US Army Corps
of Engineers®
Walla Walla District

Water Control Manual

For

Lower Granite Lock and Dam

Snake River, Oregon, Washington, and Idaho

Scanned and reformatted for Revision
April 2010

WATER CONTROL MANUAL REVISIONS
FOR LOWER GRANIT LOCK AND DAM

The following revisions are provided, for the updating of' the water control manual. These revisions will be reviewed annually and updated if necessary. Major revisions; pertaining to format content in accordance with references ETL 110-2-251 and ER ' 1110-2-240 will be accomplished as time and manpower become available.

DECEMBER 1987 REVISIONS include:

a. Notice to Users of. Manual (Pink Sheet, page iii)
b. E mergency Regulation Assistance.Procedures (Pink Sheets:', page i. & v
c. Section VI - Water Control Management
   (1) Text (pages 6-1, 6-2, 6-7)
   (2) ORGANIZATION CHART - NPD &. NPW. (page 6-8)
   (3) ORGANIZATION CHART - BPA (page 6-9)
   (4) Personnel and Telephone Number (pages 6-10 & 6-11)
d. Section VIII - Water Control Plan (pages .8-10, 8-11, & 8-12)
e. Section IX - Effect of Water Control Plan (page 9-5)
f. PLATE 9-2 Annual Peak Discharge Frequencies - Columbia River at The Dalles

1984 revisions include:

a. Emergency Regulation Assistance Procedures. (Pink Sheet, Page i}
b. Water Control Management
   (l) Organization Charts (Pages 9-1 to 9-2)
   (2) Personnel and Telephone Numbers (Pages 9-3 TO 9-4)
c. Stream Gage Rating Tables A-4 to A-7

WATER CONTROL MANUAL

FOR

LOWER GRANITE LOCK AND DAM

SNAKE RIVER

OREGON, WASHINGTON, AND IDAHO

U. S. ARMY CORPS OF ENGINEERS

WALLA WALLA DISTRICT

MAY 1987

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LOWER GRANITE LOCK AND DAM

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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 inserts can be made to keep the manual current.

As a continuing program it will be necessary to revise portions of this manual annually in order to keep it up to date. Revisions to this manual will be made by the Walla Walla District's Planning Division - Hydrology Branch. Whenever revisions are necessitated, new pages containing the revised material will be printed with the date of revision and issued to each person having a copy of the manual so that substitution may be made

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Emergency procedures are used if physical and/or structural failures occur at the Lower Granite project (dam, reservoir, and levees) and emergency coordination and action may be necessary to prevent loss of life or property. Emergency coordination and action required will be dependent upon the nature and severity of the emergency. Possible emergencies have been divided into the following categories: (1) catastrophic failures; (2) equipment failures; (3) project function emergencies (power generation and navigation); and (4) national type emergencies. The following paragraphs provide guidance on action required by operators and engineers dealing with these four categories of emergency conditions.

Castastrophic failures includes:

(1) Flooding resulting from failures at Dworshak Dam and Brownlee Dam.

(2) Assumed spillway design floods, spillway design floods with dam failures, a dam failure floods during high pool.

(3) Flooding and damage caused by earthquakes, sabotage, earthfill dam piping, cracking, equipment malfunction, leakage, embankment seepage, and foundation failures.

Catastrophic failures should be coordinated according to existing criteria within the Flood Emergency Subplans - Lower Granite Lock and Dam - Snake River, Washington, U. S. Army Engineer District, Walla Walla, March 1982.

Equipment failures that would prevent the controlled discharge of water passing through the project (powerhouse, spillway, and lock) would be an emergency and should be coordinated according to criteria within Operation and Maintenance (O&M) Manual - Lower Granite Lock and Dam - Snake River, Washington, U. S. Army Engineer district, Walla Walla.

Project function emergencies affecting power generation and navigation are the responsibility of the Granite-Goose Project Engineer or his representative. If an emergency occurs or appears to be developing, the Project Engineer will contact the Walla Walla District, Chief, Operations Division, for instructions. If the nature of the emergency is such as to require immediate action, the Project Engineer may take necessary action and report to Chief, Operations Division as soon as possible. The Bonneville power Administration will be notified of any emergency which may affect power production and navigation interests will be notified of unusual conditions which might affect navigation.

National type emergencies should be coordinated according to Annex K, Appendix 3 of the Walla Walla District Continuity of Operations Plan, which describes actions to be taken at Lower Granite Project under various types of national emergencies (terrorist attack, sabotage, nuclear war, etc.). The project can be used as a public fallout shelter during a nuclear attack situation.

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Lower Granite Lock and Dam

PERTINENT DATA

1. GENERAL:

Location:

State	Washington
Counties	Garfield and Whitman
River	Snake
River Mile	107.5
Township	14 N
Range	43 E
Section	32
Latitude	46° 39' 37"
Longitude	117° 25' 37"

River miles from mouth of Snake River	107.5
River miles upstream from Little Goose Dam	37.2

Owner U.S. Army Corps of Engineers, Walla Walla District

Authorized purpose	Power generation and inland navigation
Other uses	Flood Control (maintain levee freeboard at Lewiston), Fishery, and recreation
Type of project	Run-of-river

Real estate: Fee acquisition land

Above pool elevation 738, acres	9,224

2. RESERVOIR

Name	Lower Granite Lake 1/

Elevations (feet msl):

Maximum at dam for spillway design flood	746.5
Normal operating range at confluence gage (RM 139.5)	738-733
Minimum at dam for standard project flood	724

1/ For the purpose of continuity with existing Lower Granite Lock and Dam documents, the use of the terms "pool" or "reservoir" are used interchangeably. The term "lake" is used to designate a geographical body of water.

2. RESERVOIR (CONTINUED)

Length, miles:	39.3
Snake River (to Asotin damsite, RM 146.8)	39.3
Clearwater River	4.6
Length of Shoreline, miles	91
Average width, miles	0.3
Maximum width, miles	0.6
Surface area at El. 738 (low flow – flat pool), acres	8,900
Storage below flat pool El. 738, acre feet	483,000
Storage below flat pool El. 733, acre feet	440,200
Storage between El. 733 and 738	43,600
Height normal high pool to tailwater El. 638 (low flow 30,000 cfs or less), feet	100

3. LEVEES:

Top width, feet	12
Slopes, waterside and landside	1V on 2 H
Materials	Gravel and earth fill with impervious core
Top elevation	5 feet above backwater profile For standard project flood
Embankment length, miles:	
Lewiston	8.6
Installed pumping capacity, cfs:	
Lewiston levees	450.4

4. DAM (GENERAL):

Axis (Lambert	N 32° 00’
Length and widths (in feet):	
Dam total length at crest	3,200
North abutment embankment	1,435
South nonoverflow monoliths	32.2
Spillway overall length	512
Spillway to powerhouse nonoverflow	43.4
Powerhouse overall length	656
Spillway to navigation lock nonoverflow	43.4

4. DAM (GENERAL) (CONTINUED):

Navigation lock overall width at foundation	304
Navigation lock overall width at deck	186
Concrete heights (feet):	
Maximum overall concrete height	
(Powerhouse sump deck to deck)	254
Maximum nonoverflow monoliths height	
(North)	151
(Central)	166
(South)	181
Maximum lock wall monolith height	
(Culverts to deck)	191

Deck elevations (feet msl):	
Intake, spillway bridge, nonoverflow sections, and	
Upstream end of navigation lock	751
Downstream end of navigation lock	746
South shore fish ladder	656
Tailrace and fishwater intake	656
North abutment embankment	756

5. SPILLWAY:

Number of bays	8
Overall length, feet (abutment centerlines)	512
Deck elevation, feet msl	751
Ogee crest elevations, feet msl	681
Flip lip elevation, feet msl	630
Control gates:	
Type	Tainter
Size	50'W x 60'H
Gantry crane (joint use with powerhouse):	
Capacity, tons	100
Stilling basin length, feet	188
Stilling basin elevation, feet msl	580
Maximum design capacity, cfs	850,000

6. POWERHOUSE:

Length overall, feet	656
Spacing, feet:	
Units 1 through 5	90
Unit 6	96
Erection and service bay	110

6. POWERHOUSE (CONTINUED):

Width overall, transverse section, feet	243.17
Intake deck elevation, feet msl	751
Tailrace deck elevation, feet msl	656
Maximum height (draft tube invert to intake deck), feet	228
Turbines:	
Type	Kaplan, 6-blade
Runner diameter, inches	312
Revolutions per minute	90
Rating, horsepower	212,400
Distributor centerline elevation	599
Generators:	
Rating (nameplates), kilowatts	135,000
Power factor	0.95
Kilovolt ampere rating	142,100
Units installed complete initially	3
Skeleton units provided initially	3
Total units now installed	6
Plant capacity, nameplate rating, kilowatts	810,000
Crane capacities, tons:	
Intake (joint use with spillway)	100
Bridge	600
Draft tube gantry	50

7. NAVIGATION LOCK AND CHANNELS:

Net clear length, lock chamber, feet	674
Net clear width, lock chamber, feet	86
Upstream gate:	
Type	Submersible tainter
Height, feet	23
Downstream gate:	
Type	Miter
Height, feet	122
Operating water surface elevations in chamber	633-738
Maximum operating lock lift, feet	105
Lift, feet (riverflow 300,000 cfs, practical navigation limit)	88.2

7. NAVIGATION LOCK AND CHANNELS (CONTINUED):

Length of guide walls (from face of gate), feet:	
Upstream (floating)	750
Downstream	700
Downstream approach channel:	
Width, feet	250
Bottom elevation	617
Minimum tailwater elevation	633.0
Lower lock sill elevation	618.0
Upper lock sill elevation, feet	718.0
Maximum depth over upper sill, feet	20.0
Minimum water depth over sills, feet	15.0

8. ABUTMENT EMBANKMENT:

Embankment elevation	756
Embankment top width, feet	45
Material	Gravel fill with rock facing; impervious silt core
Upstream	Combination sand and gravel filters
Downstream	Gravel and sand filters
Slope, upstream	1V on 2H
Slope, downstream	1V on 2H

9. FISH FACILITIES:

Upstream migrants fish ladder:	
Number of fish ladders	1
Slope:	
Weir 634 – Weir 627	1V on 10H
Weir 728 - Weir 737	1V on 32H
Ladder clear width, feet	20
Design capacity, cfs	75
Exit channel:	
Location	Between weir 737 and pool in nonoverflow section
Top of trashrack	El. 732
Invert	El. 727
Width, feet	6

9. FISH FACILITIES (CONTINUED):

Alternate exit channel (pool El. below 727):	
Exit pipe to reservoir	18-inch-diameter full plastic pipe down to El. 718 and a half-round plastic pipe down to El. 710.
Operating elevations:	
Design range:	
Pool elevations	733 to 738
Tailwater elevations River flow	633 to 642
Riverflow	Zero to 225,000 cfs
Maximum operating range:	
Pool elevations	732 to 739
Tailwater elevations	633 to 645.4
Riverflow	Zero to 340,000 cfs
Adult fish trap and handling facility	
Pumps for fishway system attraction water:	
Number	3
Capacity, cfs	3,150
Downstream migrants bypass system:	
Design pool range	733 to 738
Design capacity, 'cfs	200 to 250
Submersible traveling fish screens	18
Vertical barrier fish screens	18
Orifices from bulkhead and fish screen slots:	
Number	72
Size (diameter in inches)	10
Fingerling collection gallery	1
Fingerling transportation pipe	1
Fingerling holding and sampling facility	1
Fingerling transportation facilities:	
Truck loading facility	1
Barge loading facility	1

10. HYDROLOGIC DATA (Based on streamflow data for Snake River near Clarkston, Washington):

Drainage area, square miles	103,200
Period of record	October 1915 - September 1972 December 1972 (discontinued)
Discharges in cfs:	
Instantaneous maximum of record, 29 May 1948	369,000
Instantaneous minimum of record, 2 September 1958	6,660
Average annual flow	50,300
Average annual mean daily peak flow	188,300
Extreme outside period of record:	
Flood of June 1894	409,000
Flood of June 1894, controlled by Existing projects	295,000
Standard project flood (controlled by Existing projects):	
Snake River below Clearwater River	420,000
Snake River above Clearwater River	295,000
Clearwater River above Snake River	150,000
Spillway design flood:	850,000

I - INTRODUCTION

1-01. Authorization. This Water Control Manual has been prepared according to authority contained in Section 7 of ER 1110-2-240, "Engineering and Design - Water Control Management," dated 8 October 1982. The format and content of this manual are in accordance with criteria set forth in EM 1110-2-3600 dated 25 May 1959, and ETL 1110-2-251, "Engineering and Design - Preparation of Water Control Manuals," dated 14 March 1980.

1-02. Purpose and Scope. The purpose of this manual is to present information pertinent to the regulation of Lower Granite project and to provide a reference source for higher authority and personnel responsible for the regulation of Lower Granite project. Items discussed within this manual are as follows:

a. History of project.

b. Description of project.

c. Basin characteristics.

d. Data collection and communication networks.

e. Water control management.

f. Streamflow forecasts.

g. Water control plan.

h. Effect of water control plan.

Section VI, Water Control Management, outlines responsibilities of the Corps of Engineers, BPA, and other agencies involved indirectly with the regulation of the Lower Granite project. Section VIII - Water Control Plan contains information necessary for understanding the objectives of the project and instructions to implement the regulation of the reservoir. The Master Water Control Manual for the Columbia River Basin, dated December 1984, contains policies and procedures for system regulation and coordination of major water control projects in the basin.

1-03. Related Manuals and Reports. A list of published design memorandums is provided in Exhibit 1-1 of this manual. The following list outlines manuals and reports which contain information and data pertinent to the operation of Lower Granite project, Snake River, Washington and Idaho.

a. Design Memorandum No. 1 - Hydrology, December 1963.

b. Design Memorandum No. 3 - General Design Memorandum (4 volumes), 13 March 1964.

c. Design Memorandum No. 21 - Fish Facilities, 6 September 1966. Supplement 1 - Redesign of Fish Ladder, 16 December 1969. Supplement 2 - Adult Fish Trapping Facilities, 29 May 1973.

d. Design Memorandum No. 28 - Master Plan, June 1974.

e. Design Memorandum No. 28.4 - Recreation Facilities and Public Use Areas, 14 March 1974.

f. Design Memorandum No. 39 - Lake Sedimentation Ranges, 30 May 1975.

g. Final Environmental Impact Statement, May 1975.

h. North Pacific Division - Fish Facilities Manual, U.S. Army Corps of Engineers, March 1981.

i. Flood Emergency Subplans - Identification, Operation, Repair, Notification, and Inundation Maps - Lower Granite Lock and Dam Project, March 1982.

j. Construction History Report - Lower Granite Lock and Dam, June 1984.

k. Columbia River Basin - Master Water Control Manual, December 1984.

l. Draft - Lower Granite Lock and Dam Operation and Maintenance Manual, expected submittal date for approval 1987.

m. Juvenile Fish Passage Plan for Corps of Engineers Projects, published annually by NPDEN-WM.

1-04. Project Owner and Operator. The Federal Government owns the Lower Granite project. The Walla Walla District Corps of Engineers is responsible for the operation and maintenance of the Lower Granite project and its facilities.

1-05. Regulating Agencies. Functional day-to-day water regulation at Lower Granite is the responsibility of the U.S. Army Corps of Engineers, North Pacific Division, Reservoir Control Center (RCC). RCC coordinates the regulation of existing projects with other agencies in order to provide maximum benefits to the public. The Walla Walla District Corps of Engineers is responsible for reviewing and updating the Water Control Plan for the regulation of Lower Granite and upon request from RCC aids in its regulation by providing technical advice. The BPA is authorized to market electrical energy generated at Lower Granite and other Federal projects within the Columbia Basin system. Section VI - Water Control Management outlines the responsibilities of the key agencies connected with the management of Lower Granite and other Corps of Engineers, North Pacific Division, projects.

II - HISTORY OF PROJECT

2-01. Authorization. Lower Granite project was authorized by Public Law 14, 79th Congress, 1st Session, approved 2 March 1945. The applicable portion of the act reads as follows:

> "...Snake River, Oregon, Washington, and Idaho: The construction of such dams as are necessary, and open channel improvement for the purposes of providing slackwater navigation and irrigation in accordance with the plan submitted in House Document Numbered 704, Seventy-fifth Congress, with such modifications as do not change the requirement to provide slack-water navigation as the Secretary of War may find advisable after consultation with the Secretary of the Interior and such other agencies as may be concerned: Provided, that surplus electric energy generated at the dams authorized in this item shall be delivered to the Secretary of the Interior for disposition in accordance with existing laws relating to the disposition of power at Bonneville Dam...."

2-02. Early History. Prior to the authorization of slack-water development of the lower Snake River in 1945, an existing project provided for open river improvements to obtain a 5-foot depth in the existing channel to Riparia (mile 68) and from that point a channel of the same depth and generally 60 feet wide to Lewiston, Idaho. Beyond that point, removal of boulders and rock points was contemplated. House Document 704, 75th Congress, 3rd Session, upon which authorization of the Lower Snake River Project was based, proposed an ultimate slack-water development between Pasco, Washington, and Lewiston, Idaho, by 10 locks and dams, with such power facilities as were feasible to develop at the time the work was undertaken. Subsequent to authorization, additional studies of the number of dams required for the project were made and reported in "Special Report on Selection of Sites, Lower Snake River, Oregon, Washington, and Idaho," dated 14 March 1947. This report recommended that development be accomplished by four dams with the downstream unit at Snake River Mile 10.2. The report was approved and additional planning work on the entire four-dam development was authorized, including preparation of a letter report summarizing costs and benefits and of a definite project report on relocations and flowage. Locations of the other three dams (Ice Harbor, Lower Monumental, and Little Goose) are shown on the lower Snake River map, Plate 3-1.

