Extremes				Monthly Extremes				Max. Temp.		Min. Temp	
	Max	Min	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 32.2°	<= 0°	<= 0°	<= -17.8°
	°C	°C	°C	°C		°C		°C		°C		# Days	# Days	# Days	# Days
Jan	0.6	-6.5	-2.9	13.9	1/30/1989	-28.3	1/30/1950	2.3	1990	-12.4	1950	0	13	27.9	1.9
Feb	4.8	-4.1	0.4	17.8	2/22/2002	-28.3	2/1/1950	4.8	1991	-7.3	1956	0	4.1	23.2	0.6
Mar	11.6	-0.3	5.6	25.6	3/30/2003	-16.7	3/10/1951	9.8	1992	1.2	1951	0	0.5	17	0
Apr	17.9	3.3	10.6	33.9	4/25/1977	-7.2	4/13/1968	13.6	1987	7.7	1955	0	0	5.5	0
May	22.9	7.6	15.3	39.4	5/31/1986	-3.3	5/1/1954	19.6	1958	11.7	1955	1.3	0	0.5	0
Jun	27.1	11.5	19.3	42.2	6/23/1992	0.6	6/5/1954	23.1	1992	16.4	1981	5	0	0	0
Jul	31.7	14.3	23.0	43.3	7/21/1994	1.7	7/16/1974	26.6	1985	19.7	1993	15.6	0	0	0
Aug	31.5	13.9	22.7	43.3	8/4/1998	1.7	8/17/1973	26.0	1997	19.6	1968	15	0	0	0
Sep	26.2	9.1	17.7	39.4	9/1/1967	-1.7	9/23/2000	21.3	1967	14.7	1971	3.7	0	0.2	0
Oct	17.4	3.3	10.3	30.0	10/3/1987	-12.2	10/31/2002	13.1	1988	8.4	1984	0	0	6.8	0
Nov	7.4	-1.1	3.2	23.9	11/1/1967	-22.8	11/23/1985	6.6	1990	-4.8	1985	0	1.9	17.8	0.2
Dec	1.4	-5.0	-1.8	14.4	12/3/1975	-28.3	12/29/1968	1.6	2002	-7.9	1984	0	10.8	26.9	0.5
Annual	16.7	3.8	10.3	43.3	7/21/1994	-28.3	1/30/1950	11.9	1998	8.2	1955	40.7	30.5	125.7	3.2
Winter	2.3	-5.2	-1.4	17.8	2/22/2002	-28.3	1/30/1950	2.6	1967	-6.1	1985	0	28	78	3
Spring	17.4	3.5	10.5	39.4	5/31/1986	-16.7	3/10/1951	13.2	1992	6.9	1955	1.3	0.5	23	0
Summer	30.1	13.3	21.7	43.3	7/21/1994	0.6	6/5/1954	23.8	1958	19.8	1976	35.6	0	0	0
Fall	17.0	3.8	10.4	39.4	9/1/1967	-22.8	11/23/1985	12.5	1998	6.8	1985	3.7	2	24.8	0.2

**TABLE 4-3. CHIEF JOSEPH DAM—TEMPERATURE SUMMARY (1949–2005)
AVERAGE MONTHLY AND MAXIMUM/ DAILY EXTREMES– °F**

	Monthly Average			Daily Extremes				Monthly Extremes				Max. Temp.		Min. Temp	
	Max	Min	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 90°F	<= 32°F	<= 32°F	<= 0°F
	°F	°F	°F	°F		°F		°F		°F		# Days	# Days	# Days	# Days
Jan	33.1	20.3	26.7	57	1/30/1989	-19	1/30/1950	36.2	1990	9.7	1950	0	13	27.9	1.9
Feb	40.6	24.7	32.7	64	2/22/2002	-19	2/1/1950	40.7	1991	18.9	1956	0	4.1	23.2	0.6
Mar	52.8	31.4	42.1	78	3/30/2003	2	3/10/1951	49.6	1992	34.2	1951	0	0.5	17	0
Apr	64.2	38	51.1	93	4/25/1977	19	4/13/1968	56.5	1987	45.8	1955	0	0	5.5	0
May	73.3	45.6	59.5	103	5/31/1986	26	5/1/1954	67.2	1958	53.1	1955	1.3	0	0.5	0
Jun	80.7	52.7	66.7	108	6/23/1992	33	6/5/1954	73.6	1992	61.6	1981	5	0	0	0
Jul	89.1	57.8	73.4	110	7/21/1994	35	7/16/1974	79.8	1985	67.4	1993	15.6	0	0	0
Aug	88.7	57	72.8	110	8/4/1998	35	8/17/1973	78.8	1997	67.2	1968	15	0	0	0
Sep	79.1	48.4	63.8	103	9/1/1967	29	9/23/2000	70.3	1967	58.5	1971	3.7	0	0.2	0
Oct	63.4	37.9	50.6	86	10/3/1987	10	10/31/2002	55.5	1988	47.1	1984	0	0	6.8	0
Nov	45.3	30.1	37.7	75	11/1/1967	-9	11/23/1985	43.9	1990	23.3	1985	0	1.9	17.8	0.2
Dec	34.6	23	28.8	58	12/3/1975	-19	12/29/1968	34.9	2002	17.8	1984	0	10.8	26.9	0.5
Annual	62.1	38.9	50.5	110	7/21/1994	-19	1/30/1950	53.5	1998	46.7	1955	40.7	30.5	125.7	3.2
Winter	36.1	22.7	29.4	64	2/22/2002	-19	1/30/1950	36.6	1967	21.1	1985	0	28	78	3
Spring	63.4	38.3	50.9	103	5/31/1986	2	3/10/1951	55.8	1992	44.5	1955	1.3	0.5	23	0
Summer	86.2	55.9	71	110	7/21/1994	33	6/5/1954	74.8	1958	67.7	1976	35.6	0	0	0
Fall	62.6	38.8	50.7	103	9/1/1967	-9	11/23/1985	54.5	1998	44.3	1985	3.7	2	24.8	0.2

**TABLE 4-4. CHIEF JOSEPH DAM—PRECIPITATION SUMMARY (1949–2005)
AVERAGE MONTHLY AND MAXIMUM/ DAILY EXTREMES– Centimeter (cm)**

												Total Snowfall		
	Mean	High		Low		1 Day Max.		>=	>=	>=	>=	Mean	High	Year
	cm	cm	Year	cm	Year	cm	Date	# Days	# Days	# Days	# Days	cm	cm	Year
Jan	3.4	10.8	1995	0.1	1977	2.5	1/15/1968	9	4	0	0	18.8	57.2	1950
Feb	2.6	10.7	1961	0.0	2005	2.5	2/3/1961	6	3	0	0	8.6	44.5	1989
Mar	2.1	7.0	1995	0.1	1965	1.9	3/10/1995	6	3	0	0	3.0	24.1	1962
Apr	1.6	4.2	1993	0.0	1954	2.0	4/14/1957	5	2	0	0	0.0	5.1	1955
May	2.1	6.6	1990	0.0	1992	3.1	5/11/1967	6	3	0	0	0.0	0.0	1950
June	2.1	6.2	1984	0.0	1960	3.1	6/21/1984	5	2	0	0	0.0	0.0	1950
July	1.0	7.8	1993	0.0	1953	4.4	7/23/1992	3	1	0	0	0.0	0.0	1950
Aug	1.0	5.7	1976	0.0	1950	2.9	8/29/1951	3	1	0	0	0.0	0.0	1950
Sept	0.9	6.7	1986	0.0	1953	2.3	9/23/1973	3	1	0	0	0.0	0.0	1950
Oct	1.5	5.2	1956	0.0	1952	2.6	10/27/1956	5	2	0	0	0.3	4.6	1971
Nov	3.4	14.1	1983	0.1	1976	2.9	11/11/1983	9	4	0	0	5.6	35.1	1955
Dec	4.2	13.2	1996	0.5	1989	2.8	12/29/1996	10	6	1	0	25.7	95.3	1996
Annual	26.0	54.8	1983	14.2	1985	4.4	7/23/1992	70	33	4	0	62.0	181.4	1996
Winter	10.2	21.4	1983	3.5	1955	2.8	12/29/1996	25	13	1	0	53.1	125.0	1997
Spring	5.8	12.0	1983	1.3	1973	3.1	5/11/1967	17	8	1	0	3.0	24.1	1962
Summer	4.2	12.9	1993	0.5	1960	4.4	7/23/1992	11	5	1	0	0.0	0.0	1950
Fall	5.9	17.8	1983	0.8	1976	2.9	11/11/1983	17	7	1	0	5.8	35.1	1955

**TABLE 4-5. CHIEF JOSEPH DAM—PRECIPITATION SUMMARY (1949–2005)
AVERAGE MONTHLY AND MAXIMUM/ DAILY EXTREMES– Inches**

												Total Snowfall		
	Mean	High		Low		1 Day Max.		>= 0.01 in	>= 0.10 in	>= 0.50 in	>= 1.00 in	Mean	High	Year
	in	in	Year	in	Year	in.	Date	# Days	# Days	# Days	# Days	in	in	Year
Jan	1.33	4.26	1995	0.02	1977	0.99	1/15/1968	9	4	0	0	7.4	22.5	1950
Feb	1.03	4.23	1961	0.00	2005	1.00	2/3/1961	6	3	0	0	3.4	17.5	1989
Mar	0.83	2.77	1995	0.05	1965	0.76	3/10/1995	6	3	0	0	1.2	9.5	1962
Apr	0.63	1.67	1993	0.00	1954	0.79	4/14/1957	5	2	0	0	0.0	2.0	1955
May	0.82	2.60	1990	0.01	1992	1.23	5/11/1967	6	3	0	0	0.0	0.0	1950
June	0.84	2.45	1984	0.00	1960	1.24	6/21/1984	5	2	0	0	0.0	0.0	1950
July	0.40	3.08	1993	0.00	1953	1.74	7/23/1992	3	1	0	0	0.0	0.0	1950
Aug	0.40	2.24	1976	0.00	1950	1.14	8/29/1951	3	1	0	0	0.0	0.0	1950
Sept	0.37	2.65	1986	0.00	1953	0.90	9/23/1973	3	1	0	0	0.0	0.0	1950
Oct	0.60	2.04	1956	0.00	1952	1.01	10/27/1956	5	2	0	0	0.1	1.8	1971
Nov	1.34	5.57	1983	0.05	1976	1.16	11/11/1983	9	4	0	0	2.2	13.8	1955
Dec	1.64	5.18	1996	0.20	1989	1.10	12/29/1996	10	6	1	0	10.1	37.5	1996
Annual	10.24	21.57	1983	5.61	1985	1.74	7/23/1992	70	33	4	0	24.4	71.4	1996
Winter	4.00	8.44	1983	1.36	1955	1.10	12/29/1996	25	13	1	0	20.9	49.2	1997
Spring	2.28	4.73	1983	0.52	1973	1.23	5/11/1967	17	8	1	0	1.2	9.5	1962
Summer	1.65	5.09	1993	0.20	1960	1.74	7/23/1992	11	5	1	0	0.0	0.0	1950
Fall	2.31	6.99	1983	0.31	1976	1.16	11/11/1983	17	7	1	0	2.3	13.8	1955

**TABLE 4-6. CHIEF JOSEPH DAM–MONTHLY CLIMATE SUMMARY–(cm)
PERIOD OF RECORD: 10/1/1949 TO 12/31/2005**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Total Precipitation	3.4	2.6	2.1	1.6	2.1	2.1	1.0	1.0	0.9	1.5	3.4	4.2	26.0
Average Total Snow Fall	18.8	8.6	3.0	0	0	0	0	0	0	0.3	5.6	25.7	62.0
Average Snow Depth	5.1	2.5	0	0	0	0	0	0	0	0	0	5.1	0

**TABLE 4-7. CHIEF JOSEPH DAM–MONTHLY CLIMATE SUMMARY–(in)
PERIOD OF RECORD: 10/1/1949 TO 12/31/2005**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Total Precipitation	1.33	1.03	0.83	0.63	0.82	0.84	0.40	0.40	0.37	0.60	1.34	1.64	10.24
Average Total Snow Fall	7.4	3.4	1.2	0	0	0	0	0	0	0.1	2.2	10.1	24.4
Average Snow Depth	2	1	0	0	0	0	0	0	0	0	0	2	0

4.06 Floods

a. Columbia River. Generally, maximum discharges in the Columbia River system are the result of snowmelt runoff during the April-June period. Occasionally, heavy rainstorms move through the basin during the snowmelt period adding to the runoff before cooler temperatures reduce the snowmelt contribution. This rain-on-snow condition augmented the May 1948 flood.

Monitoring the spring snowpack and processing spring runoff forecasts generally provides several weeks advance warning of high water on the Columbia River system. Short-term forecasts are used to track the runoff and help assure sufficient remaining

storage to capture the peak portion of the flood hydrograph. During the spring, headwater storage reservoirs upstream of CHJ are actively operating to refill and provide flood control if necessary. Flood control regulation at headwater reservoirs is targeted for both local areas immediately downstream of their project and the lower Columbia River in the vicinity of Portland, Oregon. Upstream storage is now sufficient to control all but the largest runoff conditions. GCL with its 640,000 ha-m (5.19 million AF) of active flood storage is able to rapidly respond to flood conditions in the mid-to-lower Columbia valley.

b. Chief

Joseph Dam. CHJ is a run-of-river project with insufficient pondage storage for effective flood control regulation. The power pool at CHJ can be used on a limited basis for re-regulation of flood flows; drafting immediately prior to a major flood crest on an ad hoc basis may provide crest stage reduction to the extent possible. Operations of this type are under the direction of the Corps, Northwestern Division, Reservoir Control Center (CENWD-PDW-R).

Based on available information, there is no significant flood damage in the vicinity of CHJ either upstream or downstream. For example, during the June 11, 1997 flood on the Columbia River when a maximum discharge of 9,231 m³/s (326,000 cfs) occurred at CHJ, the Seattle District Emergency Management Branch received no report of any flood damage on the mainstem Columbia River in Seattle District's jurisdiction.

c. 1894 and 1948 Floods. Construction of CHJ began in 1949, and the Bridgeport gage downstream of CHJ became operational in 1952. Therefore, the 1894 and 1948 floods are referenced to the USGS gage at Grand Coulee Dam. The historical flood of

1894 is recognized as the largest known flood to occur at the Grand Coulee Dam site with an estimated peak discharge of 20,530 m³/s (725,000 cfs) based on high-water marks (no streamgage was available in the vicinity of GCL at that time). The largest flood in terms of damages was the June 12, 1948 flood with an estimated peak discharge of 18,060 m³/s (637,800 cfs) at Grand Coulee Dam.

d. Highest Known Floods and Seasonal Volumes. Maximum discharges for the ten highest known floods on the Columbia River at Bridgeport (or Grand Coulee Dam, for events occurring prior to establishment of Bridgeport gage) are listed in Table 4-8. These discharges are USGS peak flows which do include effects of upstream diversions and storage projects, although these effects are minimal since significant storage development in the headwater system occurred over the 1952-1974 period. During the 56-year USGS record (1952-2007) at the Bridgeport streamgage, 14 flood peaks exceeded minimum flooding prior to completion of the headwater system (1952-1974) and only one flood (year 1997) barely exceeded minimum flooding after completion of the storage reservoirs. The ten highest April-September runoff volumes at the Bridgeport gage are listed in Table 4-9.

TABLE 4-8. TEN HIGHEST KNOWN FLOODS, COLUMBIA RIVER AT BRIDGEPORT, WA

Order No.	Date of Discharge	Discharge m ³ /sec	Discharge cfs
1	June 1894*	20,530	725,000
2	June 12, 1948**	18,060	637,800
3	June 25, 1950**	14,371	507,500
4	June 11, 1961	14,039	495,800
5	June 15, 1913*	13,932	492,000
6	June 1, 1928**	13,875	490,000
7	June 7, 1956	13,836	488,600

8	June 23, 1933**	13,281	469,000
9	June 25, 1967	12,233	432,000
10	June 30, 1955	11,836	418,000

* Flood discharges for 1894 and 1913 estimated from historical information (USGS gage 12436500, Columbia River at Grand Coulee Dam)

** Flood discharges prior to 1952 are from USGS gage 12436500, Columbia River at Grand Coulee Dam. The Columbia River at Bridgeport gage, USGS gage 12438000, was not established until 1952.

TABLE 4-9. TEN HIGHEST UNREGULATED (APRIL-SEPTEMBER) RUNOFF VOLUMES-CHIEF JOSEPH DAM AT BRIDGEPORT, WA (1928-1999)

Rank	Water Year	Volume -1,000 ha-m	Volume - KAF
1	1996-97	10,934	88,647
2	1973-74	10,749	87,140
3	1971-72	10,578	85,754
4	1953-54	10,446	84,687
5	1947-48	10,110	81,965
6	1955-56	10,056	81,522
7	1975-76	9,905	80,304
8	1958-59	9,717	78,778
9	1970-71	9,560	77,501
10	1949-50	9,460	76,695

Prepared by Seattle District using data from a report titled "Seasonal Volumes and Statistics, Columbia River Basin" dated may 2004.

4.07 Runoff Characteristics. Prior to completion of headwater storage reservoirs in the Columbia Basin in the United States and British Columbia, Columbia River natural streamflows followed a typical yearly pattern comprised of low flows during the fall, winter, and early spring, and high flows during the spring snowmelt runoff period followed by a gradual recession. Headwaters of the Columbia River normally begin their seasonal snowmelt runoff in late March, April, or early May; streamflows continue to rise usually peaking in late May or early June as warming temperatures cause basin-wide melting. A slow recession normally occurs during the late summer and fall as the high-level snowpack is gradually depleted. Occasionally, heavy rainstorms move through the

basin during the snowmelt period adding to the runoff before cooler temperatures reduce the snowmelt contribution. This rain-on-snow condition augmented the May 1948 flood. Basin watersheds and rivers are occasionally influenced by typically short but intense Pacific storms or extreme periods of Arctic cold.

The Columbia River reach within the CHJ project extends from RK 877.6 (RM 545.3) upstream to within 9.7 km (6 mi) of GCL. Tributary flow into the reservoir is limited to runoff from the 580 km² (224 mi²) Nespelem River watershed at RK 936.8 (RM 582.1), six small creeks with a total area of less than 259 km² (100 mi²), and minor ungaged surface runoff.

The run-of-river operation at CHJ as specified in this manual has had no effect on the natural or regulated monthly flows in Table 4-10. The difference between natural and regulated flow is the result of seasonal operations at upstream storage reservoirs on the Columbia River system in British Columbia and the United States.

a. Unregulated Streamflow. Lower river reaches in the basin such as at CHJ carry runoff from the basin's large headwater region and as a result, the effect of intense weather and runoff on smaller headwater areas may have limited effect on the total river flow at CHJ. Table 4-10 lists average monthly unregulated modified streamflows at CHJ for the 1928-1999 period of record, reported in the Bonneville Power Administration Year 2000 Level Modified Streamflow Report, dated May 2004. These flows are a combination of observed and correlated values adjusted to remove reservoir storage effects and account for year 2000 irrigation depletions.

**TABLE 4-10. CHIEF JOSEPH DAM–AVERAGE MONTHLY STREAMFLOWS
UNREGULATED AND REGULATED STREAMFLOWS-m³/s and cfs**

Month	Unregulated *		Regulated **	
	m ³ /s	cfs	m ³ /s	cfs
October	1340	47,340	2257	79,700
November	1277	45,100	2569	90,720
December	1190	42,020	3192	112,720
January	1070	37,790	3235	114,240
February	1179	41,640	3217	113,610
March	1499	52,940	2867	101,260
April	3184	112,430	3108	109,750
May	7461	263,500	3623	127,960
June	8832	311,900	4180	147,630
July	5272	186,170	3525	124,480
August	2708	95,630	3113	109,930
September	1670	58,980	2268	80,080
Average	3057	107,950	3096	109,340

Notes:

*. 2000 Level Modified Streamflow, period of record 1928–1999, by BPA, dated May 2004. Removes historical storage regulations and adjusts for year 2000 irrigation depletions.

** USGS Water Resources Data, period of record May 1995–May 2005. This record is shortened to reflect recent changes in seasonal streamflow in response to fish BiOp requirements.

b. Regulated Streamflow. Table 4-10 also reflects the regulated streamflows based on a ten-year, average-monthly streamflow record at CHJ, developed from daily streamflows in Northwestern Division’s Water Management Database. The short period of record was selected to incorporate changes in seasonal storage regulation since 1995 resulting from streamflow changes required by the Biological Opinions (BiOps) prepared by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA Fisheries).

4.08 Water Quality.

a. Classification. The Washington Department of Ecology (WDOE) and the Colville Confederated Tribe (CCT) determine water quality criteria for the Columbia River at Chief Joseph Dam in Washington. The CCT has classified the Columbia River as a Class I water body above Chief Joseph Dam and a Class II water body below the dam. The WDOE classified the Columbia River above and below Chief Joseph Dam as a Non-Core Salmon/Trout water body. Water quality standards for TDG and temperature for Chief Joseph Dam are presented in Table 4-11. At Chief Joseph Dam, the State of Washington and the Colville Tribe have a similar TDG standard of 110 percent. However, Washington allows exceedance of the 110 percent TDG criteria to facilitate fish passage spills as shown in Table 4-11. Typically, Chief Joseph Dam is granted a water quality criteria waiver by WDOE for the spill season for the purpose of managing system spill for improved fish conditions.

Table 4-11. Washington Department of Ecology (WDOE) and Colville Confederated Tribe (CCT) water quality standards.

Parameter/ Project	Regulator	Standard
Total Dissolved Gas		
Chief Joseph	WDOE	Shall not exceed 110% of saturation at any point of sample collection, except during spill season for fish passage in which total dissolved gas shall be measured as follows: (1) Must not exceed an average of 115% as measured in the forebay of the next downstream dam. (2) Must not exceed an average of 120% as measured in the tailrace of each dam; TDG is measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure. (3) A maximum TDG one-hour average of 125% as measured in the tailrace must not be exceeded during spillage for fish passage.
	CCT	Shall not exceed 110% of saturation at any point of sample collection.
Temperature		
Chief Joseph	WDOE	Non-Core Salmon/Trout: Shall not exceed 17.5°C as measured by the 7-day average of the daily maximum temperatures (7-DAYMax) due to human activities. When natural conditions exceed a 7-DAYMax of

17.5°C, no temperature increase will be allowed which will raise the receiving water 7-DAYMax temperature by greater than 0.3°C.

CCT Class I: Shall not exceed 16.0°C due to human activities. When natural conditions exceed 16.0°C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3°C.
Class II: Shall not exceed 18.0°C due to human activities. When natural conditions exceed 18.0°C, no temperature increase will be allowed which will raise the receiving water by greater than 0.3°C.

Prepared by Seattle District, DISSOLVED GAS AND WATER TEMPERATURE MONITORING REPORT, COLUMBIA RIVER BASIN 2008, Appendix L - Seattle TDG Report

b. Total Dissolved Gas (TDG). Elevated TDG levels can lead to a condition called gas bubble trauma or gas bubble disease (GBD). Factors that affect the vulnerability of fish to GBD include TDG level, temperature, duration of exposure - especially gas levels above 120% - recovery time following exposure, fish species, fish life stage and size, fish behavior, and fish location in the water column and river cross-section.

c. Temperature. Water temperature in the Columbia River downstream from GCL exceeds permissible levels for trout and salmon during the summer and fall because of solar heat absorption occurring on the river's artificially created reservoir surfaces.

4.09 Channel and Floodway Characteristics. Daily discharges for the station Columbia River at Bridgeport (USGS #12438000) are shown on Plate 4-1. Due to the effect of Lake Pateros encroachment on the CHJ tailwater, streamflows reported by USGS for this station are now computed by CHJ staff using hourly powerhouse data relationships (hydraulic head, generation, and spillway discharge). This original streamgage is maintained for various sampling purposes.

Small watersheds on steep side slopes adjacent to the Columbia River from GCL to Priest Rapids Dam are subject to intermittent thunderstorm activity with the potential to generate significant flash floods. Foster Creek, an 831 km² (321 sq mi) watershed on the left bank of the Columbia River south of CHJ, drains into the Columbia River through an improved channel that discharges through the CHJ project immediately downstream of the dam. A thunderstorm flood on 26 February 1957 deposited sediments and debris in the powerhouse tailrace area. As a result of the 1957 flooding, a contractor (Cherf Bros., Contract DA-45-108-CIVENG-59-17) was hired to excavate and improve the Foster Creek channel and build the “Powerhouse Access Bridge, and Pearl Hill Bridge.” Another flash flood caused by a spring “Chinook” melted the snowpack in 24 hours in 1990 creating a delta at the confluence of Foster Creek and the Columbia River.

4.10 Reservoir Pondage Characteristics. Hydropower operations result in two slightly different reservoir operating conditions. During the fall and winter, regional loads generally increase in response to colder temperature. This increases regional power demand which is mostly supplied by increased hydropower generation. At CHJ, daily generation tends to use a majority of the available pondage. During the summer, regional loads decrease in response to longer daylight and warmer temperatures and CHJ is able to operate in the upper 0.9 m (3 ft) of the reservoir most of the time.

4.11 Existing Upstream and Downstream Projects. Lists of primary dams and reservoir projects located upstream and downstream from CHJ are shown in Tables 4-12 and 4-13.

TABLE 4-12. EXISTING UPSTREAM DAMS & RESERVOIRS

Project Name	River	Owner Operator	Construction Completed	Purpose *	Drainage Area km² (sq mi) **
Mica Dam	Columbia	B.C. Hydro	1973	F P	21,000 (8,100)
Revelstoke Dam	Columbia	B.C. Hydro	1984	F P	26,700 (10,300)
Keenleyside Dam (Arrow Lakes)	Columbia	B.C. Hydro	1968	F I P R N	36,500 (14,100)
Duncan Dam	Duncan	B.C. Hydro	1967	F I P	2,410 (930)
Libby Dam	Kootenai	USACE	1973	F P	23,270 (8,985)
Corra Linn Dam	Kootenay	FortisBC	1932	F I P	45,600 (17,600)
Hungry Horse Dam	South Fork Flathead	Bureau of Reclamation	1953	F I P	4,280 (1,650)
Kerr Dam	Flathead	PPL Montana LLC	1938	F P R	18,380 (7,100)
Thompson Falls Dam	Clark Fork	PPL Montana LLC	1917	P	54,590 (21,080)
Noxon Rapids Dam	Clark Fork	Avista	1959	P	56,550 (21,830)
Cabinet Gorge Dam	Clark Fork	Avista	1952	P	57,170 (22,070)
Albeni Falls Dam	Pend Oreille	USACE	1955	F P N	62,700 (24,200)
Box Canyon Dam	Pend Oreille	Pend Oreille County PUD	1955	P	64,500 (24,900)
Boundary Dam	Pend Oreille	Seattle City Light	1967	P	65,300 (25,200)
Seven Mile Dam	Pend d'Oreille	B.C. Hydro	1979	P	66,700 (25,770)
Waneta Dam	Pend d'Oreille	Cominco Limited	1954	P I	67,300 (26,000)
Grand Coulee Dam	Columbia	Bureau of Reclamation	1942	F I P	193,500 (74,700)

Prepared by Seattle District using data from "Authorized and Operating Purposes of Corps of Engineers Reservoirs" dated July 1992 and "2000 Level Modified Streamflows" dated May 2004.

* F =Flood Control. I =Irrigation. P =Power. R =Recreation N=Navigation

** Drainage areas are approximate

TABLE 4-13. EXISTING DOWNSTREAM DAMS & RESERVOIRS

Project Name	River	Owner Operator	Construction Completed	Purpose *	Drainage Area km² (sq mi) **
Wells Dam	Columbia	Douglas County PUD	1967	P F R	223,000 (86,100)
Rocky Reach Dam	Columbia	Chelan County PUD	1961	P R	227,400 (87,800)
Rock Island Dam	Columbia	Chelan County PUD	1933	P	231,500 (89,400)
Wanapum Dam	Columbia	Grant County PUD	1964	P R	234,900 (90,700)
Priest Rapids Dam	Columbia	Grant County PUD	1961	P R	249,000 (96,000)
McNary Dam	Columbia	USACE	1957	P N	554,000 (214,000)
John Day Dam	Columbia	USACE	1971	F P N	585,000 (226,000)
The Dalles Dam	Columbia	USACE	1960	P N	614,000 (237,000)
Bonneville Dam	Columbia	USACE	1938	P N	622,000 (240,000)

Prepared by Seattle District using data from “Authorized and Operating Purposes of Corps of Engineers Reservoirs” dated July 1992 and “2000 Level Modified Streamflows” dated May 2004.

* F =Flood Control. I =Irrigation. P =Power. R =Recreation N=Navigation

** Drainage areas are approximate

Several small run-of-river powerplants downstream of Kootenay Lake in British Columbia and offstream storage and pondage reservoirs on the Spokane, Lake Chelan, Yakima, and Snake Rivers are not included in Tables 4-12 or 4-13.

4.12 Economic Data.

a. Population. The population of Douglas and Okanogan Counties estimated by the Washington State Census for year 2004 is 34,200 and 39,600, respectively. The estimated 2004 population of the largest town in each county in the vicinity of CHJ is as follows: Bridgeport (Douglas County) 2,075 and Omak (Okanogan) 4,700. Most of the

populated areas are in small towns and communities along the Columbia and Okanogan Rivers.

b. Industry. Principal industries in Douglas County and Okanogan County are fruit, wheat, and beef farming and processing, lumber and wood products, and service industries. Most of the counties' fruit orchards are located on side slopes immediately adjacent to the river to utilize the fertile valley land and available river water supply and are small to medium in size. Cattle ranching and dry-land wheat farming are predominant in the sparsely-populated, arid areas inland from the river.

c. Flood Damage. Based on available information, there is no significant flood damage in the vicinity of CHJ either upstream or downstream.

SECTION 5. DATA COLLECTION AND COMMUNICATION NETWORKS

5.01 Hydrometeorological Facilities. This section describes the hydrometeorological stations in the 1,813 km² (700 mi²) “local watershed” and the 194,249 km² (75,000 mi²) Columbia River and tributaries upstream from CHJ. Stations for recording weather and streamflow in the CHJ local watershed are limited because of the arid and dry characteristic of this watershed; whereas in the Columbia River and tributaries upstream of CHJ, large numbers of weather stations, snow recording stations and streamgages are located in the watersheds in the United States and British Columbia.

a. Meteorological Stations.

(1) National Weather Service (NWS). NWS collects data from weather stations throughout the United States. Locations of active and discontinued weather stations in the Pacific Northwest and the Columbia River Basin and their records are available in NWS publications. Current weather conditions for Chief Joseph Dam are available from the NWS Spokane, WA forecast area and can be accessed from <http://www.wrh.noaa.gov/otx/current.php>. The forecast office telephone number is (509) 244-0110. NWS along with NOAA provides comprehensive snow information that is available from the National Operational Hydrologic Remote Sensing Center at <http://www.nohrsc.nws.gov/>.

(2) The Western Regional Climate Center (WRCC). The WRCC disseminates high quality climate data and information pertaining to the western United States. It is managed by NOAA's National Climatic Data Center (NCDC). The website address, <http://www.wrcc.dri.edu/>, provides access to data for many active and

discontinued stations. Hourly images and data from RAWS and METAR stations for Washington and the Columbia Basin are available at the WRCC website -

<http://www.raws.dri.edu/> . For map of stations, see Plate 5-1.

(3) Northwestern Division, Columbia Basin Water Management Division (CBWMD). CBWM provides public access to weather and project data on their web page at <http://www.nwd-wc.usace.army.mil/report.htm#report>.

(4) CHJ and GCL Weather Data. The local watershed surrounding Rufus Woods Lake is an arid area with low annual precipitation (both rainfall and snowfall). As a result, active weather recording in the vicinity of CHJ is limited to the weather data collected at CHJ and GCL dams by project staff. Hourly and daily summaries of temperature, precipitation, snowfall, and general weather conditions are collected and transmitted to the NWS for archiving and publication. These gages are maintained by the CHJ and GCL project staff. See Plate 2-9 for the locations of gages near CHJ.

(5) Natural Resources Conservation Service (NRCS). The NRCS operates and maintains automated SNOTEL snowpack recording stations and manual snow-course measuring stations throughout the Columbia Basin in the United States. Snow data from automated recording sites are automatically transmitted via the NRCS Snow Course Telemetry System (SNOTEL) to local NRCS centers for processing and publication for public use. These data are reported on NRCS Internet web sites and published in their snow survey publications. Because of the low elevations of the CHJ local watershed and lack of seasonal snowpack, there are no NRCS stations in the vicinity of CHJ.

(6) Meteorological Service of Canada (MSC), Environment Canada. This agency is Canada's source for meteorological information. The Service monitors water

quantities, provides information and conducts research on climate, atmospheric science, air quality, ice and other environmental issues, making it an important source of expertise in these areas. Canadian Ministry of Environment maintains snow survey stations in the upper Columbia River basin. The computer URL is http://www.msc-smc.ec.gc.ca/contents_e.html.

(7) Government of British Columbia, Ministry of Water, Land and Air Protection, River Forecast Centre (RFC). RFC collects and interprets snow, meteorological and streamflow data to provide warnings and forecasts of stream and lake runoff conditions around the province. Most of the meteorological and streamflow data are collected by other agencies, but the RFC is the lead agency in the province for the collection, quality control, analysis and archiving of snow data. The computer URL is <http://www.env.gov.bc.ca/rfc/>.

b. Streamgaging Stations. The United States Geological Survey (USGS) has operated and maintained streamgaging stations in the Columbia River Basin in Idaho, Montana, and Washington since the early 1900's to provide streamgage data for public use. USGS surface water records are published in their annual Water Resource Data Reports at <http://wdr.water.usgs.gov/>. Realtime gage readings are reported on their web site at the following address: <http://nwis.waterdata.usgs.gov>. The USGS office in Kalispell, Montana, tel. (406)-755-6686, the USGS office in Sandpoint, Idaho, tel. (208)-263-4123, and the USGS field office in Spokane, tel. (509)-353-2633, should be notified concerning any streamgage operation or maintenance problems.

There are two USGS streamgages located near CHJ. The discharges reported at these gages are calculated by the project staff at the dams. The USGS does not report

realtime data for these gages. Realtime hourly data are available for the last eight days on the NWD website at the following address: <http://www.nwd-wc.usace.army.mil/report.htm>. Daily discharges are transmitted to the USGS for publication (for data access, see website addresses in paragraphs below). See Plate 2-9 for the locations of gages near CHJ.

(1) Columbia River at Bridgeport, WA (USGS #12438000). This gage is located 2.57 km (1.6 mi) downstream from CHJ. Drainage area is 196,062 km² (75,700 mi²). Period of record is April 1952 to the present. Average discharge is 3,106 m³/s (109,700 cfs) during the 51-year period from 1953-2003. Water level at this station is affected by backwater from Lake Pateros, the reservoir behind Wells Dam, and the gage site is used only for water quality sampling and similar activities. Streamflows at CHJ are manually computed each hour using a table lookup process that uses tabular relationships between hydraulic head, power generation, and discharge, then adding spillway discharge, if any. The process involves two table lookup sets, one for the “old” units #1-16 and the one for the “new” units #17-27. The head-power-discharge relationships described above are developed by Portland District’s HDC from turbine prototype and Gibson test data for each of the three turbine ratings. The daily data can be accessed at the following website:

http://waterdata.usgs.gov/wa/nwis/dv/?site_no=12438000&referred_module=sw

(2) Columbia River at Grand Coulee Dam, WA (USGS #12436500). Inflow into Rufus Woods Lake and outflow at GCL is provided by this gage which is located on pier 3 on the west side of the bridge on State Highway 155, about 975 m (3,200 ft) downstream from Grand Coulee Dam. Major water diversions for irrigation

are made at GCL and in British Columbia upstream of the GCL gage. Drainage area is 193,472 km² (74,700 mi²). Period of record is as follows: April 1913-June 1923 (monthly discharges only), July-December 1923, January 1924-May 1928 (monthly discharges only), and June 1928 to the present. Average discharge for the period of record through September 30, 2003 is 3,072 m³/s (108,500 cfs). Project outflow is affected by backwater from Rufus Woods Lake and as a result, the discharge from GCL is computed as flow through turbines plus spill, similar to the procedure used at CHJ. The daily data can be accessed at the following website:

http://waterdata.usgs.gov/wa/nwis/dv/?site_no=12436500&referred_module=sw

(3) Inland Waters Directorate, Water Resource Branch, Water Survey of Canada. Stations for streamgage and surface water data for British Columbia are operated, maintained and published by this agency.

5.02 Water Quality Stations. Total Dissolved Gas (TDG) and temperature readings are measured hourly at two gages: Chief Joseph Forebay (CHJ) and Chief Joseph Tailwater (CHQW). The forebay station is located on the project's floating boathouse and the tailwater station is located 1.13 km (0.7 mi) downstream from the dam on the right bank. TDG data are collected during the period each year from April 1st to September 30th. See Plate 2-9 for the gage locations.