Detailed studies on Lower Granite project as a separate unit of the Lower Snake River Project were initiated in 1958. With more complete data on the proposed site locations, the final site location at RM 107.5 was selected on the basis of geology and navigation channel excavation requirements.

2-03. Significant Dates.

Construction work on Lower Granite Dam was initiated on 2 August 1965 with notice to proceed on the south shore cofferdam and the north shore stripping and channel work, with construction of the Camas Prairie Railroad shoofly. This work was completed 17 December 1966. From November 1966 until May 1970, the Lower Granite project was delayed because of a postponement of congressional funding. The main dam construction started 13 May 1970 and was completed 29 November 1975. The north shore abutment was started 8 July 1974 and completed by mid-July. Lower Granite pool raise began 14 February 1975. Spillway crest elevation 681.0 was reached by 0530 hours on 15 February. The pool reached its maintenance elevation of 733 on 18 February. Final raising of the pool to elevation 738 was accomplished on 22 April 1975. Power on line was first achieved on 15 April 1975 by the operation of Unit 1. Units 2 and 3 were placed in operation on 19 May 1975 and 22 June 1975, respectively. Unit 4 was put on line on 2 January 1978. Units 5 and 6 were placed on line on 17 April 1978 and 13 May 1978, respectively. For additional information pertaining to project history, refer to the "Construction History Report - Lower Granite Lock and Dam Project," dated June 1984, which is filed in the Walla Walla District Library.

III - DESCRIPTION OF PROJECT

3-01. Project Location. Lower Granite Dam is located in southeastern Washington on the Snake River, 37.2 river miles above Little Goose Lock and Dam, 107.5 miles above its confluence with the Columbia River. The dam is 431.8 river miles above the mouth of the Columbia River. Plate 3-1 shows the geographical location of Lower Granite project in relation to other major dams and reservoirs on the lower Snake River system.

3-02. Project Purposes. The primary purposes of the project are inland navigation and hydroelectric power generation. In addition, it provides flood control, fish and wildlife, and recreation benefits. Although flood control is not an authorized project function, the levees constructed at Lewiston provide areas behind the levees with SPF protection.

3-03. Physical Components.

a. General. The following paragraphs provide a general description of the physical components of the Lower Granite project which include the dam, reservoir, and Lewiston levees. Design memorandums and project reports provide details on planning, design, and construction of the project; (refer to paragraph 1-03, Related Manuals and Reports).

b. Dam. The Lower Granite Lock and Dam main structures include a powerhouse, spillway and stilling basin, navigation lock, fish facilities, concrete nonoverflow sections, and rockfill embankment on the north shore. The dam is 3,200 feet in length, including the embankment. Plate 3-2.1 and the project photograph in the front of this manual show the relative location of the principal components of the dam. Data on various features are summarized in the Pertinent Data on pages A through G**,** and details on project equipment are contained in the Lower Granite Lock and Dam 0&M Manual.

(1) Powerhouse. The powerhouse consists of six generator bays, an erection bay, control room, and project office space. The powerhouse general plan and a transverse section of the generator bays are shown on Plate 3-2.1. The overall powerhouse length (including abutment piers, six generating units, and erection bay) is 656 feet long. Powerplant generation equipment is serviced by a 600-ton bridge crane.

(2) Generators. The generators are the vertical-shaft synchronous type and are driven by six-blade Kaplan-type hydraulic turbines. Generators 1 to 3 were supplied by Westinghouse and generators 4 to 6 were supplied by General Electric. These generators are suitable for operation under varying load conditions and can be operated continuously at 115 percent of rated capacity with a maximum power output of 155 MW. Continuous minimum power generation is limited to 80 MW because of excessive generator-turbine vibrations when operated at less than 80 MW on a

continuous basis. The following performance and operating data were provided by the original contract guarantee.

Rated capacity, kVA	142,105
Power factor	0.95
Frequency, cycles	60
Number of phases	3
Voltage between phases, rated	13,800
Speed, rpm	90
Stator winding connection	Star, suitable both for grounded or ungrounded operation
Excitation voltage, nominal	375 to 500
Direction of rotation	Clockwise
Maximum runaway speed, not less than, rpm	180

The maximum temperature rise of both stator and field windings is designed not to exceed 609 C, and stator core 550 C, when delivering rated output continuously at rated voltage, power factor, and frequency, and with cooling air entering the generator at no more than 40^0 C.

(3) Turbines.

(a) Design Characteristics. Turbines for Units 1 to 3 are Baldwin-Lima-Hamilton and turbines for Units 4 to 6 are Allis Chalmers. These turbines are Kaplan-type with six adjustable blades. Synchronous speed is 90 rpm and runner throat diameter is 311-5/8 inches. The centerline of the turbine distributor is at elevation 599.0 feet msl, and the elevation of the water surface in the tailrace will vary from 633.0 to 662.9 feet msl. Each turbine is guaranteed to develop 212,400 horsepower at rated gross head of 93.0 feet and 200,500 horsepower at gross head of 90.0 feet. The turbines are designed to have good efficiencies throughout a wide load range and for heads varying from 76 to 105 feet. Design is based on the following reservoir and plant operating conditions:

	Elevations, feet msl
Maximum pool (850,000 cfs)	746.5
Top of power pool	738.0
Normal full pool	738.0
Minimum power pool	733.0
Maximum tailwater (850,000 cfs)	662.9
Normal maximum tailwater (340,000 cfs)	645.5
Tailwater at rated condition (139,000 cfs)	639.5
Normal tailwater	638.0
Minimum tailwater (zero flow)	633.0

	Heads, feet
Extreme maximum (zero flow)	105.0
Normal maximum	102.0
Average operating	98.0
Rated	94.0
Minimum for power	85.5

(b) Operating Characteristics. Table 3-1 and Plates 3-3 and 3-4 show power-discharge relationships for both unit and plant, respectively. No turbine limits are shown on these plates other than the full gate limit. It should also be noted that heads referenced on the plates are gross heads and no accounting has been made for trashrack and other hydraulic losses.

(4) Main Unit Transformers. The main unit transformers were manufactured by Westinghouse Electric Corporation. Each transformer is three-winding (two separate, identical, low-voltage windings), oil-immersed, self-cooled/forced-air-cooled, Class OA/FA type suitable for outdoor operation. Each transformer is rated 164/218 MVA, 13.2-500 Grd. Y/289 kV, single-phase. Originally, three generators will serve the three-transformer bank with 500-kV output. Each transformer has an external manually-operated tap changer for changing connections to the taps in the high-voltage windings when the transformer is de-energized.

(5) Station Service Power. Two station service transformers are available for use. One is used for in-service and the second is a spare. Station service power is provided by one 4,500-kVA, 13.8-4.16 Y, 3-phase transformer manufactured by McGraw-Edison. It is two-winding, oil-immersed, water-cooled, Class OW, sealed tank type, with load ratio control equipment for changing taps under load, both manually and automatically. It also has an external manually-operated tap changer for changing connections to the taps in the high-voltage windings when the transformer is de-energized. Emergency standby station service power is provided by a 500-kW water-cooled diesel-powered generator.

(6) Spillway. Plate 3-2.1 shows a general plan and a typical section for the spillway. The spillway is located about mid-river and has a total length of 512 feet between abutment centerlines, including seven intermediate piers, and consists of eight gate-controlled bays, each 50 feet wide. Piers 14 feet wide separate the bays. Elevation of the spillway crest is 681 feet. Bays 1 through 8 have spillway deflectors (flip lips) at El. 630. The primary purpose of the flip lips is to minimize nitrogen supersaturation in spilled water. Nitrogen supersaturation in water is a potentially fatal condition for fish and is similar to the "bends" experienced by human divers. The spillway has a maximum height, foundation to deck, of 204.4 feet with a 20-foot-wide roadway on top at El. 751. Spillway discharges are controlled by eight tainter gates each 50 feet wide by 60.15 feet high. The gates are operated by electric hoist units mounted above the gates, with one motor and two hoist units per gate. Operation of the gates may be by manual control through pushbutton stations located near each hoist,

but normally gates are remotely controlled from the powerhouse control room. One spare hoist motor is provided for maintenance and emergency use, and all spillway gates can be operated with emergency power supplied by a diesel generator set. The gate sill is downstream of the spillway crest axis at El. 679.85. Side seal plates and sill beams of all eight gate bays are heated to prevent formation of ice at the gate seals. Heating is accomplished by electrically heated oil circulated through embedded tubing behind the seal plates and sill beam.

The design capacity of the spillway is 850,000 cfs, with a corresponding maximum pool of 746.5 feet. At normal pool elevation 738, the spillway will pass a maximum of 678,000 cfs. Table 3-2 and Plate 3-5 show the discharge for an individual bay at various gate openings and pool elevations.

Energy of the water discharging through the spillway is dissipated by a hydraulic jump type stilling basin. The stilling basin has been designed to contain the jump for all discharges up to 850,000 cfs. Plate 3-6 shows tailwater rating curves for conditions below Lower Granite Dam (RM 107.5), which are based on backwater profiles from Little Goose Dam (RM 70.3).

(7) Navigation Lock. Plate 3-2.1 shows a general plan and typical section for the navigation lock. The single-lift navigation lock is located adjacent to and north of the spillway and provides a single lift for vessels navigating the river. It has a clear inside width of 86 feet and a length of 675 feet. The maximum lift with Little Goose Reservoir at El. 633, Lower Granite forebay elevation being 738, and zero Lower Granite outflow is 105 feet. The lock is closed by a tainter gate at the upstream end and hydraulically operated miter gates at the downstream end. Provision is made for a floating bulkhead to be installed above the upstream gate and below the downstream gate for maintenance and emergency use. However, it would be impossible to install the bulkhead in flowing water. Guide walls extend 700 feet downstream and 750 feet upstream of the gates along the left bank. On the landward side, a concrete guard wall extends downstream 155 feet. This wall flares landward to accommodate the 250-foot approach channel. On the riverward side, a circular steel-cell guide wall extends downstream about 700 feet from the lock gate. This guide wall creates a wider lock approach and also protects tows from accidentally being carried into the powerhouse forebay or over to the spillway. The entrances created by the guide walls and guard walls both upstream and downstream of the lock open into deep water. Maximum rock elevation downstream is 617 and upstream is 717 in the navigation channel, to be maintained all the way to Lewiston. Authorized navigation channel dimensions are 250 feet wide by 14 feet deep at minimum regulated pool conditions. Lock control facilities are located in sheltered control stands adjacent to the upstream and downstream gates on the river wall of the lock. Partial control stations for the downstream gates are located in the lock machinery room for maintenance and emergency operation. Each gate has to be operated from its own machinery room. Minimum elevation of the wall between the lock chamber and the machinery room is 739.8. Air bubblers installed in the gate groin recesses clean trash and ice away from

the recess. Other dimensions are given in the pertinent data tabulation on page D in the front of this manual.

(8) Fish Facilities. Lower Granite's fish facilities include an adult fish passage system for upstream migrants and a juvenile fish passage system for downstream migrants.

(a) Adult Fish Passage Facilities. The adult fish passage facilities consist of a fish ladder with an adult fish trapping facility and an alternate exit for emergency passage during low pool conditions on the south shore, two south shore entrances, a powerhouse collection system, three north shore entrances with a transportation channel under the spillway to the powerhouse collection system, and an auxiliary water supply system. The powerhouse collection system is comprised of four operational floating orifice entrances, three entrances on the north end of the powerhouse, and a common transportation channel to the beginning of the fish ladder. Plate 3-7.1 shows the general plan for Lower Granite's adult fishway system.

1. Fish Ladder and Counting Station. A fish ladder is located at the south end of the powerhouse. The ladder is 20 feet wide and rises 99 feet with 104 fixed weirs. Weirs are numbered 634 to 737, corresponding to their elevation. From weirs 634 through 727, the gradient of the fish ladder is 1V on 10H except at the corners and fish counting station. From weirs 728 to 737, the ladder gradient is 1V on 32H.

A fish counting station is located between weirs 662 and 663 at an elevation near the tailrace deck. The counting station has an underwater window to view fish.

Flow in the upper portion of the fish ladder is regulated by the control section from weirs 728 to 737 and a diffusion chamber that maintains a constant ladder discharge of 75 cfs as forebay elevations vary. Amounts of 57.5 cfs and 24.4 cfs of the total ladder discharge are supplied by water from the reservoir when the forebay elevations are 738 and 733, respectively, with the balance of 75-cfs ladder discharge maintained by water from the diffusion chamber.

Two 6-foot-wide exits are provided through the nonoverflow dam. However, only one exit is used at any one time. The alternate exit provides fish passage if it becomes necessary to draft Lower Granite below normal minimum pool El. 733 in order to prevent flooding in the Lewiston area, thereby lowering the pool below the normal fish ladder exit invert El. 727. The alternate exit consists of three pumps to provide fish ladder flows and a false weir with exit pipe to the reservoir. The exit pipe is an 18-inch-diameter full plastic pipe down to El. 718 and a half-round plastic pipe down to El. 710. This should allow fish to exit the fish ladder at any reservoir level encountered in a flood operation. Bulkheads are provided for both exits to close the fish ladder.

2. Adult Fish Trap Facility. The adult fish trapping facility is located at the west end of the fish ladder where the ladder bends 180^0 between weirs 673 and 674. The key functions of the adult fish trapping facility include: (a) diverting portions or all of the adult anadromous fish from the fish ladder; (b) segregating fish marked by magnetic tags; (c) trapping desired adult fish for hauling, evaluation, or other disposition; and (d) returning unwanted or evaluated fish to the fish ladder. Plates 3-7.1 and 3-7.2 show the location and a general plan for the adult fish trapping facilities.

3. Fishway Entrances. The two south shore entrances (SSEs) consist of 4-foot-wide overflow weirs. SSE 1 is located between the fish pump intakes and the powerhouse, and SSE 2 is just downstream from the intakes. The range of operation of these gates is 17 feet - the height of the gate - or El. 625 to El. 642. Each gate (SSE 1 and SSE 2) is automatically controlled and can have separate water depth settings below tailwater.

Across the downstream face of the powerhouse, there are only four floating orifice entrances (numbers 1, 4, 7, and 10) in operation. Six other floating orifice entrances have been blocked off. The floating orifice entrances are identical to those provided at other Snake River projects and require no operation other than periodic inspection.

The three entrances at the north end of the power-house at Unit 6 consist of two 6-foot-wide entrances (NP 1 and NP 2) facing downstream and one 6-foot-wide entrance (NP 3) leading from the stilling basin. Water level control is obtained by using the north weir (NPE 1) as the master control and the other weir facing downstream (NPE 2) is operated as a slave. The entrance from the stilling basin (NPE 3) will be manually controlled and used only when no spill is occurring. The two downstream facing overflow weirs (NPE 1 and NPE 2) operate over a range of 14 feet (El. 628 to El. 642). These weirs are automatically controlled at a preset depth below tailwater. The entrance to the stilling basin (NPE 3) is controlled with a closure gate that is either 100-percent open or closed by use of a mobile crane. Normal operation will be accomplished by use of overflow weirs NPE 1 and NPE 2 with NPE 3 closed.

The three north shore entrances (NSE 1, NSE 2, and NSE 3) are identical to those at the north end of the powerhouse at Unit 6, but control is different. The north weir (NSE 1) is operated on manual control and the other weir facing downstream (NSE 2) is controlled automatically. The entrance from the stilling basin (NSE 3) will be operated as an alternate to NSE 1 when no spill is occurring. The range of operation of the overflow weirs NSE 1 and NSE 2 is identical to those at the south shore entrance (17 feet or El. 625 to El. 642), but the control is different. These weirs operate at a preset depth below tailwater to maintain the collection channel water surface approximately 1 foot above tailwater. This control is adjustable between 6 and 18 inches. The entrance from the stilling basin (NSE 3) is identical to NPE 3 and is operated in the same manner. NSE 3 and NPE 3 will be closed when spill is occurring. Normal operation will be accomplished by use of overflow weirs NSE 1 and NSE 2 with NSE 3 closed.

4. Transportation and Collection Channel. The extension of the collection channel through the spillway from the north shore entrances permitted the elimination of a fish ladder on the north shore. A 17.5-foot-wide channel with invert at El. 622 provides fish passage from the north shore entrances to the powerhouse collection channel beginning at Powerhouse Unit 6. The powerhouse collection channel then continues under the tailrace deck at invert El. 628 to the beginning of the fish ladder.

5. Auxiliary Water Supply System. The auxiliary water for the fish ladder and the powerhouse collection system is pumped by a group of three electric-motor-driven pumps located in the erection bay of the powerhouse. During normal operations and most flow conditions, two pumps are capable of providing the required flows. These pumps are capable of delivering 1,050 cfs each for a total capacity of 3,150 cfs. Under current operating criteria for the adult fish passage facilities, the operation of all three pumps for the fishway system's attraction water supply has been rare and only required during extremely high tailwater conditions. When the tailwater is below El. 639, the Project Engineer has the option to operate any two pumps. Pump No. 1 is driven by a two-speed motor and delivers either 445 cfs or 1,050 cfs. However, when the tailwater is above 639, Pump No. 1 will be operated at low speed to provide 445 cfs with the other two pumps each supplying 1,050 cfs for a total of 2,545 cfs.

The pumped flow to the fishway system leaves the discharge chamber in three separate conduits, the south conduit to Diffusers 1 to 6, the north conduit beneath and upstream from the collection channel to Diffusers 7 to 12 (Powerhouse Units 1 to 6), and the north conduit directly beneath the collection channel to Diffuser 13. Stoplog slots are provided at the entrance to each of these conduits to permit both isolation of the pump discharge chamber and various portions of the fishway for normal maintenance.

The two types of diffusers used to introduce flow into the fish ladder are the ungated ladder diffuser and the gated diffuser. Diffusers 3 through 6 are the ungated ladder type and require no operation. Diffusers 1, 2, and 7 through 13 are the gated type and require operation. As the tailwater elevation changes, a change in the diffuser gate settings is required. The exit section at the upper end of the fish ladder contains the orifice-slot control weirs, Diffuser 14, and the exit channel.

The upstream group of 10 bulkheads (designated as weirs 728 to 737) contains one slot and one orifice each. The quantity of water passing through these weirs will vary with pool fluctuations, and all additional water required to maintain 12 inches of head on the ladder weirs is added at Diffuser 14. Diffuser 14 has a sluice gate located in the south nonoverflow that is automatically controlled by the water surface in the diffuser pool. The width of the exit channel extending upstream from weir 737 to the forebay is reduced from 20 to 6 feet to maintain adequate transportation velocities. A depth of 6 feet is available at minimum pool with the channel invert at El. 727. One 5-foot by 6-foot trashrack is used at the exit to prevent small floating debris from entering the fish ladder.

Tailwater is the independent variable on which the operation hinges for this system. Plate 3-6 shows tailwater rating curves at RM 107.38. Refer to Technical Report No. 121-1, Lower Granite Dam, Snake River, Washington, dated August 1984 for details on the results of hydraulic model studies on flow conditions for selected discharges and methods of project operation.

(b) Juvenile Fish Passage Facilities. Lower Granite's juvenile fish facilities include a bypass system and a juvenile collection system. The fingerling bypass system for the passage of downstream migrants (smolts) past the dam consists of: (1) submersible traveling screens in the bulkhead slot of each power intake; (2) orifices from the bulkhead slot of each power intake to a common collector channel; (3) a collector channel across the powerhouse; and (4) a transportation pipe that discharges into the fingerling collection facilities or into the river, 1/4 mile downstream from the powerhouse. Flows in the collector channel are maintained at 200 to 250 cfs during fish passage through the bypass and collection facilities.

A special "fish screen" slot was installed in each intake slot to improve fish collection. However, studies indicated that they were ineffective. Submersible traveling screens proved to be more effective and operated in the bulkhead slots.

The submersible traveling screens guide the smolts out of the turbine intakes and into bulkhead slots. From the bulkhead slots, smolts enter the collection channel, which carries them to a transportation pipe that discharges into the fingerling collection facilities.

The collection facilities consist of: (1) an upwell and separator structure to separate fish from excess water; (2) raceways for holding fish; (3) a distribution system for distributing the fish among the raceways; (4) a sampling and marking building; and (5) truck and barge loading facilities and associated water supply lines. The collection facilities can be operated to either collect and hold juveniles for the transportation program or to bypass them to the river. The direct return of smolts to the river from the collection facilities does not normally occur except for either problems with part of the collection facility or special studies. Plates 3-8.1 and 3-8.2 show plan and section views of the fingerling bypass system.

(9) Nonoverflow Sections. Lower Granite Dam has three concrete gravity nonoverflow sections and one earth embankment. The three concrete sections have a deck elevation of 751 and connect (a) the powerhouse to the left abutment; (b) the powerhouse to the spillway; and (c) the spillway to the navigation lock. The earth embankment completes the closure between the lock and the right abutment.

The south concrete nonoverflow section connects the powerhouse to the left abutment. This section is 131 feet long at the crest, 110 feet in maximum height, and has a top width of 34.25 feet. The south shore access road connects to this section for access to the top of the dam.

The second section of concrete nonoverflow connects the powerhouse and spillway. This section is 41 feet long, 170 feet in maximum height, and contains an access stairway from the tailrace deck elevation and a vertical shaft from the intake deck to the drainage and grouting gallery. A portion of the fingerling bypass facility's collector channel is also located in this section.

The third section of the concrete nonoverflow is located between the spillway and the lock. This section is 127 feet long, 170 feet in maximum height, and 43.35 feet wide. This section contains a stoplog storage pit, an air compressor room, a power control center, an elevator to the drainage and grouting gallery, and a portion of the adult fish collection system. The north shore closure between the concrete navigation lock and the right abutment is an earth embankment. This embankment is about 1,530 feet long. The embankment has a crest elevation of 756, 5 feet above the concrete deck of the dam, and consists of a filter-protected central impervious core extending to bedrock with gravel fill shells protected by riprap. The embankment contains about 2,500,000 cubic yards of material and was constructed during the low water season.

c. Reservoir. Lower Granite reservoir extends 39.3 miles up the Snake River from Lower Granite Dam to Asotin, Washington, and 4.6 miles up the tributary Clearwater River. It has an average width of about 2,000 feet and a maximum depth of about 115 feet just upstream of Lower Granite Dam. The reservoir has a surface area of 8,900 acres at normal pool elevation 738. Plate 3-9.1 shows a reservoir and land use map, and Plate 3-9.2 shows a detailed reservoir and land use map for the Lewiston levees area.

Reservoir regulation at Lower Granite project for power generation will normally be confined to the use of storage between El. 733 and El. 738, measured at the dam. That storage amounts to about 49,000 acre-feet at low flows and about 47,000 acre-feet at a discharge of 300,000 cfs. For flows up to 30,000 cfs the pool is nearly level, but at higher flows the slope of the pool increases, particularly at the lower end. The operation of Lower Granite reservoir to maintain a given elevation at the control point near Lewiston will require drawdown at the dam. The maximum planned drawdown during the SPF conditions is 14 feet (El. 724) at the forebay of the dam.

Plate 3-10 shows Lower Granite storage capacity curves. Plates 3-11.1, 3-11.2, and 3-11.3 show reservoir backwater profiles for pool El. 738 at the confluence gage (RM 139.5) and pool El. 733 at Lower Granite Dam (RM 107.5) for the Snake River and Clearwater River reaches of Lower Granite reservoir. The following tabulation summarizes Lower Granite reservoir elevation data:

LOWER GRANITE RESERVOIR

Element		Elevation (ft. msl)
1.	Lewiston Confluence Gage at Control Point (RM 139.5):	
	Maximum Pool (850,000 cfs at dam)	760.0 1/
	Power Pool Elevations:	
	Full Pool	738.0
	Minimum Pool	733.0
	Maximum Elevation For Flood Control:	
	15 July - 14 December	738.0
	15 December - 14 March	737.0 2/
	15 March - 14 July	737.7 2/
2.	East Lewiston Gage (RM 2.9):	
	Full Pool (150,000 cfs at Spalding)	744.4 3/
3.	Forebay Elevation at Dam (RM 107.5):	
	Maximum Pool (850,000 cfs at dam)	746.5 1/
	Power Pool Elevations:	
	Full Pool	738.0
	Minimum Pool	733.0
	Maximum Elevation for Flood Control:	
	Inflow of 420,000 cfs	724.0
	Inflows of 300,000 cfs or greater	725.0
	Inflows of 120,000 cfs or greater	734.0

1/ Spillway design flood (SDF).
2/ For inflows greater than 50,000 cfs; otherwise maximum elevation is 738.0.
3/ Clearwater River at Spalding, Idaho, SPF.
4/ Snake River at Lower Granite Dam SPF.

d. Lewiston Levees. The Lewiston levees lie in two major segments encompassing essentially the entire length of the city waterfront area along both the Snake and Clearwater Rivers. The levees are constructed as a continuous lineal earthfill dam with impervious core, gravel support and fill sections, filter elements, and a protective riprap face on the water side. A system of collector drains, holding ponds, and pumping plants is provided for discharging seepage and runoff waters into the reservoir. Plate 3-2.2 shows the general layout of the levees. For descriptive purposes, the levee system is divided into three segments: the north, east, and west levees.

(1) North Lewiston Levee. The north Lewiston levee on the north bank of the Clearwater River extends about 2.4 miles and protects all of the commercial-industrial portion of the city known as north Lewiston.

(2) East Lewiston Levee. The east Lewiston levee extends for 2.1 miles along the southeast bank of the Clearwater River from a point near the Potlatch Corporation (PC) Plant downstream to the Memorial Highway Bridge and protects the wood processing complex of PC, the Camas Prairie Railroad (CPRR) switching yards, and the city of Lewiston water treatment plant.

(3) West Lewiston Levee. The west Lewiston levee continues from Memorial Bridge down the south bank of the Clearwater River to the mouth of the Snake River and then up the east bank of the Snake River to high ground. It encompasses all of the shoreline surrounding the Lewiston business area and protects mostly commercial and light industrial property nearby in addition to various operating portions of the CPRR system. Extensive landscaping and beautification have been provided through most of the west Lewiston segment with park-like development and day-use recreation facilities.

e. Debris Disposal Facilities. A trash trapping and removal facility at the dam prevents damage to the traveling fish screens and loss of turbine head caused by accumulated trash on the intake screens. This facility consists of a floating log trash shear boom originating from the center nonoverflow section of the dam and extending to the left bank, thus protecting the powerhouse intakes and fish facilities. Trash encountering the boom is sheared over to the face of the dam, where it is trapped and taken over to the right bank for disposal.

3-04. Project Lands. Project lands total about 18,124 acres and were acquired for the damsite, the lake area, wildlife mitigation, and relocations. Fee acquisition lands above flat pool El. 738 account for 9,224 acres. Plates 3-9.1 and 3-9.2 show the project boundary for Lower Granite lands.

The guide-taking lines for the boundary at the confluence of and above the confluence of the Snake and Clearwater Rivers were determined by adding 5 feet to the backwater for the SPF, regulated by existing storage and Dworshak Dam, or by measuring 300 feet horizontally from flat pool 738, whichever was greater.

To assist in the replacement of wildlife habitats inundated by the reservoir or destroyed by relocation of roads or railroads, 41.7 acres of project lands have been developed for wildlife mitigation. Major developments include irrigation, tree and shrub plantings, nesting areas, and food plots. These features are all found at Chief Timothy Habitat Management Unit on the left bank of the Snake River from RM 131.5

to RM 133. Public hunting is allowed where safety is not a problem and in accordance with state and Federal regulations.

Because of relatively steep and rugged slopes near the reservoir, only a fairly small land area above pool level is available for recreational use and access.

3-05. Recreation Facilities. Because of the large population areas nearby (Lewiston, Clarkston, Moscow, and Pullman), recreation development was an important part of project development. Initial estimates of visitor use projected an initial use of 700,000 visitor days annually, with use increasing to 1,200,000 visitor days by the end of the 100-year project life. Beautification of the levees to be built on the riverbanks near and in Lewiston was also an important consideration. Accordingly, several recreation sites were planned and built. Plates 3-9.1 and 3-9.2 show the location of recreation sites on project lands adjacent to the reservoir. The following tabulation shows these sites and the facilities available at each:

SITE	RIVER MILE	SWIMMING BEACH	BOAT LAUNCHING	BOAT DOCKS	RESTROOMS	PICNIC FACILITIES	BOAT BASIN	MARINA	CAMPING	TRAILER FACILITIES	TRAILER DUMP FACILITIES	AMPHITHEATER	ATHLETIC FIELD & FACILITIES	POWER HOOKUPS
Offield Landing	(108)		●	●	●	●								
Wawawai County Park	(110.5)				●	●			●					
Wawawai Landing	(111)	●	●	●	●	●								
Knoxway Bay	(116)			●	●	●								
Blyton Landing	(119)	●	●		●	●	●							
Nisqually John Landing	(123)	●	●	●	●	●								
Chief Timothy State Park	(132)	●	●	●	●	●			●	●	●			●
Lewiston Levee Parkways	(140)			●	●	●								
Clearwater Park	(2)				●								●	
Swallows Park	(142)	●	●	●	●	●		●						
Hells Gate State Park	(143)	●	●	●	●	●	●	●	●	●	●	●		●
Chief Looking Glass Park	(146)	●	●		●	●	●	●					●	

Detailed information on existing recreation sites can be found in the "Walla Walla District Recreation Facilities Guide" dated March 1984.

IV - BASIN DESCRIPTION

4-01. General. Lower Granite Dam has a tributary area of 103,400 square miles, comprising very nearly the entire Snake River Basin. Only a small amount of runoff occurs below Lower Granite Dam, primarily from the Tucannon and Palouse Rivers. Most of Idaho, with lesser parts of Oregon, Washington, Wyoming, Nevada, and Utah, are within the Snake River watershed. The greatest overall dimensions of the basin are about 450 miles in both the north-south and east-west directions. Plate 4-1 shows a basin map of the Snake River Basin.

The Snake River is 1,078 miles long and is the largest tributary of the Columbia River. It originates high in the Yellowstone National Park area of western Wyoming and traverses the southern part of Idaho in a broad arc running from east to west. It then flows almost due north, forming part of the boundary between Idaho, Oregon, and Washington. Near Lewiston, Idaho, it turns westerly and joins the Columbia River near Pasco, Washington. Total fall of the Snake River from its source near Two Ocean Plateau, Wyoming, to Lower Granite Dam is about 8,000 feet. Principal tributary streams are given in the following tabulation:

Stream	Drainage Area (square miles)	Snake River Mile
Henrys Fork	3,010	837
Blackfoot	1,300	751
Portneuf	1,380	737
Big Wood	3,000	571
Bruneau	3,300	493
Owyhee	11,300	392
Boise	4,100	391
Malheur	4,800	369
Payette	3,240	368
Weiser	1,660	352
Powder	1,660	296
Salmon	14,100	188
Grande Ronde	4,070	169
Clearwater	9,640	139

The numerous artificial reservoirs and partially controlled lakes in the Snake River Basin have a substantial effect on the flow of the lower Snake River. Total usable storage in the 50 reservoirs and lakes amounts to about 9,600,000 acre-feet. Dworshak Reservoir has the greatest usable capacity with 2,000,000 acre-feet, followed by American Falls Reservoir with 1,700,000 acre-feet, Palisades Reservoir with 1,202,000 acre-feet, Brownlee Reservoir with 980,000 acre-feet, and the Boise River Reservoir system with 974,000 acre-feet.

4-02. Topography. Several complex systems of mountain ranges, with intervening valleys and plains, lie within the Snake River Basin. Much of the southern part of the basin is included within the Columbia Plateau, a semiarid expanse formed by successive flows of basaltic lava. To the north of this plateau is a rugged area of mountain ridges and troughs, with deeply incised stream channels. Overall extremes of elevation are 13,766 feet at Grand Teton Mountain in Wyoming to 638 feet which is normal Little Goose pool elevation. The basin mean elevation is about 5,300 feet.

4-03. Geology and Soils.

a. Snake River Basin. The Snake River flows across a major physiographic region of the Pacific Northwest known as the Snake River Plateau and along the southern portion of the Columbia Plateau. The Snake River Plateau extends from southeastern Oregon across southern Idaho and includes parts of Nevada and Utah. The Columbia Plateau extends south from the upper curve of the Columbia River to the Blue Mountains, west to the Cascades, and east above the Snake River, just east of the Washington-Idaho line. These two regions are comprised mainly of lava flows covered with soil. In areas where the Snake River has cut canyons, the dark basalt rock is a primary surface feature. Many of the soils of the Snake River Plateau are light and highly erodible with low rainfall limiting the ability of vegetative cover to reestablish, once removed. This results in heavy sediment loads in the river, especially during the spring runoff season.

b. Project Area. Lower Granite Dam is built in a steep-walled canyon 1,800 to 2,300 feet deep, which has been cut through the basalt flows of the region by the Snake River. The canyon walls consist of a series of narrow talus-covered slopes separated by nearly vertical rock faces. About 6 miles above the dam the river has cut entirely through the basalt, exposing an area of the underlying granite commonly known as Granite Point. The project derives its name from this site. Basalt flows form the canyon walls and foundations under the dam and river and vary in thickness from a few to several hundred feet. The material is fine to medium grained. Faulting is rare and localized, with no serious faults in the project vicinity. Several dikes cut through the basalt flows near the project, but these are not considered of any engineering significance. Deep rich soils are nonexistent on the project. Soil on the steeper slopes, if any, is shallow. Organic content, even in the deepest soils, is low. See Design Memorandum No. 3, Volume 2 of 4, dated 13 March 1964, for more detailed information on project geology.

4-04. Sediment. An initial estimate of sediment load was published in Design Memorandum No. 1 (dated December 1963). This report estimated an average annual sediment load of 5,700 acre-feet with a retention of 3,700 acre-feet in the Lower Granite pool. This figure was based on 3 years of data collected at Central Ferry at RM 83 on the Snake River.

Later studies, using data from the Snake and Clearwater Rivers just upstream of the pool limits, indicated that the sediment load would be much less (about 25 percent of the original estimate).

Although sediment is not expected to result in significant loss of storage, it has created serious problems by preferentially settling adjacent to shoreline facilities. Dredging has been required in both the Port of Lewiston and the Port of Clarkston and periodic special regulation to keep the pool as high as possible has been necessary to guarantee access to the ports. In addition, recent studies have shown that sediment accumulation in the upper portion of the reservoir has significantly raised the SPF profile with the possible effect of reducing flood level protection. Studies were done in 1986 to determine the effects of this problem and to determine the feasibility of various solutions, including raising the levees and dredging the areas of accumulation.

4-05. Climate.

a. Snake River Basin.