Parameters transmitted from both stations include: Probe Depth in feet, Water Temperature in °F, Barometric Pressure in mm of Hg, and TDG in percent saturation. The probes are calibrated every two weeks. Data are recorded hourly and then transmitted every four hours by a data collection platform (DCP) via the Geostationary Operational Environmental Satellite (GOES) to the Division's WCDS where data are

stored in the Columbia River Operational Hydromet Management System (CROHMS) database. These data are available to the public on the Northwestern Division website at <http://www.nwd-wc.usace.army.mil/report/chj.htm>. The Seattle District Water Management Section is in charge of this program and maintains these gages. For service, call the NWS RCC at (206)764-6702.

5.03 Sediment Stations – Not applicable to Chief Joseph Dam.

5.04 Recording Hydrologic Data. The Corps' Hydrologic Engineering Center report, Water Control Data System (WCDS), Past, Present, and Future; RD#39, dated September 1995, describes the WCDS as follows. "The WCDS is an automated information system that supports the Corps of Engineers' water control mission including the hardware, software, manpower, and other resources required to acquire, develop, maintain, and operate the system. The WCDS includes the collection, acquisition, retrieval, verification, storage, display, transmission, interpretation, and archival of information needed to carry out the Corps' water control mission. The WCDS is a nationwide integrated system of hardware and software that allows users access to virtually any data and information in the system. A suite of software gives users the ability to display, manipulate, disseminate, interpret, and transmit information throughout the Corps and to any other interested user." Realtime data are published daily on the NWD Water Management web site at <http://www.nwd-wc.usace.army.mil/report/chj.htm>. Data are reviewed for omissions and errors and a corrected record is filed each month. Historic data may be obtained using the Northwestern Division's dataquery web site at: <http://www.nwd-wc.usace.army.mil/perl/dataquery.pl>.

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SECTION 6. HYDROLOGIC FORECASTS

6.01 General. Flood and seasonal runoff forecasts are normally not provided for CHJ because of its limited pondage capacity. CHJ is a run-of-river project and is not considered in the regulation of flood events on the Columbia River. However, the National Weather Service, Northwest River Forecast Center (NWRFC) flood discharge forecasts for GCL are a realistic indication of the flood inflow into Rufus Woods Lake and are monitored by the NWD-RCC for application to CHJ.

a. Role of the Corps. Corps Northwestern Division Reservoir Control (CENWD–PDW-R) routinely coordinates with the NWRFC on a daily basis during the winter and spring flood seasons and is primarily responsible for providing reservoir regulation guidance to CHJ during flood events.

Seattle District Water Management Section (CENWS-EC-TB-WM) supports the NWRFC by coordinating and exchanging project data necessary for watershed and river forecasting and responding to requests for special assistance.

b. Role of the National Weather Service (NWS). The NWS, Northwest River Forecast Center (NWRFC) in Portland, Oregon, is the agency primarily responsible for weather and streamflow forecasting in the Pacific Northwest. It is staffed 12 hours a day (6 am to 6 pm) year around except during flood periods when the Center is staffed 24 hours a day. Instructions for support assistance in case of emergency are provided for both periods.

6.02 Flood Condition Forecasts. Short-to-long range forecasts of streamflow rates and reservoir conditions are provided by the National Weather Service River Forecasting

System (NWSRFS). Actual flood regulation of individual projects in the Columbia River system is based on these forecasts. The ResSim program, hydraulic routing model or its equivalent will continue to be used by the CENWD-PDW-R, CENWD-PDW-H, and CENWS-EC-TB-HH to investigate specific river conditions.

a. Requirements.

(1) Short Term Forecasts. Short term forecasts of daily streamflows are especially significant during the spring runoff period to establish potential flood conditions and problems. Short-range forecasts of streamflow, up to 10 days in advance, are based upon current observed data, forecasts of meteorological conditions which will immediately affect snowmelt and/or precipitation rates, and routing through natural storage or controlled reservoirs.

(2) Long-Term Forecasts. The long-term forecasts, up to 90 days in advance, involve extending the short-range forecasts with the NWSRFS Ensemble Streamflow Predictor (ESP) capability which provides a range of streamflow forecasts using current conditions and applied historical weather events. The primary purpose of the long-term forecasts is to determine downstream peak discharge potentials to see if the current regulation plans should be revised. These forecasts for also define runoff under certain specified conditions to assess effects of reservoir filling schedules.

(3) Schedule for Producing Forecasts. The schedule for producing forecasts varies depending on the time of year and circumstances. Daily, the NWRFC produces forecasts in 6-hour time steps for the short-term forecast period. The Corps and the Reclamation update reservoir regulation for the short-term forecast period generally twice per week.

The long-term forecast is updated approximately once per month August through March, after the reservoirs have reached their maximum refill elevation. This forecast is updated approximately once per week from March through July, but may be as often as two to three times a week, depending on conditions. Reservoir regulation is updated accordingly.

b. Methods. NWRFC develops three streamflow forecasts for selected locations on the Columbia River and its tributary rivers using the “National Weather Service River Forecasting System” (NWSRFS) computer program. This program is used to forecast project inflows and flows at specified control points in the basin for a selected number of days into the future on the basis of initial and anticipated hydrometeorological conditions and reservoir regulation plans:

These forecasts utilize National Resources Conservation Service (NRCS) Snotel and snow gage data collected during the winter snow accumulation along with 10 days precipitation and temperature forecasts. Input to the 10- and 90-day forecasts includes antecedent soil moisture, snowpack and precipitation data, observed streamflows, quantitative precipitation and temperature forecasts, and the planned regulated releases from reservoirs in the watershed are furnished by CENWD-PDW-R.

Output is a forecasted regulated discharge at selected streamgages and dams in the watershed. Forecast values are normally printed in 6-hour intervals for the short range forecast and a combination of 6-hour and daily periods for the 90-day forecast. These forecasts are downloaded from the NWRFC computer and are accessible to various users, including the Seattle District.

Peak annual discharge and seasonal volume runoff forecasts are prepared from the Seasonal Volume Program, which is based on a statistical correlation process. Results of the short and long-range forecast are also considered in preparing the final result.

The NWSRFS mathematical hydrologic model is comprised of three basic components:

(1) Sacramento Soil Model. A generalized watershed model to synthesize runoff from rainfall.

(2) Snow 17 Model. A generalized watershed model for synthesizing runoff from snowmelt

(3) Various hydraulic algorithms in the NWSRFS to route streamflows from upstream to downstream points through channel and lake storage. During the snowmelt period, indexes of volume of water remaining in the snowpack and the aerial extent of the snowpack may need to be adjusted if forecast values do not verify.

6.03 Conservation Purpose Forecasts. Not applicable. CHJ is a run-of-the river project that basically passes flows from upstream, regardless of the purpose.

6.04 Drought Forecasts. During drought years, as in all water years, hydrologic models will provide the data necessary for regulation. Spring hydrologic forecasts normally begin about 1 April and continue until the flood potential becomes minimal, which is generally after 15 July. If drought conditions prevail, hydrologic forecasting will be continued to support drought response activities.

SECTION 7. WATER CONTROL PLAN

7.01 General. The water control plan for CHJ is provided to document the guidelines and procedures established to efficiently accomplish the project’s primary regulation purpose for hydroelectric power. This section describes the operating plan for CHJ, a run-of-river pondage project that normally operates throughout the year in a 1.83 m (6 ft) range, between El 289.56 m (El 950 ft) and El 291.39 m (El 956 ft).

7.02 Project Operating Limits and Constraints. The following operating limits for CHJ are provided to identify essential criteria for the project’s daily–weekly pondage operations.

- a. Normal Reservoir Operating Range..... El 289.56 to 291.39 m (El 950 to El 956 ft)
- b. Maximum Reservoir Elevation..... El 292.24 m (El 958.8 ft)
(Required to discharge the spillway design flood only)
- c. Minimum Authorized Reservoir Elevation..... El 283.46 m (El 930 ft)
- d. Normal Maximum Reservoir Elevation..... El 291.39 m (El 956 ft)
- e. Normal Minimum Reservoir Elevation..... El 289.56 m (El 950 ft)
- f. Minimum/Maximum Regulated Discharge at CHJNo Limit
- g. Minimum Discharge Below Priest Rapids Dam for DOE’s Hanford Works.

An average daily discharge of 991 m³/s (35,000 cfs) at CHJ is required to meet the mandatory minimum discharge of 1,019 m³/s (36,000 cfs) below Priest Rapids Dam for the Dept. of Energy’s Hanford Works. The required CHJ outflow may be less because of downstream tributary flow and discharges from storage releases. A minimum flow alarm is maintained at Priest Rapids Dam and BPA considers the flow requirement in their daily generation order to CHJ. Mid-Columbia Hourly Coordination does not include the requirement in their hourly program.

h. Reservoir Filling and Drafting Limits. There are no known structural, geological, or other conditions that limit the rate of filling or drafting in the normal operating range. Although a reduced drawdown rate below the normal minimum reservoir level of El 289.56 m (El 950 ft) is not required, it is advised because it allows time for slopes to dewater and stabilize. The recommended maximum drawdown rate below El 289.56 m (El 950 ft) is 0.15 m/hr (0.5 ft/hr), with 0.18 - 0.21 m/hr (0.6 - 0.7 ft/hr) occasionally acceptable.

i. Tailwater Ramping Rates (Up or Down).....No Limit

j. Goose Nesting Regulation (15 February –15 May). If drafting is required below El 289.56 m (El 950 ft) for maintenance or other special conditions during the goose nesting period specified above, CHJ must notify CENWD-PWD-R and CENWS-EC-TB-WM to coordinate protective action for the nesting geese with the State and Federal natural resource agencies.

k. Summer Drawdown Regulation. If drafting is required below El 289.56 m (El 950 ft) and occurs during the summer recreational season, the Project Resource Manager must be notified to alert the public to exposed hazards caused by the drawdown and to alert farmers to protect their irrigation pumps.

l. Emergency Drawdown. If drafting occurs below El 289.56 m (El 950 ft) due to emergencies or inadvertent conditions, adverse impacts on lake-shore pumping, damage to boat ramps, and hazards to recreational boating may occur. CHJ should immediately notify CENWD-PDW-R for guidance to return the pool to El 289.56 m (El 950 ft).

m. Reservoir Overfill. If accidental, unintentional, short-term overfilling of the reservoir occurs due to a load rejection, scheduling errors, or unforeseen emergencies, efforts should be made to bring the reservoir back to the normal operating range within

two hours by contacting CENWS-PDW-R to coordinate with BPA to adjust generation at CHJ and GCL and return the reservoir level to El 291.39 m (El 956 ft). If it is obvious the reservoir cannot be brought back to normal operating range in a timely manner, spilling shall begin and continue until the reservoir reaches El 291.39 m (El 956 ft).

n. Spillway Operating Criteria. The flow deflectors resulted in substantially different hydraulic conditions in the stilling basin and tailwater compared to a non-deflector spill. When the spill exceeds 10 kcfs/bay or total non-uniform spill exceeds 100 kcfs, visual monitoring is required (Section 7.04b).

7.03 Overall Plan For Water Control. Chief Joseph Dam is operated to maximize power production as part of the Federal Columbia River Power System (FCRPS). The project is also operated to accomplish water management objectives to comply with the biological opinions under the Endangered Species Act and water quality standards under the Clean Water Act, which includes water quality compliance and fish flow augmentation. See Section IX for discussion about parties involved in coordination and communication relevant to CHJ operations.

7.04 Standing Instructions to Damtender. Operation of the physical facilities to accomplish water management objectives is the responsibility of the CHJ project personnel. Such operation will be in accordance with the CHJ operation and maintenance manuals (O&M). Standard Operating Procedures (SOP) for the safe operation of the project are maintained by the Project Engineer. In an emergency, the Emergency Action Plan (EAP) should be followed. A copy is located at the Project and at the NWD and NWS RCCs.

a. Operating Policy. Discharge at CHJ is normally released through the 27 unit powerhouse and two service units up to a maximum of approximately 6,088 m³/s (215,000 cfs). Staff at GCL provide CHJ with a 7-day running estimate of discharge rates called a “Chief Joseph Uncoordinated Discharge.” Normally these discharges are within the hydraulic capacity of the powerhouse, but instances may arise that require CHJ to spill. Spill at Chief Joseph is determined through the Spill Priority List for the Columbia River Basins projects and real time monitoring. NWD Division and NWS Water Management should be alerted if the required spillway operation is unexpected or out of the ordinary.

b. Spillway Operating Policy. Spill at CHJ can happen for several reasons. Typically, it is caused by high river flows, insufficient power demand, or a combination of the two. Spill can also occur unexpectedly for other reasons. Increased visual monitoring and communication is required when a spillway operation has discharge rates that are expected to exceed 10 kcfs/bay or total non-uniform spill will exceed 100 kcfs.

CENWS-EC-TB-WM (Seattle District Water Management) working with CENWS-EC-TB-HE (Seattle District Hydraulic Engineering) will provide the CHJ Chief Operator the most recent table for spillway gate openings. This table will reflect the best available information for spillway operations for reducing TDG and controlling hydraulic conditions that may develop in the stilling basin.

When a spillway operation of spill amounts less than these criteria are indicated by the discharge rates furnished by GCL, powerhouse operators will promptly establish and schedule the necessary spillway gate openings as required by the most recent spill table and activate the spill gates as required to discharge the necessary flow. When spill gates are not available for use, Water Management will provide a revised table to the

CHJ Chief Operator. In case of communication outage, if gate(s) is not available when total spill is reached, add more flow in same general pattern to available gates until the additional gate can be cleared.

Additional visual monitoring is required when the spillway operation requires spill to exceed 10 kcfs/bay or total non-uniform spill will exceed 100 kcfs. Water Management or Chief Operator at CHJ will be the first office to learn of the elevated spill. If there is a high probability of spill in the next 24 hours, each will notify the other. The powerhouse operators will promptly establish and schedule the necessary spillway gate openings as required by the most recent spill table and activate the spill gates as required to discharge the necessary flow. When spill gates are not available for use, Water Management will provide a revised table to the CHJ Chief Operator. In case of communication outage, if gate(s) is not available when total spill is reached, add more flow in same general pattern to available gates until the additional gate can be cleared.

Water Management will notify CENWS-EC-TB-HE (Seattle District Hydraulic Engineering). Hydraulic Engineering will coordinate monitoring flow conditions in the tailrace and stilling basin (via visual inspections) with the Chief Operator. In the unlikely event that adverse hydraulic conditions in the tailrace or stilling basin are determined to present an unacceptable and immediate risk to dam safety, the Hydraulic Engineer will communicate with the Chief Operator and the spillway operating pattern will be altered or ceased immediately, if possible.

This policy will be revised as new model testing information becomes available. The spillway operator has the most recent spill pattern for the entire operational range. When the joint seal repair project is completed, the analysis of the effects of the flow deflectors can be completed. This Water Control Manual will be updated when the

Spillway Operating Policy is revised and the table for the spillway gate openings will be added.

c. Reservoir Drawdown Policy. Normal hydropower operations are restricted to an operating range between El 289.56 m (El 950 ft) and NFP El 291.39 m (El 956 ft) except in the event of an emergency. Erosion of the steep sandy banks surrounding the reservoir occurs in a number of locations primarily due to the terrain and reservoir fluctuations. Increased erosion could occur especially if the reservoir is subject to rapid drawdown below El 289.56 m (El 950 ft). As a result, Maintenance drawdown now requires a 14 day advance notice. Although a reduced drawdown rate for maintenance below the minimum normal operating limit is not required, it is advised because it allows time for slopes to dewater and stabilize. The recommended maximum drawdown rate below El 289.56 m (El 950 ft) is 0.15 m/hr (0.5 ft/hr), with 0.18 - 0.21 m/hr (0.6 - 0.7 ft/hr) occasionally acceptable.

d. Ice Conditions. A heated oil system is provided on alternate spillway gates to protect the gate seals. To the extent possible, only those gates with the protected seals should be used in freezing conditions. Unprotected spillway bays may be used but damage may occur to these gate seals. A gas-operated bubbler was installed in the forebay at one time to prevent freezing in the forebay. But a hard freeze in the forebay flow seldom occurs. This fact plus maintenance problems with the system resulted in its removal.

7.05 Flood Control. The system flood control objective is to regulate to meet variable flow targets for the lower Columbia River as measured at The Dalles, Oregon and to prevent the large storage projects from filling too soon, thus resulting in damaging

uncontrolled flows in the lower Columbia River. The first controlled flow of the runoff season is called the Initial Controlled Flow (ICF). The controlled flow at The Dalles is a function of the forecasted runoff on the date of the ICF and the percent of storage space filled in Category IV projects. As a run-of-river project, CHJ has a limited reservoir storage capacity. In advance of large floods, drafting the power pool at CHJ may provide a slight reduction in the peak flows; however, there are no official procedures to draft CHJ for flood control. Day to day outflow may be specified for Columbia River flood regulation (per the Columbia River Basin Master WCM).

7.06 Recreation. Although recreation facilities are operated in conjunction with the project there is no special regulation for recreation (see Recreation, section 2.09c).

7.07 Water Quality. The Corps as one of the Action Agencies regulates CHJ to comply with ESA and CWA as determined through the biological opinions and the TMDLS. The CHJ Gas Abatement Project includes spillway flow deflectors to minimize the TDG levels in the Columbia River.

7.08 Fish and Wildlife. The project is operated to comply with the biological opinions under the endangered species act, which includes fish flows. There are no prescribed instream flow requirements from CHJ for fish. Since CHJ is a run-of-river project with essentially no active storage except for power generation, the project discharges any special fish water through the project in a timely manner.

7.09 Water Supply. Although not an authorized purpose, water from Lake Rufus Woods is used for irrigation of the surrounding Lands. Land owners are notified if the reservoir elevation will be lowered beyond reasonable elevations to protect their pumps.

7.10 Hydropower. The hydropower operation at CHJ is a daily-weekly type with

maximum generation during the weekdays and limited generation during the nighttime and weekends. Generation varies seasonally with the highest generation during the winter and the lowest during summer and early fall. Water supplied from headwater storage plants provides the extra water supply for the winter generation. The project is operated in accordance with the Mid Columbia Hourly Coordination Agreement (MCHCA) that optimizes power production in the mid-Columbia River projects: Grand Coulee, Chief Joseph, Wells, Rocky Reach, Rock Island, and Priest Rapids (consisting of the Wanapum and Priest Rapids developments).

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7.11 Navigation. Not applicable.

7.12 Drought Contingency Plan (DCP). CHJ is operated as part of the Columbia River reservoir system under all conditions, including droughts. A detailed DCP for the entire Columbia River system is presented in Section XII of the *Columbia River Basin, Master Water Control Manual*, dated December 1984, and is applicable to CHJ. The 30-page

DCP is a detailed guideline for operation of the Columbia River reservoir system under adverse streamflow conditions. The plan addresses historical droughts, drought forecasting techniques, drought impacts and operational requirements for the system and individual drought management stations.

7.13 Flood Emergency Action Plan. In the event the project's structural integrity is or could be threatened, or if outflows will or could endanger downstream human life or property, follow the procedures outlined in the CHIEF JOSEPH DAM, COLUMBIA RIVER, WASHINGTON "EMERGENCY ACTION AND NOTIFICATION SUBPLAN" dated January 2008. A copy is located at the Project and at the NWD and NWS RCCs. Specifically, the plan is to be implemented in the following situations:

a. Uncontrollable Emergency. Defined as a condition in which the occurrence of a significant hazard to life and property is certain to occur, and/or no time is available to repair and/or modify operational procedures to prevent dam failure.

b. Controllable Emergency. Defined as a condition, not normally encountered in the routine operation of the dam, in which the occurrence of a significant hazard to life and/or property is possible unless timely repairs and/or modification to operational procedures are conducted to prevent dam failure. Time must be available to eliminate the conditions in order for the conditions to be declared controllable.

c. Post-Earthquake Condition. If an earthquake is felt at the dam, a post-earthquake condition exists and a property inspection is required.

d. Security Alert. A security alert relates to incidents at a project which could threaten the safety of the project. Copies of the plan are located at the project and in the Northwest Division and Seattle District Reservoir Control Centers.

e. Communications. In the event of telephone and CBT outages, communication between CHJ and Seattle District RCC may be established via the Seattle District Room satellite phone system or VHF radio system. Emergency Action Plan provides for alternate communications from Seattle District and the Chief Joseph Dam Control Room.

7.14 Deviations From Normal Regulation. The Corps is occasionally requested to approve, coordinate, and conduct special regulations that deviate from the Water Control Plan (WCP) for CHJ in the reservoir or tailwater area. Prior approval by the Division in cooperation with the BPA (only if hydropower is affected) is required for all special regulations that deviate from the Water Control Plan (WCP), with the exception as noted in subparagraph “b” below. Deviation requests should be in accordance with CENWD-PD NWD Regulation No. 1110-2-6, dated 9 November 2005.

a. Abnormal Conditions. Should a condition (s) occur or appear to be developing other than those described above, which require operational modifications, the Project Engineer or power plant operator will promptly contact the superintendents office to report the field conditions and receive instructions. BPA and other parties upstream or downstream that are possibly affected by the conditions will also be informed as soon as possible. When immediate action is required to protect life and valuable property, the Project Engineer will not wait for instructions.

b. Unplanned Minor Deviations. Project staff will take immediate action as necessary to abate a problems associated with accidents, safety, equipment failure, or temporary pollution problems. Notify Division RCC as soon as possible. BPA and GCL

and other parties upstream and downstream that are possibly affected by the condition will also be notified as soon as possible. District will provide written confirmation of the deviation to inform the division water control manager. This deviation does not fall under the normal auspice of ER 1110-2-6 requiring prior approval.

c. Planned Deviations. Situations occasionally occur that require temporary deviations from the normal regulation of the project. Construction activities and other miscellaneous in-stream activities account for the majority of the deviations. Changes in release are also sometimes necessary during maintenance for periods from a few hours to a few days and each request is evaluated on its own merits.

7.15 Rate of Release Change. All reservoir releases at CHJ are subject to the condition that no release shall be made at rates or in a manner that would be inconsistent with operating rules and regulations required for the purpose of protecting the dam and reservoir from damage.

SECTION 8. EFFECT OF WATER CONTROL PLAN

8.01 General. CHJ has operated continuously since its completion in the early 1950's, providing hydropower for the Pacific Northwest. The run-of-river operation at CHJ as specified in this manual has had no affect on the natural or regulated monthly flow (Table 4-8). The difference between natural and regulated flow is the result of seasonal operations at upstream storage reservoirs on the Columbia River system in British Columbia and the United States. Considering a much smaller time scale, the regulated hourly outflows from CHJ do vary significantly throughout the day, in response to demand on the hydro system.

Problems have developed in the Columbia involving decreases in the number of several fish stocks. Actions under the Endangered Species Act of 1973 (ESA) as amended have resulted in major changes in the operations of the Federal Columbia River Power System (FCRPS). These changes have primarily involved the operation of large FCRPS reservoir storage projects. Since CHJ is a run-of-river plant, ESA actions related to endangered listed fish have had a limited effect its operations. CHJ has cooperated with measures to improve conditions for the listed fish stocks by passing fish water augmentation flows through the project in a timely manner. In addition, installation of spillway deflectors will help minimize total dissolved gas and the affects on the fish in the lower Columbia River.

8.02 Flood Control. CHJ is a run-of-river project with insufficient pondage storage for effective flood control regulation. In the event of a rare flood such as a SPF or PMF, the Mid-Columbia run-of-river projects from Priest Rapids Dam to CHJ could be used to provide minimal flood control by drafting immediately prior to the flood crest to capture

as much of the flood peak as possible. It is the power pool at CHJ that would be used on a limited basis for re-regulation of flood flows. Such an operation would be under the direction of the Division Reservoir Control Center (CENWD-PDW-R).

a. Probable Maximum Flood (PMF). There are two PMF reports for CHJ which are nearly equal in peak discharge.

(1) The Chief Joseph Dam, Supplement 1 to Design Memorandum (Unnumbered), entitled "Spillway Design Flood" by Seattle District, dated November 1967, provides a maximum probable inflow into CHJ having an unregulated peak discharge of 46,015 m³/s (1,625,000 cfs) and a regulated discharge of 33,980 m³/s (1,200,000 cfs) when routed through the year 1975 system of upstream reservoirs.

(2) The MEMORANDUM REPORT, Columbia River Basin, LOWER COLUMBIA RIVER, STANDARD PROJECT FLOOD AND PROBABLE MAXIMUM FLOOD, prepared by the North Pacific Division (now the Northwestern Division), dated September 1969, provides SPF and PMF for a control point on the Columbia River in the vicinity of Bonneville Dam and Portland, Oregon. Sixty one upstream sub-basins were included in the evaluation. Floods at these tributary locations for the downstream control point would be slightly smaller than SPF and PMF storms centered over the sub-basins. The reported natural and regulated PMF flood component at CHJ for the lower basin are 43,891 m³/s and 33,980 m³/s (1,550,000 cfs and 1,200,000 cfs), respectively.

b. Standard Project Flood (SPF). Natural and regulated SPF values for CHJ, reported in the second document described above, are 24,211 m³/s and 13,479 m³/s (855,000 cfs and 476,000 cfs), respectively.

c. Other Floods. See Section 8.12a for description of maximum flood discharge regulation.

8.03 Recreation. Seven recreation areas totaling 128.8 ha (318.2 ac) for public use are funded by the CHJ project. These include Bridgeport State Park (and Lake Woods Golf Course), the right bank fishing area, the visitor orientation area, three viewpoints, and the downstream boatramp. In addition to these facilities, summer recreation opportunities include boating, swimming, and camping.

8.04 Water Quality.

a. Surface Water Temperature. Although temperature exceeds water quality standards, no special regulation is performed for temperature control at this time. At the time of publication, issuance of a temperature TMDL has been delayed. Until then, Ecology will address any temperature exceedances as may be necessary to meet state water quality standards for temperature.

The possibility of mining cold water from GCL has been discussed as a possible remedy together with drawdown of some of the larger reservoirs to speed the flow of water downstream. If a possibility that surface water temperature is found to be significantly impacting bull trout in Rufus Woods Lake, or a way is found to introduce fish listed as endangered under the 1973 ESA to the reservoir and those fish are harmed by the surface water temperatures, actions would result. ESA-related temperature control measures would be mandated by the Resource Agencies in the form of a Biological Opinion. Multiple factors would need to be balanced in deciding on changing the river system operations or introducing fish species to the reservoir.

b. Total Dissolved Gas. The 2000 and 2004 FCRPS Biological Opinions required

changes that resulted in the Chief Joseph Dam Gas Abatement Plan. In response to the problem of total dissolved gas at CHJ and GCL, spillway flow deflectors were constructed at CHJ. The Plan called for joint operations that involved a transfer of hydropower load from CHJ to GCL that will allow GCL to discharge more of its flow through the powerhouse and less through the spillways. The reverse will occur at CHJ where the reduced hydropower load and reduced power discharge will require a greater part of the CHJ flow to be released as spill. The spill test in May 2009 test indicated that the flow deflectors are effective at minimizing TDG. Once the project is complete, the spillway operating policy will be updated.

8.05 Fish and Wildlife. Fish habitat management is limited on Rufus Woods Lake because of the fluctuating daily lake levels resulting from the project's daily pondage operation. There are no facilities for passage of anadromous fish over CHJ dam and the dam is the upstream end point of anadromous fish migration. The Colville Confederated Tribe has indicated interest in possible methods of fish movement over the dam. Two commercial fish operations located on the reservoir grow sterilized rainbow trout and steelhead to the 2.7 to 3.6 kg (6- to 8-pound) production stage.

Fishing for rainbow trout in the forebay is good. The Buckley Bar area provides good trout and walleye fishing. Fishing has increased substantially over the last ten years with of the increase attributed to the accidental or intentional release of fish from the commercial pens.

The lands adjoining Rufus Woods Lake are home to a variety of wildlife species. The shrub-steppe local habitat supports resident and wintering mule deer, bobcats, badgers, coyotes, cottontail rabbits, yellow-bellied marmots, and several species of mice,

voles, and a variety of bats.

8.06 Water Supply. Not applicable.

8.07 Hydroelectric Power. CHJ is the second largest hydropower producer in the United States with generation capacity of 2620 MW. Grand Coulee is the first, with generating capacity of 6806 MW. Chief Joseph Dam is a re-regulating project and its storage is used to store the power peaking discharges from Grand Coulee and release them in a relatively uniform manner downstream. The hydropower produced at CHJ is used to maintain the base load of the region.

Hydropower operations result in two slightly different reservoir operating conditions. During the fall and winter, regional loads generally increase in response to colder temperature. This increases regional power demand which is mostly supplied by increased hydropower generation. At CHJ, daily generation tends to use a majority of the available pondage. During the summer, regional loads decrease in response to longer daylight and warmer temperatures and CHJ is able to operate in the upper 0.9 m (3 ft) of the reservoir most of the time.

Hydroelectric power generation at CHJ since July 1985 is tabulated in Table 8-1. When Pateros Lake encroaches on the CHJ tailwater, the loss of head reduces the CHJ generation capacity. To account for this head loss, a lower rated head was provided for the CHJ turbines. The 20-year period (1985-2005) was selected as representative of present-day generating conditions at CHJ.

TABLE 8-1. HYDROELECTRIC POWER GENERATION AT CHJ (MWh)

YEAR	ENERGY	YEAR	ENERGY
Jul 1985	4,429,799	1996	14,341,141
1986	10,427,654	1997	14,638,627

1987	10,117,639	1998	11,419,107
1988	9,829,089	1999	14,169,539
1989	9,702,669	2000	12,086,989
1990	12,744,148	2001	7,905,156
1991	13,574,737	2002	11,556,519
1992	10,283,589	2003	10,150,282
1993	9,191,803	2004	10,087,186
1994	9,609,720	Jul 2005	5,987,646
1995	10,865,843		

Total 20 year Generation=215,804,000 MWh Average annual generation=10,790,200 MWh
Annual revenue= \$431,608,000 (40 mill/ kWh rate) Total revenue (20 years) = \$8,632,000,000

8.08 Navigation. There are no navigation facilities at CHJ.

8.09 Drought Contingency Plan. As a middle Columbia, run-of-the-river project, with authorization for power generation only, CHJ is operated as part of the Columbia River reservoir system during a drought to efficiently contribute to the generation needs of the system.

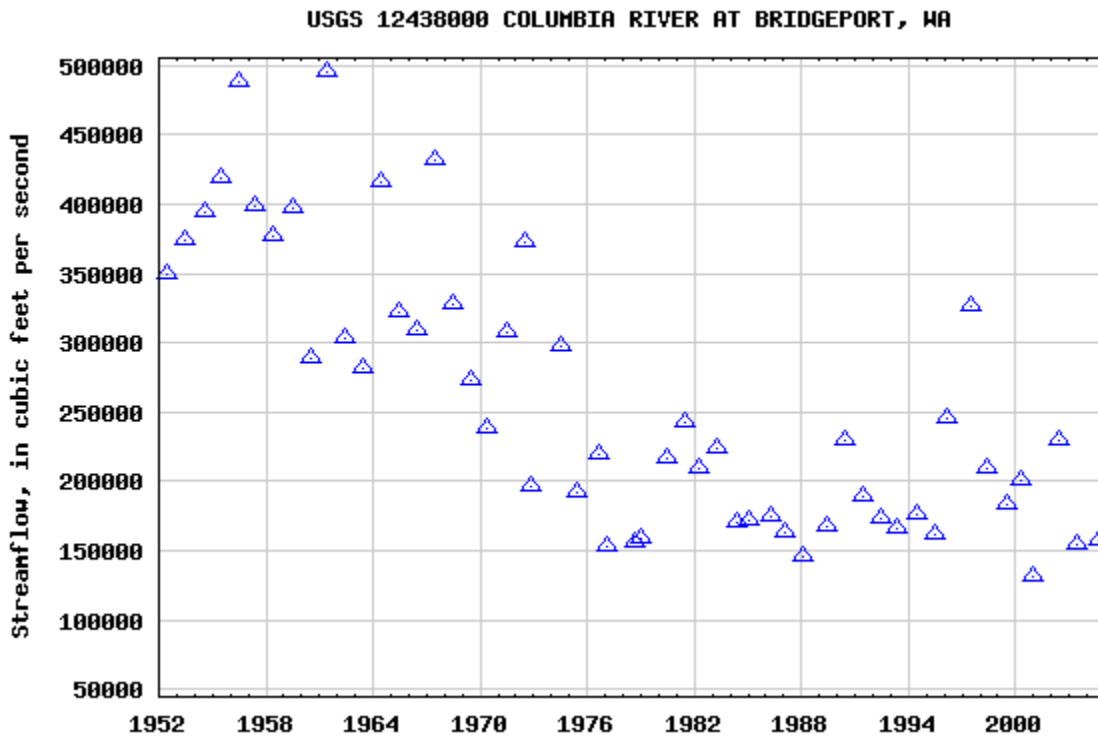
8.10 Emergency Action Plans (EAP). Following the procedures outlined in the EAP could reduce the threat to the project’s structural integrity or reduce downstream downstream human life or property in the event of high flows (Reference Section 7.13, CHIEF JOSEPH DAM, COLUMBIA RIVER, WASHINGTON “EMERGENCY ACTION AND NOTIFICATION SUBPLAN” dated January 2008).

8.11 Frequencies.

a. Peak Inflow Probabilities. Maximum annual daily discharge frequency curves for Chief Joseph Dam (regulated and unregulated conditions) are shown on Chart 8-1. The unregulated curve represents the unregulated inflow frequency to Grand Coulee. Since CHJ is a run-of-river project, the regulated curve based on modeled GCL outflow, represents the inflow frequency curve for CHJ.

b. Annual Discharges. The development of flood control storage reservoirs upstream on the Columbia River in British Columbia and the United States has had a significant effect on flooding and maximum discharges in the lower Columbia River. Tables 8-2 and 8-3 are maximum daily averages from USGS gage #12438000 Columbia River at Bridgeport that show this regulation effect. Chart 8-2 is a plot of the discharge values in Table 8-3 showing the abrupt decrease in annual discharges at Bridgeport after 1975 as a result of the completion of headwater flood control projects.

CHART 8-2 MAXIMUM ANNUAL DISCHARGE (1952-2004)



c. Key Control Points. A set of project tailwater curves showing the encroachment effect of each forebay level in Lake Pateros on the CHJ tailwater is provided in Chart 8-2. The elevation where each curve intersects the zero-discharge point indicates the Lake Pateros elevation for that curve.