(1) General. Basically, the climate of the Snake River Basin is transitional between the maritime regimen west of the Cascade Range and the continental type climate of the northern Great Plains. Both maritime and continental air masses affect the basin but since it is located in the zone of prevailing westerly flow, the maritime air masses predominate. The Rocky Mountains to the north and east provide some protection against outbreaks of cold arctic air from Canada, but such incursions do occur occasionally in the winter season, particularly over the eastern part of the basin. Because of the irregular topography and large differences in elevation and exposure, there are pronounced differences of local climate. Plate 4-1 shows a basin map of the Snake River Basin.

(2) Temperature. Air temperatures within the Snake River Basin are controlled by elevation and distance from the Pacific Ocean, as well as by air mass and season of the year. An important aspect of basin temperature to the regulation of Lower Granite project lies in the effect of temperature and solar radiation on snowmelt. The shape, timing, and peak discharge of the spring snowmelt runoff of the lower Snake River are determined to a considerable degree by the sequence of spring season basin temperatures. In addition, temperatures in the region have a pronounced effect on electric power demand and therefore on generation at Lower Granite and other hydro-electric projects which serve the area.

Normal summer maximum temperatures for most climatological stations are between 80^0 and 90^0 F and normal winter minimums are between zero and 20^0 F. Extreme recorded temperatures are minus 66^0 F at West Yellowstone, Montana, barely outside the upper Snake River Basin boundary, and 118^0 F at Ice Harbor Dam and at Orofino, Idaho. See Plate 4-1 for the general location of these areas. Average frost-free periods in agricultural areas vary with location from about 50 to 200 days, and some small high-elevation areas experience frost in every month of the year.

(3) Precipitation. The normal annual precipitation over the Snake River Basin ranges from less than 8 inches in the vicinity of Ice Harbor Dam and in portions of the plains of southern Idaho to an estimated maximum of 70 inches in the Bitterroot Mountains. The normal annual precipitation averaged over the entire basin is estimated to be 20 inches. Plate 4-1 shows the normal annual precipitation isohyetal pattern over the Snake River Basin. Much of the winter precipitation is in the form of snow, a factor of great hydrologic importance. Snow course data are used for forecasting runoff volumes from major basins within the Snake River Basin.

b. Lewiston Region. The Lower Granite project lies within a "banana belt" of slightly lower elevation than the surrounding terrain. This location, combined with the influence of Pacific air that spills over the Cascades and through the Columbia Gorge, moderates most winters. Summers are warm to hot and dry, with plenty of sunshine. This leads to a slightly lengthened, heavy use, water-oriented recreation season. Spring and fall winds are often strong and gusty and can whip up waves of 4 and 5 feet on exposed reaches of the reservoir system.

The climatological record of Lower Granite Dam is too short to be considered representative. Table 4-1 shows climatological data for Lewiston, Idaho, which is considered reasonably representative of Lower Granite Dam.

4-06. Storms and Floods.

a. Lower Snake River. Floods in the lower Snake River are of two types: (1) annual spring floods caused primarily by snowmelt but sometimes augmented by rainstorms and (2) occasional winter or early spring floods resulting from rainstorms, low elevation snowmelt, or a combination of the two factors. The spring floods usually begin in March, culminate with the peak discharge for the year, usually between late April and early June amid a succession of high fluctuating flows, and end with recession to low flows in late June and July as snow disappears from the principal contributing areas. The spring flood peaks for the Snake River near Clarkston generally occur in May. Some 57 percent or 37 of the annual peaks over a 65-year period (1910-1974) have occurred in May, 29 percent or 19 peaks occurred in June, 11 percent or 7 peaks occurred in April, and about 1.5 percent each, or 1 peak, occurred in December and March. Table 4-2 summarizes annual runoff volumes and extreme discharges from 1910 to 1974 for the Snake River near Clarkston. The winter or early spring floods are of shorter duration, seldom exceeding a week or 10 days and usually consist of one peak preceded and followed by rapidly rising and receding flows. They normally occur with much lower base flows than exist between individual peaks of the spring snowmelt runoff season. Unregulated and regulated hydrographs of the 1894, 1948, and 1956 floods are shown on Plate 4-2.

The 1894 flood was by far the largest known flood in both peak and volume on the lower Columbia River and the largest known historical flood on the lower Snake River. The 1894 flood had a peak discharge of 409,000 cfs and a 60-day runoff volume of about 27,000,000 acre-feet or 4.9 inches over the drainage area above the

Clarkston gage. The peak discharge was 48 percent of the probable maximum peak discharge of 850,000 cfs and 11 percent larger than that of any other recorded flood. The volume of runoff during the 60 days of highest flow of the 1894 flood was 45 percent of that applicable to a comparable period for the probable maximum flood, and 20 percent larger than that for any other recorded flood. The 1894 hydrograph for the Snake River near Clarkston is shown on Plate 4-2. The regulated peak is estimated to be 295,000 cfs as regulated by existing projects including Dworshak Dam.

Frequencies of unregulated and regulated annual flood peaks are shown for the Snake River at Lower Granite Dam on Plate 9-1. Natural peaks were computed by adjusting the observed peaks for storage changes in the larger upstream reservoirs and for estimates of depletions for irrigation. Statistics for the natural peak frequencies were adjusted to the long-term record of peak flows of the Columbia River near The Dalles.

b. SPF. The SPF was derived for Lower Granite project by simulating the maximum possible adverse meteorological conditions that could be reason-ably expected to occur for the several contributing upstream basins. Plate 4-3 shows the SPF at Lower Granite and contributions from key upstream basins. The runoff volume produced was reduced for upstream storage and was adopted as the SPF for design studies on Lower Granite Dam and Reservoir. SPF unregulated and regulated peak discharges for (1) Clearwater River at Spalding, (2) Snake River above Clearwater River, and (3) Snake River below Clearwater River (Lower Granite inflow) are summarized in the following tabulation:

Location	Unregulated Peak Discharge (cfs)	Regulated Peak Discharge (cfs)
Clearwater R. at Spalding	280,000	150,000
Snake R. above Clearwater R.	365,000	295,000
Snake R. below Clearwater R.	575,000	420,000

The regulated peak discharge of 420,000 cfs for the Snake River below the confluence of the Clearwater River is only 11,000 cfs greater than the largest known historical flood which occurred in 1894.

c. Spillway Design Flood. The computed probable maximum flood has a peak discharge of 850,000 cfs and a 7-month runoff volume of 81,000,000 acre-feet. It was adopted without modification as the spillway design flood for Lower Granite Dam. Derivation of the probable maximum flood, which was developed in cooperative studies with the Office, Chief of Engineers, was presented in the report on Selection of Sites, Lower Snake River, dated 14 March 1947. Plate 4-4 shows the spillway design flood.

4-07. Runoff Characteristics.

a. General. The normal pattern of streamflow for the Snake River consists of low flows from August through February and high flows from March through July. At Lower Granite Dam, the peak inflow usually occurs in May or June and is primarily the result of snowmelt, sometimes augmented by rainfall. Regulation by upstream projects does much to moderate these peaks. Daily discharge hydrographs on Plates 4-5.1 to 4-5.5 illustrate the characteristic runoff pattern and the year-to-year variations for the lower Snake River. Plate 4-6 shows summary hydrographs for the Snake River near Clarkston. Table 4-2 summarizes the annual runoff volumes and extreme discharges from 1910 through 1974 for the Snake River near Clarkston. Table 4-2A summarizes the annual computed inflow volumes and daily inflow extremes from 1975-1986 for Lower Granite reservoir. Lower Granite reservoir inflows have been computed since 1975, and Plate 4-7 shows summary hydrographs for Lower Granite inflows. Table 4-3 summarizes Lower Granite computed monthly inflow volumes by water years.

Discharge records for the Snake River near Clarkston (drainage area 103,200 square miles) and Lower Granite reservoir computed inflow (drainage area 103,500 square miles) are considered comparable because runoff contributions between the two stations are not significant. The computed mean annual runoff of the Snake River near Clarkston for the period 1910 through 1986 is 37,500,000 acre-feet. Annual runoff volumes ranged from a minimum of 20,430,000 acre-feet in the 1977 water year to a maximum of 57,410,000 acre-feet in the 1974 water year. In average depths of water over the drainage area of 103,200 square miles above the Clarkston gage the mean, minimum, and maximum annual runoffs are 6.7 inches, 3.7 inches, and 10.4 inches, respectively. The mean annual discharge is 51,000 cfs. Mean daily maximum and minimum discharges averaged 191,000 cfs and 16,000 cfs, respectively, for the 1910-1986 water year period. The maximum historical flood peak was 409,000 cfs on 5 June 1894, which is outside of the 1910-1986 period. The instantaneous low flow was 6,660 cfs on 2 September 1958 and was caused by construction closure at Brownlee Dam during the 1910-1986 water year period. For the water year period 1973-1986, mean daily maximum and minimum discharges averaged 174,000 cfs and 19,000 cfs, respectively, with system regulation by Dworshak and other existing projects above Lower Granite. In addition, the maximum mean daily discharge was 332,000 cfs on 18 June 1974, and the minimum mean daily discharge was 10,900 cfs on 21 August 1977.

Much of the runoff above Lower Granite is uncontrolled, especially during the spring flood season. This uncontrolled runoff is due mainly to the Salmon, Grande Ronde, and Clearwater River Basins. Runoff contribution and distribution above Lower Granite Dam is shown in the following tabulation:

	Drainage Area (Sq. Mi.)		Average Annual Discharge 1/ (cfs)		Average May Discharge 1/ (cfs)	
Above Dworshak Reservoir	2,440	(2 %)	5,637	(11 %)	17,990	(15 %)
Above Brownlee Reservoir	72,590	(70 %)	17,540	(36 %)	24,050	(20 %)
Uncontrolled area above Lower Granite Dam	28,470	(28 %)	25,974	(53 %)	76,460	(65 %)
	103,500		49,250	(100 %)	118,500	(100 %)

1/ From 1980 level Modified Streamflow Report dated July 1983.

b. Streamflow Records. Streamflow data records have been maintained at key gaging stations on the Clearwater and Snake Rivers by the U.S. Geological Survey (USGS) and published in the "USGS Water Resources Data for Idaho." The key gaging stations above Lower Granite Dam are (1) Clear-water at Spalding and (2) Snake River at Anatone.

c. Basin Runoff.

(1) Clearwater at Spalding. Runoff at the Spalding gaging station has two components: an unregulated component from the Clearwater River above Orofino, Idaho and a regulated component from the North Fork Clear-water River above Dworshak Dam. Plate 4-8 shows regulated discharge summary hydrographs for the Clearwater River at Spalding. Table 4-4 summarizes monthly runoff volumes by water years for the Clearwater River at Spalding.

(2) Snake River near Anatone. The Anatone gaging station measures virtually all of the runoff of the Snake River above its confluence with the Clearwater River. Streamflow at this gage is derived from both regulated flow from the Snake above its confluence with the Salmon River and an unregulated component flow from the Salmon and Grande Ronde Rivers. Plate 4-9 shows regulated discharge summary hydrographs for the Snake River near Anatone. Table 4-5 summarizes monthly runoff volumes by water years for the Snake River near Anatone.

4-08. Water Quality. A post-impoundment investigation of the lower Snake River region was jointly carried out by the Departments of Fishery Resources and Bacteriology at the University of Idaho and the Department of Civil and Environmental Engineering at Washington State University from April 1975 through October 1977 under contract with the Corps of Engineers. The major objective of the study was to describe the physical, chemical, planktonic, bacterial, and aquatic weed characteristics of the lower Snake River reservoirs. Twenty-six physiochemical parameters were regularly measured in addition to biological measurements which included water quality bacteriological indicators, primary production rates, algal and zooplankton evaluations, macrophyte distribution, and algal assays. A final report entitled "Limnology of an Impoundment Series in the Lower Snake River" was submitted to the Corps of

Engineers in 1979. Results from this study at Lower Granite are summarized in the following paragraphs.

Pronounced thermal and chemical stratification did not occur in these flow-through reservoirs. Summer temperature differentials were as little as 2^0 C from surface to bottom layers and did not exceed 5^0 C. Minimum deep water dissolved oxygen levels during a low-flow year (1977) were 28 percent of saturation. Mixing patterns of the two rivers entering the Lower Granite reservoir area changed considerably since impoundment, but each river: could still be recognized as far downstream as RM 122. Quiescent reservoir waters have allowed faster settling of particulate materials, resulting in greater light penetration and reduced phosphorus.

Impoundment stimulated the growth of reservoir algae (diatoms and green and blue-green algae). Blue-green algal blooms increased and occurred further upstream as pre-impoundment studies had predicted earlier. On occasion both phosphorus and nitrogen became limiting to continued algal growth. Chlorophyll "a" and carbon-14 productivity measurements indicated that the four reservoirs were in a mesotrophic state of enrichment. Bacterial, biochemical oxygen demand, and chemical oxygen demand measurements indicated that water quality has improved to some degree since impoundment. One possible explanation of the improved water quality conditions is improved municipal and industrial wastewater treatment. Secondary production (zooplankton production) was less than earlier expectations and showed a decrease at downstream stations compared to pre-impoundment.

4-09. Upstream and Downstream. Structures.

a. General. The Snake River, and to a lesser extent the Clearwater River, is regulated above Lower Granite by a number of dams operated by the Corps, Bureau of Reclamation, Idaho Power Company, and private irrigation companies. Regulation by upstream projects has a great effect on the flows at Lower Granite, and coordination between the agencies and companies involved is necessary. Corps of Engineers run-of-river structures down-stream of Lower Granite Dam on the Snake River include: (1) Little Goose Dam; (2) Lower Monumental Dam; and (3) Ice Harbor Dam. These major projects, along with Lower Granite, are operated for multiple purposes on a system basis. For a listing of coordination organizations and agreements, refer to paragraph 6-02. In addition, details on reservoir system operation are provided in the Columbia River Basin Master Water Control Manual dated December 1984.

b. Travel Times. Releases from Dworshak Dam on the Clearwater River and Hells Canyon Dam on the Snake River determine much of the inflow at Lower Granite. Large changes in releases could have an effect on operation of Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams (for example, advance drawdown to moderate extreme flood peaks). The following tabulation shows travel times from Dworshak Dam and Hells Canyon Dam to Lewiston, Idaho, and from Lewiston to the mouth of the Snake River.
* Release at Hells Canyon Dam 21-27 March 1973 (see Plate 4-10).

Location	Flow (kcfs)	Approximate Travel Time
Dworshak Dam to Lewiston, Idaho (42.4 miles)	16	8 hrs
Clearwater River at Spalding to Lewiston, Idaho (11.6 miles)	16	2.5 hrs
Snake River at Anatone to Lewiston, Idaho (27.7 miles)	12-18	4-6 hrs
Hells Canyon Dam to Lewiston, Idaho (107.5 miles)	5-12 *	16-20 hrs
Lewiston to mouth of Snake River (140 miles)	200	4.6 days

* Release at Hells Canyon Dam 21-27 March 1973 (see Plate 4-10).

Plate 4-10 provides detailed information on travel times and relative stages of Snake River discharges from Hells Canyon Dam (RM 247.0) downstream to the Lewiston area (RM 141.9) for various discharges. Refer to the Columbia River Basin Master Water Control Manual for details on travel times in major rivers and lakes in the Columbia River system.

4-10. Water Supplies. Lower Snake River streamflows have been undergoing progressive modification during the entire period of recorded flows because of upstream irrigation and storage developments. The depletions above Lower Granite Dam now amount to approximately 6 million acre-feet per year. Modified streamflows for future conditions with anticipated irrigation and upstream irrigation reservoir developments as of the years 1960 and 2010 have been determined for the 20-year period July 1928 to June 1948, a period of subnormal flow. From these data, system studies were made as of the year 1985 (average of conditions for years 1960 and 2010) to show the effects of system regulation of reservoir projects on main streams for power, navigation, basic elements of flood control, and water conservation. Several systems were studied, each of which gave slightly different water supply conditions at Lower Granite Dam. Results are shown in the report entitled "Water Resource Development Columbia River Basin" (Review of House Document 531, 81st Congress, 2d Session) dated June 1958 and are considered representative of regulated flow conditions for illustration of the regimen and changes in flows expected to occur. The following tabulation briefly summarized the flow determined in these studies for the Snake River at Lower Granite Dam:

SUMMARY OF MEAN MONTHLY FLOWS, 1928 – 1948 (1,000 cfs)									
	Average			Maximum			Minimum		
Month	Act	Mod	Reg	Act	Mod	Reg	Act	Mod	Reg
Oct	21.4	21.7	31.4	30.6	29.2	38.3	16.6	17.5	27.2
Nov	25.6	25.4	37.3	36.2	35.0	45.4	17.6	18.5	24.7
Dec	29.2	27.8	46.6	52.4	57.6	74.6	16.9	17.6	34.2
Jan	27.8	26.8	50.3	55.5	54.7	75.0	14.9	14.9	29.3
Feb	29.5	28.1	52.7	46.7	43.5	81.2	19.1	17.5	27.0
Mar	43.8	42.4	61.2	63.9	65.1	93.5	28.0	27.7	39.5
Apr	79.6	73.6	47.6	158.4	158.3	86.5	48.8	43.4	19.8
May	108.4	100.2	44.8	179.1	172.6	99.7	69.0	66.0	17.7
Jun	93.1	85.2	50.3	191.6	183.2	123.2	33.9	32.0	15.1
Jul	33.9	32.0	30.1	85.0	75.7	75.1	15.3	16.6	13.6
Aug	18.8	18.8	21.7	28.5	26.9	26.8	11.1	13.0	18.0
Sep	18.4	19.6	26.0	24.5	25.4	32.1	12.7	14.9	21.4
Ave	44.1	41.8	41.6	79.4	77.3	71.0	25.3	25.0	24.0
Max	108.4	100.2	61.2	191.6	183.2	123.3	69.0	66.0	39.5
Min	18.4	18.8	21.7	24.5	25.4	26.8	11.1	13.0	13.6

Act = Actual historical.
Mod = Discharges modified by irrigation, 1985 conditions. Reg = Discharges regulated by at-site and upstream power storage, Sequence IV-H, 1985 conditions.

An emergency closure of Brownlee Dam caused a minimum instantaneous low of 6,660 cfs on 2 September 1958 and a minimum mean daily flow of 9,320 cfs on 3 September 1958 in the Snake River at Clarkston. The minimum mean daily discharge otherwise has only fallen as low as 9,800 cfs on 29 August 1924. The minimum mean monthly flow was 11,000 cfs during August 1931. Minimum flows are not likely to be as low in the future as in the past. Since 1973 with Dworshak and other existing projects above Lower Granite, the effect has been a higher magnitude of base flows and a lengthening of the duration for the moderately low-flow period. From the foregoing compilation of data on modified and regulated flow 1985 conditions, the dependable minimum mean monthly flows would be about 13,000 cfs without regulation by upstream projects and 13,600 cfs with regulation by these main stream projects.

4-11. Icing. The upper end of Lower Granite reservoir in the vicinity of Asotin, Washington, may be expected to freeze over on occasion with resulting accumulation of ice from upstream and increased height of pool near the head of the reservoir. To date, this has not been a problem, and no special regulation is planned or has been necessary to deal with icing.

4-12. Economic Data.

a. Snake River Basin.

(1) Population. Overall, the Snake River Basin is sparsely populated, with two-thirds of the people living on farms or in small towns. The 1970 census indicates a basin population of 678,000 (upstream of Clarkston gage), which is equivalent to an average density of about six persons per square mile. The largest cities are Boise and Pocatello, with metropolitan area populations of approximately 80,000 and 40,000, respectively. Both rural and urban populations are concentrated along the Snake River and major tributaries where the principal towns and agricultural areas are located.

(2) Industry. Agriculture and associated processing and service industries constitute the primary economic base of the Snake River Basin. Other important industries are based on forestry and wood products, mineral deposits, and the recreational resources of the region. More than 3.3 million acres of land in the Snake River Basin are under irrigation, and it is expected that the acreage will increase substantially in the future. House Document 403, 87th Congress, contains additional information on development of the agricultural and other resources.

b. Lewiston Region.

(1) Population. The population data presented in the following tabulation show the population changes in the five counties adjacent to the Lower Granite project and for the four major cities in the region during a 30-year period, 1950 to 1980.

POPULATION OF LOWER GRANITE DAM REGION

	County			
Year	Latah	Nez Perce	Garfield	Whitman
1950	20,971	22,658	3,204	32,469
1960	21,170	27,066	2,976	31,263
1970	24,891	30,376	2,911	37,900
1980	28,667	33,232	2,468	40,103

MAJOR CITIES IN LOWER GRANITE REGION

	County			
Year	Clarkston	Lewiston 1/	Moscow	Pullman
1950	5,617	16,928	10,599	12,022
1960	6,209	22,696	11,183	12,957
1970	6,312	26,355	14,146	20,509
1980	6,903	27,972	16,431	23,579

1/ Includes Lewiston and Lewiston Orchards.

NOTE: Data obtained from Bureau of Census reports 1950 to 1980.

(2) Industry. Timber and agriculture are the major economic resources within the five counties around the Lower Granite project. These counties are Latah and Nez Perce counties in Idaho, and Asotin, Garfield, and Whitman counties in Washington; they have a total area of about 3.5 million acres. The following tabulation outlines the land use distribution within these five counties.

LAND USE IN LOWER GRANITE DAM REGION

Land Use	Area (1,000 Acres)	Percent of Total Area
Forest	841	24
Agriculture	1,863	54
Range	728	21
Towns, Roads, etc.	35	1
Totals	3,467	100

(3) Flood Damages. The lower Clearwater River reach in the vicinity of the Potlatch Forests, Inc., paper and plywood mill and the city of Lewiston, Idaho, has SPF protection by a combination of Dworshak regulation and levees. The east Lewiston levees are designed to protect the area from flooding by a flow of 150,000 cfs in the Clearwater with a freeboard of 5 feet. The winter SPF at Spalding has a natural peak of 280,000 cfs and can be regulated to 150,000 cfs by Dworshak. The entire levee system is designed to prevent flooding from a total flow in the Snake and Clear-water Rivers of 420,000 cfs, again with a freeboard of 5 feet. Flood damages primarily due to bank erosion begin at 90,000 cfs on the lower Clearwater River above the Lower Granite levees. Flood stage is 18 feet (115,000 cfs) for the Clearwater River at Spalding, Idaho. For the Snake River above the confluence of the Clearwater River, flood damages are caused mainly by water over the county road between Clarkston, Washington, and Asotin, Washington. Flood stage is 21 feet (157,000 cfs) for the Snake River near Anatone, Washington, and at this stage flooding of the county road begins. Extremely high discharges of 195,000 cfs and 183,000 cfs were recorded in 1974 and 1984, respectively, for the Snake River near Anatone.

Information on areas of possible flooding near the Lewiston levees can be found in Flood Insurance Study, City of Lewiston, Idaho, Clearwater River and Snake River, Federal Emergency Management Agency, Federal Insurance Agency, Community Number 160104, January 1981 (Preliminary).

(4) Navigation. In the early days of regional development, the Snake River served as the major transportation artery to east-central Washington and west-central Idaho. Sternwheelers with cargo capacities up to 250 and 300 tons navigated the Snake River to Lewiston, Idaho, and played a most important part in the growth of the area. Following completion of water-grade railroads, the need for water transport over a hazardous unimproved river route was eliminated and commercial navigation operations on the Snake River were soon suspended. Completion of Lower Granite Lock and Dam has permitted reestablishment of navigation to Lewiston, Idaho. The

principal commodities carried by barges are petroleum and fertilizer products upstream and grain and lumber downstream.

(5) Irrigation. Previous preliminary investigations and the recent detailed studies made by the Bureau of Reclamation on the irrigation aspects of Lower Granite project indicate there are only a few small scattered areas of adjacent tillable land that could be served by low-lift pumping. In view of the scattered nature of the irrigable areas and the small amount of land above normal pool level suitable for irrigation of any significance, Federal development of a reclamation project would not be feasible. Therefore, no provision has been made in the project plan for the inclusion of irrigation facilities either along the reservoir shoreline or in the dam structure. Private development of sprinkler pumping systems by individual farm ownerships could occur, with the extent and number of developments being subject to the availability of suitable access.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Data Collection.

a. General. Automated hydromet data and project data are collected daily in order to evaluate streamflow conditions upstream of Lower Granite Dam and to schedule day-to-day and future regulation for both project and system operation. Since Lower Granite Dam is operated as a run-of-river project with a very small amount of storage, it is necessary to monitor both lake elevations and inflow into the lake in order to determine minimum project releases for levee freeboard.

(1) Automated Hydromet Data. Data from the Automated Hydromet Network for the Lower Granite project is collected from remote gages upstream of the dam. As a result, telemetry gages to monitor lake elevations were installed at the confluence of Snake and Clearwater Rivers (control point at RM 139.5), at Clearwater RM 2.9 (east Lewiston gage). Telemetry gages to monitor lake inflow were also installed at streamgages on the Clearwater River at Spalding and on the Snake River near Anatone, which are used to compute inflow into the lake. The Corps of Engineers, Walla Walla District (NPW), maintains a data acquisition controller (Tascmaster) in Walla Walla. The Automated Hydromet Network uses a radio system to collect data from the key gages and provide data with alarms to the Lower Granite project site, where it is processed and relayed to the Walla Walla District's Tascmaster and then transmitted into the Columbia River Operational Hydromet Management System (CROHMS). Plate 5-1 is a map showing the automated hydromet facilities for the Lower Granite project.

(2) Project Data. Project data is collected by recorded observations on gages at the dam for reporting reservoir elevations (forebay and tailwater), project inflow and discharge, power generation, and miscellaneous data (fish counts, navigation lockages, power unit status, etc.). NPW operates a project data acquisition controller for the Snake River area. The lower Snake data acquisition system collects project data from the four lower Snake River reservoirs (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) and Dworshak and transmits data on a scheduled basis into CROHMS via the Columbia Basin Telecommunications (CBT) Network.

b. Lake Elevation Gages.

(1) Confluence Gage (RM 139.5). The confluence gage is located in the visitor center on the right bank of the Snake River immediately upstream of the confluence with the Clearwater River. This station monitors pool elevation in feet msl and is the primary control station for Lower Granite pool. Forebay elevations at the project are adjusted to provide the desired elevation at this point. Gaging facilities include a staff gage, a float well, a float to drive the radio and recorder, and an independent float and telemark that is used to drive the phone. Electronic equipment for transmittal of the data to the Lower Granite project control room and into the Automated Hydrologic Network is located in the gage room. Included in the equipment

is the capability for acquiring the data by calling the gage on the telephone in the event of a radio failure. Because of the dual float system at this gage, readings that are believed to be in error may be checked by calling the gage on the phone, which gives a reading independent of that given by the radio.

(2) East Lewiston Gage. The east Lewiston gage at RM 2.9 of the Clearwater River is located at the east Lewiston levee pumping plant. This station monitors water surface elevation in the Clearwater River arm of Lower Granite pool. The primary purpose of this gage is to provide data to insure that the Clearwater River does not overtop east and north Lewiston levees during floods, but it also can be used as a backup whenever the confluence is out of order. Lower Granite pool is lowered if required during floods to maintain adequate (5-foot) freeboard at this location. During floods, the slope of the water surface on the Clearwater arm of Lower Granite Lake increases substantially between gages. At the SPF level of 150,000 cfs on the lower Clearwater River, the water surface elevation increases from El. 738.0 at the confluence gage (RM 139.5) to El. 744.4 at the east Lewiston gage (RM 2.9). Plate 3-11 shows reservoir water surface profiles.

Gaging facilities include a sloping staff gage and a digital punch tape recorder. A float well and synchro-transmitter are located in a 48-inch CMP housing identical to the adjacent siphon breaker housings on the riverside of the levee. The well is outside of the impervious core and the end of the inlet pipe is located 30 feet upstream of the pumping plant discharge structure at El. 730. The synchro-transmitter is connected to a receiver in the pumping plant station which drives the data transmission gear and digital punch tape recorder. The synchro equipment is equipped so that in the event of a power failure, the transmitter and receiver will remain in synchronism. Data from this station is transmitted to the Lower Granite control room and into the CROHMS network. The station is equipped so that the data can be obtained by calling the gage on the telephone in the event of radio failure. However, the phone cannot be used to verify the accuracy of the data sent by radio since both are dependent on the same float and synchro-transmitter.

(2) Forebay Gage. A forebay gage located at the dam monitors the lake elevation at the dam. This gage is used in conjunction with the confluence gage to determine operating elevation criteria. The forebay gage reading is telemetered to a two-pen recorder in the control room where it is recorded in combination with the tailwater gage reading.

c. Inflow Gages.

(1) Spalding. Clearwater River at Spalding gage (RM 11.6) is operated by the USGS. It has a servomanometer driving a recorder with three taps for data transmission via radio to Lower Granite, to the BPA's Radiotelemetry Network, and to telephone interrogation equipment for use in the event of a radio failure. However, doubtful data obtained by radio from this gage cannot be verified by phone since both the radio and phone are driven by the same float and servomanometer.

This station indicates river stage, which is converted to discharge in CROHMS. This gage measures essentially all the Clearwater River flow into Lower Granite reservoir. The purpose of the gage is to provide "real time" data of the Clearwater River discharge to facilitate Lower Granite project operations, especially flood control operations and minimum release computations.

(1) Anatone. The Snake River near Anatone gage is located 27.9 miles above Lewiston and is operated by the USGS. It consists of a float well, float-driven recorder and phone interrogation system, and a servomanometer-driven recorder and radio. Data from this station is transmitted via radio to the project and into the CROHMS network. Data obtained by radio can be verified by calling the gage by phone since the radio and phone are driven independently.

This station indicates river stage, which is converted to discharge in CROHMS. Since this gage measures nearly all the Snake River flow entering Lower Granite project, it is used in conjunction with the Spalding gage to determine total inflow to the project.

d. Gage Communications and Recording Facilities. The radio telemetry system between the gage sites and Lower Granite consists of a five-channel, UHF backbone link from the dam to a repeater location on the hill north of the Lewiston-Clarkston area and a VHF link from this point to the gage site. The data from all of these systems is obtained from the registers at Lower Granite and sent in over the Automated Hydrologic Network to Walla Walla and into CROHMS.

Because the operation of the levee system is under the jurisdiction of the Granite-Goose Project Engineer, communication is required between the dam and project personnel in the Lewiston area. The UHF link serves multiple purposes by providing one channel for project personnel communication in the Lewiston area, one channel for the gaging information, one channel for the Automated Hydrologic Network, one channel for the Lewiston levee alarms, and one spare channel.

The data from the sites is fed into the registers at the Lower Granite control room, which in turn furnish it to the computer, the multi-pen strip chart recorders, and to the Tascmaster. The Tascmaster supplies the data in a form acceptable to the Automated Hydrologic Network. The data is normally printed on the computer printout once each hour unless preselected limits are exceeded at which time more frequent printouts can be called for. Mounted in the control room is one two-pen recorder for the two lake levels and a two-pen recorder for Spalding and Anatone. The range for the two lake level gages is approximately 10 feet, while that for Anatone and Spalding gages is 20 feet. Because the recorder has a 10-inch strip chart, a scale of one-half inch on the chart representing 1 foot of change in river level was chosen. This gives sufficient accuracy to deter-mine the change in water level but not to determine the exact level making both the recording and the computer printout necessary. The river gage recorders punch data and send it to Lower Granite every 15 minutes. If no new signal reaches Lower Granite, the last one received remains in the register with no way to determine the age of the data. Output is made in BCD parallel form to the readouts, to the recorders through D to A converters, to SAT-4, and to a logic package for transmission of the hydromet data to Walla Walla. In case of a malfunction of a site or all sites, data can be obtained by telephoning the sites.

e. Temperature Gage. Intake water temperature at Lower Granite Dam is recorded daily in the morning by project personnel. This temperature is measured at the point where cooling water leaves the scroll case of the turbine. Temperature data is entered into CROHMS via the CBT system, usually at the same time as daily fish counts.

f. Maintenance. The lake elevation gages and radio and telemetry equipment at the streamflow gaging sites are maintained by Granite-Goose personnel. Gaging equipment at the Spalding and Anatone sites is maintained by the USGS.

5-02. CROHMS System - Corps of Engineers.

a. General. The CROHMS is a real-time water resources data management system. A computer system is used for data reduction, system modeling, forecasting, and data base support functions. The data acquisition for these functions is supported through the Central Facility Data Controller (CFDC). Figure 5-1 on page 5-7 shows the CROHMS network diagram. Details on the CROHMS data collection system are contained in the following documents:

(1) Columbia River Basin Master Water Control Manual, December 1984.

(2) Central Facility Data Controller Users Manual, February 1984.

In addition, the CBT network, operated by the Corps of Engineers, is now merged with CROHMS. The CROHMS central facility, instead of the LINGO, performs the polling functions for the CBT circuit. The CBT system's primary functions include: (1) transmitting project data on an hourly basis and (2) issuing day-to-day operating instructions and schedules to the project. Refer to CBT Users Manual, September 1980, for details on the CBT network.

b. Use of CROHMS Data. The real-time data are used for the operational management and forecasting of the Columbia River system. The output system is designed to be flexible and easy to use in carrying out the water management responsibilities on a day-to-day basis or for special operating conditions, for maintaining surveillance of the river and reservoir system, and for developing forecasts or operating plans for future regulation.

5-03. Sedimentation Stations. To monitor the amount and pattern of sediment deposition in Lower Granite reservoir, 71 sediment ranges were initially established beginning at Snake RM 107.73 and extending to Snake RM 148.83, and Clearwater RM 7.85. Since the project was built, additional ranges have been established, for a total of 105 stations. Data from these stations is also used to calibrate a one-dimensional sediment deposition model for use in determining water surface profiles for flood control purposes. Plates 5-2.1 and 5-2.2 show the location of sedimentation ranges in Lower Granite reservoir for the Snake and Clearwater Rivers, respectively.

5-04. Water Quality Stations. The Walla Walla District Environmental Resources Branch is responsible for collecting water quality data. Water quality data is collected quarterly at two stations (RM's 107 and 120) within Lower Granite reservoir. The parameters collected in profile are temperature, pH, turbidity, and alkalinity. Samples for selected chemical, physical, and biological parameters are also collected at these stations. Project resource personnel take monthly water quality samples at swim beaches.

In conjunction with the water quality sampling at Lower Granite, three stations downstream are also sampled: RM 83 (Little Goose); RM 44 (Lower Monumental); and RM 18 (Ice Harbor). Dissolved gasses data has been collected seasonally during the downstream migration of the salmon and steelhead smolts. Permanent stations, with satellite reporting capabilities, for monitoring dissolved gas levels are presently installed at all the Snake River projects.

5-05. Communications. Direct communication between the project and the District Office is normally by telephone via a leased line between McNary and Walla Walla, then via microwave to Lower Granite. The Federal Telecommunications System (FTS) is used between NPW and North Pacific Division, and via this system most other long distance calling can be handled.