TABLE 8-2 COLUMBIA RIVER AT BRIDGEPORT, USGS #12438000 (metric)

Water Year	Date	Gage Height (m)	Stream-flow (m ³ /s)	Water Year	Date	Gage Height (m)	Stream-flow (m ³ /s)
1952	May 26, 1952	25.43	9,902 ⁶	1979	Dec. 31, 1978		4,502 ^{1,6}
1953	Jun. 17, 1953	25.82	10,605 ⁶	1980	Jun. 01, 1980	25.84	6,145 ⁶
1954	Jul. 14, 1954	26.27	11,151 ⁶	1981	Jun. 05, 1981		6,853 ^{1,6}
1955	Jun. 30, 1955	26.78	11,836 ⁶	1982	Mar. 15, 1982		5,918 ^{1,6}
1956	Jun. 07, 1956	28.10	13,836 ⁶	1983	Mar. 22, 1983		6,343 ^{1,6}
1957	May 25, 1957	26.54	11,270 ⁶	1984	May 04, 1984		4,814 ^{1,6}
1958	Jun. 05, 1958	26.15	10,664 ⁶	1985	Feb. 05, 1985		4,870 ^{1,6}
1959	Jun. 27, 1959	26.53	11,256 ⁶	1986	Apr. 15, 1986		4,927 ^{1,6}
1960	Jul. 05, 1960	24.55	8,164 ⁶	1987	Jan. 15, 1987		4,616 ^{1,6}
1961	Jun. 11, 1961	28.09	14,039 ⁶	1988	Feb. 05, 1988		4,134 ^{1,6}
1962	Jun. 02, 1962	24.83	8,603 ⁶	1989	May 23, 1989		4,729 ^{1,6}
1963	Jun. 24, 1963	24.42	7,974 ⁶	1990	Jun. 13, 1990		6,485 ^{1,6}
1964	Jun. 17, 1964	26.79	11,785 ⁶	1991	May 28, 1991		5,352 ^{1,6}
1965	Jun. 21, 1965	25.15	9,104 ⁶	1992	Jun. 16, 1992		4,899 ^{1,6}
1966	Jun. 11, 1966	24.91	8,750 ⁶	1993	May 22, 1993		4,701 ^{1,6}
1967	Jun. 25, 1967	27.70	12,233 ⁶	1994	Jun. 13, 1994		4,984 ^{1,6}
1968	Jun. 08, 1968	26.55	9,260 ⁶	1995	Jun. 26, 1995		4,559 ^{1,6}
1969	Jul. 06, 1969		7,730 ⁶	1996	Feb. 24, 1996		6,938 ^{1,6}
1970	Jun. 03, 1970	25.72	6,739 ⁶	1997	Jun. 11, 1997		9,231 ^{1,6}
1971	Jun. 17, 1971	26.72	8,722 ⁶	1998	Jun. 02, 1998		5,947 ^{1,6}
1972	Jun. 15, 1972	27.58	10,562 ⁶	1999	Jul. 13, 1999		5,210 ^{1,6}
1973	Nov. 17, 1972		5,550 ⁶	2000	Apr. 24, 2000		5,663 ^{1,6}
1974	Jul. 02, 1974		8,410 ^{1,6}	2001	Dec. 07, 2000		3,710 ^{1,6}
1975	May 24, 1975		5,437 ^{1,6}	2002	Jun. 02, 2002		6,485 ^{1,6}
1976	Sep. 07, 1976		6,201 ^{1,6}	2003	Jun. 16, 2003		4,361 ^{1,6}
1977	Jan. 29, 1977		4,332 ^{1,6}	2004	Aug. 31, 2004		4,446 ^{1,6}
1978	Sep. 09, 1978		4,417 ^{1,6}	2005	May 26, 2005		4,616 ^{1,6}
				2006	May 28, 2006		6,343 ^{1,6}

Codes. 1 -- Discharge is a Maximum Daily Average
6 -- Discharge affected by Regulation or Diversion

TABLE 8-3 COLUMBIA RIVER AT BRIDGEPORT, USGS 12438000 (standard)

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1952	May 26, 1952	83.43	349,700 ⁶	1979	Dec. 31, 1978		159,000 ^{1,6}
1953	Jun. 17, 1953	84.70	374,500 ⁶	1980	Jun. 01, 1980	84.77	217,000 ⁶
1954	Jul. 14, 1954	86.20	393,800 ⁶	1981	Jun. 05, 1981		242,000 ^{1,6}
1955	Jun. 30, 1955	87.85	418,000 ⁶	1982	Mar. 15, 1982		209,000 ^{1,6}
1956	Jun. 07, 1956	92.20	488,600 ⁶	1983	Mar. 22, 1983		224,000 ^{1,6}
1957	May 25, 1957	87.06	398,000 ⁶	1984	May 04, 1984		170,000 ^{1,6}
1958	Jun. 05, 1958	85.80	376,600 ⁶	1985	Feb. 05, 1985		172,000 ^{1,6}
1959	Jun. 27, 1959	87.03	397,500 ⁶	1986	Apr. 15, 1986		174,000 ^{1,6}
1960	Jul. 05, 1960	80.53	288,300 ⁶	1987	Jan. 15, 1987		163,000 ^{1,6}
1961	Jun. 11, 1961	92.15	495,800 ⁶	1988	Feb. 05, 1988		146,000 ^{1,6}
1962	Jun. 02, 1962	81.46	303,800 ⁶	1989	May 23, 1989		167,000 ^{1,6}
1963	Jun. 24, 1963	80.11	281,600 ⁶	1990	Jun. 13, 1990		229,000 ^{1,6}
1964	Jun. 17, 1964	87.90	416,200 ⁶	1991	May 28, 1991		189,000 ^{1,6}
1965	Jun. 21, 1965	82.50	321,500 ⁶	1992	Jun. 16, 1992		173,000 ^{1,6}
1966	Jun. 11, 1966	81.74	309,000 ⁶	1993	May 22, 1993		166,000 ^{1,6}
1967	Jun. 25, 1967	90.88	432,000 ⁶	1994	Jun. 13, 1994		176,000 ^{1,6}
1968	Jun. 08, 1968	87.12	327,000 ⁶	1995	Jun. 26, 1995		161,000 ^{1,6}
1969	Jul. 06, 1969		273,000 ⁶	1996	Feb. 24, 1996		245,000 ^{1,6}
1970	Jun. 03, 1970	84.37	238,000 ⁶	1997	Jun. 11, 1997		326,000 ^{1,6}
1971	Jun. 17, 1971	87.66	308,000 ⁶	1998	Jun. 02, 1998		210,000 ^{1,6}
1972	Jun. 15, 1972	90.49	373,000 ⁶	1999	Jul. 13, 1999		184,000 ^{1,6}
1973	Nov. 17, 1972		196,000 ⁶	2000	Apr. 24, 2000		200,000 ^{1,6}
1974	Jul. 02, 1974		297,000 ^{1,6}	2001	Dec. 07, 2000		131,000 ^{1,6}
1975	May 24, 1975		192,000 ^{1,6}	2002	Jun. 02, 2002		229,000 ^{1,6}
1976	Sep. 07, 1976		219,000 ^{1,6}	2003	Jun. 16, 2003		154,000 ^{1,6}
1977	Jan. 29, 1977		153,000 ^{1,6}	2004	Aug. 31, 2004		157,000 ^{1,6}
1978	Sep. 09, 1978		156,000 ^{1,6}	2005	May 26, 2005		163,000 ^{1,6}
				2006	May 28, 2006		224,000 ^{1,6}

Codes. 1 -- Discharge is a Maximum Daily Average
6 -- Discharge affected by Regulation or Diversion

8.12 Other Information.

a. Examples of Regulation. Average annual discharge at the USGS streamgage,

Columbia River at Bridgeport (USGS #12438000) is 3,092 m³/s (109,200 cfs) for the 53 year period from Oct 1952 to September 2005. The maximum, minimum, and average water years are described below. In all cases, the reservoir operated within its normal range without exceeding NFP El 291.39 m (El 956 ft). The BPA Seasonal Volumes and Statistics Report (1928-1999) was used to pick the maximum, average, and minimum annual natural-condition runoff events from the period of record. Water Year 1964, the water year with largest average annual discharge during the period of record, was not selected because it preceded the present reservoir storage system. Reservoir stage-discharge hydrographs for the three events described below are not included because the reservoir elevations in all three cases are within the project's normal operating range and the hourly operating patterns are also similar.

i. Maximum Flood Discharge (Water Year 1997 (June)). Daily discharges exceeded the powerhouse capacity (approx. 6,088 m³/s (215,000 cfs)) from May 17th to June 27th with a maximum daily discharge of 9,231 m³/s (326,000 cfs) occurring on June 11th. The maximum forebay elevation for the period listed above was 291.36 m (El 955.9 ft). The operating range during this period was generally 290.78 to 291.08 m (954 to 955 ft) with a few higher levels.

ii. Minimum Annual Discharge. The average discharge during water year 2001, reported in the USGS Water Resources Data for Washington, is 2,148 m³/s (75,870 cfs). Winter discharges exceeded spring and summer flows for water year 2001. Minimum and maximum elevations during May and June were 290.14 m and 291.14 m (951.9 ft and 955.2 ft) with most elevations closest to 290.78 m (El 954 ft).

iii. Average Annual Discharge. The average annual discharge is 3,092

m³/s (109,200 cfs) based on the 53 year period from Oct 1952 to September 2005. Within the past 30 years (since completion of the reservoir storage system) the year closest to this value was water year 1993, which had an average annual discharge of 3,178 m³/s (112,241 cfs). The reservoir fluctuations in this case are similar to those described under the maximum flood scenario with fluctuations in a 0.61 to 0.91 m (2 to 3 ft) range above El 290.47 m (El 953 ft).

b. Cultural Resources. Since the mid-1970's, the Seattle District has sponsored a program at Chief Joseph Dam to identify, test, and recover data from cultural resource sites that could be affected by construction and operations. Testing at about 100 of the prehistoric sites (there are nearly 300 prehistoric and historic sites) identified their age and importance. This supported a formal determination in 1978 that the Rufus Woods Lake Archeological District, which encompasses the entire Chief Joseph Dam project, was eligible for the National Register of Historic Places. The determination of eligibility provided sufficient federal protection of the cultural resource sites; therefore, it was not necessary to pursue a formal nomination. Between 1978 and 1980, intensive excavation recovered data from 18 prehistoric sites in the archeological district that were to be flooded or otherwise lost to the immediate effects of construction. The program significantly advanced knowledge of regional prehistory through production of over 25 technical reports and compilation of a large, carefully organized collection of artifacts and data. One of the more prominent aspects of the program has been the close coordination and cooperation with the Colville Confederated Tribes, who have maintained a continued intensive involvement through all the program phases.

SECTION 9. ORGANIZATION AND COORDINATION FOR RESERVOIR REGULATION

9.01 Responsibilities and Organizations. CHJ is a major hydroelectric project in the Federal Columbia River Power System (FCRPS). Extensive planning and coordination of this reservoir system assures the project's power generation and other water resource requirements are satisfied. When dealing with matters associated with the FCRPS and the ESA, the Corps, Bureau of Reclamation, and BPA are commonly referred to as the "Action Agencies." USFWS and NOAA Fisheries are referred to as the "Resource Agencies." The following agencies and regional organizations are involved in planning, scheduling, and operating the Columbia River water resource system.

a. Action Agencies. The Federal Government owns the CHJ project and the Corps operates it through coordination with Reclamation and BPA. Telephone numbers for the Corps, BPA, Bureau of Reclamation (Reclamation), and Grand Coulee Dam (GCL) departments directly involved in the operation and regulation of CHJ are provided in page ii of this manual.

(1) U.S. Army Corps of Engineers (Corps). Direct responsibility for the regulation of CHJ is assigned to the Northwestern Division's Reservoir Control Center (CENWD-PDW-R) which is also known as the NWD-RCC. This office coordinates and cooperates with many other agencies and groups to accomplish effective and efficient regulation.

The Seattle District Water Management Section (CENWS-EC-TB-WM) includes a Reservoir Control Center commonly referred to as the NWS-RCC to distinguish it from

Division's RCC. Seattle District's Water Management Section supports the Division Reservoir Control Branch and the Hydrologic Engineering Branch (CENWD-PDW-R and CENWD-PDW-H) in flood-control regulation matters at CHJ by assisting in the preparation of special reservoir operations, public coordination, and preparation of reservoir regulation studies and water control manuals. The CJD Gas Abatement Project is the most recent example of this support. Northwestern Division and Seattle District are connected to the Internet for high-speed exchange of hydromet data and related project information.

(2) U.S. Bureau of Reclamation (Reclamation). Reclamation owns and operates GCL for hydropower, flood control, and irrigation. The GCL project office provides a daily generation and outflow schedule to CHJ to help coordinate the hourly operation of CHJ. Reclamation's Irrigation Operation and Maintenance Branch of the Division of Water, Power, and Lands in the Regional Office in Boise, Idaho, exercises primary staff responsibility over the operation and maintenance of all Reclamation irrigation and power facilities in the Pacific Northwest Region. The Technical Service Center in Denver, Colorado, provides technical support services for operation and maintenance of Reclamation projects. The Center also periodically examines all major structures, performs project safety studies, reviews project behavior data, and provides technical advice and assistance in the solution of operation and maintenance problems.

(3) Bonneville Power Administration (BPA). BPA is the marketing agency for power generated at Federal projects in the Pacific Northwest. The agency has constructed and maintains the nation's largest network of long-distance high-voltage transmission lines as part of its power marketing operation. The transmission facilities

and the federal electric generating projects they interconnect are known as the Federal Columbia River Power System (FCRPS). Power is scheduled and dispatched by BPA from the Dittmer Control Center, Vancouver, Washington.

b. Resource Agencies. The U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA Fisheries) (the Resource Agencies) are the lead agencies responsible for specifying necessary changes to the FCRPS to assure the long-term survival of listed fish species pursuant to the ESA of 1973. The Resource Agencies have the lead in developing Biological Opinions that protect ESA-listed fish from jeopardy and require formal recovery plans to guide their recovery. Installation of spillway deflectors at CHJ was a Biological Opinion (BiOp) requirement. Other requested BiOp requirements are primarily associated with the management of reservoir water supplies for the overall benefit of listed fish species. Since CHJ is a run-of-river project with essentially no active storage except for power generation, the project should discharge any special fish water through the project in a timely manner.

(1) National Oceanic and Atmospheric Administration (NOAA Fisheries). NOAA Fisheries, previously the National Marine Fisheries Service (NMFS), is responsible for anadromous fish resources. As a result of the salmon management activities in the Columbia River, NOAA Fisheries is involved in water management planning with BPA, Reclamation, and the Corps. The regional office in Seattle, Washington may be contacted at telephone (206) 526-6150 for assistance. The address of the Portland, Oregon office is 525 NE Oregon Street, Suite 500, Portland, OR 97232.

(2) U.S. Fish and Wildlife Service (USFWS). At the federal level, the USFWS is the agency primarily responsible for ensuring the conservation and management of the nation's wild birds, mammals, and sport fishes for their recreational and economic values. The following are included in the USFWS major program areas: technical assistance to federal, state, and private organizations in the development and administration of sport fish and wildlife management programs; administration and operation of a national system of fish hatcheries engaged in the propagation and distribution of sport fish; and cooperation with other federal and non-federal agencies engaged in water resource development projects to determine the effects of such projects on fish and wildlife resources and recommend measures for the protection and improvement of these resources. Addresses of the USFWS offices in Portland and Spokane are listed below.

U.S. Fish and Wildlife Service
911 Northeast 11th Avenue
Portland, OR 97232-4181

Upper Columbia Office
11103 E. Montgomery Dr.
Spokane, WA 99206-4779

c. Other Federal Agencies.

(1) National Weather Service. The National Weather Service operates weather stations throughout the Columbia Basin in the United States. Hydromet data from these stations are used for planning and scheduling regulation at CHJ. Refer to Section 5 for additional details.

(2) Northwest River Forecast Center (NWRFC), Portland. In 1948, the National Weather Service, formerly the U.S. Weather Bureau, was authorized to develop a modern river forecast program for the United States. The Portland NWRFC was established in January 1950 and began limited forecasting in 1951. The NWRFC

provides deterministic streamflow forecasts (10-day outlook), seasonal water supply forecasts based on regression equations, and Ensemble Streamflow Prediction forecasts, as well as quantitative precipitation forecasts and the current daily satellite summary. Staff at CHJ provides daily hydrometeorological data to WCDS which is used by the NWRFC in support of regional forecasts.

(3) U.S. Geological Survey (USGS). The USGS Water Resources Division collects and processes water quality and quantity records for stations throughout the United States and Northwest including Idaho, Montana, Oregon, and Washington. This information is available for use in system hydropower and flood control planning studies and for real-time operations at projects such as CHJ and GCL. Streamflow, storage, and water quality data obtained from the USGS data collection system are assembled and published in annual Water Resource Reports by each USGS district office. USGS offices in the Columbia Basin include the district office at Helena, Montana, the district office at Boise, Idaho, and the district office at Tacoma, Washington. The appropriate district office should be called in case of streamgauge operation or maintenance problems.

(4) Natural Resources Conservation Service (NRCS). The NRCS operates snow courses in the Columbia Basin in the United States that provide data used in the preparation of annual reports and for water resource management and forecasting. The NRCS office in Bozeman, Montana, the Boise, Idaho office, and the Spokane, Washington, office for snow-related information.

(5) Environmental Protection Agency (EPA). Under the CWA, the Colville tribes and the U.S. Environmental Protection Agency (EPA) are responsible for managing water quality for tribal waters of the Colville reservations to compliance with state standards through development and implementation of the Water Quality Improvement Project process or Total Maximum Daily Loads (TMDL, established by Section 303(d) of the CWA).

(6) Confederated Tribes of the Colville Reservation. The Tribes have adopted water quality standards that EPA has approved consistent with its obligations under the Clean Water Act (CWA) and the Endangered Species Act (ESA).

d. State and County Agencies.

(1) Washington State Department of Fish and Wildlife (WDFW). The WDFW has the authority for regulation of fish and wildlife in the Columbia River basin.

(2) Washington State Department of Ecology (DOE). Washington State Department of Ecology is charged with returning state waters to compliance with state standards through development and implementation of the Water Quality Improvement Project process or Total Maximum Daily Loads (TMDL, established by Section 303(d) of the CWA). The DOE is the agency responsible for the instream resources protection program in accordance with Chapter 173-500 WAC (Water Resources Management Program).

(3) Chelan, Douglas and Grant Counties Public Utility Districts (PUD).

As owners of Wells, Rocky Reach, Rock Island, and Priest Rapids hydroelectric

projects, these counties participate in the Mid-Columbia Hourly Coordination Agreement. They are involved in coordination for the Water Quality Planning for the Columbia River.

9.02 Interagency Coordination

a. Technical Management Team (TMT). The NOAA Fisheries 2000 BiOp calls for the utilization of a TMT to advise the Action Agencies on dam and reservoir operations to optimize fish passage conditions for juvenile and adult anadromous salmonids and resident fish. A full description of the TMT is provided in Exhibit 9-1.

b. Regional Coordination for the Water Quality Plan (WQP) for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers. The first WQP, produced in April 2003, was developed in coordination with water quality regulatory agencies, other State and Federal agencies, Tribes and private entities. Implementation of the WQP for the Columbia River Basin has been ongoing, with updates in November 2004 and again in November 2006. The WQP focuses on implementable water quality measures to improve water quality conditions; primarily TDG and temperature. The geographic scope includes the Columbia River from Lake Roosevelt at the Canadian border, the Clearwater River from Dworshak Dam downstream to the lower Snake River, and from Brownlee Dam on the Snake River, to below Bonneville Dam on the lower Columbia. This plan also briefly addresses issues above the international border with Canada for consideration under the Clean Water Act. This coordination has led to Canadian efforts to reduce TDG levels in the Columbia

River coming into U.S. waters at Lake Roosevelt. Specific groups include the Regional Forum Water Quality Team, Mainstem Water Quality Plan Workgroup, Water Quality Workgroup, Transboundary Gas Group, and the Adaptive Management Team.

Participation is extensive - information can be found on the Columbia Basin Water Management Division website - <http://www.nwd-wc.usace.army.mil/>.

c. Northwest Power Pool (NWPP). The NWPP is a voluntary organization comprised of major generating utilities serving the Pacific Northwest, British Columbia and Alberta. Smaller, principally non-generating utilities in the region participate indirectly through the member system with which they are interconnected. The NWPP was originally formed in 1942, when the federal government directed utilities to coordinate operations in support of wartime production. The NWPP serves as a forum in the electric industry for reliability and operational adequacy issues in the Northwest.

(1) Pacific Northwest Coordination Agreement (PNCA). The PNCA is the formal contract of the NWPP for coordinating the seasonal operation of the generating resources of the member systems for the best utilization of their collective reservoir storage. The agreement became effective on January 4, 1965, and was updated in 1997. It is a voluntary agreement. Parties to the PNCA coordinate the operation of their respective systems to (1) entitle each system to its optimum firm load-carrying capability, (2) provide optimum firm load-carrying capability for the coordinated system, and (3) produce the optimum amount of usable secondary energy for each system consistent with the PNCA objectives. The Chief of the CENWD-PDW-P is the Corps representative on this committee. Operating programs are prepared annually from load

forecasts and available resources to provide a guide for the upcoming yearly operation.

(2) Project Data Submittal (PDS). The PDS is furnished by the Operational Planning Unit in the Division power branch (CENWD-PDW-P) to the PNCA Coordinating Group each year prior to February 1st. The PDS lists any parameters that affect power generation during the following power year (August 1st to July 31st). The PDS is primarily a hydropower report used to define current project conditions for annual power studies conducted by the Coordinating Group for the NWPP. The PDS includes powerplant and reservoir operating characteristics, operating priorities, reservoir operating limits, streamflow maximum and minimum requirements, and powerhouse maintenance schedules.

d. U.S. Forest Service. The Forest Service does not have direct involvement with forest resources within the CHJ jurisdiction.

e. Northwest Power and Conservation Council (NWPCC). The Pacific Northwest Electric Power Planning and Conservation Act of December 5, 1980 established an 8 member Pacific Northwest Electric Power Planning Council, now known as the Pacific Northwest Power and Conservation Council (NWPCC), comprised of 2 voting members representing each state: Washington, Oregon, Idaho, and Montana. Although initially governors designated one of their two representatives to serve only 2 years, each member currently serves a term of 3 years. Convinced that regional electric energy planning should be placed firmly in the hands of the people of the Pacific Northwest, Congress made each council member an officer of his respective state and subject to removal in accordance with state laws. The Council was initially formed in April 1981. The initial

tasks of the Council were to (1) adopt a fish and wildlife program by November 15, 1982 and (2) prepare a regional electric power and conservation plan by April 1983. The adopted fish and wildlife program was developed to protect, mitigate, and enhance fish and wildlife, including related spawning grounds on the Columbia River and its tributaries. Under the program, flows of sufficient quality and quantity must be provided between and below hydroelectric facilities to improve production, migration, and fish habitat as required to meet sound biological objectives.

9.03 Interagency Agreements.

a. Agreement for the Hourly Coordination of Projects on the Mid-Columbia River (Mid Columbia Hourly Coordination (MCHC)). This Agreement was established in 1997 to coordinate the hydroelectric operation of the following mid-Columbia River projects: Grand Coulee, Chief Joseph, Wells, Rocky Reach, Rock Island, and Priest Rapids (consisting of the Wanapum and Priest Rapids developments) in order to secure optimum usable generation at the affected projects and equitable distribution of the benefits. The Agreement provides broad flexibility for scheduling, generating, and accounting for hourly operation between the Agreement members and their customers. A copy of the current agreement, which runs from July 1, 1997 through June 30, 2017, has been provided in Exhibit 9-2. A control center located at Ephrata, Washington is responsible for implementation of the Agreement.

b. Power Loss From Wells Project Encroachment on Chief Joseph Dam. Agreement, dated 26 August 1968. Wells Project was constructed after completion and filling of the Phase I CHJ dam to El 288.34 m (El 946 ft) in 1955. Recognizing that Wells Reservoir (Lake Pateros) would encroach on the CHJ tailwater and reduce the

hydraulic head and power generation, an agreement was completed to reimburse the Federal Government for the losses resulting from the encroachment on original units #1-16. All units are converted to equivalent 80 MW units.

A Supplement to the 1968 Agreement was completed in 1982 to provide for losses resulting from a 0.61 m (2 ft) pool raise on Lake Pateros from El 237.44 m to El 238.05 m (El 779 ft to El 781 ft). Pursuant to this Supplement, Douglas County PUD will pay for losses due to:

(a) encroachment on units #1-16 in accordance with terms of the original agreement of 26 August 1968; and

(b) the additional encroachment caused by the 0.61 m (2 ft) pool raise from El 237.44 m to El 238.05 m (El 779 ft to El 781 ft):

(2) on units #17-27 and

(3) on the incremental increase in generation due to the uprating (including rewind and new transformers) of units #1-16.

Details of this process are described in the Agreement and Supplement in Exhibits 9-3 and 9-4, respectively.

9.04 Commissions, River Authorities, Compacts, and Committees. See section 9.02 for entities who share interest in river basin water control activities.

9.05 Non-Federal Hydropower. Non- applicable.

9.06 Reports. Many reports are available on line from the home page for the Columbia Basin Water Management Division, Northwestern Division, U.S. Army Corps of Engineers. NWD is responsible for the Corps' river and reservoir regulation activities in the Columbia River Basin. <http://www.nwd-wc.usace.army.mil/>

TABLES

Number

2-1	Rufus Woods Lake—Gross Storage in Hectare Meters (HA-M)	*
2-2	Rufus Woods Lake—Gross Storage in Acre Feet (AF).....	*
2-3	Single Spillway Bay Discharge Capacity (m^3/s)	*
2-4	Single Spillway Bay Discharge Capacity (cfs).....	*

TABLE 2-1 CHIEF JOSEPH DAM-STORAGE IN HECTARE-METERS

meters	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
238	12.3	12.3	24.2	24.7	24.7	34.6	37.0	37.0	49.3	60.8
239	61.7	74.0	83.5	86.3	98.7	106.2	111.0	123.3	128.9	135.7
240	148.2	160.4	172.7	185.0	197.4	209.7	222.0	234.4	246.7	259.0
241	271.4	283.7	296.0	308.4	320.7	335.9	351.7	370.0	383.3	399.1
242	419.4	431.7	446.4	468.7	481.1	493.8	518.1	530.4	542.7	567.4
243	585.2	604.4	629.1	644.9	666.1	688.8	704.6	727.8	748.6	764.8
244	789.4	808.3	826.4	851.1	868.0	888.1	912.0	937.4	962.1	984.0
245	1,011.5	1,036.1	1,056.1	1,084.2	1,110.1	1,128.2	1,156.3	1,184.1	1,200.2	1,228.4
246	1,256.5	1,284.6	1,312.8	1,340.9	1,369.0	1,397.2	1,425.3	1,453.4	1,481.6	1,509.7
247	1,537.8	1,566.0	1,594.1	1,622.2	1,662.7	1,690.8	1,719.0	1,759.4	1,787.6	1,815.7
248	1,856.2	1,884.3	1,912.4	1,952.9	1,981.0	2,021.5	2,049.7	2,090.1	2,130.6	2,158.7
249	2,199.2	2,239.7	2,269.6	2,308.3	2,348.7	2,380.6	2,417.3	2,457.8	2,498.3	2,538.7
250	2,579.2	2,619.7	2,660.1	2,700.6	2,741.1	2,781.6	2,822.0	2,862.5	2,903.0	2,943.4
251	2,995.1	3,036.7	3,077.2	3,126.9	3,170.4	3,210.9	3,258.7	3,304.2	3,344.6	3,390.5
252	3,437.9	3,478.4	3,531.2	3,578.6	3,624.5	3,677.3	3,722.7	3,770.5	3,823.3	3,866.8
253	3,916.6	3,969.4	4,011.0	4,062.7	4,115.5	4,168.3	4,221.1	4,273.9	4,326.7	4,379.5
254	4,432.3	4,485.1	4,537.9	4,592.9	4,649.2	4,708.7	4,761.7	4,818.0	4,879.4	4,932.2
255	4,986.8	5,050.2	5,111.6	5,168.1	5,233.2	5,292.8	5,351.2	5,416.3	5,473.9	5,534.3
256	5,598.8	5,655.0	5,723.6	5,782.5	5,848.5	5,917.1	5,977.9	6,043.0	6,110.6	6,173.3
257	6,238.4	6,315.9	6,381.1	6,446.2	6,522.2	6,588.8	6,653.9	6,728.0	6,796.5	6,865.2
258	6,933.8	7,004.3	7,083.4	7,152.0	7,224.4	7,301.5	7,370.1	7,444.5	7,519.6	7,600.6
259	7,669.2	7,750.1	7,831.1	7,899.7	7,980.6	8,061.5	8,142.5	8,223.4	8,304.3	8,385.3
260	8,466.2	8,547.2	8,640.4	8,721.4	8,802.3	8,895.6	8,976.5	9,069.8	9,150.7	9,244.0
261	9,337.2	9,418.2	9,511.5	9,604.7	9,698.0	9,791.3	9,884.6	9,977.8	10,071.1	10,164.4
262	10,257.6	10,363.3	10,456.5	10,549.8	10,654.5	10,751.2	10,854.3	10,957.0	11,053.7	11,158.8
263	11,259.6	11,357.6	11,465.4	11,568.9	11,674.5	11,780.2	11,885.7	11,991.3	12,107.4	12,214.8
264	12,320.4	12,434.7	12,543.7	12,652.8	12,761.9	12,873.1	12,992.4	13,101.4	13,214.6	13,331.9
265	13,453.3	13,562.4	13,683.8	13,805.2	13,914.3	14,035.7	14,157.1	14,278.5	14,399.9	14,521.3
266	14,642.7	14,764.1	14,885.5	15,019.2	15,140.6	15,262.1	15,395.8	15,517.2	15,650.9	15,772.3
267	15,906.1	16,039.8	16,161.2	16,295.0	16,428.7	16,562.5	16,696.2	16,829.9	16,963.7	17,097.4
268	17,231.2	17,364.9	17,511.0	17,644.7	17,778.5	17,924.5	18,062.4	18,204.3	18,349.2	18,486.4
269	18,630.2	18,773.1	18,910.3	19,059.9	19,202.2	19,348.3	19,496.1	19,640.4	19,786.5	19,944.8
270	20,091.0	20,237.1	20,393.4	20,541.6	20,692.5	20,842.0	20,992.1	21,153.4	21,302.9	21,455.0
271	21,614.4	21,776.2	21,925.8	22,087.6	22,249.5	22,399.1	22,560.9	22,722.8	22,884.7	23,046.6
272	23,208.4	23,370.3	23,532.2	23,694.1	23,868.3	24,030.1	24,204.3	24,366.2	24,540.4	24,714.6
273	24,888.8	25,063.1	25,240.4	25,418.1	25,598.0	25,784.6	25,963.4	26,145.3	26,331.1	26,518.4
274	26,698.8	26,888.8	27,078.8	27,268.8	27,463.5	27,661.2	27,851.2	28,053.5	28,246.6	28,445.9

Note: Rufus Woods Reservoir storage in hectare meters is computed from the acre foot storage capacity table, Rufus Woods Lake at Bridgeport, Washington, prepared by the U.S. Geological Survey, file Number, field 026, dated 10 Jan 1955.

TABLE 2-1 CHIEF JOSEPH DAM-STORAGE IN HECTARE-METERS

meters	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
275	28,648.2	28,850.6	29,052.9	29,255.2	29,469.9	29,672.3	29,874.6	30,089.3	30,304.0	30,516.6
276	30,733.3	30,940.6	31,158.7	31,377.3	31,595.0	31,819.0	32,043.6	32,261.8	32,487.7	32,710.4
277	32,940.9	33,168.8	33,401.8	33,632.3	33,862.8	34,093.2	34,328.5	34,566.5	34,809.3	35,039.8
278	35,282.6	35,525.4	35,768.3	36,011.1	36,253.9	36,496.7	36,739.5	36,982.3	37,237.5	37,480.3
279	37,723.1	37,978.2	38,221.0	38,476.2	38,719.0	38,974.1	39,229.3	39,472.1	39,727.2	39,982.4
280	40,237.5	40,492.7	40,747.8	41,003.0	41,258.1	41,513.3	41,768.9	42,035.9	42,291.0	42,546.2
281	42,813.7	43,074.3	43,336.3	43,603.8	43,862.4	44,126.4	44,392.0	44,650.6	44,921.5	45,184.0
282	45,451.5	45,722.0	45,986.4	46,253.9	46,533.7	46,801.2	47,068.7	47,347.7	47,616.0	47,889.6
283	48,160.5	48,431.5	48,714.8	48,985.7	49,257.9	49,539.9	49,823.2	50,094.2	50,377.4	50,660.7
284	50,931.7	51,214.9	51,498.2	51,769.2	52,052.4	52,335.7	52,631.3	52,914.6	53,197.9	53,493.5
285	53,776.8	54,060.1	54,355.7	54,639.0	54,934.6	55,217.9	55,513.5	55,809.1	56,092.4	56,388.0
286	56,683.6	56,979.2	57,274.8	57,570.4	57,866.1	58,161.7	58,457.3	58,752.9	59,048.5	59,344.1
287	59,639.9	59,947.7	60,243.3	60,538.9	60,846.9	61,142.5	61,438.1	61,745.8	62,044.8	62,349.6
288	62,655.3	62,954.4	63,261.1	63,564.9	63,864.7	64,172.7	64,474.5	64,776.2	65,085.0	65,392.1
289	65,700.1	66,006.9	66,316.0	66,623.9	66,928.8	67,239.8	67,547.8	67,863.0	68,174.4	68,483.9
290	68,797.3	69,108.7	69,407.8	69,691.1	69,974.4	70,278.4	70,617.9	70,964.8	71,300.9	71,612.3
291	71,933.1	72,247.5	72,558.9	72,881.6	73,194.1	73,517.8	73,829.2	74,153.0	74,476.7	74,788.1
292	75,111.9	75,435.6	75,747.1	76,070.8	76,394.5	76,718.3	77,042.0	77,365.8	77,689.5	78,013.3

Note: Rufus Woods Reservoir storage in hectare meters is computed from the acre foot storage capacity table, Rufus Woods Lake at Bridgeport, Washington, prepared by the U.S. Geological Survey, file Number, field 026, dated 10 Jan 1955.

TABLE 2-2 CHIEF JOSEPH DAM-RESERVOIR STORAGE (1,000 AF)

Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
780.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
781.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
782.0	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
783.0	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5
784.0	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7
785.0	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9
786.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1
787.0	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4
788.0	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7
789.0	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	1.9	2.0
790.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.3
791.0	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.6
792.0	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	2.9	3.0
793.0	3.0	3.0	3.1	3.1	3.2	3.2	3.2	3.3	3.3	3.4
794.0	3.4	3.4	3.5	3.5	3.6	3.6	3.6	3.7	3.7	3.8
795.0	3.8	3.8	3.9	3.9	4.0	4.0	4.0	4.1	4.1	4.2
796.0	4.2	4.2	4.3	4.3	4.4	4.4	4.4	4.5	4.5	4.6
797.0	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0	5.1
798.0	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5	5.5	5.6
799.0	5.6	5.7	5.7	5.8	5.8	5.9	5.9	6.0	6.0	6.1
800.0	6.1	6.2	6.2	6.3	6.3	6.4	6.4	6.5	6.5	6.6
801.0	6.6	6.7	6.7	6.8	6.8	6.9	6.9	7.0	7.0	7.1
802.0	7.1	7.2	7.2	7.3	7.3	7.4	7.5	7.5	7.6	7.6
803.0	7.7	7.8	7.8	7.9	7.9	8.0	8.1	8.1	8.2	8.2
804.0	8.3	8.4	8.4	8.5	8.5	8.6	8.7	8.7	8.8	8.8
805.0	8.9	9.0	9.0	9.1	9.1	9.2	9.3	9.3	9.4	9.4
806.0	9.5	9.6	9.6	9.7	9.7	9.8	9.9	9.9	10.0	10.0
807.0	10.1	10.2	10.2	10.3	10.4	10.5	10.5	10.6	10.7	10.7
808.0	10.8	10.9	10.9	11.0	11.1	11.2	11.2	11.3	11.4	11.4
809.0	11.5	11.6	11.6	11.7	11.8	11.9	11.9	12.0	12.1	12.1
810.0	12.2	12.3	12.3	12.4	12.5	12.6	12.6	12.7	12.8	12.8
811.0	12.9	13.0	13.1	13.1	13.2	13.3	13.4	13.5	13.5	13.6
812.0	13.7	13.8	13.9	13.9	14.0	14.1	14.2	14.3	14.3	14.4
813.0	14.5	14.6	14.7	14.7	14.8	14.9	15.0	15.1	15.1	15.2
814.0	15.3	15.4	15.5	15.5	15.6	15.7	15.8	15.9	15.9	16.0
815.0	16.1	16.2	16.3	16.4	16.5	16.6	16.6	16.7	16.8	16.9
816.0	17.0	17.1	17.2	17.3	17.4	17.5	17.5	17.6	17.7	17.8
817.0	17.9	18.0	18.1	18.2	18.3	18.4	18.4	18.5	18.6	18.7
818.0	18.8	18.9	19.0	19.1	19.2	19.3	19.3	19.4	19.5	19.6
819.0	19.7	19.8	19.9	20.0	20.1	20.2	20.3	20.4	20.5	20.6
820.0	20.7	20.8	20.9	21.0	21.1	21.2	21.3	21.4	21.5	21.6
821.0	21.7	21.8	21.9	22.0	22.1	22.2	22.3	22.4	22.5	22.6
822.0	22.7	22.8	22.9	23.0	23.1	23.2	23.3	23.4	23.5	23.6
823.0	23.7	23.8	23.9	24.0	24.1	24.3	24.4	24.5	24.6	24.7
824.0	24.8	24.9	25.0	25.1	25.2	25.4	25.5	25.6	25.7	25.8
825.0	25.9	26.0	26.1	26.2	26.3	26.5	26.6	26.7	26.8	26.9

Rufus Woods reservoir storage in acre feet is based on the storage capacity table, Rufus Woods Lake at Bridgeport, Washington, prepared by the U.S. Geological Survey, file number 026, dated 10 Jan 1955.