A large amount of river, reservoir, weather, and related operating data is transmitted via the CBT network. The CBT network connects the North Pacific Division and the Walla Walla, Portland, and Seattle District Offices with all major projects in the Columbia River Basin system. The network also includes BPA, Portland, Oregon; Bureau of Reclamation and Weather Bureau Offices, Boise, Idaho; and the USGS Northwest Regional Water Data Center in Portland, Oregon. An elaborate radio, microwave radio, and telephone system connects all District projects except Lucky Peak. McNary Dam is the control center for this system. Radio communication to commercial floating craft and the U.S. Coast Guard utilizes assigned marine frequencies 156.65 megacycles for contacting and emergencies, and 156.80 megacycles for working traffic. Radio communication between mobile and portable units and the District Office or a project control room is on the Corps' operating frequency 163.4125 megacycles. Relay stations on Johnson Butte and near Pomeroy in the Blue Mountains are provided to increase mobile radio coverage. Microwave radio channels link the project control rooms and the District Office.

When the operator at Lower Granite leaves the control room, McNary can switch the microwave radio system and rebroadcast over the mobile or portable frequency, 163.4125 megacycles, and reach the operator anywhere on the project. The operator can monitor and answer the navigation radio on 156.65 megacycles by activating the rebroadcasting feature when he leaves the control room. He must return to the nearest telephone to conduct any radio traffic on 156.80 megacycles.

A microwave telephone system provides an additional link between the District Office and the projects. With the microwave radio and telephone system available, it is possible to communicate between a mobile radio and any project or District telephone extension via McNary control room.

FIGURE 5-1, CROHMS Network Diagram

CROHMS

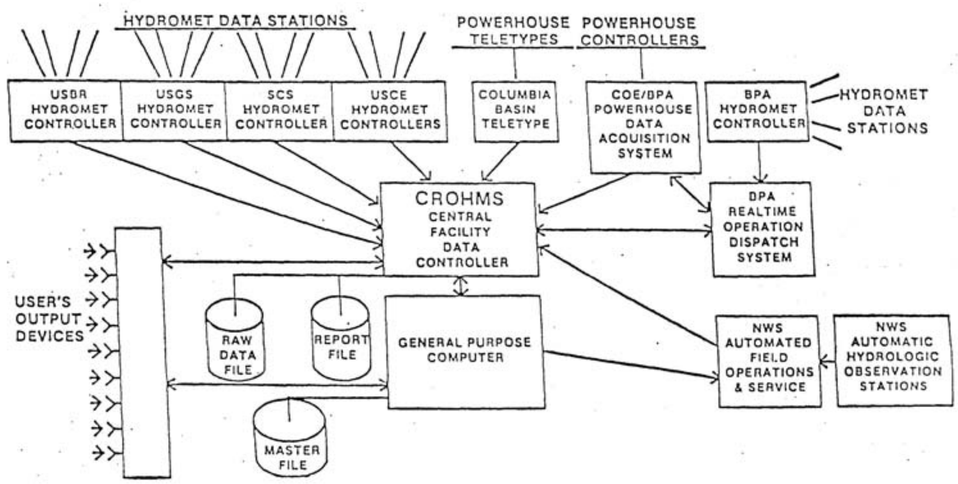


FIG. 5-1 CROHMS NETWORK DIAGRAM

VI - WATER CONTROL MANAGEMENT

6-01. Responsibilities and Organization. The complex system of reservoirs in the Columbia River Basin and their diverse ownership requires a high degree of cooperation and coordination between Federal, state, municipal, and other public and private organizations which have interests in the reservoir regulation activities of the Columbia River system. Lower Granite is a part of this system. Functional water regulation at Lower Granite Project is the responsibility of the Engineering Division of the North Pacific Division. Physical operation and maintenance are the responsibility of the Operations Readiness Division of the Walla Walla District. Project responsibility is assigned to the Granite - Goose Project Engineer, who reports to the Chief, Operations Division, Walla Walla District. Details of organization and responsibilities, liaison with other agencies, coordinated regulation of reservoirs on a system basis, and related matters are described in the Master Water Control Manual for the Columbia River Basin dated December 1984.

a. Corps of Engineers. In general, the NPD Reservoir Control Center (RCC) plans and directs the regulation of NPD reservoirs and certain non-Corps reservoirs that have space allocated for flood control. The RCC coordinates the regulation of NPD, non-Corps, and Canadian reservoirs in the Columbia River Basin in order to increase the effectiveness of the system operation under routine and critical conditions.

The real-time daily regulation of Lower Granite is the direct responsibility of the RCC. For special reservoir operations, the RCC collaborates with the Hydrology Branch of the Walla Walla District. The Hydrology Branch provides assistance and support to the RCC by participating in reservoir regulation studies, supplying hydrometeorological data, and providing reservoir regulation manuals for District projects. Final regulation plans are approved and administered by the RCC. Physical operation and maintenance of the Lower Granite project is the responsibility of the project engineer who is under the supervision of the Operations Division, Walla Walla District. Pages 6-8 through 6-10 show organizational charts, corresponding personnel names and telephone numbers pertinent to the operation of Lower Granite for the Corps of Engineers and Bonneville Power Administration.

b. Portland River Forecast Center (RFC). The Portland RFC is the official office responsible for issuing coordinated runoff volume forecasts, peak flow forecasts, and flood stage forecasts for key gaging stations within the Columbia River Basin. See Section VII of this manual for details on hydrologic forecasts. A formal agreement in 1963 between the Corps of Engineers and the National Weather Service formed the Cooperative Columbia River Forecasting Service. In 1971, this agreement was amended to include Bonneville Power Administration. A three-member technical committee provides technical advice and guidance to the Columbia River Forecasting Service. The three committee members are as follows:

(1) Chief, Hydrologic Engineering Section, NPD
(2) Hydrologist in Charge, National Weather Service, Portland RFC
(3) Chief, Hydrometeorology Branch, Bonneville Power Administration

c. Bonneville Power Administration (BPA). The BPA is the marketing agency for electric power produced at Federal hydroelectric projects throughout the Columbia River Basin system. This group of Federal hydroelectric plants along with BPA's transmission facilities is known as the Federal Columbia River Power System. Lower Granite is a unit of this system. The Chief of the RCC coordinates with the BPA Chief of Division of Power Supply and Chief of Power Scheduling Branch on significant regulation decisions that affect power generation. Routine power scheduling is accomplished by NPD/RCC in coordination with BPA's Power Scheduling Branch. BPA dispatchers coordinate power production from the Federal projects on a real-time basis.

A Memorandum of Understanding, entered into on 8 October 1956 and revised on 16 November 1970, between the NPD and the BPA documents the policies and procedures to be followed in the operation of the Corps of Engineers projects. The objective of this Memorandum of Understanding is to maximize power generation by coordinated operations within the normal and special operating limits of NPD projects.

c. Other Agencies. Other entities with which the RCC coordinates and exchanges information in the process of carrying out reservoir regulation activities include the Bureau of Reclamation, U.S. Geological Survey, Soil Conservation Service, Federal Energy Regulatory Commission, Northwest Power Planning Council, the Fish Passage Center representing Federal and state fish and wildlife agencies and the Indian tribes, Federal and state water quality agencies, non-Federal public utilities, private power utilities, and navigation interests. Details on coordination of reservoir regulation activities with other agencies on a system basis are provided in the RCC Guidance Memorandum dated January 1972 and the Master Water Control Manual for the Columbia River Basin dated December 1984.

6-02. Coordination Committees and Agreements. The principal organizations which have been formed to coordinate the planning and operation of the Columbia River system projects are the Northwest Power Pool, the Pacific Northwest Coordination Contract Committee, the Columbia River Treaty Operating Committee, and the Columbia River Water Management Group.

a. Northwest Power Pool. The Northwest Power Pool is a voluntary organization whose primary function is to coordinate the operation and maintenance of the power systems of the Pacific Northwest. It also serves as a coordinating group for the solution of a variety of system operating problems.•

The membership of the Northwest Power Pool includes 20 utilities and agencies as follows:

(1) BPA
(2) Bureau of Reclamation

(3) British Columbia Hydro and Power Authority
(4) Chelan County PUD
(5) Corps of Engineers
(6) Douglas County PUD
(7) Eugene Water and Electric Board
(8) Grant County PUD
(9) Idaho Power Company
(10) Montana Power Company
(11) Pacific Power and Light Company
(12) Portland General Electric Company
(13) Puget Sound Power and Light Company
(14) Seattle City Light
(15) Sierra Pacific Company
(16) Tacoma City Light
(17) Transalta Utilities Corporation
(18) Utah Power and Light Company
(19) Washington Water Power
(20) West Kootenay Power and Light Company

The functions of the pool are carried out by means of an Operating Committee and a Coordinating Group:

(1) Operating Committee. The Operating Committee consists of one member from each participating system through whom all pool matters are handled. Implementation of any pool action requires unanimous approval by the Operating Committee. The Operating Committee has three continuous sub-committees: Relaying, Communications, and Maintenance.

(2) Coordinating Group. he Coordinating Group, headquartered in Portland, Oregon, consists of five full-time professionals. It acts as a staff for the Operating Committee and the Coordination Contract Committee of the Pacific Northwest Coordination Agreement and provides a clearing-house for all pool utilities. The group initiates telephone conference calls, chairs Operating Committee meetings, prepares numerous load-resource analyses, takes a lead in coordinating operation with the pool and with adjacent areas, and makes other operating studies and reports. A considerable amount of time is spent on making load resource analyses for both the Coordinated System of the Pacific Northwest Coordination Agreement and the Northwest Power Pool. Utilizing digital computers, these analyses are made from load and resource data supplied by the utilities. The Northwest Power Pool does not maintain a centralized group to schedule and dispatch the combined resources of the members of the pool. Rather, each member system remains autonomous, scheduling and dispatching its own resources to serve its own load. The Northwest Power Pool is a member of the North American Power Systems Interconnection Committee (NAPSIC) which coordinates energy interchange between 10 regional systems.

b. Pacific Northwest Coordination Agreement. The utilities of the Pacific Northwest have long recognized the need for coordinated operation. Through the years the Northwest Power Pool and other inter-utilities arrangements have accomplished much toward this end. These efforts culminated in the Pacific Northwest Coordination Agreement, a formal contract for coordinating the seasonal operation of the generating resources of the member systems for the best utilization of their collective reservoir storage. Finalized in mid-August 1964, the agreement (Contract No. 14-02-4822) became effective on 4 January 1965 and terminates on 30 June 2003. The following 18 agencies and utilities have ratified the agreement:

(1) BPA
(2) Bureau of Reclamation
(3) Corps of Engineers
(4) Chelan County PUD
(5) Colockum Transmission Company
(6) Cowlitz County PUD
(7) Douglas County PUD
(8) Eugene Water and Electric Board
(9) Grant County PUD
(10) Montana Power Company
(11) Pacific Power and Light Company
(12) Pend Oreille PUD
(13) Portland General Electric Company
(14) Puget Sound Power and Light Company
(15) Seattle City Light
(16) Snohomish County PUD
(17) Tacoma City Light
(18) Washington Water Power Company

A fundamental concept of the Coordination Agreement is "Firm Load Carrying Capability," commonly abbreviated as FLCC. For the coordinated system of all 18 parties, the FLCC is the aggregate firm load that the system could carry under coordinated operation with critical period stream-flow conditions and with the use of all reservoir storage.

In order to accomplish such coordinated operation, the combined power facilities of the parties are operated to produce optimum FLCC.

Each party is entitled to a Firm Energy Load Carrying Capability (FELCC) equal to its capability in the critical streamflow period with full upstream storage release, except for reimbursement of Canadian Treaty benefits and restoration of capability to parties which suffer loss in critical period energy capability as a result of the Canadian Treaty storage. FELCC's are sustained by exchange of energy between parties.

Prior to the start of a contract year, a reservoir operating and storage schedule is developed to provide the optimum FELCC of the coordinated system within nonpower constraints. This schedule is melded with a schedule that provides adequate assurance of reservoir refill. The resulting schedule, called an Energy Content Curve (ECC), is used to deter-mine system energy generation capability. Generation in excess of FELCC resulting from draft to ECC can be used to serve secondary load. If draft below ECC is required to carry FELCC, then secondary load may not be served.

The above discussion refers primarily to the procedures followed to ensure meeting FELCC during periods of critical streamflow. However, the same basic procedures are used to insure optimum utilization of reservoir storage during years of plentiful streamflow as well.

If, as may frequently happen, the best operation for the coordinated system requires a utility to cut back on releases and to hold storage for later use, thereby reducing its present generation below its FELCC and perhaps below its load requirements, it has the right to call for and receive interchange energy from a party with excess capability. Later, when the first party's storage is scheduled for release, it will be able to return the energy. Provision is made to pay for any imbalances in such interchange energy exchange accounts that may remain at the end of a contract year.

The agreement provides that, upon request, a utility is entitled to the energy that it could generate at its plants if upstream reservoirs released all water above their FCC's. The upstream party can either release the water or, if it has surplus energy and wishes to conserve its storage for later use, it may deliver energy "in lieu" of the water. The upstream party is not required to spill water to satisfy demands of a downstream utility.

Other provisions of the agreement include the following: Each party shall accept for storage in available reservoir space energy surplus to other parties' needs. Equitable compensation shall be made for the benefits from reservoir storage. The obligation to reimburse treaty power to Canada shall be shared by the projects which benefit from treaty storage in proportion to their benefits. Interconnecting transmission facilities shall be made available for coordination use subject to the owners' prior requirements. Equitable charges shall be made for capacity, energy, transmission, storage, and other services. Nothing in the agreement is intended to conflict with project constraints for other functions such as flood control, recreation, fish, irrigation, etc.

Representatives of the participants in the agreement are members of the Coordination Contract Committee. This committee makes studies and analyses and rules on any actions concerning the agreement. Most of its work is delegated to the Northwest Power Pool Coordinating Group. However, some of the work is delegated to one or more of the participants.

c. Columbia River Treaty. In 1964, the Columbia River Treaty for the international development of the Columbia River was ratified by the governments of Canada and the United States. The treaty provided for Canada to build and operate three reservoirs presently known as Duncan Lake, Arrow Lake, and Kinbasket Lake. These three reservoirs have a combined usable storage of 20.5 million acre-feet. Under the treaty, Canada operates these reservoirs in a manner which increases downstream power generation and reduces flood damage in the United States. In return for the benefits received, the United States gives Canada half of the dependable capacity and half the energy gain in the United States as a result of Canadian storage and pays Canada an amount equal to half the value of flood damages prevented.

In carrying out the functions required under the Columbia River Treaty, each country has set up a working organization. The treaty working organization is comprised of a permanent engineering board, U.S. and Canadian entities, U.S. coordinators, Manager - Canadian Entity Service, and two international committees. The RCC Guidance Memorandum dated January 1972 provides details on functions and responsibilities of these working organizations.

d. Columbia River Water Management Group. The Columbia River Water Management Group acts as a committee to consider problems relating to operation and management of water control facilities in the Columbia River Basin. Upon review and discussion of the problems, the group makes tentative recommendations for consideration of the individual agencies having primary responsibilities in these areas. The basic function of the group is coordination of river systems operations including the efficient operation of the hydrometeorological system required for each operation. The Water Management Group prepares an annual report which summarizes hydrometeorological and reservoir regulation activities and activities and accomplishments of member agencies as related to the Columbia River and tributaries.