TABLE 2-2 CHIEF JOSEPH DAM-RESERVOIR STORAGE (1,000 AF)

Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
826.0	27.0	27.1	27.2	27.3	27.4	27.6	27.7	27.8	27.9	28.0
827.0	28.1	28.2	28.3	28.5	28.6	28.7	28.8	28.9	29.1	29.2
828.0	29.3	29.4	29.5	29.7	29.8	29.9	30.0	30.1	30.3	30.4
829.0	30.5	30.6	30.7	30.9	31.0	31.1	31.2	31.3	31.5	31.6
830.0	31.7	31.8	31.9	32.1	32.2	32.3	32.4	32.5	32.7	32.8
831.0	32.9	33.0	33.2	33.3	33.4	33.6	33.7	33.8	33.9	34.1
832.0	34.2	34.3	34.5	34.6	34.7	34.9	35.0	35.1	35.2	35.4
833.0	35.5	35.6	35.8	35.9	36.0	36.2	36.3	36.4	36.5	36.7
834.0	36.8	36.9	37.1	37.2	37.4	37.5	37.6	37.8	37.9	38.1
835.0	38.2	38.3	38.5	38.6	38.8	38.9	39.0	39.2	39.3	39.5
836.0	39.6	39.7	39.9	40.0	40.2	40.3	40.4	40.6	40.7	40.9
837.0	41.0	41.2	41.3	41.5	41.6	41.8	41.9	42.1	42.2	42.4
838.0	42.5	42.7	42.8	43.0	43.1	43.3	43.4	43.6	43.7	43.9
839.0	44.0	44.2	44.3	44.5	44.6	44.8	44.9	45.1	45.2	45.4
840.0	45.5	45.7	45.8	46.0	46.1	46.3	46.5	46.6	46.8	46.9
841.0	47.1	47.3	47.4	47.6	47.7	47.9	48.1	48.2	48.4	48.5
842.0	48.7	48.9	49.0	49.2	49.3	49.5	49.7	49.8	50.0	50.1
843.0	50.3	50.5	50.6	50.8	51.0	51.2	51.3	51.5	51.7	51.8
844.0	52.0	52.2	52.3	52.5	52.7	52.9	53.0	53.2	53.4	53.5
845.0	53.7	53.9	54.0	54.2	54.4	54.6	54.7	54.9	55.1	55.2
846.0	55.4	55.6	55.8	55.9	56.1	56.3	56.5	56.7	56.8	57.0
847.0	57.2	57.4	57.6	57.7	57.9	58.1	58.3	58.5	58.6	58.8
848.0	59.0	59.2	59.4	59.5	59.7	59.9	60.1	60.3	60.4	60.6
849.0	60.8	61.0	61.2	61.4	61.6	61.8	61.9	62.1	62.3	62.5
850.0	62.7	62.9	63.1	63.3	63.5	63.7	63.8	64.0	64.2	64.4
851.0	64.6	64.8	65.0	65.2	65.4	65.6	65.8	66.0	66.2	66.4
852.0	66.6	66.8	67.0	67.2	67.4	67.6	67.8	68.0	68.2	68.4
853.0	68.6	68.8	69.0	69.2	69.4	69.7	69.9	70.1	70.3	70.5
854.0	70.7	70.9	71.1	71.3	71.5	71.8	72.0	72.2	72.4	72.6
855.0	72.8	73.0	73.2	73.5	73.7	73.9	74.1	74.3	74.6	74.8
856.0	75.0	75.2	75.4	75.7	75.9	76.1	76.3	76.5	76.8	77.0
857.0	77.2	77.4	77.7	77.9	78.1	78.4	78.6	78.8	79.0	79.3
858.0	79.5	79.7	80.0	80.2	80.4	80.7	80.9	81.1	81.3	81.6
859.0	81.8	82.0	82.3	82.5	82.8	83.0	83.2	83.5	83.7	84.0
860.0	84.2	84.4	84.7	84.9	85.2	85.4	85.6	85.9	86.1	86.4
861.0	86.6	86.9	87.1	87.4	87.6	87.9	88.1	88.4	88.6	88.9
862.0	89.1	89.4	89.6	89.9	90.1	90.4	90.6	90.9	91.1	91.4
863.0	91.6	91.9	92.1	92.4	92.6	92.9	93.2	93.4	93.7	93.9
864.0	94.2	94.5	94.7	95.0	95.2	95.5	95.8	96.0	96.3	96.5
865.0	96.8	97.1	97.3	97.6	97.9	98.2	98.4	98.7	99.0	99.2
866.0	99.5	99.8	100.0	100.3	100.6	100.9	101.1	101.4	101.7	101.9
867.0	102.2	102.5	102.8	103.0	103.3	103.6	103.9	104.2	104.4	104.7
868.0	105.0	105.3	105.6	105.8	106.1	106.4	106.7	107.0	107.2	107.5
869.0	107.8	108.1	108.4	108.7	109.0	109.3	109.5	109.8	110.1	110.4
870.0	110.7	111.0	111.3	111.6	111.9	112.2	112.4	112.7	113.0	113.3
871.0	113.6	113.9	114.2	114.5	114.8	115.1	115.4	115.7	116.0	116.3

Rufus Woods reservoir storage in acre feet is based on the storage capacity table, Rufus Woods Lake at Bridgeport, Washington, prepared by the U.S. Geological Survey, file number 026, dated 10 Jan 1955.

TABLE 2-2 CHIEF JOSEPH DAM-RESERVOIR STORAGE (1,000 AF)

Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
872.0	116.6	116.9	117.2	117.5	117.8	118.1	118.4	118.7	119.0	119.3
873.0	119.6	119.9	120.2	120.5	120.8	121.2	121.5	121.8	122.1	122.4
874.0	122.7	123.0	123.3	123.6	123.9	124.3	124.6	124.9	125.2	125.5
875.0	125.8	126.1	126.4	126.8	127.1	127.4	127.7	128.0	128.4	128.7
876.0	129.0	129.3	129.6	130.0	130.3	130.6	130.9	131.2	131.6	131.9
877.0	132.2	132.5	132.9	133.2	133.5	133.9	134.2	134.5	134.8	135.2
878.0	135.5	135.8	136.2	136.5	136.8	137.2	137.5	137.8	138.1	138.5
879.0	138.8	139.1	139.5	139.8	140.2	140.5	140.8	141.2	141.5	141.9
880.0	142.2	142.5	142.9	143.2	143.6	143.9	144.2	144.6	144.9	145.3
881.0	145.6	146.0	146.3	146.7	147.0	147.4	147.7	148.1	148.4	148.8
882.0	149.1	149.5	149.8	150.2	150.5	150.9	151.2	151.6	151.9	152.3
883.0	152.6	153.0	153.3	153.7	154.0	154.4	154.8	155.1	155.5	155.8
884.0	156.2	156.6	156.9	157.3	157.6	158.0	158.4	158.7	159.1	159.4
885.0	159.8	160.2	160.5	160.9	161.3	161.7	162.0	162.4	162.8	163.1
886.0	163.5	163.9	164.2	164.6	165.0	165.4	165.7	166.1	166.5	166.8
887.0	167.2	167.6	168.0	168.3	168.7	169.1	169.5	169.9	170.2	170.6
888.0	171.0	171.4	171.8	172.1	172.5	172.9	173.3	173.7	174.0	174.4
889.0	174.8	175.2	175.6	176.0	176.4	176.8	177.1	177.5	177.9	178.3
890.0	178.7	179.1	179.5	179.9	180.3	180.7	181.0	181.4	181.8	182.2
891.0	182.6	183.0	183.4	183.8	184.2	184.6	185.0	185.4	185.8	186.2
892.0	186.6	187.0	187.4	187.8	188.2	188.6	189.0	189.4	189.8	190.2
893.0	190.6	191.0	191.4	191.8	192.2	192.7	193.1	193.5	193.9	194.3
894.0	194.7	195.1	195.5	196.0	196.4	196.8	197.2	197.6	198.1	198.5
895.0	198.9	199.3	199.8	200.2	200.6	201.1	201.5	201.9	202.3	202.8
896.0	203.2	203.6	204.1	204.5	205.0	205.4	205.8	206.3	206.7	207.2
897.0	207.6	208.1	208.5	209.0	209.4	209.9	210.3	210.8	211.2	211.7
898.0	212.1	212.6	213.0	213.5	213.9	214.4	214.9	215.3	215.8	216.2
899.0	216.7	217.2	217.6	218.1	218.6	219.1	219.5	220.0	220.5	220.9
900.0	221.4	221.9	222.4	222.8	223.3	223.8	224.3	224.8	225.2	225.7
901.0	226.2	226.7	227.2	227.7	228.2	228.7	229.1	229.6	230.1	230.6
902.0	231.1	231.6	232.1	232.6	233.1	233.6	234.1	234.6	235.1	235.6
903.0	236.1	236.6	237.1	237.6	238.1	238.7	239.2	239.7	240.2	240.7
904.0	241.2	241.7	242.2	242.8	243.3	243.8	244.3	244.8	245.4	245.9
905.0	246.4	246.9	247.5	248.0	248.5	249.1	249.6	250.1	250.6	251.2
906.0	251.7	252.2	252.8	253.3	253.9	254.4	254.9	255.5	256.0	256.6
907.0	257.1	257.7	258.2	258.8	259.3	259.9	260.4	261.0	261.5	262.1
908.0	262.6	263.2	263.7	264.3	264.8	265.4	266.0	266.5	267.1	267.6
909.0	268.2	268.8	269.3	269.9	270.5	271.1	271.6	272.2	272.8	273.3
910.0	273.9	274.5	275.1	275.6	276.2	276.8	277.4	278.0	278.5	279.1
911.0	279.7	280.3	280.9	281.5	282.1	282.7	283.2	283.8	284.4	285.0
912.0	285.6	286.2	286.8	287.4	288.0	288.6	289.2	289.8	290.4	291.0
913.0	291.6	292.2	292.8	293.4	294.0	294.6	295.2	295.8	296.4	297.0
914.0	297.6	298.2	298.8	299.4	300.0	300.7	301.3	301.9	302.5	303.1
915.0	303.7	304.3	304.9	305.5	306.1	306.8	307.4	308.0	308.6	309.2
916.0	309.8	310.4	311.0	311.7	312.3	312.9	313.5	314.1	314.8	315.4
917.0	316.0	316.6	317.2	317.9	318.5	319.1	319.7	320.3	321.0	321.6

Rufus Woods reservoir storage in acre feet is based on the storage capacity table, Rufus Woods Lake at Bridgeport, Washington, prepared by the U.S. Geological Survey, file number 026, dated 10 Jan 1955.

TABLE 2-2 CHIEF JOSEPH DAM-RESERVOIR STORAGE (1,000 AF)

Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
918.0	322.2	322.8	323.5	324.1	324.7	325.4	326.0	326.6	327.2	327.9
919.0	328.5	329.1	329.8	330.4	331.0	331.7	332.3	332.9	333.5	334.2
920.0	334.8	335.4	336.1	336.7	337.4	338.0	338.6	339.3	339.9	340.6
921.0	341.2	341.8	342.5	343.1	343.8	344.4	345.0	345.7	346.3	347.0
922.0	347.6	348.3	348.9	349.6	350.2	350.9	351.5	352.2	352.8	353.5
923.0	354.1	354.8	355.4	356.1	356.7	357.4	358.0	358.7	359.3	360.0
924.0	360.6	361.3	361.9	362.6	363.2	363.9	364.6	365.2	365.9	366.5
925.0	367.2	367.9	368.5	369.2	369.8	370.5	371.2	371.8	372.5	373.1
926.0	373.8	374.5	375.1	375.8	376.5	377.2	377.8	378.5	379.2	379.8
927.0	380.5	381.2	381.8	382.5	383.2	383.9	384.5	385.2	385.9	386.5
928.0	387.2	387.9	388.6	389.2	389.9	390.6	391.3	392.0	392.6	393.3
929.0	394.0	394.7	395.4	396.0	396.7	397.4	398.1	398.8	399.4	400.1
930.0	400.8	401.5	402.2	402.9	403.6	404.3	404.9	405.6	406.3	407.0
931.0	407.7	408.4	409.1	409.8	410.5	411.2	411.8	412.5	413.2	413.9
932.0	414.6	415.3	416.0	416.7	417.4	418.1	418.7	419.4	420.1	420.8
933.0	421.5	422.2	422.9	423.6	424.3	425.1	425.8	426.5	427.2	427.9
934.0	428.6	429.3	430.0	430.7	431.4	432.2	432.9	433.6	434.3	435.0
935.0	435.7	436.4	437.1	437.8	438.5	439.3	440.0	440.7	441.4	442.1
936.0	442.8	443.5	444.2	445.0	445.7	446.4	447.1	447.8	448.6	449.3
937.0	450.0	450.7	451.4	452.2	452.9	453.6	454.3	455.0	455.8	456.5
938.0	457.2	457.9	458.7	459.4	460.1	460.9	461.6	462.3	463.0	463.8
939.0	464.5	465.2	466.0	466.7	467.4	468.2	468.9	469.6	470.3	471.1
940.0	471.8	472.5	473.3	474.0	474.7	475.5	476.2	476.9	477.6	478.4
941.0	479.1	479.8	480.6	481.3	482.1	482.8	483.5	484.3	485.0	485.8
942.0	486.5	487.2	488.0	488.7	489.5	490.2	490.9	491.7	492.4	493.2
943.0	493.9	494.6	495.4	496.1	496.9	497.6	498.3	499.1	499.8	500.6
944.0	501.3	502.1	502.8	503.6	504.3	505.1	505.8	506.6	507.3	508.1
945.0	508.8	509.6	510.3	511.1	511.8	512.6	513.3	514.1	514.8	515.6
946.0	516.3	517.1	517.8	518.6	519.3	520.1	520.8	521.6	522.3	523.1
947.0	523.8	524.6	525.3	526.1	526.8	527.6	528.4	529.1	529.9	530.6
948.0	531.4	532.2	532.9	533.7	534.4	535.2	536.0	536.7	537.5	538.2
949.0	539.0	539.8	540.5	541.3	542.0	542.8	543.6	544.3	545.1	545.8
950.0	546.6	547.4	548.1	548.9	549.7	550.5	551.2	552.0	552.8	553.5
951.0	554.3	555.1	555.8	556.6	557.4	558.2	558.9	559.7	560.5	561.2
952.0	562.0	562.7	563.4	564.1	564.8	565.5	566.2	566.9	567.6	568.3
953.0	569.0	569.9	570.7	571.6	572.4	573.3	574.1	575.0	575.8	576.7
954.0	577.5	578.3	579.1	579.8	580.6	581.4	582.2	583.0	583.7	584.5
955.0	585.3	586.1	586.9	587.6	588.4	589.2	590.0	590.8	591.5	592.3
956.0	593.1	593.9	594.7	595.5	596.3	597.1	597.8	598.6	599.4	600.2
957.0	601.0	601.8	602.6	603.4	604.2	605.0	605.7	606.5	607.3	608.1
958.0	608.9	609.7	610.5	611.3	612.1	612.9	613.6	614.4	615.2	616.0
959.0	616.8	617.6	618.4	619.2	620.0	620.8	621.6	622.4	623.2	624.0
960.0	624.8	625.6	626.4	627.2	628.0	628.8	629.6	630.4	631.2	632.0
961.0	632.8	633.7	634.6	635.5	636.4	637.3	638.2	639.1	640.0	640.9
962.0	641.8									

Rufus Woods reservoir storage in acre feet is based on the storage capacity table, Rufus Woods Lake at Bridgeport, Washington, prepared by the U.S. Geological Survey, file number 026, dated 10 Jan 1955.

**TABLE 2-3 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (m³/s)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	1	2	3	4	5	6	7	8	9	10	11	12	13
283.46	19.8	41.1	63.7	86.9	110.2	133.7	157.2	180.4	202.5	225.1	247.5	268.4	290.2
283.77	20.1	41.9	64.8	88.3	112.1	136.2	160.3	184.1	206.4	229.4	252.6	274.1	296.5
284.07	20.7	42.5	66.0	90.0	114.1	138.8	163.1	187.5	210.4	233.9	257.4	279.5	302.4
284.38	21.0	43.3	67.1	91.5	115.8	141.0	165.9	190.9	214.1	238.1	262.2	284.9	308.4
284.68	21.2	43.9	68.0	92.9	117.8	143.3	168.8	194.0	217.8	242.4	267.0	290.2	314.0
284.99	21.5	44.5	69.1	94.6	119.8	145.8	171.6	197.4	221.4	246.6	271.6	295.3	319.7
285.29	21.8	45.3	70.2	96.0	121.5	148.1	174.1	200.5	225.1	250.6	276.1	300.4	325.4
285.60	21.8	45.3	70.2	96.0	121.5	148.1	174.1	200.5	225.1	250.6	276.1	300.4	325.4
285.90	22.4	46.4	72.2	98.8	125.2	152.3	179.5	206.7	232.2	258.8	285.2	310.4	336.4
286.21	22.7	47.0	73.1	100.0	126.9	154.6	182.1	209.8	235.6	262.5	289.4	315.2	341.5
286.51	22.9	47.9	74.2	101.4	128.8	156.9	184.9	212.7	239.3	266.5	293.9	319.7	346.9
286.82	23.2	48.4	75.0	102.8	130.5	158.9	187.2	215.8	242.4	270.1	298.2	324.5	352.0
287.12	23.5	49.0	76.2	104.2	132.2	161.1	189.7	218.6	245.8	274.1	302.1	329.0	357.1
287.43	23.8	49.6	77.0	105.3	133.7	163.1	192.3	221.4	249.2	277.8	306.4	333.6	361.9
287.73	24.1	50.1	77.9	106.8	135.4	165.1	194.8	224.3	252.3	281.5	310.4	338.1	367.0
288.04	24.4	50.7	79.0	107.9	137.1	167.1	197.1	227.1	255.4	284.9	314.3	342.6	371.8
288.34	24.6	51.3	79.9	109.3	138.8	169.1	199.6	229.9	258.8	288.5	318.6	346.9	376.6
288.65	24.9	51.8	80.7	110.4	140.2	171.0	201.9	232.5	261.9	291.9	322.2	351.4	381.4
288.95	25.2	52.4	81.6	111.9	141.9	173.0	204.2	235.3	264.8	295.3	326.2	355.7	386.0
289.26	25.5	53.0	82.4	113.0	143.6	175.0	206.4	237.9	267.9	299.0	330.2	359.6	390.8
289.56	25.8	53.5	83.3	114.1	145.0	177.0	208.7	240.7	271.0	302.4	333.9	363.9	395.3
289.86	26.1	54.1	84.1	115.2	146.4	178.7	211.0	243.2	273.8	305.5	337.5	368.1	399.8
290.17	26.3	54.7	85.0	116.4	148.1	180.7	213.2	245.8	276.9	308.9	341.2	372.1	404.4
290.47	26.6	55.2	85.8	117.8	149.5	182.4	215.5	248.3	279.8	312.3	344.9	376.0	408.6
290.78	26.9	55.8	86.6	118.9	150.9	184.3	217.5	250.9	282.6	315.4	348.6	380.0	413.1
291.08	27.2	56.4	87.5	120.1	152.3	186.0	219.7	253.4	285.4	318.8	352.3	384.0	417.4
291.39	27.5	56.9	88.3	121.2	154.0	188.0	222.0	256.0	288.3	322.0	355.7	387.9	421.6

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-3 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (m³/s)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	14	15	16	17	18	19	20	21	22	23	24	25	26
283.46	311.8	333.0	353.4	373.8	393.6	411.4	430.4	448.8	466.9	484.2	501.2	517.6	533.5
283.77	318.6	340.1	361.6	382.6	402.7	421.4	441.2	460.1	479.1	497.2	514.8	532.1	548.8
284.07	325.1	347.4	369.3	390.8	412.0	431.3	451.4	471.5	490.7	509.7	528.1	546.2	563.5
284.38	331.6	354.5	376.9	399.0	420.8	440.6	461.6	482.2	502.3	521.9	541.1	559.8	577.9
284.68	338.1	361.3	384.3	407.2	429.6	450.0	471.5	492.7	513.7	533.8	553.9	573.1	592.1
284.99	344.0	368.1	391.6	415.1	438.1	459.0	481.4	503.2	524.7	545.7	566.1	586.2	606.0
285.29	350.3	374.6	399.0	422.8	446.3	468.1	491.0	513.4	535.5	557.0	578.2	598.9	619.3
285.60	350.3	374.6	399.0	422.8	446.3	468.1	491.0	513.4	535.5	557.0	578.2	598.9	619.3
285.90	362.2	387.7	412.9	438.1	462.7	485.4	509.4	533.2	556.4	579.4	601.7	623.8	645.3
286.21	368.1	393.9	419.7	445.4	470.6	493.8	518.5	542.8	566.6	590.1	613.1	635.7	658.1
286.51	373.8	400.1	426.5	452.8	478.3	502.3	527.3	552.2	576.5	600.6	624.4	647.6	670.5
286.82	379.4	406.3	433.2	459.9	485.9	510.6	536.0	561.5	586.4	611.1	635.4	659.2	682.7
287.12	384.8	412.3	439.8	466.9	493.6	518.5	544.8	570.6	596.1	621.3	646.2	670.5	694.6
287.43	390.2	418.2	446.0	473.7	500.9	526.4	553.0	579.6	605.7	631.5	656.7	681.9	706.5
287.73	395.6	424.2	452.5	480.5	508.3	534.3	561.5	588.4	615.0	641.4	667.1	692.9	718.1
288.04	401.0	429.8	458.7	487.3	515.6	542.0	569.7	597.2	624.1	651.0	677.6	703.7	729.4
288.34	406.3	435.5	465.0	493.8	522.7	549.6	577.7	605.7	633.4	660.6	687.5	714.4	740.8
288.65	411.4	441.2	470.9	500.6	529.8	557.0	585.9	614.2	642.2	670.0	697.7	724.9	751.8
288.95	416.5	446.8	476.9	506.9	536.6	564.6	593.5	622.4	651.0	679.3	707.4	735.1	762.6
289.26	421.6	452.2	482.8	513.4	543.4	571.7	601.4	630.9	659.8	688.7	717.3	745.3	773.3
289.56	426.7	457.6	488.7	519.6	550.2	579.1	609.1	638.8	668.6	697.7	726.9	755.5	784.1
289.86	431.5	463.0	494.4	525.8	557.0	586.2	616.7	647.0	677.1	706.8	736.2	765.4	794.3
290.17	436.4	468.4	500.4	532.1	563.5	593.2	624.1	655.0	685.3	715.6	745.6	775.3	804.8
290.47	441.2	473.7	506.0	538.3	570.0	600.0	631.5	662.6	693.8	724.3	754.9	784.9	815.0
290.78	446.0	478.8	511.4	544.2	576.5	607.1	638.8	670.5	702.0	733.1	764.0	794.6	824.9
291.08	450.8	483.9	517.1	550.2	582.8	613.9	646.2	678.2	709.9	741.6	773.0	804.2	835.1
291.39	455.3	489.0	522.4	556.1	589.3	620.4	653.3	685.8	718.1	750.1	781.8	813.5	844.7

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-3 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (m³/s)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	27	28	29	30	31	32	33	34	35	36	37	38	39
283.46	548.8	563.2	577.4	590.7	603.4	615.3	626.7	637.1	647.0	655.8	664.0	671.4	677.6
283.77	564.9	580.2	595.2	609.4	623.3	636.3	648.5	660.1	671.1	681.0	690.4	699.1	706.8
284.07	580.5	596.9	612.5	627.8	642.2	656.4	669.7	682.2	694.3	705.4	715.8	725.8	734.5
284.38	595.8	612.8	629.5	645.6	660.9	675.9	690.1	703.7	716.7	728.9	740.5	751.5	761.4
284.68	610.5	628.4	645.9	662.9	679.0	694.9	709.9	724.6	738.5	751.8	764.3	776.4	787.5
284.99	625.0	643.6	662.0	679.6	696.6	713.3	729.4	744.7	759.7	773.9	787.5	800.5	812.7
285.29	639.1	658.6	677.6	696.0	713.9	731.4	748.1	764.6	780.1	795.4	809.9	823.7	837.0
285.60	639.1	658.6	677.6	696.0	713.9	731.4	748.1	764.6	780.1	795.4	809.9	823.7	837.0
285.90	666.6	687.5	707.9	727.7	747.3	766.0	784.7	802.5	819.8	836.8	853.2	868.8	884.1
286.21	679.9	701.4	722.4	743.0	763.1	783.0	802.2	820.9	839.0	856.6	873.9	890.3	906.4
286.51	692.9	715.3	736.8	758.0	779.0	799.4	819.2	838.7	857.7	876.1	894.0	911.5	928.5
286.82	705.9	728.6	751.0	772.8	794.3	815.5	836.2	856.3	875.8	895.1	914.1	932.2	949.7
287.12	718.4	741.9	764.8	787.5	809.6	831.4	852.6	873.6	894.0	913.8	933.3	952.3	970.7
287.43	730.9	754.6	778.4	801.6	824.3	846.7	868.8	890.3	911.5	932.2	952.3	972.1	991.4
287.73	743.0	767.7	791.7	815.5	839.0	862.0	884.6	907.0	928.8	950.0	971.0	991.4	1011.5
288.04	754.9	780.1	804.8	829.4	853.2	877.0	900.2	923.1	945.5	967.6	989.4	1010.3	1031.3
288.34	766.8	792.3	817.8	842.7	867.3	891.7	915.5	939.0	962.2	984.9	1007.2	1029.0	1050.6
288.65	778.4	804.5	830.5	856.0	881.2	906.1	930.8	954.8	978.6	1001.9	1024.8	1047.4	1069.5
288.95	789.8	816.7	843.0	869.0	895.1	920.3	945.5	970.1	994.8	1018.6	1042.3	1065.3	1088.2
289.26	801.1	828.3	855.5	882.1	908.4	934.5	960.2	985.4	1010.3	1035.0	1059.3	1083.1	1106.6
289.56	812.1	839.9	867.6	894.8	921.7	948.3	974.7	1000.4	1025.9	1051.1	1076.0	1100.4	1124.7
289.86	823.2	851.5	879.5	907.3	934.7	961.9	988.8	1015.2	1041.5	1067.3	1092.5	1117.7	1142.3
290.17	833.9	862.8	891.4	919.7	947.8	975.2	1002.7	1029.9	1056.5	1082.8	1108.9	1134.7	1159.9
290.47	844.7	873.9	903.0	931.9	960.5	988.5	1016.6	1044.0	1071.5	1098.4	1125.0	1151.1	1177.1
290.78	855.2	884.9	914.6	943.8	973.0	1001.6	1030.2	1058.2	1086.0	1113.7	1140.9	1167.5	1194.1
291.08	865.6	895.9	926.0	955.7	985.4	1014.6	1043.5	1072.1	1100.7	1128.7	1156.5	1183.6	1210.8
291.39	875.8	906.7	937.3	967.6	997.6	1027.3	1056.8	1086.0	1114.8	1143.4	1171.8	1199.8	1227.3

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-3 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (m³/s)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	40	41	42	43	44	45	46	47	48	49	50
283.46	683.0	687.5	690.6	692.9	694.0	694.0	692.6	689.8	685.6	679.9	672.2
283.77	713.6	719.2	724.3	728.3	731.1	732.8	733.4	732.8	730.9	727.5	722.6
284.07	742.8	750.1	756.3	761.7	766.3	769.7	771.9	773.3	773.3	772.2	769.7
284.38	770.8	779.6	787.2	794.0	800.0	804.8	808.7	811.8	813.5	814.4	813.8
284.68	798.0	807.9	816.7	824.9	832.2	838.5	843.8	848.4	852.1	854.3	855.7
284.99	824.3	835.1	845.3	854.6	863.1	871.0	877.8	883.8	888.6	892.8	895.7
285.29	849.8	861.7	873.0	883.5	893.1	902.2	910.4	917.5	924.0	929.6	934.2
285.60	849.8	861.7	873.0	883.5	893.1	902.2	910.4	917.5	924.0	929.6	934.2
285.90	898.5	912.4	925.7	938.4	950.3	961.6	972.1	981.7	990.8	999.0	1006.4
286.21	922.0	936.7	951.2	964.8	977.5	990.0	1001.6	1012.3	1022.5	1031.9	1040.6
286.51	944.7	960.5	975.8	990.2	1004.1	1017.4	1030.2	1042.1	1053.4	1063.9	1073.8
286.82	967.0	983.7	999.6	1015.2	1030.2	1044.3	1057.9	1070.9	1083.4	1095.0	1105.8
287.12	988.8	1006.4	1023.1	1039.5	1055.4	1070.7	1085.1	1099.0	1112.6	1125.0	1137.2
287.43	1010.1	1028.5	1046.0	1063.3	1080.0	1096.1	1111.7	1126.4	1140.9	1154.5	1167.5
287.73	1031.0	1050.0	1068.7	1086.5	1104.1	1121.1	1137.5	1153.3	1168.6	1183.1	1197.2
288.04	1051.4	1071.2	1090.5	1109.5	1127.6	1145.4	1162.7	1179.4	1195.5	1211.1	1226.1
288.34	1071.5	1092.2	1112.0	1131.8	1150.8	1169.5	1187.6	1205.2	1222.2	1238.6	1254.4
288.65	1091.3	1112.6	1133.2	1153.6	1173.5	1192.7	1211.7	1230.1	1247.9	1265.2	1281.9
288.95	1110.6	1132.4	1153.9	1175.1	1195.8	1215.9	1235.5	1254.7	1273.4	1291.5	1309.1
289.26	1129.6	1152.2	1174.3	1196.1	1217.6	1238.3	1258.7	1278.8	1298.0	1317.0	1335.4
289.56	1148.2	1171.5	1194.4	1217.1	1238.9	1260.7	1281.6	1302.3	1322.7	1342.2	1361.5
289.86	1166.7	1190.7	1214.2	1237.4	1260.1	1282.2	1304.3	1325.5	1346.5	1367.1	1387.0
290.17	1184.8	1209.4	1233.5	1257.3	1280.8	1303.7	1326.4	1348.4	1370.0	1391.2	1412.2
290.47	1202.6	1227.8	1252.7	1277.1	1301.2	1324.7	1347.9	1370.8	1393.2	1415.3	1436.8
290.78	1220.2	1245.9	1271.4	1296.6	1321.3	1345.6	1369.4	1392.9	1416.1	1438.8	1460.9
291.08	1237.4	1264.1	1290.1	1315.6	1341.1	1366.0	1390.4	1414.7	1438.5	1461.7	1484.7
291.39	1254.7	1281.6	1308.2	1334.6	1360.6	1386.1	1411.3	1435.9	1460.6	1484.4	1508.2

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-4 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (CFS)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	1	2	3	4	5	6	7	8	9	10	11	12	13
930	700	1450	2250	3070	3890	4720	5550	6370	7150	7950	8740	9480	10,250
931	710	1480	2290	3120	3960	4810	5660	6500	7290	8100	8920	9680	10,470
932	730	1500	2330	3180	4030	4900	5760	6620	7430	8260	9090	9870	10,680
933	740	1530	2370	3230	4090	4980	5860	6740	7560	8410	9260	10,060	10,890
934	750	1550	2400	3280	4160	5060	5960	6850	7690	8560	9430	10,250	11,090
935	760	1570	2440	3340	4230	5150	6060	6970	7820	8710	9590	10,430	11,290
936	770	1600	2480	3390	4290	5230	6150	7080	7950	8850	9750	10,610	11,490
937	770	1600	2480	3390	4290	5230	6150	7080	7950	8850	9750	10,610	11,490
938	790	1640	2550	3490	4420	5380	6340	7300	8200	9140	10,070	10,960	11,880
939	800	1660	2580	3530	4480	5460	6430	7410	8320	9270	10,220	11,130	12,060
940	810	1690	2620	3580	4550	5540	6530	7510	8450	9410	10,380	11,290	12,250
941	820	1710	2650	3630	4610	5610	6610	7620	8560	9540	10,530	11,460	12,430
942	830	1730	2690	3680	4670	5690	6700	7720	8680	9680	10,670	11,620	12,610
943	840	1750	2720	3720	4720	5760	6790	7820	8800	9810	10,820	11,780	12,780
944	850	1770	2750	3770	4780	5830	6880	7920	8910	9940	10,960	11,940	12,960
945	860	1790	2790	3810	4840	5900	6960	8020	9020	10,060	11,100	12,100	13,130
946	870	1810	2820	3860	4900	5970	7050	8120	9140	10,190	11,250	12,250	13,300
947	880	1830	2850	3900	4950	6040	7130	8210	9250	10,310	11,380	12,410	13,470
948	890	1850	2880	3950	5010	6110	7210	8310	9350	10,430	11,520	12,560	13,630
949	900	1870	2910	3990	5070	6180	7290	8400	9460	10,560	11,660	12,700	13,800
950	910	1890	2940	4030	5120	6250	7370	8500	9570	10,680	11,790	12,850	13,960
951	920	1910	2970	4070	5170	6310	7450	8590	9670	10,790	11,920	13,000	14,120
952	930	1930	3000	4110	5230	6380	7530	8680	9780	10,910	12,050	13,140	14,280
953	940	1950	3030	4160	5280	6440	7610	8770	9880	11,030	12,180	13,280	14,430
954	950	1970	3060	4200	5330	6510	7680	8860	9980	11,140	12,310	13,420	14,590
955	960	1990	3090	4240	5380	6570	7760	8950	10,080	11,260	12,440	13,560	14,740
956	970	2010	3120	4280	5440	6640	7840	9040	10,180	11,370	12,560	13,700	14,890

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-4 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (CFS)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	14	15	16	17	18	19	20	21	22	23	24	25	26
930	11,010	11,760	12,480	13,200	13,900	14,530	15,200	15,850	16,490	17,100	17,700	18,280	18,840
931	11,250	12,010	12,770	13,510	14,220	14,880	15,580	16,250	16,920	17,560	18,180	18,790	19,380
932	11,480	12,270	13,040	13,800	14,550	15,230	15,940	16,650	17,330	18,000	18,650	19,290	19,900
933	11,710	12,520	13,310	14,090	14,860	15,560	16,300	17,030	17,740	18,430	19,110	19,770	20,410
934	11,940	12,760	13,570	14,380	15,170	15,890	16,650	17,400	18,140	18,850	19,560	20,240	20,910
935	12,150	13,000	13,830	14,660	15,470	16,210	17,000	17,770	18,530	19,270	19,990	20,700	21,400
936	12,370	13,230	14,090	14,930	15,760	16,530	17,340	18,130	18,910	19,670	20,420	21,150	21,870
937	12,370	13,230	14,090	14,930	15,760	16,530	17,340	18,130	18,910	19,670	20,420	21,150	21,870
938	12,790	13,690	14,580	15,470	16,340	17,140	17,990	18,830	19,650	20,460	21,250	22,030	22,790
939	13,000	13,910	14,820	15,730	16,620	17,440	18,310	19,170	20,010	20,840	21,650	22,450	23,240
940	13,200	14,130	15,060	15,990	16,890	17,740	18,620	19,500	20,360	21,210	22,050	22,870	23,680
941	13,400	14,350	15,300	16,240	17,160	18,030	18,930	19,830	20,710	21,580	22,440	23,280	24,110
942	13,590	14,560	15,530	16,490	17,430	18,310	19,240	20,150	21,050	21,940	22,820	23,680	24,530
943	13,780	14,770	15,750	16,730	17,690	18,590	19,530	20,470	21,390	22,300	23,190	24,080	24,950
944	13,970	14,980	15,980	16,970	17,950	18,870	19,830	20,780	21,720	22,650	23,560	24,470	25,360
945	14,160	15,180	16,200	17,210	18,210	19,140	20,120	21,090	22,040	22,990	23,930	24,850	25,760
946	14,350	15,380	16,420	17,440	18,460	19,410	20,400	21,390	22,370	23,330	24,280	25,230	26,160
947	14,530	15,580	16,630	17,680	18,710	19,670	20,690	21,690	22,680	23,660	24,640	25,600	26,550
948	14,710	15,780	16,840	17,900	18,950	19,940	20,960	21,980	22,990	23,990	24,980	25,960	26,930
949	14,890	15,970	17,050	18,130	19,190	20,190	21,240	22,280	23,300	24,320	25,330	26,320	27,310
950	15,070	16,160	17,260	18,350	19,430	20,450	21,510	22,560	23,610	24,640	25,670	26,680	27,690
951	15,240	16,350	17,460	18,570	19,670	20,700	21,780	22,850	23,910	24,960	26,000	27,030	28,050
952	15,410	16,540	17,670	18,790	19,900	20,950	22,040	23,130	24,200	25,270	26,330	27,380	28,420
953	15,580	16,730	17,870	19,010	20,130	21,190	22,300	23,400	24,500	25,580	26,660	27,720	28,780
954	15,750	16,910	18,060	19,220	20,360	21,440	22,560	23,680	24,790	25,890	26,980	28,060	29,130
955	15,920	17,090	18,260	19,430	20,580	21,680	22,820	23,950	25,070	26,190	27,300	28,400	29,490
956	16,080	17,270	18,450	19,640	20,810	21,910	23,070	24,220	25,360	26,490	27,610	28,730	29,830