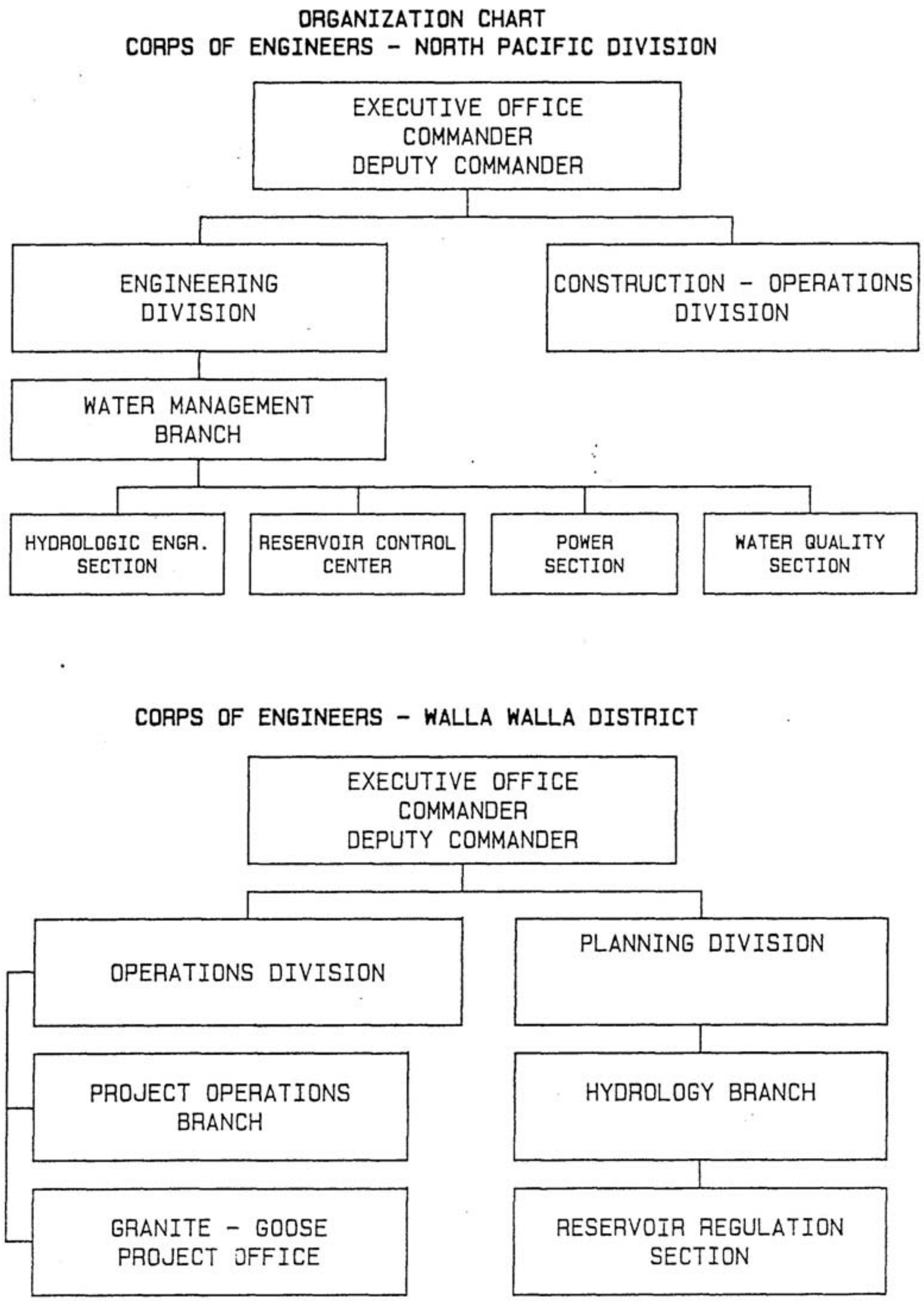
The membership of the Columbia River Management Group is composed of representatives from the following state and Federal agencies:

(1) Bureau of Reclamation
(2) BPA
(3) Corps of Engineers
(4) National Weather Service
(5) USGS
(6) Environmental Protection Agency - Water Quality Office
(7) U.S. Forest Service
(8) Soil Conservation Service
(9) Bureau of Land Management
(10) Federal Energy Regulatory Commission
(11) Fish and Wildlife Service
(12) National Marine Fisheries Service
(13) Oregon Water Resources Department
(14) Washington Department of Ecology
(15) Idaho Department of Ecology
(16) Nevada State Engineer

(17) Department of Natural Resources and Conservation (Montana)
(18) Wyoming State Engineer

6-03. Regulation Decisions and Records. The RCC is responsible for making regulation decisions which affect project discharge rates and storage. The goal of the RCC is to effectively and efficiently schedule project operations in order to maximize benefits for project purposes. A daily log noting pertinent conversations and discussions leading to regulation decisions will be kept current both at the project and the RCC. Regulation decisions and instructions are discussed with appropriate project personnel and confirmed both on the CBTT and the CROHMS (Report Number 42 - Project Regulation Messages). Details and completeness of the daily log will be as necessary for after-the-fact review and analysis of regulation plans.

Insert ORGANIZATION CHART
CORPS OF ENGINEERS - NORTH PACIFIC DIVISION



LOWER GRANITE LOCK & DAM 6-8 REVISED DEC. 1987

INSERT - ORGANIZATION CHART – BONNEVILLE POWER ADMINISTRATION

INSERT – PERSONNEL AND TELEPHONE NUMBERS –

BONNEVILLE POWER ADMINISTRATION

TITLE	NAME	OFFICE TELEPHONE COMMERCIAL
Administrator		
Deputy Administrator		
Senior Assistant Administrator For Power Facilities		

INSERT – PERSONNEL AND TELEPHONE NUMBERS –

CORPS OF ENGINEERS – NORTHWESTERN DIVISION

TITLE	NAME	OFFICE TELEPHONE COMMERCIAL
Commander		
Deputy Commander		
Engineering Division Division Chief		

CORPS OF ENGINEERS – WALLA WALLA DISTRICT

TITLE	NAME	OFFICE TELEPHONE COMMERCIAL
Commander		
Deputy Commander		
Engineering Division Division Chief		

* Microwave procedure from District to Project

VII - STREAMFLOW FORECASTS

7-01. General. The development of reservoir regulation plans for the Lower Granite project is based primarily on power operations and daily streamflow forecasts. The NPD RCC is directly responsible for coordination of operational planning and regulation of Corps of Engineers reservoirs. The Northwest RFC of the National Weather Service is responsible for issuing coordinated water supply forecasts for the Columbia River Basin system based on forecasts from B.C. Hydro, BPA, Bureau of Reclamation, Corps of Engineers, Soil Conservation Service, and the Northwest RFC. RFC also makes peak discharge estimates for key gaging stations in the Columbia River Basin based on 1 April runoff volume forecasts. These peak flow forecasts are based on statistical relationships between peak flow and runoff volume.

For real-time short-range daily regulation, the RCC uses the Streamflow Synthesis and Reservoir Regulation (SSARR) model. The SSARR model utilizes routing procedures, snowmelt, and precipitation data to simulate stream-flows. The storage effects of lakes and reservoirs can also be evaluated with specified streamflow and reservoir conditions. The RFC and the RCC develop SSARR forecasts cooperatively and use results to carry out daily service and daily operational responsibilities. Refer to the Master Water Control Manual dated December 1984 for more information on use of the SSARR model.

7-02. SSARR Forecasts. The SSARR model is comprised of three basic components:

a. A generalized watershed model for synthesizing runoff from snow-melt, rainfall, or a combination of the two as drainage basin outflows.

b. A river system model for routing streamflows from upstream points to downstream points through channel and lake storage. Streamflows may be routed as a function of multivariable relationships involving backwater effects from tides or reservoirs.

c. A reservoir regulation model whereby reservoir outflow and contents may be analyzed in accordance with predetermined or synthesized inflow and free flow or any of several modes of operation.

SSARR forecasts normally begin about 1 April and continue until the flood potential becomes minimal, which is usually sometime in July. During the early part of the spring flood season, the frequency of these forecasts is 3 days per week on Monday, Wednesday, and Friday. The Monday and Friday forecasts are short-range forecasts for 10 days in advance. The Wednesday forecast is a long-range forecast which covers the period from the initial forecast date through July. During the peak flow and recession flow period, long-term extended forecasts are made every day. These extended forecasts continue until the danger of flooding is past and the reservoirs are filled. Since weather forecasts are usually reliable for no more than 3 to 5 days in advance, the hydrometeorological factors affecting runoff must be extended during the forecast period on the basis of average and extreme snowmelt conditions in order to compare probable flows with the most severe flows likely to occur.

VIII - WATER CONTROL PLAN

8-01. General Objectives. The objective of this Water Control Plan is to define reservoir regulation procedures and practices which provide maximum benefits from authorized project uses when the project is regulated as a part of the Columbia River Basin system. To accomplish this objective the Lower Granite project will be regulated as a run-of-river project with primary functions of navigation and hydroelectric power generation, while also providing the best possible conditions for other project uses of flood control, fish and wildlife, and recreation. Flood control is not an authorized or planned function because of the limited amount of usable reservoir storage, but because of levees at Lewiston, project regulation is needed for maintenance of levee freeboard, which provides areas behind the levees with standard flood protection.

8-02. Major Constraints. The major constraints on the regulation of Lower Granite project are: (a) lake elevation limitations; (b) reservoir release limitations; (c) minimum release for levee freeboard; and (d) spillway operation.

a. Lake Elevation Limitations.

(1) Operating Range. For normal power operation, the forebay limits at Lower Granite Dam will normally be between El. 733.0 and El. 738.0.

(2) Maximum Pool at Confluence Gage (RM 139.5). Because of design criteria for the levee system in the Lewiston-Clarkston area, the maximum pool limit of 738.0 will apply to the reservoir elevation at the confluence of the Snake River and the Clearwater River as measured at the confluence gage. Forebay elevations at Lower Granite Dam will be regulated as required to insure that El. 738.0 is not exceeded at the confluence gage.

(3) Maximum Pool at East Lewiston Levee Gage (RM 2.9). During periods of high flow there will be substantial slope of the water surface on the Clearwater arm of Lower Granite Lake. These levees are designed to provide 5 feet of freeboard above the computed water surface for 150,000 cfs (SPF). A water level gage has been established at the upper pumping plant of the east Lewiston levee (Clearwater RM 2.9) to monitor levee freeboard. The design water level at this point is 744.4. Should this level be exceeded, immediate action will be taken to determine the cause and necessary action to reduce the stage to below the maximum pool limit (El. 744.4). The forebay will be lowered if required to maintain the pool level below the 744.4 maximum pool limit at the east Lewiston levee gage.

(4) Minimum Lake Elevation. The minimum pool for Lower Granite Lake has been established at El. 733.0. The 738-733 elevation range as measured at the confluence gage will not be violated, except in an emergency. Normally, a minimum pool elevation of 733 will also be maintained at the forebay of the project. During certain flood situations, the forebay elevation may need to be drawn down below 733. The NPD

RCC will specify forebay elevations of less than 733 when required for prudent reservoir system flood control operation to maintain levee freeboard, provided that this action would not lower the confluence gage (RM 139.5) below El. 733.

Forebay elevations below 733 will be allowed and required if necessary to maintain the confluence gage or the east Lewiston levee gage at or below levels specified in operating criteria. Drafting the forebay below El. 733 will be allowed 72 hours prior to the period when streamflow forecasts indicate that this action would be required to maintain levee freeboard. The intent is to permit evacuation prior to the flood peak when efficient reservoir systems operation justifies this action, even though the action may cause the interruption of navigation in Lower Granite reservoir and may also affect the operation of the juvenile fish bypass and collection systems at the dam. This action will be ordinarily directed by the RCC, who will coordinate it with the NPW Hydrology Branch.

b. Reservoir Release Limitations.

(1) Minimum Discharge. Minimum project discharge limits ensure the safe passage of anadromous fish during their migration to spawning grounds. From December to February, "zero" minimum project discharge is permitted on a limited basis. Under an agreement between the Corps of Engineers and the fishery agencies, zero riverflow is allowed for water storage during low power demand periods (at night and on weekends) when there are few, if any, actively migrating anadromous fish present in the Snake River. From March to November, the minimum project discharge will be 11,500 cfs for power generation and conservation purposes. This minimum discharge is the approximate design discharge of one power unit operated at the continuous minimum generation limit of 80 MW. Special conditions may develop which make zero minimum project discharge desirable for a limited time during the March to November period. The RCC will be responsible for coordinating such zero flow requests with the fishery agencies for approval. Water stored under zero riverflow conditions may maximize power production from the Columbia River Basin system, but zero riverflow operations are not recommended at Lower Granite when fish are actively migrating in the Snake River.

In addition, during a flood operation, when Lower Granite inflow is greater than 120,000 cfs, minimum project discharges may be required to maintain adequate levee freeboard on the Lewiston levees. These flood control release requirements are explained in paragraph 8-02.c, Minimum Release for Levee Freeboard.

(2) Rate of Change of Discharge. The maximum rate of change per hour for project discharge will normally be limited to 70,000 cfs, which is based on a 1.5-foot-per-hour rate of change for tailwater elevation. Plate 3-6 shows tailwater discharge rating curves. However, no limitation on the rate of change of discharge will be imposed as a major constraint during a flood operation when the regulation objective is to maintain levee free-board on the Lewiston levees.

c. Minimum Release for Levee Freeboard.

(1) Purpose. A conservative regulation procedure is needed to protect the Lewiston-Clarkston population center from excessively high lake elevations. Although levees have been constructed to protect low-lying areas at Lewiston and Clarkston, the design criteria for these levees was that the lake elevation at the confluence of the Snake and the Clearwater Rivers would not exceed El. 738.0 for all flows up to the SPF level (420,000 cfs total inflow). The levees were provided with only 5 feet of freeboard for contingencies, and this freeboard must not be encroached upon for in-flows less than 420,000 cfs. The purpose of requiring minimum releases is to insure maintenance of design levee freeboard at all times.

(2) Concept. The forebay elevation at Lower Granite Dam and the total inflow determine lake elevation in the Lewiston-Clarkston area (confluence gage). The higher the inflow, the lower the forebay elevation must be to maintain a constant elevation at the confluence. Therefore, as inflow increases, the minimum release must increase. Some correction must also be added to the release if the lake elevation is above the maximum limit to evacuate the lake to its proper level. Conversely, if the lake is below the maximum limit, a correction can be subtracted from the release to allow filling. A minimum release is to be determined hourly using the procedure outlined in detail in Exhibit 8-1, Procedure for Minimum Project Release Determination.

(3) Responsibility. The RCC is responsible for providing reservoir regulation instructions to the Lower Granite project. Lower Granite's powerplant operators are responsible for operating the project within the project operating limits by computing project inflow and adjusting project releases in accordance with procedures and criteria in this manual.

d. Spillway Operation. The spillway is operated to pass the desired discharge with the best practical hydraulic conditions in the stilling basin, particularly at the fish ladder entrances. On the basis of experience, it appears that the most desirable stilling basin conditions would be obtained with uniform discharge through all eight bays. With gate openings of 0.5 foot or less, the aeration of the thin jet is so complete that vast amounts of spray are produced. This is undesirable and is particularly objectionable during freezing weather. Therefore, the spill-way gates will be opened to at least one stop each and in accordance with criteria in the Walla Walla District - Fish Facility Operation and Maintenance Plan, Appendix C - Operating Standards for Adult Fish Passage Facilities. Table 8-1, on page 8-5, shows the spill pattern based on current criteria for spillway gate operation during the fish passage season from 1 March through 31 December, with gates numbered 1 to 8 from left to right looking downstream. If the desired spill becomes greater than the capacity of eight gates for the spill pattern shown in Table 8-1, repeat the gate operating sequence shown in Table 8-1 with increased gate stop openings.

The foregoing procedure is a guide rather than a firm rule. Additional experience and further testing of various other combinations may result in modifications of the above plan. Table 3-2 is the discharge rating table for one spillway gate and Plate 3-5 shows spillway rating curves.

TABLE 8-1
LOWER GRANITE SPILL PATTERN
(1 March - 31 December)

Gate No.									
1	2	3	4	5	6	7	8		
Gate Stops								Total Stops	Spill (kcfs) 1/
1	0	0	0	0	0	0	0	1	1.75
1	0	0	0	0	0	0	1	2	3.50
1	0	0	0	0	0	1	1	3	5.25
1	1	0	0	0	0	1	1	4	7.00
1	1	0	0	0	1	1	1	5	8.75
1	1	1	0	0	1	1	1	6	10.50
1	2	1	0	0	1	1	1	7	12.37
1	2	1	0	0	1	2	1	8	14.25
1	2	1	1	0	1	2	1	9	15.99
1	2	2	1	0	1	2	1	10	17.86
1	2	2	1	1	1	2	1	11	19.61
1	2	2	2	1	1	2	1	12	21.48
1	2	2	2	2	1	2	1	13	23.35
1	2	2	3	2	1	2	1	14	25.27
2	2	2	3	2	1	2	1	15	27.14
2	2	2	3	3	1	2	1	16	29.06
2	2	2	3	3	2	2	1	17	30.93
2	2	3	3	3	2	2	1	18	32.85
2	3	3	3	3	2	2	1	19	34.77
2	3	3	4	3	2	2	1	20	36.67
3	3	3	4	3	2	2	1	21	38.61
3	3	4	4	3	2	2	1	22	40.53
3	3	4	4	3	3	2	1	23	42.45
3	4	4	4	3	3	2	1	24	44.37
3	4	4	4	4	3	2	1	25	46.29
3	4	4	5	4	3	2	1	26	48.21
3	4	5	5	4	3	2	1	27	50.13
4	4	5	5	4	3	2	1	28	52.05
4	5	5	5	4	3	2	1	29	53.97
4	5	5	5	4	4	2	1	30	55.89
4	5	5	5	5	4	2	1	31	57.81
4	5	5	6	5	4	2	1	32	59.73
4	5	6	6	5	4	2	1	33	61.65
4	6	6	6	5	4	2	1	34	63.57

1/ Forebay El. 737.

Source: Walla Walla District - Fish Facility Operation and Maintenance Plan, Appendix C - Operating Standards for Adult Fish Passage Facilities.

8-03. Flood Control Plan.

a. General. When Lower Granite was constructed, flood control was not an authorized function. However, a flood control plan during a flood period will provide a conservative method for maintaining levee freeboard and as an incidental benefit will minimize sedimentation and the potential requirement for dredging in the confluence area. The purpose of this flood control plan is to define regulation criteria and procedures for the Lower Granite project during a flood period. The flood control plan will also complement flood control operations on the lower Columbia River.

b. Flood Period. A flood period will be defined as a period when Lower Granite inflow is greater than 120,000 cfs or The Dalles flow is greater than 450,000 cfs and when these flows have the potential to increase substantially and to remain above the indicated levels for at least 24 hours because of past or forecasted near future meteorological events. Any rising flood hydrograph because of rain and/or snowmelt with flows exceeding those stated above and increasing more than 5 percent per day should be considered a flood period.

For the purposes of this flood control plan, a nonflood period exists when Lower Granite inflows are predictable and high because of large discharges from upstream reservoirs and relatively stable natural flows from gradually changing snowmelt. Also, major flooding on the lower Columbia River is not a consideration.

The flood control plan was developed for flood periods typified by relatively unstable riverflows driven primarily by rain and melting snow, which may rise relatively fast and may not be accurately forecasted. The intent of the flood control plan is to allow RCC some flexibility and judgment in the operation of the Lower Granite project during a flood period.

c. Flood Operation. The RCC will direct the flood operations for the Lower Granite project during flood periods and will notify the Walla Walla District Hydrology Branch of these operations. Flood operations will begin in a flood period as defined above in paragraph b., Flood Period.