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-4 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (CFS)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	27	28	29	30	31	32	33	34	35	36	37	38	39
930	19,380	19,890	20,390	20,860	21,310	21,730	22,130	22,500	22,850	23,160	23,450	23,710	23,930
931	19,950	20,490	21,020	21,520	22,010	22,470	22,900	23,310	23,700	24,050	24,380	24,690	24,960
932	20,500	21,080	21,630	22,170	22,680	23,180	23,650	24,090	24,520	24,910	25,280	25,630	25,940
933	21,040	21,640	22,230	22,800	23,340	23,870	24,370	24,850	25,310	25,740	26,150	26,540	26,890
934	21,560	22,190	22,810	23,410	23,980	24,540	25,070	25,590	26,080	26,550	26,990	27,420	27,810
935	22,070	22,730	23,380	24,000	24,600	25,190	25,760	26,300	26,830	27,330	27,810	28,270	28,700
936	22,570	23,260	23,930	24,580	25,210	25,830	26,420	27,000	27,550	28,090	28,600	29,090	29,560
937	22,570	23,260	23,930	24,580	25,210	25,830	26,420	27,000	27,550	28,090	28,600	29,090	29,560
938	23,540	24,280	25,000	25,700	26,390	27,050	27,710	28,340	28,950	29,550	30,130	30,680	31,220
939	24,010	24,770	25,510	26,240	26,950	27,650	28,330	28,990	29,630	30,250	30,860	31,440	32,010
940	24,470	25,260	26,020	26,770	27,510	28,230	28,930	29,620	30,290	30,940	31,570	32,190	32,790
941	24,930	25,730	26,520	27,290	28,050	28,800	29,530	30,240	30,930	31,610	32,280	32,920	33,540
942	25,370	26,200	27,010	27,810	28,590	29,360	30,110	30,850	31,570	32,270	32,960	33,630	34,280
943	25,810	26,650	27,490	28,310	29,110	29,900	30,680	31,440	32,190	32,920	33,630	34,330	35,010
944	26,240	27,110	27,960	28,800	29,630	30,440	31,240	32,030	32,800	33,550	34,290	35,010	35,720
945	26,660	27,550	28,420	29,290	30,130	30,970	31,790	32,600	33,390	34,170	34,940	35,680	36,420
946	27,080	27,980	28,880	29,760	30,630	31,490	32,330	33,160	33,980	34,780	35,570	36,340	37,100
947	27,490	28,410	29,330	30,230	31,120	32,000	32,870	33,720	34,560	35,380	36,190	36,990	37,770
948	27,890	28,840	29,770	30,690	31,610	32,500	33,390	34,260	35,130	35,970	36,810	37,620	38,430
949	28,290	29,250	30,210	31,150	32,080	33,000	33,910	34,800	35,680	36,550	37,410	38,250	39,080
950	28,680	29,660	30,640	31,600	32,550	33,490	34,420	35,330	36,230	37,120	38,000	38,860	39,720
951	29,070	30,070	31,060	32,040	33,010	33,970	34,920	35,850	36,780	37,690	38,580	39,470	40,340
952	29,450	30,470	31,480	32,480	33,470	34,440	35,410	36,370	37,310	38,240	39,160	40,070	40,960
953	29,830	30,860	31,890	32,910	33,920	34,910	35,900	36,870	37,840	38,790	39,730	40,650	41,570
954	30,200	31,250	32,300	33,330	34,360	35,370	36,380	37,370	38,350	39,330	40,290	41,230	42,170
955	30,570	31,640	32,700	33,750	34,800	35,830	36,850	37,860	38,870	39,860	40,840	41,800	42,760
956	30,930	32,020	33,100	34,170	35,230	36,280	37,320	38,350	39,370	40,380	41,380	42,370	43,340

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

**TABLE 2-4 — SINGLE SPILLWAY BAY DISCHARGE CAPACITY (CFS)
(COLUMN #1 IS FOREBAY ELEVATION —ROW #1 IS GATE STOPS)**

Elev.	40	41	42	43	44	45	46	47	48	49	50
930	24,120	24,280	24,390	24,470	24,510	24,510	24,460	24,360	24,210	24,010	23,740
931	25,200	25,400	25,580	25,720	25,820	25,880	25,900	25,880	25,810	25,690	25,520
932	26,230	26,490	26,710	26,900	27,060	27,180	27,260	27,310	27,310	27,270	27,180
933	27,220	27,530	27,800	28,040	28,250	28,420	28,560	28,670	28,730	28,760	28,740
934	28,180	28,530	28,840	29,130	29,390	29,610	29,800	29,960	30,090	30,170	30,220
935	29,110	29,490	29,850	30,180	30,480	30,760	31,000	31,210	31,380	31,530	31,630
936	30,010	30,430	30,830	31,200	31,540	31,860	32,150	32,400	32,630	32,830	32,990
937	30,010	30,430	30,830	31,200	31,540	31,860	32,150	32,400	32,630	32,830	32,990
938	31,730	32,220	32,690	33,140	33,560	33,960	34,330	34,670	34,990	35,280	35,540
939	32,560	33,080	33,590	34,070	34,520	34,960	35,370	35,750	36,110	36,440	36,750
940	33,360	33,920	34,460	34,970	35,460	35,930	36,380	36,800	37,200	37,570	37,920
941	34,150	34,740	35,300	35,850	36,380	36,880	37,360	37,820	38,260	38,670	39,050
942	34,920	35,540	36,130	36,710	37,270	37,810	38,320	38,810	39,290	39,730	40,160
943	35,670	36,320	36,940	37,550	38,140	38,710	39,260	39,780	40,290	40,770	41,230
944	36,410	37,080	37,740	38,370	38,990	39,590	40,170	40,730	41,270	41,780	42,280
945	37,130	37,830	38,510	39,180	39,820	40,450	41,060	41,650	42,220	42,770	43,300
946	37,840	38,570	39,270	39,970	40,640	41,300	41,940	42,560	43,160	43,740	44,300
947	38,540	39,290	40,020	40,740	41,440	42,120	42,790	43,440	44,070	44,680	45,270
948	39,220	39,990	40,750	41,500	42,230	42,940	43,630	44,310	44,970	45,610	46,230
949	39,890	40,690	41,470	42,240	43,000	43,730	44,450	45,160	45,840	46,510	47,160
950	40,550	41,370	42,180	42,980	43,750	44,520	45,260	45,990	46,710	47,400	48,080
951	41,200	42,050	42,880	43,700	44,500	45,280	46,060	46,810	47,550	48,280	48,980
952	41,840	42,710	43,560	44,400	45,230	46,040	46,840	47,620	48,380	49,130	49,870
953	42,470	43,360	44,240	45,100	45,950	46,780	47,600	48,410	49,200	49,980	50,740
954	43,090	44,000	44,900	45,790	46,660	47,520	48,360	49,190	50,010	50,810	51,590
955	43,700	44,640	45,560	46,460	47,360	48,240	49,100	49,960	50,800	51,620	52,430
956	44,310	45,260	46,200	47,130	48,050	48,950	49,840	50,710	51,580	52,420	53,260

This table is provisional due to absence of “gate stop increments vs. net gate openings” above 18 stops. Upgrading of the spillway monitoring instrumentation to include new digital instrumentation has been initiated.

CHARTS

Number

2-1	Reservoir Area Capacity Curves.....*
8-1	Chief Joseph Dam Inflow Frequency Curves (Regulated and Unregulated).....*
8-3	Tailwater Rating Curves*

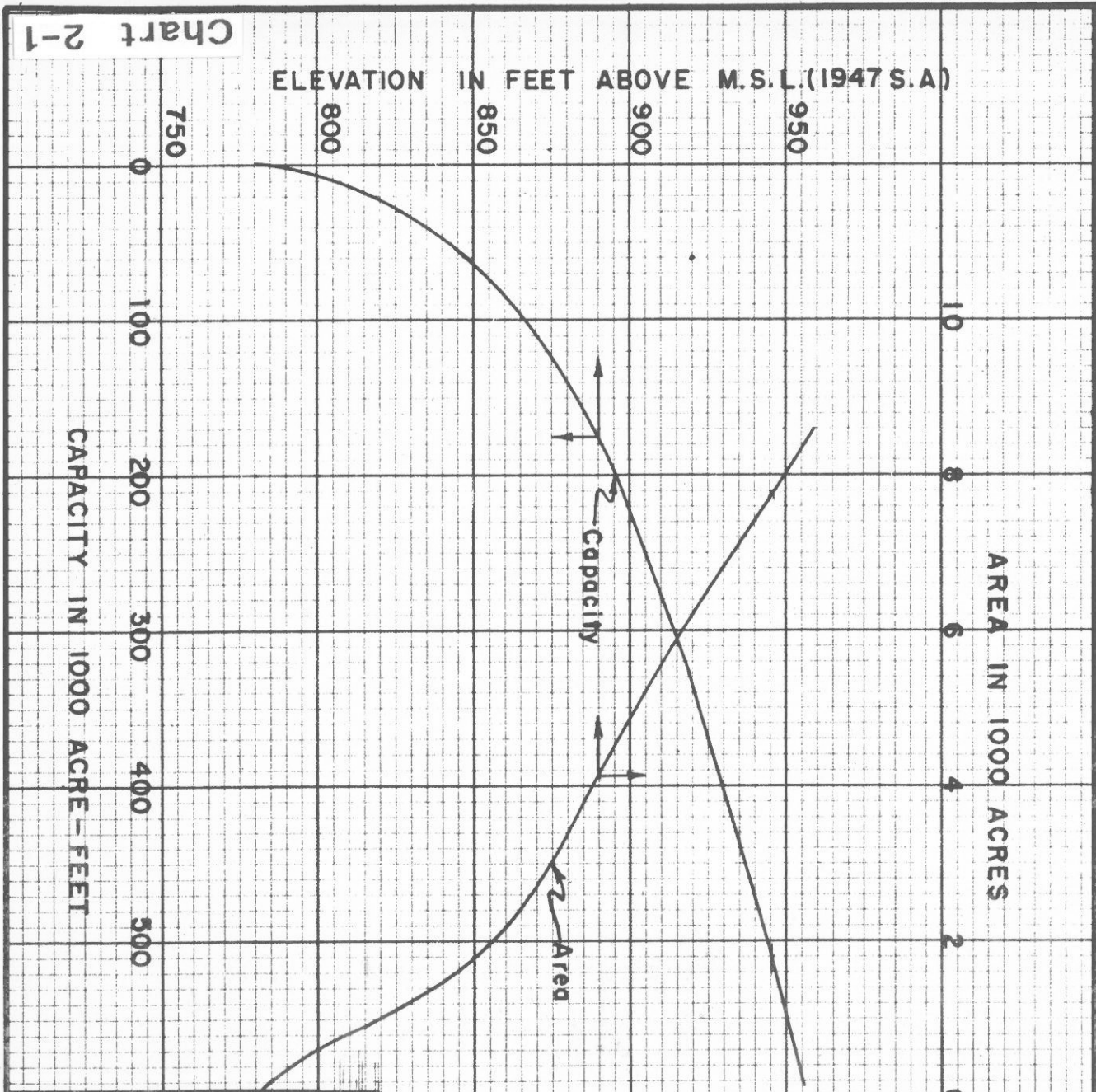


Chart 2-1

Note: These curves based on a level pool at all elevations.

(A-1)

NO.	ADDED NOTE	DATE	BY
1	ADDED		

COLUMBIA RIVER, WASHINGTON
CHIEF JOSEPH DAM
RESERVOIR
AREA - CAPACITY CURVE

Seattle District, Seattle, Wn. Oct. 1953

Drawn: N.H.D.
Traced: C.O.M.
Checked: K.T.C. File No. E-51-49-89

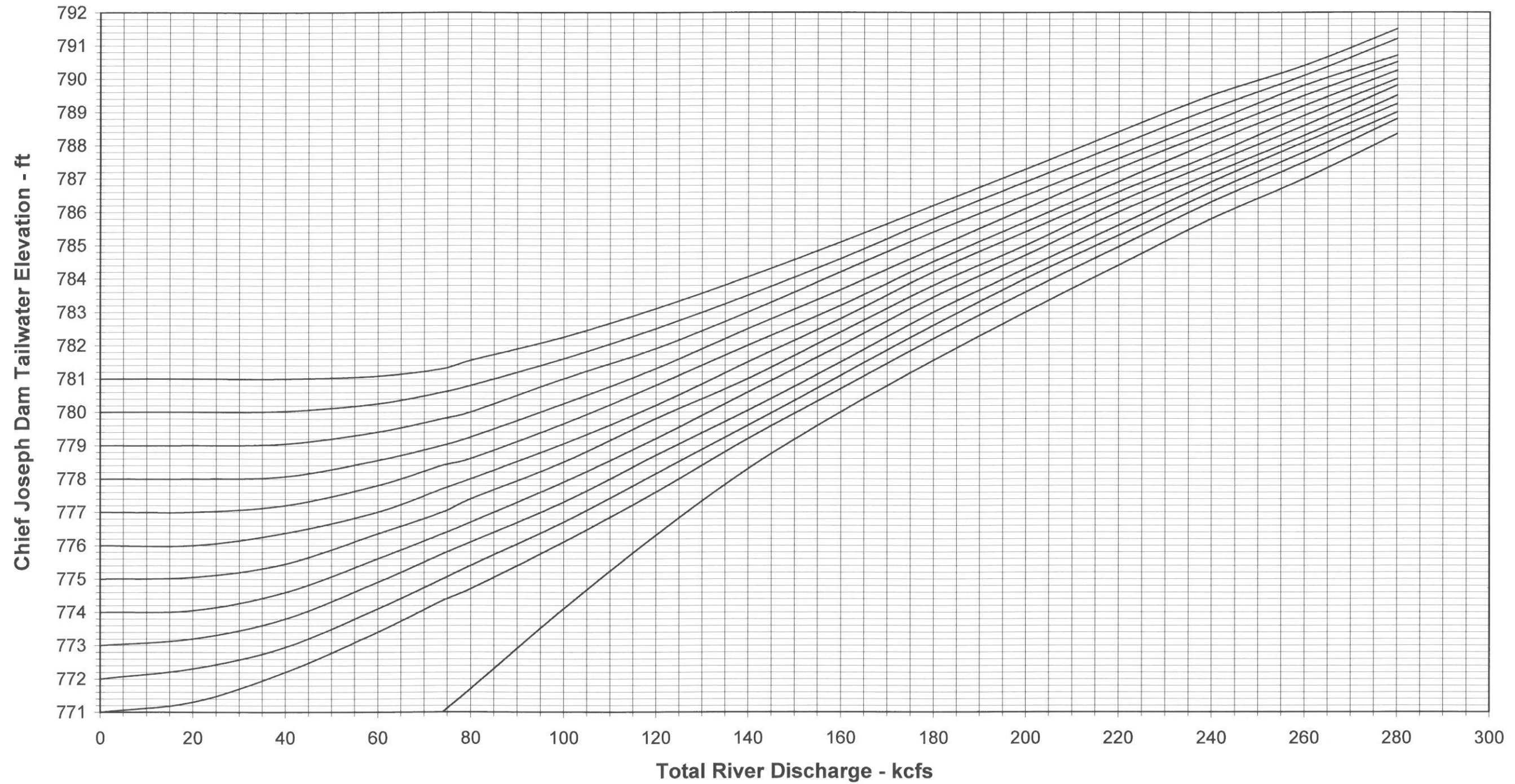
Chart 2-1

CHART 8-3 CHIEF JOSEPH Dam - TAILWATER RATING CURVES

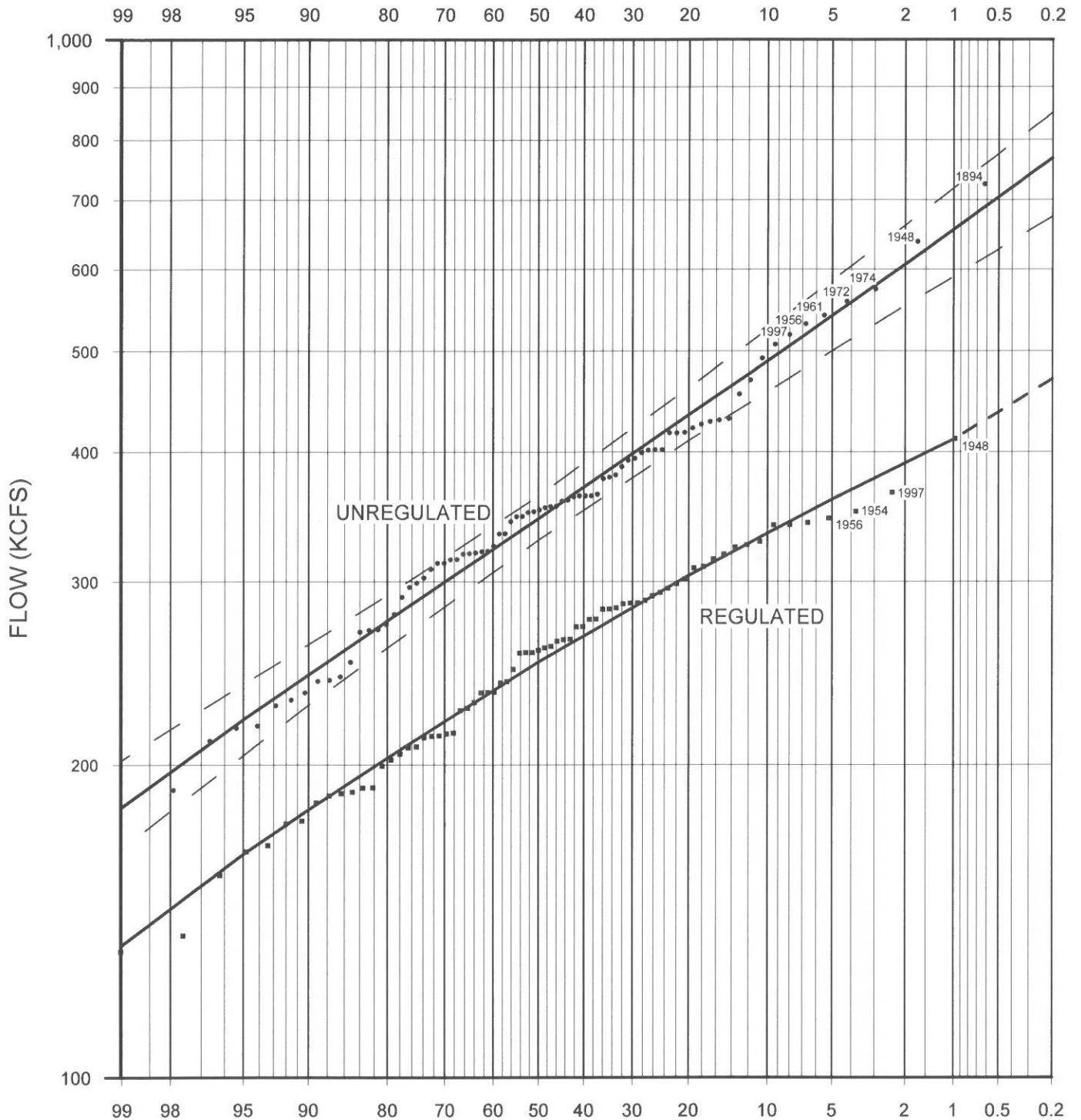
Tailwater Elevations at Zero Discharge Reflect Effect of
Wells Dam Encroachment (11 curves)

Based on a Combination of Observed Data and Modelling Values

Nov. 25, 1981 CENWS-EC-TB-WM



EXCEEDANCE FREQUENCY IN PERCENT



LEGEND

- UNREGULATED FLOW FREQUENCY (expected probability)
- 5% & 95% CONFIDENCE LIMITS
- REGULATED FLOW FREQUENCY (based on BA1F modeling)
- - - REGULATED FLOW FREQUENCY (based on SPF routing)

CHIEF JOSEPH DAM INFLOW FREQUENCY CURVES MAXIMUM ANNUAL DAILY DISCHARGE BASIN AREA = 75,400 SQ MI

1. UNREG. CURVE BASED ON UNREGULATED INFLOW TO GRAND COULEE (USACE COLUMBIA RIVER SSARR MODEL USED TO UNREGULATE FLOWS) AND USGS GAGE NO 12436500 WHERE OBSERVED FLOW EXCEEDS SSARR-UNREGULATED VALUE. WYS 1894, 1929-2006. LOG TRANSFORM FREQUENCY STATISTICS:

MEAN	2.5384	SKEW	0.0128
STANDARD DEV	0.1162	REGIONAL SKEW	-0.3700
		ADOPTED SKEW	0.0000

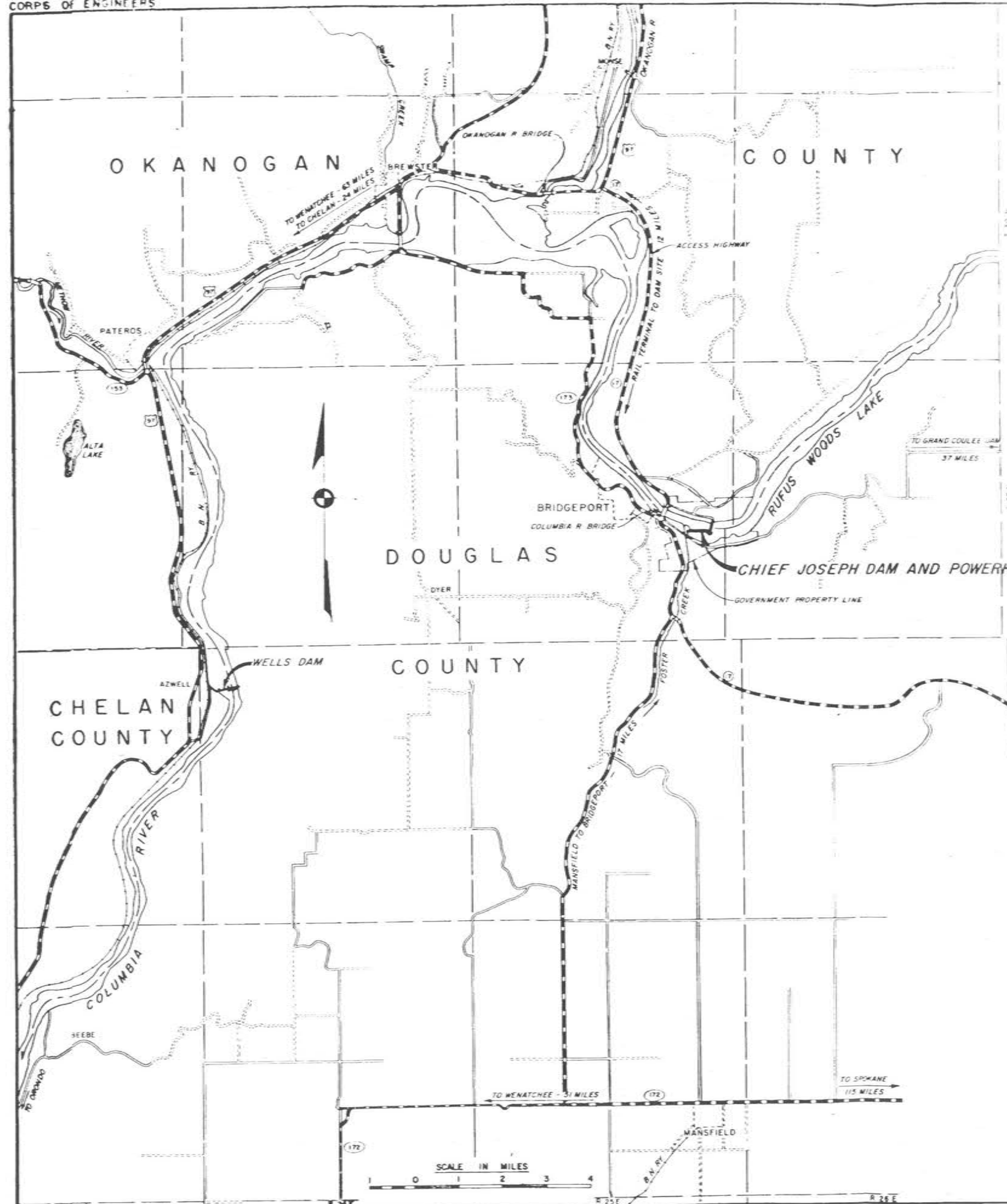
2. REG. CURVE BASED ON MODELED GRAND COULEE OUTFLOW (WY 1929-1999) FROM EIS SCENARIO BA1F. GRAPHICAL FREQUENCY ANALYSIS. BEYOND 1% CHANCE EXCEEDANCE EVENT, CURVE IS SHOWN AS DASHED LINE BECAUSE IT IS BASED ON SPF STUDIES PERFORMED BY NWD (DATED SEPT 1969). SPF MAGNITUDE IS 476 KCFS.

DATE: 27 NOVEMBER 2007
UNREG and REG by CJF

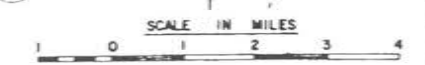
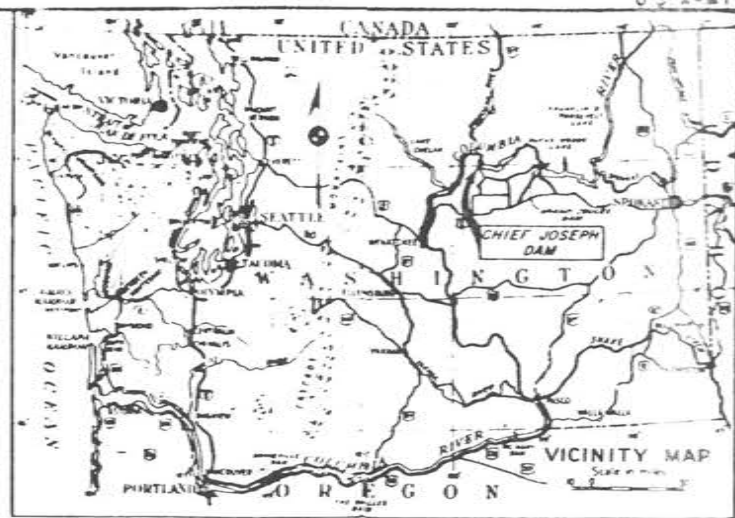
PLATES

NUMBER

- 2-1 Project Vicinity Map
- 2-2 Project Plan
- 2-3 Spillway and Non-Overflow Sections—Plans, Elevations, and Sections
- 2-4 Typical Deflector Sections
- 2-5 Intake and Closure Monoliths—General Plan
- 2-6 Non-Overflow Monoliths Plan—Elevations and Sections Mono. 35-44
- 2-7 Intake and Closure Monoliths Sections
- 2-8 One—Line Diagram for Chief Joseph Dam
- 2-9 Land Classification and Gauge Locations
- 2-10 Navigation hazards and Tree Density Map
- 4-1 Daily Discharge Hydrographs—Columbia River At Bridgeport, #12438000 (3 shts)
- 5-1 RAWS and METAR Stations
- 5-2 CENWD-PDW-HP WCDS NETWORK
- 5-3 Seattle District Water Control Data System—Data Collection
- 5-4 Sample Form—Hourly/Daily Data Collection



- LEGEND**
- +—+— BITUMINOUS SURFACE HIGHWAYS
 - IMPROVED ROADS
 - UNIMPROVED ROADS
 - - - - - TOWNSHIP AND RANGE LINES
 - RAILROADS
 - TOWNS
 - - - - - LIMIT OF GOVERNMENT PROPERTY
 - COUNTY LINES



U. S. ARMY ENGINEER DISTRICT, SEATTLE			
CORPS OF ENGINEERS			
SEATTLE, WASHINGTON			
STABILITY ANALYSIS			
VICINITY MAP			
COLUMBIA RIVER CHIEF JOSEPH DAM WASHINGTON			
DATE	DESIGNATION NO.	PLAT NO.	PLAT DATE
A	E-51-6-56	88 MAY	1
DRW. BY	CHK. BY	APP. BY	
	CH. ENGLAND		

REDACTED CONTENT

REDACTED CONTENT

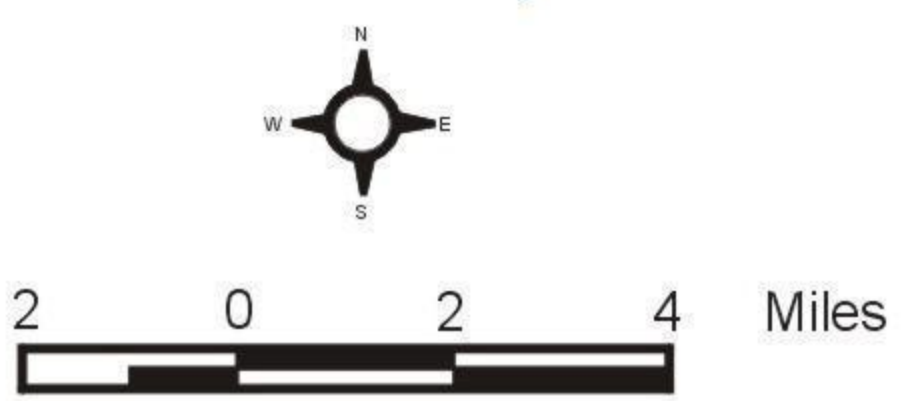
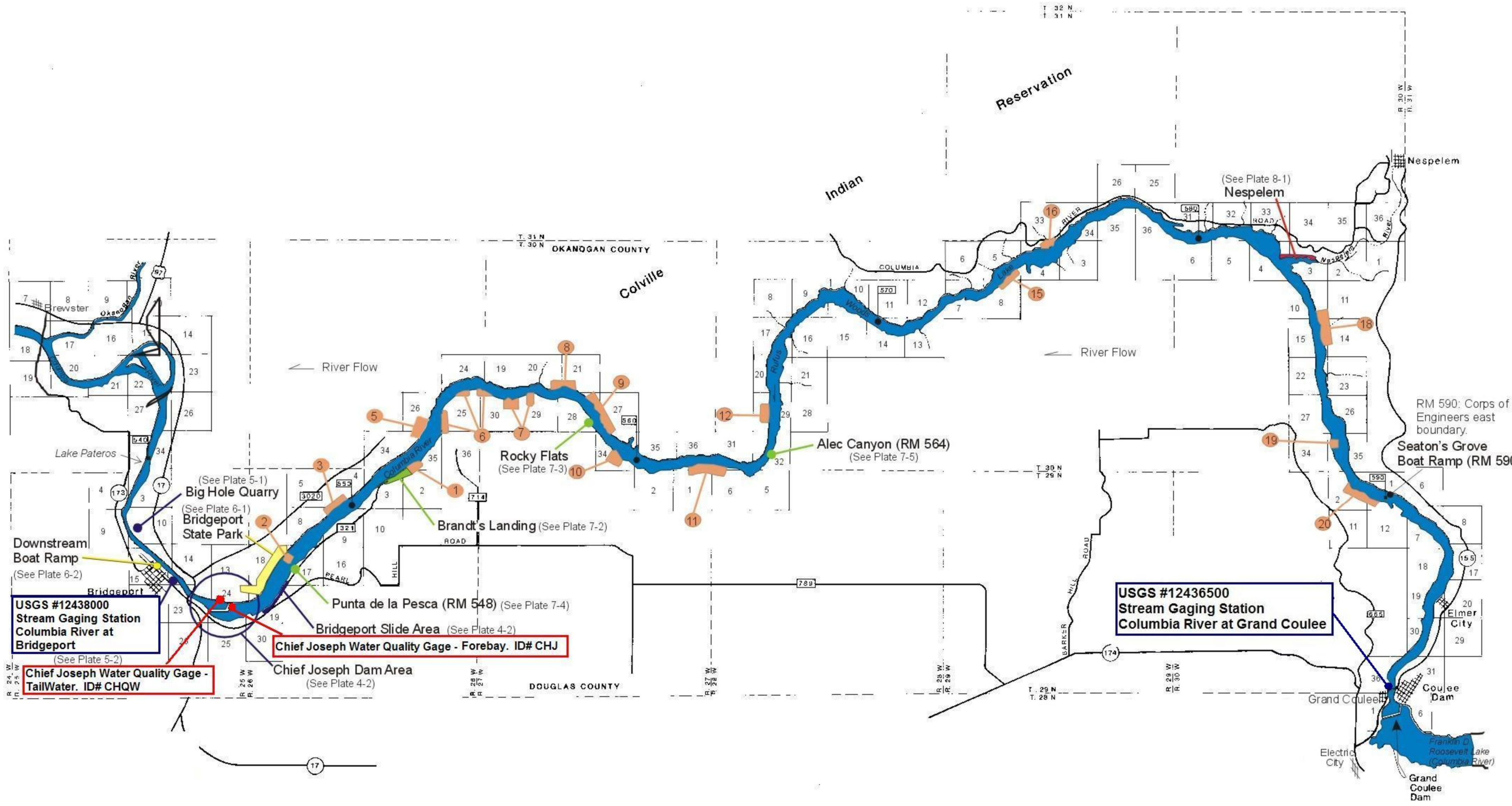
REDACTED CONTENT

REDACTED CONTENT

REDACTED CONTENT

REDACTED CONTENT

REDACTED CONTENT



- Project Operations
- Recreation
- Multiple Resource Management
- Mitigation (Wildlife Mitigation Sites)
- Environmentally Sensitive Areas
- Public Domain Lands (see Plate B-1)

Originally, this was Plate 4-1 from Design Memorandum 60, Chief Joseph Dam - Rufus Woods Lake, Project Master Plan, 2002, Land Classification.

Modified to add additional gage locations for Chief Joseph Dam Water Control Manual, 2009. Plate number changed to 2-9.

JLG 06/28/00

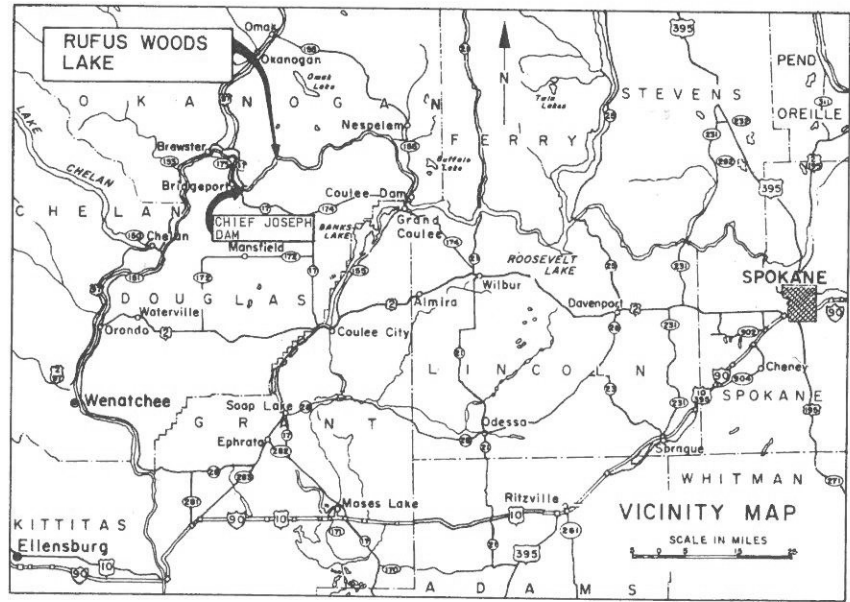
Chief Joseph Dam Master Plan LAND CLASSIFICATION and Gage Locations



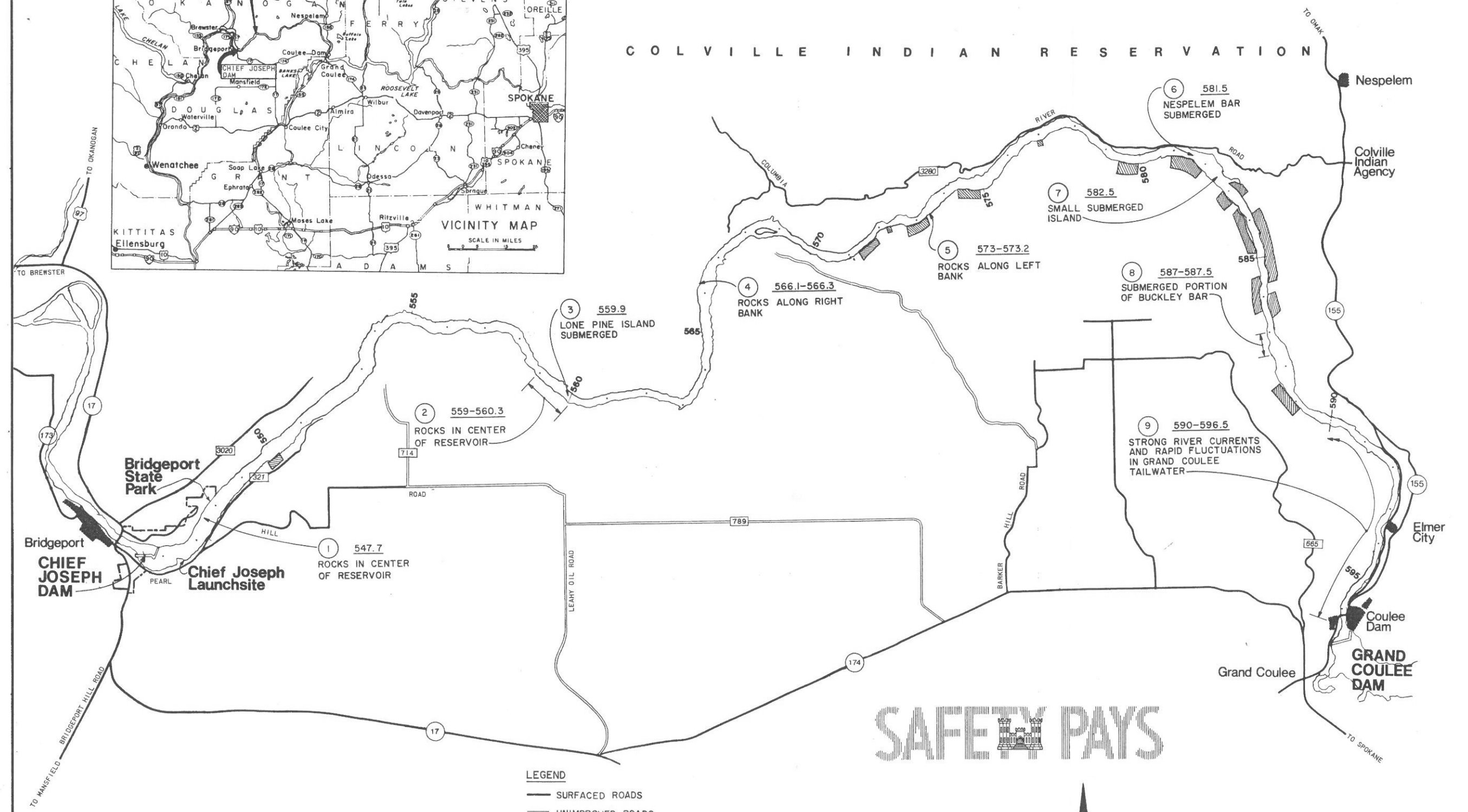
US Army Corps of Engineers®
Seattle District

Plate 2-9

REVISIONS				
SYMBOL	ZONE	DESCRIPTION	DATE	BY



COLVILLE INDIAN RESERVATION

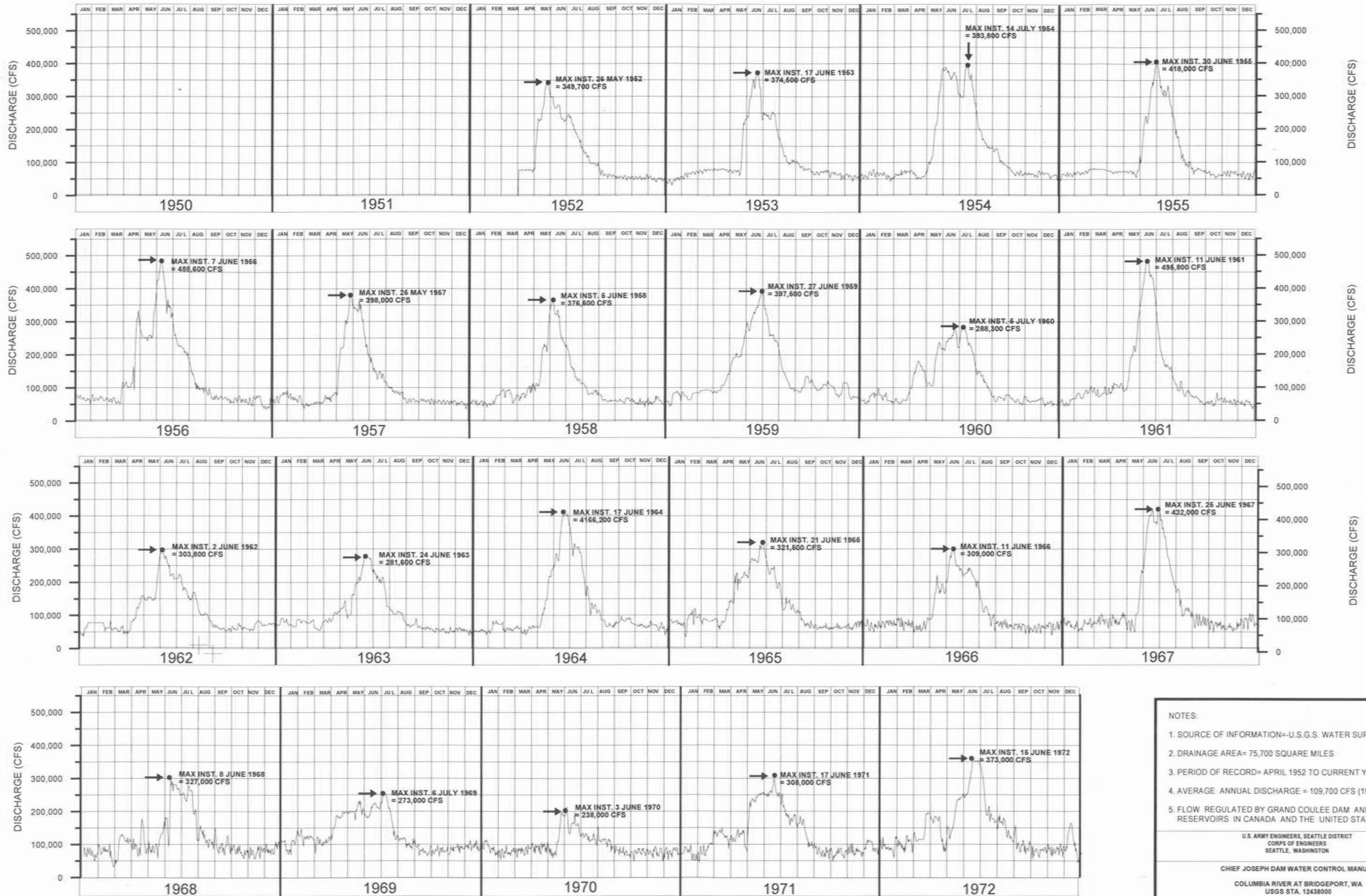


SAFETY PAYS

- LEGEND**
- SURFACED ROADS
 - == UNIMPROVED ROADS
 - - - LIMITS OF GOVERNMENT PROPERTY
 - 550 RIVER MILE DESIGNATION (MILES)
 - ▨ TREE CONCENTRATIONS
 - 559.9 NAVIGATION HAZARDS AT RIVER MILE
 - ①-⑨ MAJOR HAZARDS



U. S. ARMY ENGINEER DISTRICT, SEATTLE			
CORPS OF ENGINEERS			
SEATTLE, WASHINGTON			
RESERVOIR SWEEPING			
NAVIGATION HAZARDS AND TREE DENSITY MAP			
CHIEF JOSEPH DAM			
COLUMBIA RIVER		WASHINGTON	
SIZE	INVESTIGATION NO.	FILE NO.	DATE
F			79 MAY 22
DRN: CHINELLA	CHK: SOULE	SWEEP	PLATE
			1



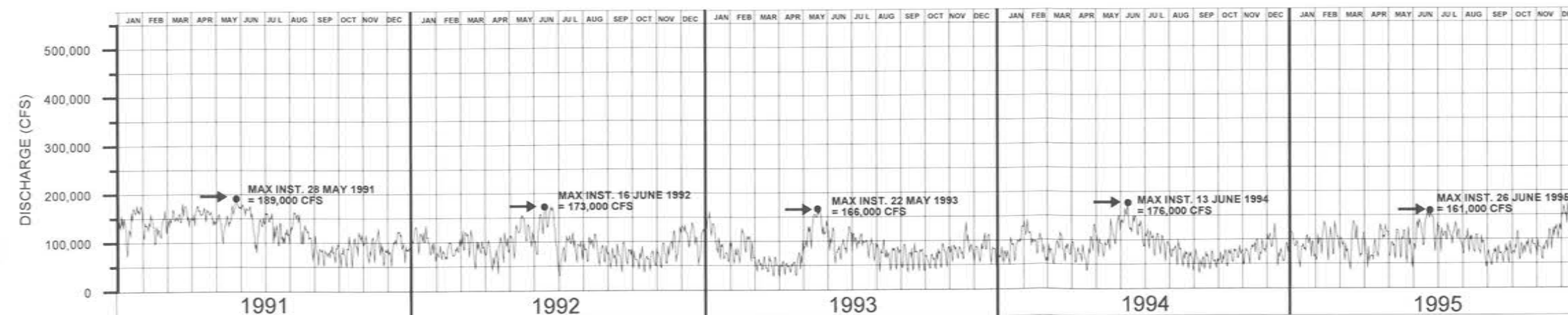
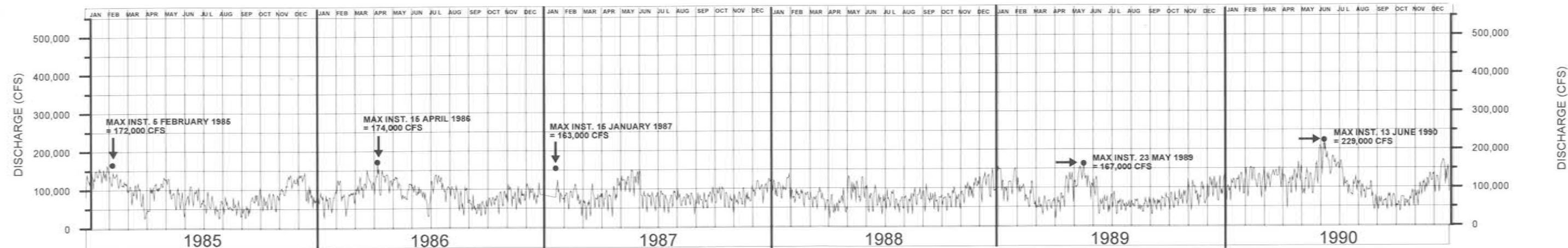
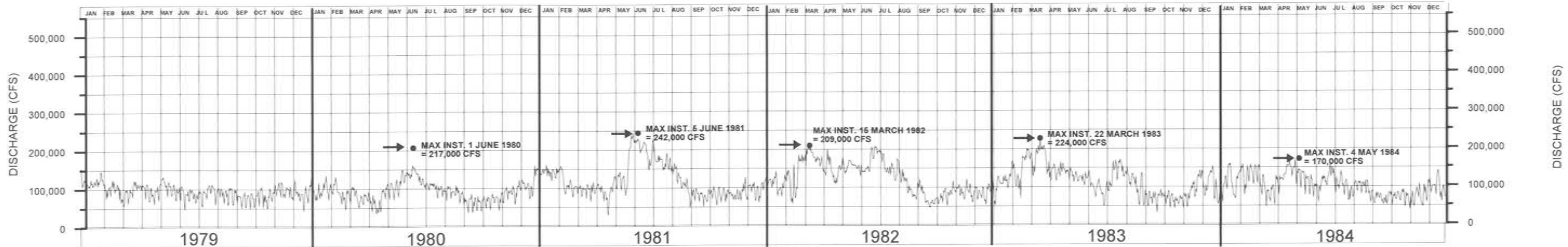
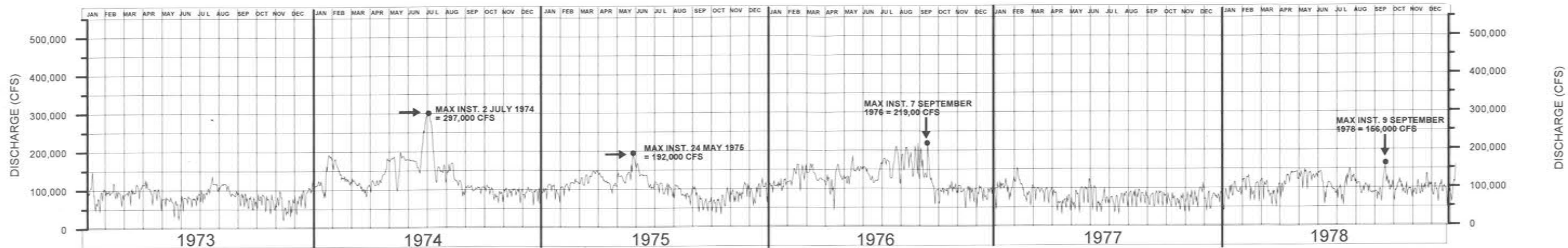
NOTES:

1. SOURCE OF INFORMATION=U.S.G.S. WATER SUPPLY PAPERS
2. DRAINAGE AREA= 75,700 SQUARE MILES
3. PERIOD OF RECORD= APRIL 1952 TO CURRENT YEAR
4. AVERAGE ANNUAL DISCHARGE = 109,700 CFS (1953-2003)
5. FLOW REGULATED BY GRAND COULEE DAM AND OTHER RESERVOIRS IN CANADA AND THE UNITED STATES.

U.S. ARMY ENGINEERS, SEATTLE DISTRICT
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

CHIEF JOSEPH DAM WATER CONTROL MANUAL
COLUMBIA RIVER AT BRIDGEPORT, WA
USGS STA. 12438000

DEVELOPED	CHECKED	DATE	SHEET
G. BARTLETT	R. BROWN	JAN 2005	1 OF 3

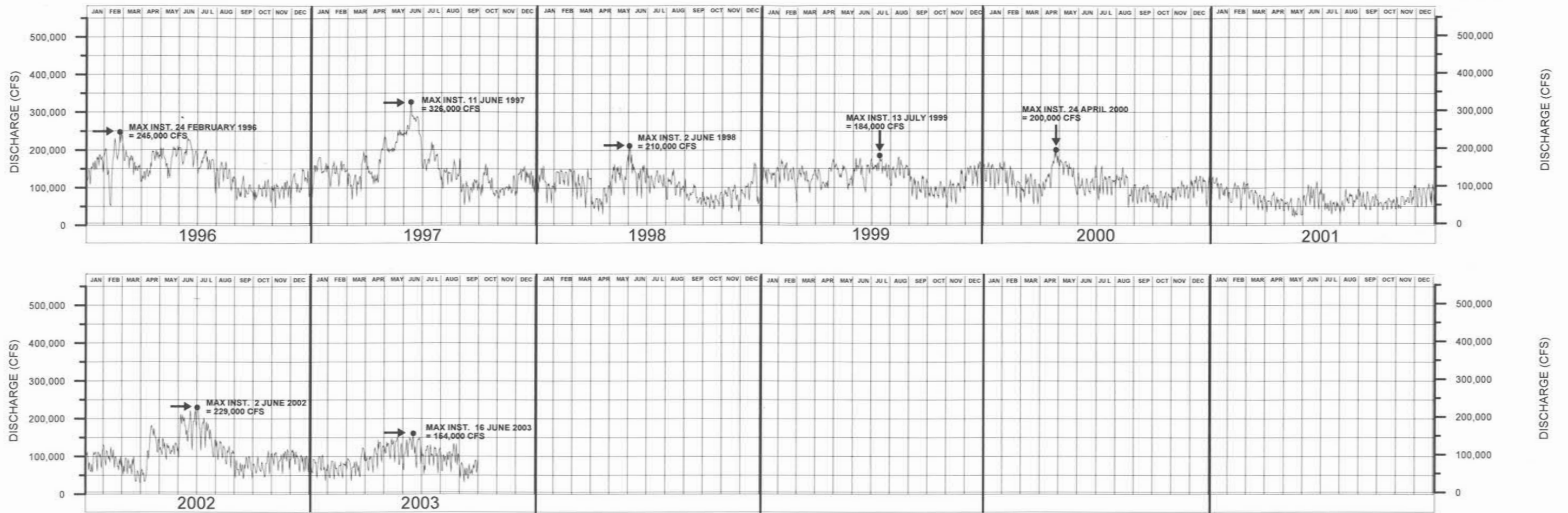


- NOTES:
1. SOURCE OF INFORMATION=U.S.G.S. WATER SUPPLY PAPERS
 2. DRAINAGE AREA= 75,700 SQUARE MILES
 3. PERIOD OF RECORD= APRIL 1952 TO CURRENT YEAR
 4. AVERAGE ANNUAL DISCHARGE = 109,700 CFS (1953-2003)
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USGS STA. 12438000

DEVELOPED	CHECKED	DATE	SHEET
G. BARTLETT	R. BROWN	JAN 2005	2 OF 3



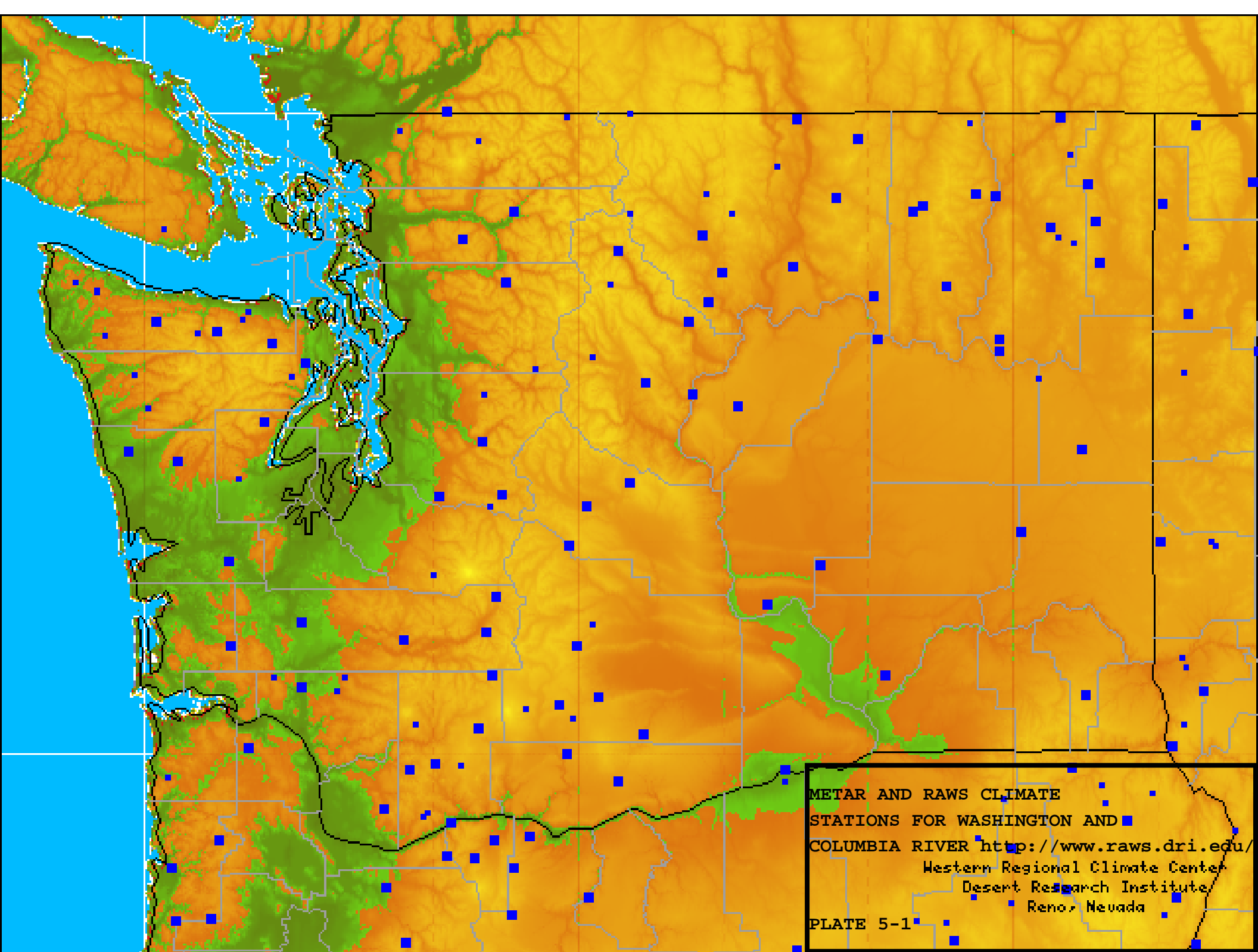
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1. SOURCE OF INFORMATION—U.S.G.S. WATER SUPPLY PAPERS
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U.S. ARMY ENGINEERS, SEATTLE DISTRICT
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

CHIEF JOSEPH DAM WATER CONTROL MANUAL
COLUMBIA RIVER AT BRIDGEPORT, WA
USGS STA. 12438000

DEVELOPED	CHECKED	DATE	SHEET
G. BARTLETT	R. BROWN	JAN 2005	3 OF 3



METAR AND RAWS CLIMATE
STATIONS FOR WASHINGTON AND
COLUMBIA RIVER <http://www.raws.dri.edu/>
Western Regional Climate Center
Desert Research Institute
Reno, Nevada
PLATE 5-1

REDACTED CONTENT

REDACTED CONTENT

CHIEF JOSEPH DAM - OPERATIONS

GENERATION AND HYDRAULIC DATA

DAY:

DATE:

HR	Generation (Mw)		River Flow (Kcfs)		Instantaneous Elevation		Spinning Reserve	MAIN UNITS #/ON/OFF	AVG FOREBAY	AVG TAILWATER	AVAL 1-16	Generation Capability 17-27	AVAL 17-27	Units not forced Out 1-16	Units not forced Out 17-27	S G Open	01	02	1 - 16	17 - 27	NET HOURLY	ACCUMULATED MW	HEAD	1-16 HRS	17-27 HRS	KCFS 1-16	KCFS 17-27	HR		
	Gross	S.S.	T D	Turbine	Spill	Forebay																							Tailwater	
24																													24	
01																														01
02																														02
03																														03
04																														04
05																														05
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23																														23
24																														24

DAILY WATER TOTALS

RIVER (KCFS)	TURBINE (KCFS)	SPILL (KCFS)	AVG. FOREBAY	AVG. TAILWATER
--------------	----------------	--------------	--------------	----------------

WEATHER

MX	MN	OB	PP
----	----	----	----

RIVER TEMP

--

STORAGE

PREVIOUS MIDNIGHT	KCFS ±
THIS MIDNIGHT	RIVER
ACRE FEET / 2000	INFLOW KCFS

DAILY GENERATION SUMMARY REPORT

CHJ D	DATE	GEN + S.S.	S.S.	INFLOW AVG.	AVG. RIVER FLOW	AVG. TURB. DISCH.	AVG. SPILL	MIDNIGHT FOREBAY	AVG. FOREBAY	AVG. TAILWATER	AVG HEAD
-------	------	------------	------	-------------	-----------------	-------------------	------------	------------------	--------------	----------------	----------

Hourly and daily generation and hydraulic data sample collection form CHJ Project.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION, CORPS OF ENGINEERS
P. O. Box 2870
Portland, Oregon 97208-2870

CENPD-EN-WM
Regulation
Number 1165-2-2

2 January 1990

Water Resource Policies and Authorities
WATER MANAGEMENT RESPONSIBILITIES

1. PURPOSE. This regulation pertains to the management of the Columbia River reservoir system through the regulation and operation of Corps of Engineers dams and those owned by other agencies. The purpose of this regulation is to clarify the organizational structure of and define specific responsibilities for the Division, districts, and project offices engaged in this activity. It also defines the Water Management Board and associated procedures for Division-district interface on water management activities.
2. APPLICABILITY. This regulation is applicable to Engineering and Operations elements in Headquarters North Pacific Division (HQNPD), and in Portland, Seattle, and Walla Walla Districts (including Planning Division in CENPW).
3. REQUIRED PUBLICATIONS.
 - a. ER 1110-2-240 (Water Control Management). Cited in paragraph 5a, 6b, 11b, 12 and 13.
 - b. ER 1110-2-241 (Use of Storage Allocated for Flood Control and Navigation at Non-Corps Projects). Cited in paragraph 5a.
 - c. ER 1110-2-249 (Management of Water Control Data Systems). Cited in paragraph 12a.
 - d. ER 1110-2-1400 (Reservoir Control Centers). Cited in paragraph 4.
 - e. EM 1110-2-3600 (Management of Water Control Systems). Cited in paragraph 5a.
 - f. Columbia River Master Water Control Manual. Cited in paragraph 5c.
 - g. CENPD Master Plan for Water Control Data Systems. Cited in paragraph 11.

*Supersedes NPDR 1165-2-2, 10 January 1967

4. BACKGROUND AND DEFINITIONS.

a. Water control management of dams and reservoirs in North Pacific Division (NPD) is the responsibility of both district and division offices. In the Columbia River basin, which encompasses three district jurisdictions, a need exists for centralized management of reservoir regulation activities, since the system of reservoirs requires unified coordination and operation. Accordingly, a system management organization, now the Water Management Branch, was established in 1968 in the HQNPD. The duties and responsibilities of the Branch, which includes a Reservoir Control Center, are defined by ER 1110-2-1400. District offices also remain involved with the Columbia basin reservoirs, but in a secondary capacity. In certain geographic areas that are independent from the Columbia River basin, however, district offices assume primary regulation responsibilities. Jurisdiction for district/division responsibilities for each major project within the NPD boundaries have been defined and are shown in Appendix A. Responsibilities have generally been assigned to the district office in which the project exists unless the project is connected electrically and/or hydraulically to the Columbia system.

b. Certain key terms used in this regulation are defined in Appendix B. Some of these terms are used very explicitly in defining the responsibilities covered by this regulation.

5. WATER MANAGEMENT POLICIES, GUIDANCE.

a. General Policies and Guidance. Corps of Engineers' projects will be regulated to conform with basic provisions in authorizing documents and water management policies and criteria. Corps of Engineers' policies with regard to water management are contained in ER 1110-2-240 and ER 1110-2-241. Technical guidance in carrying out reservoir regulation is contained in EM 1110-2-3600.

b. Project Regulation Guidance. Project water control plans have been developed to define and describe regulation procedures for each Corps project and for non-Corps projects for which the Corps has primary regulation responsibility. These are usually contained in the project water control manuals.

c. Policies and Guidance for System Management. The Master Water Control Manual for the Columbia River (reference 3f) contains policy and guidance for regulating the dams and reservoirs in the Columbia basin to fulfill integrated system objectives. Since the projects in the Columbia system are interrelated, regulation for individual projects must be coordinated with objectives for the system as a whole. Project obligations to meet system objectives are broadly defined in authorizing documents, with specific requirements contained in contractual agreements which are described in the CENPD Master Water Control Manual (reference 3f).

6. DIVISION OFFICE ORGANIZATION AND RESPONSIBILITIES.

a. Organization. The organizational chart for those elements in the HQNPD associated with water management is shown in Appendix C. Also shown are the other agencies with which coordination is required. Water management activities are carried out by the Water Management Branch in Engineering Division. The Branch is organized into three sections which carry out the various responsibilities relating to the water management mission described below. These are also summarized on the organizational chart.

b. Responsibilities. HQNPD is responsible for:

(1) Preparing the annual operating plan for the Columbia system in accordance with Pacific Northwest Coordination Contract and Columbia River Treaty, including performing system regulation studies and coordination as shown in Appendix A.

(2) Preparing the annual operating plan for the Willamette basin.

(3) Primary regulation of the Columbia reservoir system, including coordination with BPA, USBR, district offices, fishery agencies, electrical utilities, etc.; performing back-up analyses; and issuing instructions to projects. Also performing secondary regulation for other projects as necessary. See specified projects in Appendix A.

(4) Implementing the Columbia River Treaty in accordance with Treaty documents, through the Treaty Operating Committee and Hydrometeorological Committee, including performing required studies as well as daily regulation activities.

(5) Representing the Corps of Engineers on the Coordination Contract Committee and NWPP Operating Committee, for water management responsibilities.

(6) Developing, coordinating, planning and implementing the juvenile fish passage plan and water budget plan on the Columbia and Snake Rivers.

(7) Coordinating water supply forecasts with NWRFC, BPA and other agencies, overseeing forecast integrity, and preparing forecasting procedures for projects listed in Appendix A.

(8) Performing system flood control, power, water quality, and conservation storage studies to improve regulation procedures or analyze problem areas for projects for which water control plan responsibilities exist.

(9) Maintaining and implementing the CROHMS System, including the central computer facility hardware and software (in conjunction with CENPD-IM). Includes maintenance of communications facilities such as the CBT

network and the GOES system; coordination of remote stations; and the processing of real-time data.

(10) Performing public information/involvement activities in accordance with annual plans.

(11) Participating in activities associated with the Water Management Board.

(12) Assuming necessary dam safety responsibilities relating to reservoir regulation and flood warning and notification, including conducting and participating in emergency action plan exercises.

(13) Preparing and maintaining master water control manuals for the Columbia and Willamette River basins and portions of other water control manuals for projects designated in Appendix A.

(14) Implementing water quality programs required for mainstem Columbia and Snake River projects.

(15) Preparing the Columbia River Treaty and Columbia River Water Management Group Annual Reports, and special after-action reports such as post-flood reports, as defined in Appendix A.

(16) Performing oversight and approval of district Water Control Data System (WCDS) development as required by ER 1110-2-240.

(17) Performing oversight and approval of District water control plans and manuals as required by ER 1110-2-240.

(18) Performing oversight of district reservoir regulation activities.

7. DISTRICT OFFICE ORGANIZATION AND RESPONSIBILITIES.

a. Organization. Appendix C contains separate organizational charts for those parts of the organizations associated with water management. This activity resides as a section within the Districts' Hydrology and Hydraulics branches.

b. Jurisdiction. Projects and responsibilities that fall within the jurisdiction of each District Office are shown in Appendix A.

c. Responsibilities. District Offices will be responsible for:

(1) Maintaining and updating as necessary the water control plan for projects shown in Appendix A, including making studies and coordinating with other agencies as appropriate.

(2) Primary and secondary regulation of those projects specified in Appendix A, including the necessary coordination and back-up analyses.

(3) Preparing and updating water control manuals or projects specified in Appendix A.

(4) Performing flood control and conservation storage studies to improve regulation procedures or analyze problem areas for projects for which water control plan responsibility exists (Appendix A).

(5) Operating and maintaining designated Water Control Data Systems, including data controllers and remote stations.

(6) Developing and implementing water supply and streamflow forecasting procedures for those projects listed in Appendix A.

(7) Preparing special after-action reports such as post-flood reports for projects shown in Appendix A.

(8) Participating in activities associated with the Water Management Board.

(9) Assuming necessary dam safety responsibilities.

(10) Performing public information activities in accordance with annual plans.

(11) Conducting and participating in emergency action plan exercises.

(12) Water quality studies and activities for tributary and coastal streams.

(13) Collecting snow cover data from aerial flights and satellite imagery for use in spring flood forecasting (CENPS and CENPW).

8. PROJECT OFFICE ORGANIZATION AND RESPONSIBILITIES.

a. Organization and Coordination. Project offices are within the purview of CENPD Construction-Operations Division, with Operations organizations in district offices providing oversight to project engineers and staff. Interface with water management personnel in district or division offices occurs in the project regulation process. In routine regulation situations this is normally accomplished by direct contact between district or division reservoir regulation personnel and project personnel. In unusual situations, district or division managers may be brought into the communication line. For Columbia Basin projects, the NPD Reservoir Control Center communicates directly with project personnel, unless otherwise agreed or if special circumstances arise that would be of significance to the District (e.g., regulation that would be sensitive to local communities, or a change in operating plans).

b. Responsibilities. Project offices will be responsible for the following actions, with regard to water management.

(1) Carrying out instructions from Division/District water control managers.

(2) Reporting project status and hydromet data as required.

(3) Coordinating with water control managers regarding O&M activities that will affect project regulation.

(4) Carrying out responsibilities with regard to dam safety.

(5) Carrying out public information activities with regard to project regulation.

9. WATER MANAGEMENT BOARD. The Water Management Board is composed of district (excluding CENPA) and HQNPD representatives who consult with the Chief, CENPD-EN, on water management of the Columbia River reservoir system by CENPD-EN-WM. The purpose of the Board is to provide consultation on this Division-wide activity, to assist in resolving differences between division and district offices on setting policy, and to keep district offices better informed on the management of the Columbia River. The Board is an independent consultative body, reporting to the Chief, CENPD-EN and assisting him by presenting a perspective on the management of the Columbia River that reflects points of view of district offices and CENPD-CO. The Board receives overall direction from the Chief, CENPD-EN.

a. Composition. The HQNPD will be represented by the Chief, CENPD-EN and by the Chief, CENPD-CO-O or their representatives. Each District Office will be represented by the District Commander or his representative. These will be designated in writing to the Chief, CENPD-EN. Each office may have additional supporting staff to assist in the Board's activities, but there will be only one official spokesperson for each of the five organizations represented.

b. Board Chair. The Board meetings will be chaired by the Chief, CENPD-EN.

c. Meetings. The Board will have a formal meeting at least once a year, generally in the month of January or February. This time-frame is desirable because it provides the best opportunity to address matters pertaining to the current operational outlook, the development of the next year's Operating Plan, and the O&M budget submittal. Additional meetings may be requested by Board members and set by the Chief, CENPD-EN.

d. Responsibilities. The Board will address both routine items as listed below, and special issue topics requested by Board members or by Chief, CENPD-EN. Routine items are to include:

(1) The Corps' input to the Annual Operating Plan prepared by the Pacific Northwest Coordination Agreement Contract Committee.

(2) Requests for changes by board members to the current year's operating plan and actual system regulation, as driven by current water supply forecasts and operating requirements.

(3) The annual public information program.

(4) Water Management Branch's staffing expenditures, and budget, including staffing, budget, and expenditures for operating and maintaining the NPD CROHMS computer facility.

(5) CENPD-EN-WM (and other participants as appropriate) will prepare the necessary information to address agenda topics. Technical information will be distributed to Board members at least one week prior to the meeting.

e. Procedures. Prior to the scheduled Board meeting, the following will be implemented. For special Board meetings, similar procedures will be followed as appropriate.

(1) Chief, CENPD-EN will set the date of the meeting.

(2) Chief, CENPD-EN will solicit issue papers from Board members, which will be considered as agenda topics for the meeting. Additionally, the Chief, CENPD-EN will circulate to Board members his desires for agenda topics. The meeting agenda will be set by the Chief, CENPD-EN at least one month prior to the meeting/date.

(3) CENPD-EN-WM will provide an update of financial, budgetary, and staffing information to Board members at least two weeks prior to the meeting date.

(4) CENPD-EN-WM will provide the annual power operating plan and summary of the supporting refill study data for the current operating year two months before the meeting.

(5) CENPD-EN-WM (and other participants as appropriate) will prepare the necessary information to address agenda topics. Technical information will be distributed to Board members at least one week prior to the meeting.

f. Documentation. Minutes of Board meetings, along with any formal correspondence relating to the Board, will constitute the record of the Board's activities

and actions. HQNPD will be responsible for recording, preparing, and distributing the minutes of the Board's meetings.

g. Resolution of Issues. Where there are unresolved issues, the Chief, CENPD-EN will submit a copy of the minutes along with his plan to address these issues to the Division Commander and the Board members.

10. PUBLIC INFORMATION. A reservoir regulation outlook will be developed by CENPD-EN-WM each year in January, reflecting Corps of Engineers obligations to the system, the first water supply forecasts for runoff in the northwest, projected reservoir regulation, and other factors. The reservoir regulation outlook is to address in particular the potential impacts of reservoir regulation on local users of the projects, such as reservoir and downstream river users. This outlook will be reviewed by the Water Management Board at its January/February meeting and a plan will be established with agreed-upon procedures for informing and involving the public regarding the regulation of reservoirs for the forthcoming winter-spring-summer period. In years having especially low or high runoff, or if other circumstances are expected to result in unusual project regulation, the board may recommend special public meetings. Otherwise routine procedures to inform the public would suffice. The Districts have the lead responsibility for public information, including gathering input from the public disseminating information, and organizing public meetings. Technical assistance will be provided by CENPD-EN-WM as necessary.

11. WATER CONTROL PLANS AND MANUALS.

a. Responsibilities. District offices have the responsibility for preparing and maintaining project water control plans and manuals, and HQNPD is responsible for reviewing and approving those manuals. In the case of several projects on the mainstem of the Columbia River which involve extensive system-wide coordination, HQNPD will also be involved in the preparation and maintenance of the plans and manuals. Appendix A indicates the Division/District responsibilities by project. HQNPD will also be responsible for preparing and maintaining two master water control manuals, for the Willamette and Columbia River basins.

b. Requirements. The following requirements and procedures apply to project water control manuals, with the objective of maintaining the most important parts of the manuals (including the water control plan) in an accurate and up-to-date status while utilizing a minimum of personnel resources.

(1) The water control plan for the project is to be current and accurate.

(2) The water control manual will be considered functional and officially acceptable if it contains at least an up-to-date plan. Preferably, it would also contain other chapters that are of a technical nature. It need not contain other chapters with general information to be a functional manual.

(3) Water control manuals will be updated such that the more important parts are given a higher priority.

(4) The manual will be contained in a loose-leaf binder with cover sheets at the front that indicate status of the chapters in the manual.

(5) District offices will prepare their annual status report to HQNPD in accordance with ER 1110-2-240. A division-wide report will be submitted to HQUSACE.

12. WATER CONTROL DATA SYSTEMS.

a. Responsibilities. General responsibilities as defined in ER 1110-2-240 and ER 1110-2-249 are for district offices to develop and maintain Water Control Data Systems, while HQNPD maintains approval authority for systems and networks through the submittal of the Master Plan for Water Control Data Systems and its annual updates. Because of the necessity of having a centralized data collection and processing system for the management of the Columbia River, the HQNPD has developed the Columbia River Operational Hydromet and Management System (CROHMS) in conjunction with district offices and other federal agencies. The maintenance of CROHMS, along with the Columbia Basin Telecommunications (CBT) system requires that the Division be involved with data collection at some projects. Appendix A defines specific areas of responsibility for each project.

b. Requirements and Procedures. ER 1110-2-240 gives specific requirements for submittal and updating of district and Division WCDS mater plans.

13. AFTER-ACTION REPORTING.

a. Routine Reports. ER 1110-2-240 requires that a Division report on water management activities be submitted to HQUSACE annually. For NPD, HQUSACE has permitted the Columbia River Water Management Group Annual Report to fulfill this requirement. This report is prepared by HQNPD at the end of each water year, with input requested from district offices. Another routine water management report prepared by HQNPD that may require district input is the Columbia River Treaty Annual Report.

b. Special after-action reports. After the occurrence of large floods and other unusual events such as natural disasters, an after-action report may be required. General guidance on responsibilities for these are shown in Appendix A.

FOR THE COMMANDER:

/s/

CLIFTON P. JACKSON, JR.
Executive Assistant

3 Appendices

App A - District/Division Water Management Responsibilities

App B - Definitions and Acronyms

App C - Division/District Organizations for Water Management

Distribution:

A and B

EXHIBITS

Number

- 1-1 NPDR 1165-2-2, subject “Water Resource Policies and Authorities, WATER MANAGEMENT RESPONSIBILITIES,” dated 2 January 1990
- 1-2 Glossary
- 1-3 Metric Conversion Table
- 1-4 Previously Issued Design Memoranda
- 3-1 Grand Coulee Operating Order No. 152, Tailbay Restrictions
- 9-1 Technical Management Team (TMT)
- 9-2 Mid-Columbia Hourly Coordination (Implementation Manual Introduction)
- 9-3 Power Loss from Wells Project Encroachment on Chief Joseph Dam–Agreement
- 9-4 Supplement to Power Loss Agreement from Wells Project Encroachment

**CHIEF JOSEPH DAM
GLOSSARY
ABBREVIATIONS & ACRONYMS**

INCH-POUND (IP) UNITS

AF	acre foot
KAF.....	one thousand acre feet
MAF.....	one million acre feet
cfs.....	cubic foot per second
El.....	elevation
ft.....	foot
in.....	inch
IP.....	inch-pound unit of measurement
mi.....	mile
mi ²	square mile
RM.....	river mile

INTERNATIONAL SYSTEM (SI) METRIC UNITS

(See Exhibit 1-1 for conversion factors)

cm.....	centimeter
ha.....	hectare
ha-m.....	hectare meter
km.....	kilometer
km ²	square kilometer
m.....	meter
m ³ /s.....	cubic meter per second
RK.....	river kilometer
SI.....	international unit of measurement

POWERHOUSE ELECTRICAL-MECHANICAL TERMS

hp.....	horsepower
kV.....	kilovolt
kVA.....	kilo volt amp
kW.....	kilowatt
kWh.....	kilowatt hour
mWh.....	megawatt hour
MW.....	megawatts
pf.....	power factor
rpm.....	revolution per minute
V.....	volt

GENERAL

AFOS	Automation of Field Operation and Services System
AOP.....	Annual Operating Plan
ARC.....	Assured Refill Curve
BiOp	Biological Opinion

**CHIEF JOSEPH DAM
GLOSSARY
ABBREVIATIONS & ACRONYMS**

CBT.....	Columbia Basin Teletype System
CFDC.....	Central Facility Data Controller
CRC.....	Critical Rule Curve
CROHMS.....	Columbia River Operational Hydromet Management System
DCP.....	Data Collection Platform
DCP.....	Drought Contingency Plan
DO.....	Dissolved Oxygen
DRS.....	Data Retrieval System
ECC.....	Energy Content Curve
EIS.....	Environmental Impact Statement
EM.....	Engineering Manual
ER.....	Engineering Regulation
ESA.....	Endangered Species Act
EPP.....	Emergency Preparation Plan
ESP.....	Ensemble Streamflow Prediction
ETL.....	Engineering Technical Letter
FELCC.....	Firm Energy Load Carrying Capability
FM.....	Radio Term–Frequency Modulated
GOES.....	Geo-Stationary Operational Environmental Satellite System
GDACS.....	Generic Data Acquisition and Control System
HMR.....	Hydrometeorological Report
HYDSIM.....	Hydro Simulation–computer program
HYSSR.....	Hydro System Seasonal Regulation–computer program
IP.....	Inch-Pound Units
HHZ.....	Radio Term–one million cycles per second
MCHC.....	Mid-Columbia Hourly Coordination
NEPA.....	National Environmental Policy Act
NFP.....	Normal Full Pool
NWPCC.....	Northwest Power & Conservation Council
NWSRFS.....	National Weather Service River Forecast System
ORC.....	Operating Rule Curve
PDS.....	Power Data Submittal
PL.....	Public Law
PMF.....	Probable Maximum Flood
QPF.....	Quantitative Precipitation Forecast
RK.....	River Kilometer
RM.....	River Mile
RPA.....	Reasonable and Prudent Alternative
SDF.....	Spillway Design Flood
SI.....	International System (metric) Units
SNOTEL.....	Snowpack Telemetry
SOP.....	Standard Operating Procedure
SPF.....	Standard Project Flood
SRD.....	Storage Reservation Diagram

CHIEF JOSEPH DAM
GLOSSARY
ABBREVIATIONS & ACRONYMS

SSARR.....	Streamflow Synthesis and Reservoir Regulation–Computer Program
TDG	Total Dissolved Gas
UPA.....	Updated Proposed Action
URC	Upper Rule Curve
VDL	Variable Drawdown Limit
VECC.....	Variable Energy Content Curve
VHF.....	Radio Term–Very High Frequency
WCDS.....	Water Control Data System
WCM.....	Water Control Manual

ORGANIZATIONS

Action Agencies.....	USFWS and NOAA Fisheries are referred to as the “Resource Agencies” and the three parties, Reclamation, Corps, and BPA, are referred to as the “Action Agencies” when these agencies are dealing with matters associated with FCRPS–ESA issues.
BPA.....	Bonneville Power Administration
CENWD, NWD	U.S. Army Corps of Engineers, Northwestern Division
CENWD-PDW-H.....	CENWD Hydrologic Engineering Branch
CENWD-PDW-P	CENWD Power Branch
CENWD-PDW-R.....	CENWD Reservoir Control Center
CENWS.....	Seattle District, U.S. Army Corps of Engineers
CENWS-EC-TB-WM	Seattle District Water Management Section
<i>Note: Seattle District WM Section contains a reservoir control center which has no section code but is commonly referred to as NWS-RCC.</i>	
Corps.....	U.S. Army, Corps of Engineers
CRWMG.....	Columbia River Water Management Group
FCRPS.....	Federal Columbia River Power System
FERC.....	Federal Energy Regulatory Commission
FPC	Federal Power Commission (now Federal Energy Regulatory Commission)
NOAA Fisheries.....	National Oceanic & Atmospheric Administration Fish Unit
NMFS.....	National Marine Fisheries Service (Renamed the NOAA Fisheries)
CENPD	North Pacific Division (now Northwestern Division)
NRCS	Natural Resources Conservation Service
NWPP	Northwest Power Pool
NWRFC	Northwest River Forecast Center
NWS.....	National Weather Service
NWSRFS.....	National Weather Service River Forecasting Service
NWPP	Northwest Power Pool
NWPPC	Northwest Power Planning Council
OCE.....	Office of the Chief of Engineers
PNCA	Pacific Northwest Coordination Contract
RECLAMATION, USBR, BOR.....	U.S. Bureau of Reclamation
Resource Agencies.....	(see Action Agencies above)
TMT	Technical Management Team

**CHIEF JOSEPH DAM
GLOSSARY
ABBREVIATIONS & ACRONYMS**

USACE U.S. Army Corps of Engineers
USFS U.S. Forest Service
USFWS U.S. Fish & Wildlife Service
USGS U. S. Geological Survey
WDFW Washington State Department of Fish and Wildlife

METRIC CONVERSION TABLE

<u>LENGTH</u>	ABBREVIATION	NUMBER OF METERS	US EQUIVALENT
kilometer	km	1000	0.62137 miles
mile	mi	1,609.35 m	1 mile
meter	m	1 m	39.37 inches
foot	ft	0.3048 m	1 feet
meter	m	1	1.09361 yards
decimeter	dm	0.1	3.937 inches
centimeter	cm	0.01	0.3937 inches
millimeter	mm	0.001	.03937 inches
<u>AREA</u>		NUMBER OF SQ. METERS	
Square kilometer	sq km or km ²	1,000,000	0.3861 square miles
Hectare	ha	10,000	2.47 acres
Are	a	100	119.6 sq yds
Square centimeter	sq cm or cm ²	0.0001	0.155 sq inch
<u>VOLUME</u>		NUMBER OF CUBIC METERS	
Cubic centimeter	cu cm, cm ³ , cc	0.000001	0.061 cubic inches
cubic decimeter	dm ³	0.0001	61.023 cubic inches
cubic meter	m ³	1	1.307 yards
<u>CAPACITY</u>		NUMBER OF LITERS	cubic
kiloliter	kl	1,000	1.31 cubic yds
hectoliter	hl	100	3.53 cubic yds
dekaliter	dal	10	0.35 cubic foot
liter	l	1	61.02 cubic inches
cubic decimeter	dm ³	1	61.02 cubic inches
deciliter	dl	0.1	6.1 cubic inches
centiliter	cl	0.01	0.61 cubic inches
milliliter	ml	0.001	0.061 cubic inches
<u>WEIGHT</u>		NUMBER OF GRAMS	
metric ton	t	1,000,000	1.102 short tons
kilogram	kg	1,000	2.2046 pounds
hectogram	hg	100	3.527 ounces
dekagram	dag	10	0.353 ounces
gram	g	1	0.035 ounces
decigram	dg	0.10	1.543 grains
centigram	cg	0.01	0.154 grain
milligram	mg	0.001	0.015 grain

The following standard to metric conversion factors are used in this manual:

METRIC CONVERSION TABLE (CONTINUED)

Length and Distance

1 inch = 2.54 centimeters.

1 foot = 0.3048 meter

1 mile = 1.609 kilometer

Slope

1 foot per mile = 0.1894 meters per kilometer

Area

1 hectare (ha) = 2.471 acres

1 acre (ac) = 43,560 sq ft = 1 ha / 2.471 ac = 0.40469 ha

1 square mile = 2.588888 sq km

Volume

1 cubic yard = 0.76455 cubic meters

1 acre foot (AF) = 43,560 ft³ = (0.40469 ha)(.3048 m) = 0.12335 ha-m

Flow Rate

1 cubic foot per second (cfs) = 0.028316 cubic meters per second

1 cfs per day = 1.98347 AF = 0.24466 ha-m

1 cfs per year = 723.9666 AF = 89.3009 ha-m

Runoff per square mile

1 inch of runoff per square mile = 53.333 AF = 6.5786 ha-m

Miscellaneous

1 US gallon = 3.785 liters

1 short ton = 0.907 metric tons

1 pound = 453.592 grams

1 hp = 0.746 kW

Temperature

Fahrenheit (F) temperature = $(9/5)C + 32$

Celsius (C) temperature = $(5/9)(F - 32)$

CHIEF JOSEPH DAM
COLUMBIA RIVER, WASHINGTON

PREVIOUSLY ISSUED DESIGN MEMORANDA

<u>Number</u>	<u>Title</u>	<u>Approval Date</u>
None	Closure of Monolith C-2, Intake Channel Closure	Sep 1953
None	Spillway Design Flood	Jun 1947
None (Suppl 1)	Spillway Design Flood	Mar 1968
None	Type of Access Facilities	Jan 1948
None	Type, Number, and Size of Spillway Gates	Jan 1948
None	Access Bridge - Okanogan River	Sep 1948
1	Larger Turbines	Mar 1949
2	Power Generating Installation	Mar 1949
3	Location and Layout of Dam	Mar 1949
4	Access Highway	Feb 1949
5	Turbine Output and Power Generating Installation	Mar 1949
6	Columbia River Bridge	Apr 1949
7	Operations Village	Jul 1949
7 (Suppl 1)	Operations Village	Nov 1949
8	Not Issued	
9	Concrete Aggregate Investigation	Mar 1950
9 (Suppl 1)	Concrete Materials Investigation	Mar 1975
10	20-Unit Intake Structure and Powerhouse for Initial Phase of Construction	Oct 1950
11	Reanalysis of Upstream Impervious Blanket	Feb 1954
12	Reservoir Clearing (Rev)	Aug 1953
13	Relocation of Washington State Hwy 10A (Rev) 30 December 1953	Mar 1954
14	Determination of Guide Taking Line for Reservoir	Aug 1953
15	Machine Shop Equipment	Aug 1953
16	Alteration of L. J. Tillman Water Well and Facilities, Elmer City, Washington	Sep 1953
17	Relocation of Okanogan County Roads 269/381	Feb 1954

CHIEF JOSEPH DAM

<u>Number</u>	<u>Title</u>	<u>Approval Date</u>
18	Piezometer Installations, Right Abutment	Feb 1954
18 (Suppl 1)	Piezometer Installations, Right Abutment	Feb 1955
18 (Suppl 2)	Piezometer Installations, Right Abutment	Nov 1956
18 (Suppl 3)	Additional Piezometers for Right Abutment Blanket Extension	Mar 1957
18 (Suppl 4)	Piezometer Installations, Right Abutment	Jul 1958
18 (Suppl 5)	Piezometer Installations, Right Abutment	Feb 1961
18 (Suppl 6)	Piezometer Installations, Right Abutment	Nov 1962
18 (Suppl 7)	Piezometer Installations, Right Abutment	Oct 1964
18 (Suppl 8)	Piezometer Installations, Right Abutment	Oct 1966
19	Log Booms and Related Facilities	May 1954
20	Storage and Shop Facilities	Jul 1954
20 (Suppl 1)	Storage and Shop Facilities	Sep 1954
20 (Suppl 2)	Storage and Shop Facilities	Jul 1957
20 (Suppl 3)	Storage and Shop Facilities	Sep 1960
20 (Rev Suppl 3)	Storage and Shop Facilities	Oct 1960
21	Facilities for Visitors	Jun 1954
21 (Suppl 1)	Facilities for Visitors	Nov 1954
21 (Suppl 2)	Facilities for Visitors	Aug 1957
21 (Suppl 3)	Facilities for Visitors	Apr 1959
22	Alteration of Facilities, Nespelem Valley Electrical Cooperative, Inc.	Nov 1954
23	Report on Necessity for Relocation of County Road No. 321, Douglas County, Washington	Apr 1956
24	Stilling Basin Damage and Proposed Repair	Aug 1957
24 (Suppl 1)	Stilling Basin Damage and Proposed Repair	May 1958
24 (Suppl 2)	Stilling Basin Damage and Proposed Repair	Nov 1959
24 (Suppl 3)	Stilling Basin Damage and Proposed Repair	Jul 1965
25	Foster Creek Channel Improvement	Jan 1958
25 (Suppl 1)	Foster Creek Channel Improvement	Oct 1958
26	Tailrace Excavation	Nov 1959
27	Improvement of Public Access Facilities	Sep 1959
28	Centralized Controls of Main Generating Units and Annunciation Modifications	Not Approved
29	Plan for Sedimentation Observation	Oct 1959
30	Public Access Facilities	May 1961
30 (Suppl 1)	Public Access Facilities	Jan 1962
30 (Suppl 2)	Public Access Facilities	Sep 1962
30 (Suppl 2A)	Public Access Facilities Recreation	Sep 1964
31	Downstream Boat Launching Ramp	Jan 1962
32	Public Access Facilities at Elmer City	Dec 1962

CHIEF JOSEPH DAM

<u>Number</u>	<u>Title</u>	<u>Approval Date</u>
33A	Not Issued	
33B	Master Plan for Development and Management of Reservoir Lands	Feb 1965
33B (Appen 1)	Cost Estimates	Feb 1965
33C	Public Use Development Plan	Sep 1975
33C (Suppl 1)	Public Use Development Plan	Mar 1979
34	Not Issued	
35	Additional Units 17-27, General DM [2 Vols]	Jul 1968
35 (Suppl 1)	Intake Gate Operating System	Dec 1968
35 (Suppl 2)	Peaking at Upper Columbia River Hydroelectric Projects	Jan 1970
35 (Suppl 3)	Peaking Operations on Upper Columbia River Projects	Jul 1971
35 (Suppl 4)	Pool Raising [2 Vols]	Apr 1971
35 (Ltr Suppl 1 to Suppl 4)	Ancestral Burials	Jun 1978
35 (Suppl 5)	Interim Visitor Facilities	Jul 1975
35 (Suppl 6)	Unified Design Concepts for Project Grounds, Structures, and Appurtenant Features	Jun 1974
35 (Ltr Rpt 1)	Additional Units 17-27, Powerhouse Cofferdam and Excavation	Apr 1974
35 (Ltr Rpt 2)	Interim Visitor Facilities, Revisions to Supplement 5 to DM 35	Nov 1976
35 (Ltr Rpt 3)	D/S Bank Stabilization	Jan 1978
36	Preliminary Design Rpt, Powerhouse Units 17-27	Aug 1969
36 (Suppl 1)	Preliminary Design Rpt, Powerhouse Units 17-27	Apr 1974
36 (Ltr Rpt 1)	Preliminary Design Rpt, Powerhouse Units 17-27 Penstocks	Jun 1974
36 (Ltr Rpt 2)	Preliminary Design Rpt, Powerhouse Units 17-27 Power Intake Modification	Apr 1975
36 (Ltr Rpt 3)	Draft Tube Liner Cavitation Repair	Dec 1982
37	Resident Engineer Facility	Aug 1969
37 (Suppl 1)	Admin. Bldg. (Interim Resident Engr. Facility)	Jun 1974
37 (Ltr Rpt 1)	Resident Engineer Facility	Nov 1963
38	Cultural Resources	Jun 1977
39	Cancelled	
40	Cost Allocation	Nov 1977
41	Temporary Family Housing	Dec 1973

CHIEF JOSEPH DAM

<u>Number</u>	<u>Title</u>	<u>Approval Date</u>
42	Pool Raising - Structural Modifications	Jun 1974
42 (Suppl 1)	Pool Raising - Structural Modifications	Mar 1975
42 (Suppl 2)	Pool Raising - Structural Modifications	Jun 1975
42 (Suppl 3A)	Relocation of Public Access in the Powerhouse	Mar 1984
42 (Suppl 4)	Earthquake Analysis of Chief Joseph Dam	Jan 1982
42 (Ltr Rpt 1)	Project Operations Boat Moorage	Nov 1975
42 (Ltr Rpt 2)	Prestressing	Dec 1975
42 (Ltr Rpt 3)	Stability Effects from Uplift	Jan 1979
42 (Ltr Rpt 4)	Cancelled	
42 (Ltr Rpt 5)	Intake Trashrake	May 1979
42 (Ltr Rpt 6)	Not Issued	
42 (Ltr Rpt 7)	Spillway Gate Controls	Jan 1979
42 (Ltr Rpt 8)	Tower Obstruction Lighting	Dec 1978
42 (Ltr Rpt 9)	Spillway Tainter Gate Cable Wear	Oct 1979
42 (Ltr Rpt 10)	Reservoir Sweeping	Aug 1979
42 (Ltr Rpt 11)	Project Completion Items	May 1984
42 (Suppl 1 to Ltr Rpt 11)	Project Completion Items	Mar 1986 <u>1/</u>
42 (Ltr Rpt 12)	Spillway Crack Investigation	Aug 1984
43	Relocations - Roads and Utilities	Apr 1977
44	Cancelled	
45	Box Canyon Public Use Site - Real Estate	May 1975
45 (Suppl 1)	Real Estate	Sep 1975
46	Land Restoration, Project Roads and Utilities	Mar 1979
46 (Ltr Rpt 1)	Project Signs	Jul 1980
46 (Ltr Rpt 2)	Land Restoration, Modifications and Additions	Dec 1980
47	Not Issued	
48	Box Canyon Public Use Site	Oct 1975
49	Cancelled	
50	Bridgeport State Park Expansion	Apr 1979
51	Support to Local School Districts	May 1977
52	Wildlife and Threatened Species Mitigation	Jan 1981
52 (Ltr Rpt 1)	Maintenance Vessel Requirements	Apr 1984
52 (Ltr Rpt 2)	Boat Dock Facilities	Dec 1984
53	Cancelled	
54	Project Security	Mar 1986
55	Log Boom and Debris Handling Facility	May 1978
56	Maintenance, Storage Facilities and Project Administration Building	Jul 1981
57	Project Master Plan	Oct 1988 <u>1/</u>

1/Submittal date; awaiting approval from higher authority

REDACTED CONTENT

REDACTED CONTENT

GUIDELINES FOR TECHNICAL MANAGEMENT TEAM

-May 2003

I. Introduction. The National Marine Fisheries Service's (NMFS) Biological Opinion on the "Reinitiation of Consultation on Operation of the Federal Columbia River Power System (FCRPS), Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin", dated December 21, 2000, and the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion on the "Effects to Listed Species from Operations of the FCRPS", dated December 20, 2000, call for the utilization of a Technical Management Team (TMT) to advise the operating agencies on dam and reservoir operations, thus optimizing passage conditions for juvenile and adult anadromous salmonids and resident fish. These guidelines are adopted in accordance with those Opinions. The TMT is one of several technical teams within the Columbia River Regional Forum established by the NMFS, USFWS, the U.S. Army Corps of Engineers (COE), the U.S. Bureau of Reclamation (BOR), and the Bonneville Power Administration (BPA). The Regional Forum provides for regional discussion and recommendation on the operation and configuration of the FCRPS. Its goal is to develop consensus among the various members on these recommendations. The TMT's mission is specifically to ensure broad technical participation and use of the best available technical information, and to encourage consensus in recommendations on operating the FCRPS. When consensus is not achieved, the TMT ensures that the basis for participants' recommendations and Federal decisions is fully explained and documented. In such situations, questions can be elevated to the Implementation Team (IT) for resolution if requested by a TMT member. The TMT operates under the Guidelines and Procedures approved November 7, 2002, for the Columbia River Regional Implementation Forum. The following more specific guidelines supplement the Forum's procedures for TMT operations. As the Forum procedures are refined, these guidelines may be revised.

II. Scope. The focus of the TMT is to implement the NMFS and USFWS Biological Opinions on operation of the FCRPS while considering the provisions of (and effects on) the Northwest Power Planning and Conservation Council's (NPP&CC) Fish and Wildlife Program, other biological opinions, State and Tribal plans and programs, and other relevant operational requirements. Specifically, the TMT should explore operational scenarios under the Biological Opinions that would serve to protect other fish and wildlife in the Columbia River Basin and promote coordination and consistency with these other objectives to the extent possible.

III. Membership. See Forum Guidelines and Procedures. The members and alternates of the TMT are listed in Attachment 1. Initial confirmation of membership, designation of representatives, and any changes in representation should be provided in writing to the NMFS Implementation Team Chair.

IV. Roles and Responsibilities. The TMT is responsible for discussion and recommendations to the Action Agencies (COE, BOR, and BPA) on hydro system flows at designated control points and expected project operations to implement the Biological Opinions for listed salmon, steelhead, sturgeon, and bull trout species within the Columbia River basin while taking into account the needs of (and effects on) other listed and non-listed species. The TMT is to engage in joint decision-making that works toward consensus

within the recognized authorities and management jurisdictions of its participating members. Specifically, the State, Tribal and Federal salmon managers (Salmon Managers) recommend the flows at the control points that best meet the needs of salmon and steelhead. These may include specific project operations, but this does not foreclose TMT consideration of alternative means of providing the same operating condition. Other participants (e.g., Resident Fish Managers) may also make recommendations consistent with the scope of these guidelines. The vehicle for communicating a river or project condition, which will benefit salmon/steelhead/sturgeon migrations or resident fish, is a system operational request (SOR). See Section V(d). All parties submitting SORs are encouraged to coordinate with other participants to the extent possible. The Salmon Managers are responsible for the management of anadromous and resident fish in the basin. The COE and BOR are responsible for decisions on operation of the FCRPS projects; and the COE and BPA are responsible for Treaty agreements with Canada, regarding storage in Canada and other Treaty-related matters. The participation of other affected sovereign and non-sovereign entities is intended to ensure that decision-makers have the broadest possible source of information upon which to base their decisions. All parties are encouraged to succinctly present their views regarding biological or operational recommendations. Input can provide alternative options for the appropriate authority to consider when making their decisions, but authority for implementing the request remains with the appropriate agencies. The TMT is a year-round technical body. Winter planning will consist of development of a Water Management Plan and updating the 1-year and 5-year Biological Opinion Implementation Plans. The purpose of in-season management is to implement the Biological Opinions and the Water Management Plan. Post-season review will consist of a review of the previous year's activities and performances, and updating operating procedures as needed. Throughout the year the COE, BOR, and BPA will coordinate planning and operational decisions that may affect salmon and other species, through the TMT (e.g., yearly agreement on Non-Treaty Storage Agreement spring/summer operation, the 5-year Idaho Power Company Agreement, and the Libby/Arrow swap). The COE, BOR and BPA will specifically use the TMT as a forum for the coordination and consideration of potential effects on salmon, steelhead and other species prior to a final decision. Idaho Power Company, the Mid-Columbia Public Utility Districts, and other non-sovereign participants are also encouraged to use TMT as a forum for coordination of planning and operational decisions throughout the year.

V. Operating Procedures.

a) Annual Water Management Plan. By April 15 each year, the TMT will finalize an annual Water Management Plan based on the run-off forecast and other factors specific to that year. A complete draft, subject to refinement based on the April 1 forecast, should be available for review no later than March 10 each year. All interested parties may participate in the plan development and will be given an opportunity to review and comment on the draft plan. In general, the Salmon Managers will provide information on salmon and salmon operational requirements to be included in the plan. Resident Fish Managers will provide information on resident fish needs. The Action Agencies will provide information on reservoir status; planned project operations (and operating constraints); flow forecasts; anticipated special operations for research and other purposes; turbine outage and maintenance plans; and operating agreements and contracts that may affect annual operations. Priorities among competing needs should be resolved within the context of the scope of these guidelines.

b) Summary of In-season Management Key Events.

Monday. Begin implementing operations based on last week's decision.

Tuesday (9 a.m.). The COE posts or otherwise distributes flow projections to TMT members for Priest Rapids, McNary and Lower Granite, along with resulting reservoir operations and elevations, and current dissolved gas and temperature data. Salmon Managers will post or otherwise distribute biological information.

Tuesday (4 p.m.). TMT Members (or others) submit SORs to the Reservoir Control Center (RCC) and send (fax) hard copies to TMT members and participants. The Salmon Managers will fax SORs to all project owners for which an operation is requested. The Salmon Managers will post the SOR to the Fish Passage Center web page, or an electronic version of any SOR will be simultaneously sent to the Corps so that it is available for the TMT web page as soon as possible.

Wednesday 9 a.m. The TMT meets bi-weekly, with conference call on alternate weeks if needed, to discuss in-season management data and SORs, document operations, and recommend the following two week's operations. By the start of the meeting all SORs and the disposition will be posted to the TMT web page for use by members who can not attend the meeting. If necessary, the TMT frames the issue(s) to be raised to the IT before 12 a.m.

Thursday (3 p.m.). In case of impasse, disputes are resolved through the IT.

Friday (noon). In the event an issue has been raised to the IT and the IT has resolved the issue, the Action Agencies document the operation to begin on the following Monday. This decision, and rationale, should be documented before the next regularly scheduled TMT meeting and sent to the Chair of TMT, who will post it on the TMT homepage

Friday (p.m.). The TMT draft meeting notes are posted or otherwise distributed

c) In-season Management Data. The TMT will use the National Weather Service's River Forecast Center's (RFC) streamflow forecast for the Columbia River Basin. This forecast (and the basic reservoir operations that are assumed when producing it) is the official forecast to be used for the decision-making process. The BPA forecast may be used as supplemental information. The COE will use the RFC forecast to prepare flow projections for Priest Rapids, McNary and Lower Granite. By 9 a.m. (or as early as possible after that) on Tuesday, the flow projections and resulting reservoir operations will be distributed to TMT members. The Action Agencies will also provide dissolved gas, temperature, and other physical monitoring data available for decision-making. During the anadromous fish migration period, the Salmon Managers will provide biological information on salmon and steelhead numbers, migration timing and condition, for both the current year and historically. The USFWS, and others as appropriate, will provide relevant information on other fish and wildlife resources. These data will be posted by NMFS and USFWS each Tuesday by 4 p.m.

d) System Operational Requests. TMT members will provide recommendations to the TMT on hydro system flows and/or expected project operations consistent with the scope of these guidelines. Non-TMT members may also submit recommendations for

consideration. These recommendations will be in the form of system operational requests (SORs) stating the flow objective(s) sought (e.g., keep flows at a location X in a W-Z range). Expected project operations may also be added. Each SOR will include the biological basis for the recommendation. Each SOR will also indicate whether the request is to implement a NMFS or USFWS Biological Opinion, NPPC Fish and Wildlife Program, or other Federal, State or Tribal program. Non-TMT members may also submit SORs for special operating purposes for TMT consideration. All SORs will be submitted by 4:00 p.m. on Tuesday via fax to the action agencies, or any other project owner that may be required to deliver a specified operation, provided that the flow projections were available by 9 a.m. that day. Electronic submittal through the Proposal Submission/Review form on the TMT homepage may also be used. TMT and public comments on the proposal can also be appended via the Internet form. If proposals are incomplete, or are not received in time for sufficient review, the TMT may choose to delay action, but lack of an SOR should not preclude discussion of relevant matters at the meeting. SORs should list members of the agencies who have reviewed and support the request. The SOR will be outlined for description on the TMT SOR disposition web page. The SOR will be posted to the disposition page prior to the start of the TMT meeting so that telephone participants can follow the meeting. When an SOR has been properly submitted, the Action Agencies (COE, BOR, BPA) should be prepared at TMT to describe the operational options and implications of meeting the request.

e) Meetings. Between the last week of March and up to at least August 31 the TMT will meet every other Wednesday, or more often if necessary, to conduct in-season management. All meetings will be open to interested parties. A conference line will be available for those who cannot attend in person. An agenda for each meeting will be distributed at least two business days prior to the meeting (the preceding Monday in the case of the regularly scheduled in-season meetings). The principal purpose of the meetings and standing agenda items during the migration season is to review the status of the preceding week's SOR and operations, biological data, new SORs and project operating data, and to reach informed decisions on FCRPS operations for the following week(s). As other items are brought forward for TMT consideration they will be added to the agenda for future discussion, but lack of an agenda item will not preclude discussion of relevant matters at the meeting. The discussion of SORs at TMT meetings will include distinct segments dealing with both biological and operational issues. Biological questions associated with an SOR will be addressed to ensure that the biological basis of the SOR is clear, and to allow the TMT to consider any additional biological information that may be made available at the meeting. The meeting will then move on to a discussion of operational alternatives to meet the SOR by the Action Agencies and members of the TMT. The Chair should ensure that adequate time is allotted to each segment of the meeting. The Chair should also ensure that the support or opposition of each TMT member for an SOR and a final decision by the Action Agencies are noted in the minutes.

f) Meeting Facilitation. Meetings of the TMT will be facilitated by an impartial facilitator, who will allow all TMT members the opportunity to fully participate in discussions and to help members resolve conflicts as they arise. The meeting facilitator shall serve at the will of all members of TMT and should have skills as a meeting manager and conflict resolver. The meeting facilitator's role will include:

- Assisting the chair and TMT members in the development of meeting agendas.

- Managing the meeting agenda in a balanced and even-handed fashion so that all members have an opportunity to speak and be heard.
- Helping the group stay focused on the agenda and prioritize items that need action and further discussion
- Enforcing the ground rules established by the TMT (see Attachment 2).
- Helping the group reach consensus on decisions.
- Helping the group resolve conflicts that may arise in the course of discussion.
- Highlighting any decisions the group may reach.
- Working with members between meetings to clarify issues, resolve disputes, and seek potential solutions to impasses.
- Assisting members to develop opportunities that may resolve conflicts and increase the overall satisfaction with the TMT process in the long term, and
- Helping the group maintain a sense of humor.

TMT members may give feedback directly to the facilitator or to the chair if they have concerns with the manner by which meetings are managed. The facilitator will be replaced if, after discussion with the facilitator, members believe he or she is not remaining impartial in the delivery of service.

g) In-season Decision making. On Wednesday morning the TMT will decide on operations for the following two weeks based on the available information and any pending SORs. These operating decisions will be made by consensus whenever possible. Consensus is defined as lack of a strong objection that would prompt one or more of the TMT members to elevate the issue to the IT. In the absence of consensus, the decision will be referred to the IT in accordance with the dispute resolution process described below. Objections to decisions that are not strong enough to prompt one or more TMT members to elevate the issue will be documented in the minutes of the TMT meeting. If the recommendation is to implement the SOR or a modification of the SOR as agreed to by the TMT, then this should be documented for the minutes, and the SOR (and the Biological Opinion, Council's program or other plan on which it is based) may form the basis for the decision. If the Action Agencies do not agree to implement an SOR, they will describe for the minutes both the intended operation and the basis for that decision. The basis for the decision could include that the proposed operation is inconsistent with a Biological Opinion, that operational constraints prevent its implementation, that cost is prohibitive beyond that already included in the so-called "Fish Cap", or that the Action Agency has an alternative view of the best available biological information. If the Action Agencies believe the best available biological information supports a position that differs from that of the SOR sponsor(s), then the explanation should acknowledge this difference and should provide a clear, succinct written explanation of the data, analysis or judgment that supports the alternative view. In each case, a full explanation will be provided by the Action Agencies to the TMT and IT. The final decision made by the COE and BOR on the following week's operation will be made at the meeting whenever possible. The TMT will try to avoid making decisions outside the established process. In-season FCRPS operating decisions made through a separate process, such as those under the Action Agencies' authority for

emergency situations, will be explained and documented as soon as possible, but in any case no later than Friday following the TMT meeting.

h) Documentation. Minutes of all TMT meetings will be prepared in accordance with Regional Forum procedures and approved by the TMT. Every effort will be made to post the draft meeting notes to the TMT home page by close of business Friday afternoon following the meeting. Comments will be due by the following meeting. The TMT meeting minutes will be used to keep track of the decision-making process. The minutes will include the substance of any SOR, the decision, the decision-maker, and the basis for the decision. The minutes will also include: (1) documentation of consensus or a listing of members objecting to an SOR or a final decision; and (2) when an SOR is not implemented, clear documentation of the reasons provided by the decision-maker. If a decision is elevated to the IT and therefore not made at the weekly TMT meeting, documentation on the final decision reached will be provided separately in writing by the IT and will include the same information noted above. This documentation of the decision should happen before the next regularly scheduled TMT meeting and be sent to the Chair of TMT, who will post it on the TMT homepage. Each member is responsible for reviewing the decision documentation and the meeting minutes, especially if the agency he/she represents is one of the decision-makers. Interested parties may request copies of the minutes if they have no access to the TMT homepage.

i) Distribution of Information. Meeting notes and material will be made available to TMT participants throughout the year. These materials will be made available through the TMT home page and may be reproduced on other Internet home pages where available. They will also be faxed to members and participants that request such services. Regular mail may be used for materials when time permits.

j) Public Participation. The public may comment on an issue at the end of the discussion on that issue or at the end of the meeting, based on the discretion of the group and the facilitator. They may also comment outside the TMT process.

VI. TMT Dispute Resolution Process. In the event that the TMT is unable to reach consensus on an issue, any member may request that the item be elevated to the IT. Every effort should be made to ensure that the issue is raised at least one week in advance of the monthly IT meeting (first Thursday of the month). If, despite all efforts to the contrary, the TMT finds at its Wednesday morning meeting that it is unable to resolve a weekly in-season management dispute, and the decision cannot await consideration at the next regularly scheduled meeting, the IT will meet by conference call at 3:00 on Thursday afternoon. In the event that such a meeting is necessary, the TMT will prepare, and agree to, a brief summary of the issue(s) and a short description of the opposing viewpoints. This document will be given to the IT members by 1:00 p.m. on Thursday afternoon. The IT will attempt to reach consensus. If the IT is unable to reach a consensus, then a final recommendation will be made by the appropriate agency (e.g., NMFS or USFWS if the issue relates to implementation of a Biological Opinion, or NPPC if the issue relates to implementation of the Fish and Wildlife Program). The member with the authority for the action will then make the decision and explain the rationale in writing. Whether IT acts by consensus, or the member with the authority for the action makes the decision to resolve a TMT conflict, it should be

documented before the next regularly scheduled TMT meeting and sent to the Chair of TMT, who will post it on the TMT homepage.

VII. Emergency Meetings. Any member of the TMT may call a meeting when an emergency situation requires action of the TMT.

ATTACHMENT 1: TECHNICAL MANAGEMENT TEAM (TMT) MEMBERS, ORGANIZATION REPRESENTATIVE, ALTERNATES

National Marine Fisheries Service; Paul Wagner, Chris Ross
U. S. Army Corps of Engineers; Cindy Henriksen, Rudd Turner
Bonneville Power Administration; Scott Bettin, John Wellschlager
U.S. Bureau of Reclamation; Tony Norris, John Roache
U.S. Fish & Wildlife Service; David Wills, Stever Haeseker
State of Washington, Cindy LaFleur
State of Oregon, Ron Boyce
State of Idaho, Russ Kiefer
State of Montana, Jim Litchfield
Confederated Tribes of the Colville Indian Reservations; Jerry Marco, Kirk Truscott
Shoshone-Bannock Tribes of Fort Hall, Keith Kutchins

ELIGIBLE ORGANIZATION WITH NO OFFICIALLY DESIGNATED MEMBER (CONTACT PERSON ALTERNATE)

Kootenai Tribe of Idaho
Confederated Tribes of the Umatilla Indian Reservation
Confederated Salish & Kootenai Tribes of the Flathead Reservation
Confederated Tribes of the Warm Springs Reservation
Yakama Indian Nation
Shoshone-Paiute Tribes of Duck Valley Reservation
Burns Paiute Tribe
Kalispel Tribe
Spokane Tribe of Indians; Deanne Pavlik, Chuck Lee
Nez Perce Tribe of Idaho; Dave Statler, Greg Haller
Coeur d'Alene Tribe of Idaho
State of Alaska

ATTACHMENT 2. MEETING GROUND-RULES & EXPECTATIONS.

The following meeting ground-rules and expectations were discussed and agreed to by all members present at the _____ meeting of the TMT. They may be changed at the request of the Team.

I. Ground-Rules. Meetings will start and end on time unless members agree otherwise. Members will treat each other with respect, which includes:

- Separating the people from the problem
- Listening to what others have to say
- No interruptions
- Monitoring your own air time
- No side conversations
- Letting the facilitator or chair know when you would like to speak

- Being mindful of tone when speaking directly to others
- Remembering that members are representing agencies, not stating individual opinions

During in-season management, each member agency/group will have one primary TMT representative who will sit at the table during meetings. Alternates or technical resource staff are welcome to attend and provide input through their primary representative, or when called on by TMT members. All are welcome to sit at the table --with preference for the primary representatives if there is a space limitation.

Any issues elevated from the TMT to the Implementation Team (IT) will be thoroughly discussed at TMT. TMT members will agree on the “issue statement” for the IT. The TMT Chair will then present the issue at the IT meeting. All TMT members will brief their agency IT representative on the issue prior to the IT meeting.

The meeting facilitator may make process comments in order to keep the group on track, focused and productive.

II. Expectations.

- Members are expected to come prepared to participate in the meetings. This means, they will provide necessary input to discussions and work towards making decisions based on information they have gathered from their respective agencies between meetings.
- Members are expected to keep their agencies and staff apprised of decisions or important meeting discussions.
- Members are expected to attend all meetings or send an alternate. If an alternate attends the meeting, a briefing, both before and after the meeting, is expected of the primary representative. The group will not revisit information for members who were absent from or late to a meeting.
- Members are expected to follow through on assignments to which they agree, or are given by other team members, on a timely basis. This includes requests for comments on information or reports from other team agencies.
- The meeting facilitator is expected to keep the group on track and focused on agenda items.
- Additionally, the group expects the facilitator to assure equal participation, highlight any decisions that the group reaches, and maintain a sense of humor.
- People who listen in on the telephone are expected to “sign-in” as they call in on the conference telephone line.
- Group members may contact the facilitator at any time to make process suggestions, raise concerns or request additional assistance at or between meetings.

Chapter I Introduction

A. Background

Prior to Hourly Coordination, operation of the Projects on the Mid-Columbia River was uncoordinated. That is, the operation of one Project did not consider the operation at another Project. Each Party that participated at a Project had to schedule generation directly with the Project owner. A Party also had a reservoir energy storage account (pond account) at each Project. This operation was inefficient in that a given reservoir was seldom full, so its hydraulic operating head was seldom at its maximum. Since energy production from a unit of water is directly proportional to operating head, energy generation efficiency was seldom maximized. Since peaking capability is also proportional to operating head, it was also seldom maximized. Further, uncoordinated operation sometimes caused unnecessary spill. For example, if the Parties at an upriver Project temporarily needed a great deal of generation, while the Parties at a downriver Project could not use the extra inflow, the result was reservoir draft upriver and spill downriver. This was clearly a disadvantage of uncoordinated operation.

B. Hourly Coordination Contracts and Agreements

The first contract, entitled Agreement for the Hourly Coordination of Projects on the Mid-Columbia River, was executed on July 1, 1972 for a term of one year. This contract was extended for one year, through June 30, 1974. This contract extension was further extended for two additional years: first through June 30, 1975 and then through June 30, 1976. Another contract was executed on July 1, 1976 for a term of one year. On July 1, 1977, a 10-year contract was executed. This contract expired on June 30, 1987. A second 10-year contract was executed on July 1, 1987, and expired on June 30, 1997. A four-month extension of this contract was necessary to allow sufficient time for the current 20-year Agreement to be reviewed by the Federal Energy Regulatory Commission (FERC). The current Agreement runs from July 1, 1997 through June 30, 2017.

The Agreement provides the following general objectives:

1. Primary Objective

The primary objective is to coordinate the hydraulic operation of the Projects. The intended result is to optimize the amount of energy from the available water consistent with the needs to both (i) adjust the total actual generation to match the total requested generation, and (ii) operate within all Parties' power and non-power requirements.

2. Secondary Objective

The secondary objective is to provide flexibility and ease of scheduling generation for the Projects through centralized coordinated scheduling, and to provide flexibility in scheduling Project generation through the use of composite scheduling and accounting procedures.

3. Tertiary Objective

The tertiary objective is, to the extent such can be made consistent with the primary and secondary objectives, to minimize unnecessary Project generation changes, including generator starts and stops.

The procedures to implement these objectives are outlined in Exhibit A of the Agreement, which contains specifications for the following:

- Operating Strategy
- Limits
- Scheduling and Control
- Accounting
- Implementation Manual

With regard to an Implementation Manual, Exhibit A states that: "The Operating Group shall prepare and distribute a manual (Implementation Manual) incorporating the current, detailed procedures for implementing the provisions of this Agreement. The Parties are to use the manual as a guide and source of information." This manual is intended to satisfy the guidelines set forth in Exhibit A.

C. General Description of Hourly Coordination

1. Project Ownership

The U.S. Bureau of Reclamation operates Grand Coulee, and the U.S. Army Corps of Engineers operates Chief Joseph. Wells is owned and operated by Douglas County Public Utility District (PUD). Rocky Reach and Rock Island are owned and operated by Chelan County PUD. Wanapum and Priest Rapids are owned and operated by Grant County PUD.

2. Project Participation

In order to finance the Projects, the three PUDs sold part of the output of each Project on a long-term basis to several Northwest utilities. Lists of the utilities that purchased shares of outputs are contained in the Power Sales Contracts, but a single listing of most of them can be found in Appendix A. A 10% Party in a Project has the rights to 10% of the maximum generating capability, reservoir storage capacity, and inflow of that Project. One of the basic principles of the Agreement is that each Party shall have full access to, but not in excess of, its share of the capability of the Projects in which it has Projects Rights.

3. Operating Strategy

For the purpose of hydraulic coordination, the seven-Project system is operated as though it is owned by a single entity. To accomplish this, Grant County Control Center operates

an on-line computer that dispatches all of the Projects. Grant County Control Center is, therefore, designated as "Central". The on-line computer essentially looks at the total generation request for the Mid-Columbia, and then computes the optimal generation distribution for the seven-Project system, without regard to ownership or participation.

4. Dispatching the Projects

Once the Operating Strategy Program has computed the optimal generation for each Project, it dispatches the Projects by sending each Project Control Center a Bias signal, which can be either positive or negative. Bias signals are necessary because the Uncoordinated Request sent to each Project Control Center is not normally equal to the optimal generation request for that control center's Projects based on the overall hydraulic efficiency of the seven Project system. For each Project Control Center, the Uncoordinated Request is the total of all generation requests sent to that Project Control Center in accordance with the provisions of Part III of Exhibit A, "*Scheduling and Control*".

In order to make each Project generate the optimal Coordinated Request, the Operating Strategy Program at Central computes the difference between the optimal generation and the Uncoordinated Request. The difference, which is Bias, is then sent to each Project Control Center as an additional generation request. At each Project Control Center, the Bias is added to the Uncoordinated Request to yield the optimal generation request, and the Projects are then dispatched accordingly.

Some Parties have rights in several Projects, but only send generation requests to one or, in some cases, two Project Control Centers. This means that the Uncoordinated Request at each Project Control Center does not reflect the request which might otherwise be expected based on percentage participation in that Project. The result of this mismatch is that Bias values are generally negative at the Grant Project Control Center and generally positive at the Chelan and Douglas Project Control Centers. For the BPA Project Control Center, Bias values have an equal probability of being positive or negative.

5. Accounting

Prior to Hourly Coordination, each Party had a pond account at each Project in which it participated. For each Project, there was a pond account for each Party, and the total of these, called the project pond account, always equaled the physical reservoir energy storage (physical pond). A Party had to schedule directly with each Project owner, so it was easy to see exactly where each Party's energy came from. Therefore, it was easy to maintain Party's Pond Accounts for all Parties at that Project. At the end of an hour, a Party's Pond Account was computed as its previous end-of-hour Party's Pond Account, plus its share of inflow for the hour, minus its scheduled generation from the Project for the hour.

With Hourly Coordination, the Operating Strategy Program seeks only to generate the total generation request in the most efficient manner and does not care what percentage interest a Party has in a Project. Therefore, it is no longer clear from where a Party's energy

comes. Since it is still desired to maintain a pond account for each Party at a Project, a Party's total generation request for the hour must be "reallocated" on paper, after the hour, among its Projects. A Party has a right to allocate its generation requests however it wishes, within certain limits. These allocated generation requests, instead of scheduled generation, are used for pond accounting. At the end of an hour, a Party's Pond Account is computed as its previous end-of-hour Party's Pond Account, plus its share of inflow for the hour, minus its allocated generation request at the Project for the hour.

The difference between a Project's actual net generation for the hour and the sum of its allocated integrated Uncoordinated Requests is called Coordination Exchange for the hour. Neglecting the effects of Inflow Averaging, if the Project Pond Account and the Physical Pond are equal at the beginning of the hour, this Coordination Exchange will also be the difference between the Project Pond Account and the Physical Pond after the hour. Therefore, at any time, again neglecting the effects of Inflow Averaging, Accumulated Coordination Exchange will equal the difference between the Project Pond Account and the Physical Pond.

AGREEMENT

POWER LOSS FROM WELLS PROJECT ENCROACHMENT
ON
CHIEF JOSEPH DAM

BY AND BETWEEN THE
CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY
AND
PUBLIC UTILITY DISTRICT No. 1 OF
DOUGLAS COUNTY, WASHINGTON

1968

Exhibit 9-3

AGREEMENT

Power Loss From Wells
Project Encroachment on
Chief Joseph Dam

FPC License, Project No. 2149

This agreement, entered into this 26th of August, 1968, by and between the Chief of Engineers, Department of the Army, represented by the contracting officer executing this agreement (hereinafter called the "Chief of Engineers") and Public Utility District No. 1 of Douglas County, Washington, a Public Utility District and Municipal Corporation organized and existing under the laws of the State of Washington (hereinafter called "the District"), witnesseth that:

WHEREAS, the Federal Power Commission of the United States of America on 12 July 1962 issued to the District a license entitled Project No. 2149, for the construction, operation and maintenance of the Wells Hydroelectric Project at approximately River Mile 516 upon the Columbia River, Washington;

WHEREAS, the license entitled Project No. 2149 states that the pool of the proposed project will be operated at elevation 779 feet and encroach upon the tailwater of the Chief Joseph Dam constructed by the Corps of Engineers at approximate River Mile 546 upon the Columbia River, that the proposed encroachment is recognized by the Corps of Engineers, and that provision for compensation to the United States for damages resulting from such encroachment is thereafter provided;

WHEREAS, Article 32(i) of the license for Project No. 2149 requires

the District prior to beginning of operation of the Wells power plant to enter into an agreement with the Chief of Engineers, Department of the Army, or his designated representative, to compensate the United States for encroachment on the Chief Joseph Project resulting from the operation of the Wells Project;

WHEREAS, Article 32(i) of the license for Project No. 2149 requires replacement of power loss at Chief Joseph in time and kind, unless otherwise mutually agreed;

WHEREAS, Article 32(i) of the license for Project No. 2149 further requires that the loss will be computed on the basis of using the same quantity of water at any given time through the units of the Chief Joseph powerhouse with and without the Wells Project; that the difference in power output will be the loss to be replaced; that in any computation pertaining to the power loss, the generating capacity will be limited to 125 percent of nameplate rating; and that the turbine and generator units to be used in computing the loss will be those in existence at Chief Joseph at the time the Wells Project is licensed;

WHEREAS, Article 32(ii) of the license for Project No. 2149 requires the District to compensate the United States a capital sum of \$294,000 payable to the Treasurer of the United States on or before operation of the initial installation at the Wells Project for the increased cost of future turbines, units 17 through 27 (of Chief Joseph), required to generate the same power under reduced head conditions as a result of the encroachment of the Wells pool on Chief Joseph tailwater, which sum has now been paid.

WHEREAS, there were sixteen turbine and generator units of 64,000 KW nameplate rating each in existence at Chief Joseph Dam on 12 July 1962;

WHEREAS, the District began operation of the Wells project on May 25, 1967 by raising the pool of that project to approximately elevation 772 feet and has encroached thereafter upon the tailwater of the Chief Joseph Dam; and

WHEREAS, the District has compensated the United States for the power loss element of the damages resulting from that encroachment to date by replacement of the power loss in time and kind pursuant to the terms of a letter from the North Pacific Division, Corps of Engineers to the District dated 5 June 1967 by which replacement an accord and satisfaction for that encroachment was effected.

NOW THEREFORE, in accordance with the provisions of Federal Power Commission License, Project No. 2149, and in consideration of the premises and covenants contained herein, the parties hereto agree as follows:

ARTICLE 1. TERM OF AGREEMENT. This agreement shall be in full force and effect for the duration of the existing Federal Power Commission License for Project No. 2149.

ARTICLE 2. BASIC ASSUMPTIONS. The power loss at the Chief Joseph Project, as hereinafter described, resulting from the tailwater encroachment caused by the operation of the Wells Project, will be replaced by the District to the United States in time and kind except as otherwise agreed herein. The power loss at the Chief Joseph Project will be deemed to be the power loss computed in the manner described in Exhibit 1 attached hereto, and by this reference incorporated herein as fully as though set forth verbatim in the body of this agreement. The computation of the power loss shown in Exhibit 1

is based on the overload capability of 80 MW per unit of the Chief Joseph turbines and generators existing at the time the Wells Project is licensed irrespective of the specific units being operated.

ARTICLE 3. REPLACEMENT OF POWER LOSS. The replacement of power loss at the Chief Joseph Project, as hereinbefore described, will be delivered at no cost to the United States at the nearest point of electrical inter-connection between the Wells Project and the Federal Transmission System. If the United States does not accept replacement power for any hour, the United States shall be deemed to have had no power loss at Chief Joseph for that hour.

ARTICLE 4. DATA. The Chief of Engineers will make available to the District, upon request, such physical data as records of unit output and flow, forebay and tailwater elevation, performance characteristics of the Chief Joseph Project and such other information as required to assist the District in the computation of power losses at Chief Joseph Project referred to in Article 3 and described in Exhibit 1.

ARTICLE 5. ADMINISTRATION. The District shall at its own expense furnish the District Engineer, US Army Engineer District, Seattle, on behalf of the Chief of Engineers, tabulations of power loss and replacement. These tabulations shall be transmitted on or before the 15th day of the month succeeding the month for which the computations are made. After acceptance by the US Army Engineer District, Seattle, the tabulation will be returned to the District and will constitute confirmation by the United States that power loss occurred and replacement was made as set forth in such tabulation. Any reasonable cost incurred by US Army Engineer District, Seattle, in checking power loss and replacement calculations shall be reimbursed

by the District upon submittal of statements by the US Army Engineer District, Seattle.

ARTICLE 6. SAVINGS CLAUSE. The provisions contained herein shall not be construed as a waiver of any of the provisions in license, Project No. 2149.

ARTICLE 7. UNCONTROLLABLE FORCES. Neither party shall be considered to be in default in respect to any obligation hereunder if prevented from fulfilling such obligation by reason of uncontrollable forces, the term "uncontrollable forces" being deemed for the purpose of this agreement to mean any cause beyond the control of the party affected, including but not limited to destruction or impairment of facilities resulting from flood, earthquake, storm, lightning, fire, epidemic, war, riot, civil disturbance, labor disturbance, sabotage, proceeding by court of public authority, which uncontrollable forces, by exercise of due diligence and foresight, the party affected could not reasonably have been expected to avoid. When either party is unable to fulfill any obligation by reason of uncontrollable forces it shall exercise due diligence to remove such inability with all reasonable dispatch.

ARTICLE 8. COVENANT AGAINST CONTINGENT FEES. The District warrants that no person or selling agency has been employed or retained to solicit or secure this agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the District for the purpose of conducting business. For breach or violation of this

warranty the United States shall have the right to annul this agreement without liability, or in its discretion to deduct from the agreement price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 9. OFFICIALS NOT TO BENEFIT. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

ARTICLE 10. DEFINITIONS.

(a) The term "head of the agency" or "Secretary" as used herein means the Secretary of the Army; and the term "his duly authorized representative" means the Chief of Engineers, Department of the Army, or an individual or board designated by him.

(b) The term "Contracting Officer" as used herein means the person executing this contract on behalf of the Government and includes a duly appointed successor or authorized representative.

ARTICLE 11. APPROVAL. This agreement shall be subject to the written approval of the Chief of Engineers, Department of the Army or his duly authorized representative, and shall not be binding until so approved. IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the day and year first above written.

CHIEF OF ENGINEERS
DEPARTMENT OF THE ARMY

R. E. MC CONNELL
Colonel, Corps of Engineers
Contracting Officer

PUBLIC UTILITY DISTRICT NO. 1
OF DOUGLAS COUNTY, WASHINGTON

ATTEST

President

Secretary

Vice President

EXHIBIT 1

This exhibit sets forth the method to be used to determine the power replacement to be delivered to the United States for the power loss at the Chief Joseph Project resulting from the operation of the Wells Project. The power loss calculations will be based on average hourly data. The District normally will make the calculations five days per week and in no event will the calculations be delayed more than five days after the actual loss has occurred.

The time when replacement of power losses will be made is based upon the following general conditions:

1. When the peaking capability of Chief Joseph would not be affected by the tailwater encroachment from the Wells reservoir the replacement of all or part of the power loss may be delayed at the request of the District. Delayed replacement must be scheduled within one week of the time the loss is incurred unless otherwise mutually agreed to by the parties to this agreement.
2. The District shall replace the power loss at Chief Joseph in time and kind when the United States expresses a need by scheduling such replacement from the District. However, if in order to make such replacement in time and kind either the District or its Purchasers would be required to make purchases not otherwise required or run a steam unit not otherwise being operated, the replacement may be deferred to the extent of such purchase or steam operation, except

when required for the Federal System to supply power demands in the Pacific Northwest Area and demands in conformity with Public Law 88-552 as approved August 31, 1964. In determining the ability of the Federal System to meet such power demands, consideration shall be given to reserve requirements, transmission line loadings, equipment operating limits, hydraulic limitations and limitations imposed by non-power requirements on hydro-electric projects.

The power loss will be computed on the attached form titled "Power Replacement Calculation," using the attached tables and the following procedure:

Col. 1 Hour - The loss will be computed for the 60 minute period ending at the time shown in Column 1.

Col. 2 Average Observed Forebay Elevation (ft.) - Average hourly value obtained from the powerhouse forebay gage. The forebay elevation shall be the actual forebay elevation limited to not less than El. 945 when Chief Joseph Project is not spilling and not less than El. 946 when spilling, except when the replacement of power loss is required to serve power demands on the Federal System as defined in paragraph 2 immediately above, the actual forebay elevation shall be used.

Col. 3 Average Observed Tailwater Elevation (ft.) - Average hourly value at the location of the original 16 unit plant.

Col. 4 Gross Head with Wells (ft.) - Average observed forebay

elevation, Column 2, less the average observed tailwater elevation, Column 3.

- Col. 5 Operable Units - Original 16 - The number of the original 16 units which are in service or ready for service. Original units out of service for planned maintenance or on forced outage (see Col. 17) are to be subtracted from the total number of original units (16).
- Col. 6 Operable Units - New - The number of new units (Unit 17 and above) which are in service or ready for service. New units out of service for planned maintenance or on forced outage (see Col. 17) are to be subtracted from the total number of new units in the plant.
- Col. 7 Plant Generator Limit (MW) - The summation of the rated generator output plus overload capacity of all operable units.
- Col. 8 Spill - If the project is spilling enter "Yes." If not, enter "No."
- Col. 9 Equivalent Number of Operable Units - The number of operable units of the original 16 units (Col. 5) plus the number of operable new units (Col. 6) multiplied by an equivalence factor relating the performance of the new units to that of the original units.
- Col. 10 Total Turbine Discharge (KCFS) - The average hourly powerhouse discharge.

Col. 11 Discharge per Equivalent Unit (KCFS) - The total turbine discharge, Column 10, divided by the equivalent number of operable units, Column 9.

Col. 12 Full Gate - Enter "Yes" or "No." However, if the plant is operating on load frequency control, and is between 97 percent of full gate output and full gate limit, enter "Yes."

Col. 13 Generator Limit - If the observed plant output (Col. 28) equals or exceeds Column 7 enter "Yes." If not, enter "No."

NOTE: Continue with the calculation if:

- (a) Col 8 is answered "No," ^{spill} or if: *No or less (water spill)*
- (b) Col 8 and Col 12 are answered "Yes" and Col 13 is *generator limit* answered "No."

In all other cases no further calculation is required and zero is entered in Col. 40 and Col. 45.

Col. 14 Average Project Discharge (KCFS) - The sum of the average hourly value of all spillway and powerhouse discharge.

Col. 15 Average Tailwater Without Wells (ft.) - Determined from the tailwater rating table, Attachment No. 2, using the average project discharge, Column 14.

Col. 16 Gross Head Without Wells (ft.) - Average observed forebay elevation, Column 2, less the average tailwater without Wells, Column 15.

Col. 17 Number of Original 16 Units not on Forced Outage - "Forced Outage" shall mean an outage due to any failure of the turbine, generator, transformer or switchgear or

any of their auxiliaries or pertinent structures extending from, and including, the water passages to the line take-off from the switchyard which requires the unit to be taken out of service. An outage to be considered forced must satisfy one of the following conditions:

- (1) It is necessary to take the unit out of service immediately.
- (2) It is not necessary to take the unit out of service immediately, but the eventual outage cannot be delayed until a normally scheduled maintenance period or light load period which is of sufficient length to make necessary repairs.

When only existing 16 units are installed use Column 5 value in this column.

Col. 18 Equivalent Number of 80 MW Units in Plant - Add to Column 17

the following: The number of new units not on forced outage (see Col. 17) multiplied by an equivalence factor relating the performance of the new and original units.

Col. 19 Unit Flow - Not Limited by the Hydraulic Limit (KCFS) -

Average project discharge, Column 14 divided by the equivalent number of units in the plant, Column 18. This shall not be less than 5.6 KCFS, the approximate point of best unit efficiency.

Col. 20 Unit Flow at the Hydraulic Limit without Wells (KCFS) -

Enter the tables of Attachment No. 1 at the column corresponding to the gross head without Wells. Select the unit

flow corresponding to the MW/KCFS value at the hydraulic limit line. This will be at the last MW/KCFS value in the column.

- Col. 21 Unit Flow (KCFS) - The flow through the units of Column 17 under conditions of most efficient plant operation. When additional units are added to the plant, it will be assumed that the units of Column 17 will be loaded to best gate before loading the additional units. This flow is the smaller of Column 19 or Column 20.
- Col. 22 "K" Factor with Wells (MW per KCFS) - Determined from Attachment No. 1 using the quantities in Columns 4 and 21. If the intersection of these two quantities falls outside the limits of the Table, use the "K" factor corresponding to the hydraulic limit for the head entered in Column 4.
- Col. 23 "K" Factor without Wells (MW per KCFS) - Determined from Attachment No. 1 using the quantities in Cols. 16 and 21. If the intersection of these two quantities falls outside the limits of the table, use the "K" factor corresponding to the hydraulic limit for the head entered in Column 16.
- Col. 24 ΔK (MW per KCFS) - Column 23 less Column 22.
- Col. 25 Original Plant Flow at the Hydraulic Limit Without Wells (KCFS) - Column 17 multiplied by Column 20.
- Col. 26 Flow for Loss Calculation (KCFS) - The smaller of the values shown in Column 14 or Column 25.
- Col. 27 Calculated Loss (MW) - Column 24 multiplied by Column 26.

- Col. 28 Observed Plant Output (MW) - The plant output for the hour determined from the totalizing meter.
- Col. 29 Calculated Unit Hours (Unit-Hours) - Column 14 divided by Column 21.
- Col. 30 Original Unit Hours Operable (Unit-Hours) - The smaller of Column 17 or Column 29.
- Col. 31 Total Number of Unit Hours Operable (Unit-Hours) - The smaller of Column 18 or Column 29.
- Col. 32 Ratio for Assigning Generation to Original Units - Column 30 divided by Column 31.
- Col. 33 Output Assigned to the Original Units (MW) - Column 28 multiplied by Column 32.
- Col. 34 Maximum Output of Original Units (MW) - 80 MW multiplied by Column 17.
- Col. 35 Calculated Loss plus Output Assigned to Original Units (MW) - Column 27 plus Column 33 limited to Column 34.
- Col. 36 Power Loss Owed for Encroachment (MW) - Column 35 less Column 33. This can be a negative value only when the Wells Project delays payment. Otherwise, if a negative value is calculated, use zero.

NOTE: The water use calculation is made only if one of the following two conditions exist:

1. Wells delays payment and Column 35 is limited to Column 34.
2. A value of cumulative difference in water use is in

Column 40 for the previous hour and Column 35 is not limited to Column 34.

- Col. 37 Flow Assigned to Original Plant (KCFS) - Column 14 multiplied by Column 32.
- Col. 38 Hydraulic Capacity for No. of Units in Column 17 at Head Without Wells (KCFS) - The value determined from Attachment No. 3 using values in Column 2 and Column 18, multiplied by Column 17/Column 18.
- Col. 39 Difference in Water Use (KCFS) - Subtract from the flow assigned to the original plant, Column 37, the flow in Column 38. Negative values should be included. Zero if spilling.
- Col. 40 Cumulative Difference in Water Use (KCFS-Hours) - This is the accumulation of the difference in water use, Column 39. If it becomes negative, enter a zero. If spilling, enter a zero. At the end of each day, a check is made to determine whether the cumulative value in this column can be carried over to the next day. This is done by comparing the daily sum of Column 7 with the total daily generation, plus the daily sum of power loss owed for encroachment, Column 36. If the sum of Column 7 is less, no carryover can be made, and the cumulation in Column 40 will begin again at zero. If the sum of Column 7 is equal to or greater, the cumulation will continue.
- Col. 41 Theoretical Storage Draft (KCFS) - This represents the storage draft that could have been made during the hour without Wells, if the water had not been used earlier to maintain peaking

capability with Wells. It is determined by subtracting the value shown in Column 40 for this hour from the value shown in Column 40 for the previous hour.

- Col. 42 Incremental Hours at Generator Limit - This ratio of theoretical storage draft, Column 41, to difference in water use, Column 39, represents the fraction of the hour that generation at rated output plus overload capability could have been maintained without Wells, using the water from storage which was required to maintain peaking capability of the plant with Wells constructed.
- Col. 43 Maximum Generation from Theoretical Storage Draft (MW) - This represents the upper limit of the generation possible from the theoretical storage draft in MW and is determined by subtracting the output of original units without Wells, Column 35, from the plant maximum output of the original units, Column 34.
- Col. 44 Power Loss Owed for Difference in Water Use (MW) - Column 42 multiplied by Column 43.
- Col. 45 Total Power Loss Owed (MW) - The total loss is the sum of the power loss owed for encroachment, Column 36, and the power loss owed for difference in water use, Column 44. However, if the United States does not accept replacement power for any hour, the total power loss owed for that hour shall be shown as zero and marked by an asterisk to indicate this fact.
- Col. 46 Scheduled Replacement (MW) - This is the replacement of power for the hour as estimated before the hour. It will be based

on estimates of river flow, number of units operating during the hour, and any other information which will assist in the accurate estimation of this quantity.

Replacement of power loss for encroachment will be scheduled during periods like that in which the loss occurred, except as previously provided in this Exhibit 1. If replacement is deferred or cancelled, the reason will be indicated by an appropriate notation in Col. 46 as follows or as otherwise mutually agreed:

- (a) When Chief Joseph peaking capability not affected.
- (b) District must purchase power or start steam unit and United States does not require power to serve loads.
- (c) Replacement power refused by United States.
- (d) Water use accumulation.

When replacement of power loss is delayed, a water use calculation will be made to determine the incremental discharge required to maintain capability of the 16 unit plant. Replacement of the power value of the incremental discharge shall be made within a period of time equal to that in which it was accumulated, commencing within 24 hours after the accumulation ceases.

Col. 47 Deviation (MW) - Column 46 less Column 45 represents the excess or deficiency of the scheduled replacement.

Summary

Each day the total power loss owed, scheduled replacement, and

deviation will be entered in the summary box at the foot of Columns 45, 46 and 47. The total loss, Column 45, will be multiplied by 0.9956 (Chief Joseph Transformer efficiency) to correct for transformation loss to the 230 KV bus at the Chief Joseph Project. Appropriate change will then be made to the deviation, Column 47, to account for the adjustment in the total loss, considering no adjustment to the scheduled payment. Cumulative totals for these columns will be carried over from the previous day until the end of the month. The cumulative total of Col. 47 will be carried over to the next month.

ATTACHMENTS

1. Chief Joseph Powerhouse Mean Unit Performance, from Corps of Engineers studies published in a report entitled "Chief Joseph Dam Turbine Ratings by the Current Meter Methods," March 1967.
2. Chief Joseph Tailwater Rating Curve Prior to the Construction of Wells - Prepared from data collected at four temporary tailwater gages along the face of the Chief Joseph Powerhouse in 1965 and 1966, and from recorded data at the permanent station tailwater gage.
3. Hydraulic Capacity at Head Without Wells - Prepared from the mean unit performance data reported in "Chief Joseph Dam Turbine Ratings by the Current Meter Method," March 1967.
4. Power Replacement Calculation

SUPPLEMENT TO 1968 ENCROACHMENT AGREEMENT

RECITALS:

(1) Douglas County Public Utility District (the District) has operated the Wells Project with a forebay level that has caused a headloss at Chief Joseph and has been compensating the United States for power loss caused by the encroachment in accordance with the Agreement entered into on August 26, 1968, entitled "Power Loss From Wells Project Encroachment of Chief Joseph Dam" (hereafter Agreement). The parties intend that the Agreement remain in full force and effect, supplemented by the terms contained herein.

(2) The District has a proposal before the Federal Energy Regulatory Commission (FERC) to amend the project license to allow the maximum forebay level to be raised from elevation 779 feet to elevation 781 feet.

(3) The Corps of Engineers (the Corps) has installed Units 17-27 and is now authorized and funded to rewind Units 1-16 and to purchase and install transformers with increased ratings.

(4) The District and the Corps both acknowledge that the data used in performing the calculations to determine the power loss resulting from the additional encroachment under this supplemental agreement are derived in part from theoretical models and studies. The parties recognize that when it becomes available the most accurate and valid data must be substituted only into this supplemental agreement as provided in Paragraph (3) below.

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NOW, THEREFORE, the parties hereby agree that the 1968 agreement entitled, "Power Loss From Wells Project Encroachment on Chief Joseph Dam" will continue in full force and effect and will be supplemented as follows:

(1) The District will replace power loss resulting from:

(a) encroachment on Units 1-16 in accordance with the terms of the Agreement to forebay elevation 781 feet; (b) the additional encroachment caused by any operation at Wells within the forebay range elevation 779 to 781 feet (i) on units 17-27 and (ii) on units 1-16 taking into consideration only the incremental increase in generation due to uprating (includes rewind and new transformers). Calculation of such additional encroachment will be made in accordance with the detailed procedures set forth in Attachments 1, 1(a) and 2 of this supplement.

(2) If Column 54 in Attachment 1 is zero, no additional encroachment shall be paid.

(3) When more accurate and valid data is obtained from observation of operating and test conditions, it will be substituted into Attachments 1, 1(a) and 2 of this supplement for the purpose of calculating additional encroachment under this supplemental agreement and it will not affect the Agreement.

(4) The terms of this supplemental agreement resolve all present encroachment issues between the parties and shall have no precedential value. Neither this supplemental agreement nor its terms may be utilized in any subsequent negotiations or proceedings relating to encroachment beyond that contemplated herein.

(5) If it is determined in the future that the method of computation provided for herein does not reflect actual power loss, a revision in the procedures pertaining to this supplement only, as mutually agreed by the parties hereto will be made. If the parties are unable to reach agreement as to what revisions in the method of computation in the supplement agreement are necessary to reflect actual power loss, the method of computation in this supplemental agreement will remain in effect until resolution of the disagreement is accomplished by an appropriate forum.

DATED this 27 day of SEPTEMBER, 1982.

PUBLIC UTILITY DISTRICT NO. 1
OF DOUGLAS COUNTY

By _____
Michael Doneen, President

By _____
William E. Bechtol, Vice President

ATTEST:

By _____
Howard Prey, Secretary

UNITED STATES ARMY CORPS OF ENGINEERS

By _____

Attachment 1

CHIEF JOSEPH + SUPPLEMENTAL POWER REPLACEMENT CALCULATION
(Wells Two Foot Raise)

Hour	Avg. Observ. T.W. Elev. Ft.	Avg. Chief Joseph T.W. Elev. From Attach. 1a Ft.	Chief Joseph T.W. Diff. Ft.	New Unit Assigned Disch. KCFS	Additional Supplemental Encro. Due MW	Encro Due Orig. Units MW	Total Power Loss Owed MW	Sched. Reperm't	Deviation
51	.1	.1	54	56	.1	.1	45	46	47

(Col. 57) + (Col. 56) + (Col. 44)

From (Col. 36)

(Col. 55) x (Col. 54) x slope factor
Slope factor = .075 head ranges, 165-185 ft.
Slope factor = .085 below, 165 ft. (See Col. 4)

Total Turbine Disch. (Col. 10) less Disch Assigned to Orig. 16 Units (Col. 26)

Col. 52 less Col. 53. If zero or negative, enter zero here and in Col. 56.

From TW Rating Curve (Attachment 1a) using average Project discharge (Col. 14)

Col. 3 (Power Replacement Calculation)

ATTACHMENT 1(a)

CHIEF JOSEPH TAILWATER RATING CURVE

Developed from actual operating data as of November 25, 1981, Wells forebay 779.0 elevation, subject to continued study and improvement.

<u>Chief Joseph Disch KCFS .1</u>	<u>Chief Joseph T.W. Elev. Ft.</u>
0.0	779.0
20.0	779.0
40.0	779.1
60.0	779.4
80.0	780.1
100.0	780.9
120.0	781.9
140.0	783.0
160.0	784.1
180.0	785.4
200.0	786.5
220.0	787.7
240.0	788.7
260.0	789.8

ATTACHMENT 2

Detailed Procedures for Calculating Additional Encroachment

- Col. 51 Hour of Day: Same as Col. 1 of the Original Agreement.
- Col. 52 Average Observed Chief Joseph Tailwater Elevation: Same as Col. 3 of the Original Agreement. (This tailwater elevation is measured at the same point for the Agreement and the Supplement.)
- Col. 53 Average Chief Joseph Tailwater Elevation for Wells at 779.0: From Attachment 1(a).
- Col. 54 Additional Encroachment due to Incremental Raise at Wells: Col. 52 less Col. 53. If negative, enter 0. If value entered is 0, enter 0 in Col. 56 and continue with Col. 57.
- Col. 55 Turbine Discharge Used for Additional Encroachment: Col. 10 (Total Turbine Discharge) Less Col. 26, (Discharge Assigned to original units). This is the discharge thru Units 1-16 due to uprating and thru Units 17-27 not substituted.
- Col. 56 Additional Encroachment: Col. 55 x Col. 54 x slope factor. The slope factor is Delta-K per foot. Based on the best currently available data, below a head of 165.0 ft., this slope factor is 0.085 per foot; above that head it is 0.075 per foot. When more accurate data become available, it will be used in determining these values.
- Col. 57 Encroachment Due on Original Units: Same as Col. 36 of Original Agreement.
- Col. 58 Total Power Loss Owed: The sum of Col. 57, Col. 44 and Col. 56.