(1) Rising Inflow Hydrograph. For rising inflows during a flood period, the forebay at Lower Granite Dam will be drawn down to El. 734 at a rate not to exceed 0.5 foot per hour. On a rising hydrograph, the forebay elevation will be maintained near 734 until the 3-day forecast of the sum of flows at Spalding and Anatone exceeds 300,000 cfs, at which time the forebay at Lower Granite may be drawn down to El. 725 at a rate not to exceed 0.5 foot per hour. The forebay at the dam will be drawn down to 724 for the SPF inflow of 420,000 cfs. Care must be taken during this operation not to go to below minimum pool El. 733 at the confluence. Plate 8-1 is provided for guidance to prevent violating this minimum lake level. For inflows greater than 420,000 cfs, the forebay elevation at the dam will coincide with the free-flow spillway rating curve shown on Plate 3-5 if the total inflow is passed through the spillway.

(2) Falling Inflow Hydrograph. During a falling hydrograph, the forebay elevation at Lower Granite Dam will be maintained near 725 until the sum of Spalding and Anatone gages drops to less than 300,000 cfs or until it is necessary to fill the reservoir to maintain minimum pool El. 733 at the confluence. Elevation at the confluence will then be maintained in the 733 to 734 range until the sum of the flows at Spalding and Anatone gages is less than 250,000 cfs, at which time the forebay will be returned to 733. When either the sum of these gages is less than 120,000 cfs or The Dalles flow is below 450,000 cfs, project operations will return to normal.

(3) Summary. The flood control plan provides guidance for the interruption of normal operation, but does not change the limitations and procedures of the preceding paragraphs. In particular, lake level limits of 733 minimum and 738 maximum described in paragraph 8-02a. for the confluence gage (RM 139.5), and the minimum release requirements for levee freeboard described in paragraph 8-02c. will be observed during the flood operation. During major floods, when streamflows are high, relatively unstable, and subject to rapid changes, the criteria in paragraph 8-03c. will prevail, and the pool elevation should be lower than shown on Plate 8-2. Some flexibility and judgment should be used by the RCC in limiting pool levels below those required on Plate 8-2, with the primary considerations being the predictability of inflows. In a nonflood period, it is intended that criteria on Plate 8-2 will prevail. Plate 8-2 shows maximum forebay elevations versus inflow that should not be exceeded at anytime when streamflows are stable and not expected to change rapidly. The flood operation does permit interruption of normal operation 3 days before an elevation of less than 734 at the forebay gage is required and extends this interruption several days beyond the time when normal operation could be resumed. It should be noted that power production from the powerhouse may be reduced when the forebay gage goes below 733, and that navigation will be disrupted and bypass/collection facilities affected when this gage goes below 732.

d. Extremely High Inflows. The project was designed to pass an inflow of 420,000 cfs and still maintain a 738 elevation at the confluence gage. The possibility exists that the project may lose outside communications during extremely high inflows. If the project becomes isolated and the inflow is judged to be 420,000 cfs or greater, the spillway gates will be gradually opened to the full open position in 2 hours. The full open position will give the maximum protection to the confluence area from encroachment on the freeboard.

In addition, during extremely high flows it may be necessary to draw down the forebay at Lower Granite at a faster rate than 0.5 foot per hour to ensure that the maximum pool elevation constraint of 738.0 is not exceeded. Under extremely high flows, the RCC may also consider drawing down downstream reservoirs on the lower Snake River in advance of increasing discharges from Lower Granite Dam if such a system regulation plan would significantly reduce the flood peak at downstream locations on the Snake and Columbia Rivers.

e. Procedure for Monitoring Project Gages.

(1) Pool Elevation Gages.

(a) Confluence Gage. The confluence gage (RM 139.5) will read 738.0 when there is 5 feet of freeboard on the levees in the immediate gage area. If the confluence gage exceeds 738.5 feet, the project operation will be considered abnormal and the following actions will be taken:

1. NPW Hydrology Branch will be notified and project personnel will be dispatched to check the gage.

2. Preparations will be made to increase the project release by 50,000 cfs.

3. If the gage is functioning properly, the project release will be increased 50,000 cfs.

4. Further drafting of the lake will then be determined by NPW personnel.

5. Local civil defense and law enforcement units will be periodically briefed on the situation.

(b) East Lewiston Gage. The east Lewiston levee gage (RM 2.9) will be at El. 744.4 feet when there is 5 feet of levee freeboard. This freeboard was designed for a flow in the Clearwater River of 150,000 cfs and the confluence gage at 738.0 feet. If the east Lewiston levee gage exceeds 744.9 feet and the confluence gage reads less than 738.5 feet, the project operation will be considered abnormal and the following actions will be taken:

1. NPW Hydrology Branch will be notified and project personnel will be dispatched to check the gage and to visually check the lake in the Clearwater arm for the cause of encroachment upon the freeboard.

2. Preparations will be made to increase the project release by 50,000 cfs.

3. If the gage is functioning properly, the project release will be increased 50,000 cfs.

4. A 50,000-cfs increase should reduce the water surface about one-half foot in 1 hour. If the east Lewiston levee gage exceeds El. 744.9 after 1 hour of increased release, increase the project release by another 50,000 cfs.

5. Further drafting of the lake will then be determined by NPW personnel.

6. Local civil defense and law enforcement units will be briefed on the situation.

(c) Forebay Gage. The forebay gage located at the dam (RM 107.5) can be used to check that the project is operating properly. Plate 8-2 shows the maximum elevation of the forebay gage for any given inflow to the lake. Plate 8-2 is a computed set of values for steady flow and some discretion should be used because it does not reflect wind setup or unsteady flow. The gage can be used in the event that all communications to the dam are lost, in which case the discharge and forebay elevation will be controlled to maintain the relationship shown on Plate 8-2 for 15 December to 14 March.

(2) Inflow Gages. Project inflow will be determined from Spalding gage on the Clearwater River and the Anatone gage on the Snake River by allowing 1 hour travel time from each gage to the lake. Discharge rating tables for the Clearwater River at Spalding and the Snake River near Anatone are shown on Tables 8-1 and 8-2, respectively. If the gages malfunction, forecasted inflow will be used. The Hydrology Branch at the District Office will be notified of the malfunction.

8-04. Fish and Wildlife Plan.

a. Background. Every spring juvenile salmon and steelhead smolts leave spawning grounds and hatcheries on the Columbia and Snake Rivers and begin their downstream migration to the Pacific Ocean. These young fish depend on river currents to carry them downstream. The many hydroelectric dams constructed on these rivers have resulted in adverse survival conditions for these smolts due to: (1) increased travel times to the ocean caused by slower flows in reservoirs and (2) restricted downstream fish movement past the dams.

The spring runoff of 1973, which was one of the lowest droughts of record, brought about a heightened awareness of the problems facing juvenile fish during their migration past Columbia and Snake River dams.

During the 1973 spring runoff period, migrating juvenile fish suffered heavy mortalities as a result of (1) the extended transit time through the system and (2) the passage of most fish through the turbine units of the dams. A Committee on Fishery Operations (COFO) was established in 1975 to coordinate the effort to provide for the protection of juvenile fish within a balance of reduced firm power and adverse impacts on other uses of the water resource. Definitive steps were taken to assist juvenile fish passage during the 1977 drought which was more severe than the one in 1973. The COFO continued to coordinate the annual juvenile fish passage program through 1982.

In November 1982, the Northwest Power Planning Council, under guidelines of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Regional Act, Public Law 96-501), developed the first regional fish and wildlife program for the Columbia River and its tributaries. The fish and wildlife program , amended in October 1984, proposes development of an interim regional plan to coordinate, refine, and develop operations and facilities for protecting these migrating fish and improving migration conditions. The NPD Corps of Engineers is responsible for developing and implementing the juvenile fish passage plan for Corps of Engineers projects.

b. Lower Snake River Fish and Wildlife Program. The Lower Granite Water Budget is a recommended amount of water specifically reserved for the enhancement of flows at Lower Granite Dam to aid in the spring migration of smolts through the Lower Snake River reservoir system. This Water Budget may be used during the 15 April-15 June period when the major smolt migration is occurring at Lower. Granite Dam, hence the water budget approach rather than a minimum flow requirement to enhance spring migration conditions. A total Water Budget of 20 Kcfs-months (1.19 MAF) has been recommended for shaping spring flows under the Columbia River Basin Fish and Wildlife Program developed by the Pacific Northwest Power Planning Council in 1982 and amended in 1984 and 1987.

In most years, the Water Budget flows will be the result of runoff from uncontrolled drainage basins above Lower Granite because of the limited amount of water available from storage in Dworshak and Brownlee reservoirs with which to control the Lower Snake River flows. If the Snake River flows at Lower Granite Dam are not adequate (less than 85 Kcfs) to move fish quickly through the reservoir, additional water may be released from upstream reservoirs (Dworshak and Brownlee), if available.

Under the Lower Granite Water Budget Implementation Procedure developed by the Engineering Division of the NPD Corps of Engineers, a sliding scale, based on the Lower Granite April-July runoff volume forecast, is used to determine the volume of water to be allocated from upstream reservoirs (Dworshak and Brownlee) for the Lower Granite Water Budget. Idaho Power Company's participation, use of Brownlee storage, in the Lower Granite Water Budget is still under negotiation with the Bonneville Power Administration. Water Budget flows at Lower Granite will be an operational consideration whenever requested during the 15 April to 15 June period. Requests for Water Budget flows will originate from fish and wildlife agencies and tribes through two Fish Passage Managers. These managers will be the primary points of contact between the power system operators and the fish and wildlife agencies and tribes on matters concerning the Water Budget and fish passage. The flow requests must be greater than average weekly firm power flows and less than 140 Kcfs. For Water Budget accounting purposes, the Power Planning Council has used firm power flows for Lower Granite Dam as follows:

Period	Average Weekly Firm Power Flows (Kcfs)
15-30 April	50
1-31 May	65
1-15 June	60

Use of the water budget approach during the spring runoff season will be based on the following criteria:

(1) Water Budget Regulation. During a year when the Lower Granite runoff volume inflow forecast for April-July is 23.0 MAF or less, the use of upstream reservoir storage for providing Water Budget flows will he coordinated by the NPD RCC. The RCC and Fish Passage Managers will jointly monitor the runoff and juvenile migration and may, by mutual agreement, modify the minimum level of flow at Lower Granite if necessary. The RCC will be responsible for coordinating releases from upstream storage to the extent that water is available for shaping fish flows at Lower Granite. The regulation objectives will he to provide well-timed flows from upstream reservoirs in addition to the uncontrolled spring runoff to aid and enhance migration. Total water available for Water Budget requests above uncontrolled runoff is provided from Dworshak and Brownlee storage under the following conditions:

(a) Brownlee storage may be available to meet Lower Granite Water Budget requests if such releases are agreeable to Idaho Power Company.

(b) Water from Dworshak for shaping Water Budget flows at Lower Granite may he used to maintain average weekly flows of at least 85 Kcfs at Lower Granite. Additional water may be available from Dworshak to provide extended flows up to 140 Kcfs if Dworshak refill is not jeopardized, and the Corps is not collecting and transporting juvenile fish at Lower Granite or Little Goose.

(c) A water budget request may not be implemented if it conflicts with other nonpower constraints at Dworshak. The severity of the conflict will be analyzed by the NPD RCC and appropriate action taken, with documentation of the basis of the-decision forwarded to the Fish Passage Managers.

(2) Nonwater Budget Regulation. During a year when the Lower Granite runoff volume inflow forecast for April-July is greater than 23.0 MAF and the reservation of water for the Water Budget is not required at Dworshak, the RCC would still coordinate the regulation of releases from Dworshak and Brownlee to the extent that water is available for flow augmentation at Lower Granite.

c. Juvenile Fish Transportation Program. In addition to the juvenile fish passage facilities for moving fish past the dam during their downstream migration, a program exists whereby barges and trucks are used to transport fish collected at Lower

Granite, Little Goose, and McNary to points below Bonneville Dam. This program is a means of decreasing travel times in the river and eliminating passage mortality at downstream projects. When fish are diverted at the power intakes into the bypass system and juvenile collection system, the capability exists to either bypass them below the dam or to divert them to holding areas for loading into trucks and barges. The facilities at lower Granite Dam are used mostly for collection, with bypass capability being used only when the collection facility malfunctions, special studies are being conducted, or fish numbers make transportation unfeasible.

The juvenile fish passage facilities are described in paragraph 3-03.b (8)(b). From 1 April to the end of the transportation season, Lower Granite's juvenile fish facilities will be operated according to criteria in the Walla Walla District - Fish Maintenance Plans, Appendix D - Operating Standards For Downstream Migrant Fish Passage Facilities and the Fish Transportation Oversight Team's (FTOT) Annual Work Plan for transport operations at Lower Granite, Little Goose, and McNary Dams.

Spillway releases may be required during the outmigration period to facilitate fish passage past the dam if problems develop with the bypass system, juvenile collection system, or transport operations. This is separate from the Water Budget, which is only intended to facilitate migration downstream between the dams.

8-05. Power Plan. Lower Granite Project will be operated for power within the foregoing pondage and release limitations and in accordance with a working agreement between the Corps of Engineers and BPA, the marketing agency for Federally generated power in the Pacific Northwest. Power scheduling for Lower Granite will he accomplished by BPA in coordination with NPD of the Corps of Engineers. To implement scheduling and maintain optimum operating conditions, close coordination between the Lower Granite and McNary powerplant operators and the BPA dispatchers will be essential.

Routine power operations will be remotely controlled from McNary through the system optimizer controller, which can also remotely control Ice Harbor, Lower Monumental, and Little Goose. Discussion of overall coordinated operation of the Northwest Federal Power System is presented in the Columbia River Basin Master Water Control Manual dated December 1984.

Load factoring may be accomplished by making use of the 43,600 acre-feet of storage between El. 733 and El. 738 when the reservoir inflow is less than powerplant hydraulic capacity and downstream projects can accommodate the extra flow. The discharge capacity of the six existing power units is about 130,000 cfs in the range of normal operating head.

Turbine unit operating priority will be 1, 2, 3, and then 4 through 6. Generally, the power units will be operated to provide maximum overall powerplant efficiency. This will be in the interest of smooth and efficient turbine operation and also will provide more satisfactory conditions for any downstream migrating fingerling fish which pass through the turbines. All operations will be within the safe limitations of the equipment as set forth in the Operations and Maintenance Manual.

In the event of a transmission system breakup which would leave Lower Granite project the only major generating facility on an isolated segment of the BPA system, a maximum effort will be made to carry the load. Under such conditions, it may be justified on a short-time basis to load the generators above the normal 15 percent overload, and to utilize somewhat more than the normal 5-foot reservoir operating range. If at all possible, at least one generator will be kept in operation throughout an emergency which has isolated or threatens to isolate the project from other power sources. If no other power is available, the spillway gates may be operated with emergency power supplied by a diesel-generator set.

8-06. Navigation Plan.

a. General. The Columbia-Snake barge channel extends from the head of deep water navigation at Vancouver to the Pasco-Kennewick area on the Columbia River and to Lewiston on the Snake River, 465 miles from the Pacific Ocean. The lower Snake River navigation channel (mouth of the Snake River to Lewiston) accounts for 140 miles of the Columbia-Snake barge channel and is an important link in the Columbia-Snake barge channel system because it connects interior agricultural areas with the Columbia River for the transport of major commodities to world marketplaces. This element of the water control plan will discuss reservoir regulation procedures and practices which pertain to the navigation purposes of (1) barge lockages and (2) slack-water navigation in the reservoir.

b. Barge Lockages. The lock facilities are operable at the full range of normally experienced riverflows. The navigation regulations and procedures are set forth in Exhibit 8-2. The lock facilities will be closed periodically for maintenance; however, these closures will be scheduled in advance and public notices will be issued. Water which is passed through the dam by lockages is accounted for and reported. A lockage requires approximately 15 to 30 minutes, varying somewhat with head and other factors. The following tabulation shows the relationship between head and volume in a lockage expressed in acre-feet and equivalent cfs averaged over a 1-hour period.

Head	Lockage Volume	
(feet)	(acre-feet)	(cfs-hr)
104	150	1,814
100	144	1,744
96	138	1,675
92	133	1,605
88	127	1,535
84	121	1,465
80	115	1,396

c. Slack-water Navigation in the Reservoir. The Lower Granite reservoir is designed to operate within the normal water surface levels of 733.0 to 738.0. As a result, navigation requirements are fully met under normal multipurpose project operation. Minor conflicts may arise with regard to special regulation for a particular shipment, use of port facilities, shoaling problems along reservoir reaches, or other special navigation functions on the reservoir or at a downstream location. Special regulations of this type will generally be accommodated by either advance scheduling whereby the system operation can be adjusted, or by imposing a soft constraint for a temporary period on the operation of Lower Granite pool to meet the particular need. The RCC will be responsible for the coordination and implementation of special regulations for navigation. Table B-1, Exhibit 8-2, shows a list of personnel and companies that should be notified in the event of any unscheduled navigation lock closures or situations which may impede lock usage or navigation in the reservoir.

8-07. Recreation Plan. The water control plan for the Lower Granite project does not specifically provide regulation criteria for recreation because the recreational facilities at Lower Granite are developed to accommodate normal reservoir fluctuation between El. 733.0 and El. 738.0. Under special conditions and when clearly not detrimental to other interests, the RCC may consider special regulation for special recreation interests activities on the reservoir for short periods. Recreation facilities are fully described in the Lower Granite Master Plan for management of natural and manmade resources. This publication was prepared by NPW and published June 1974. Additional information on recreation facilities may also be obtained by referring to the Walla Walla District Recreation Facilities Guide dated March 1984.

8-08. Special Operations. Special reservoir regulation activities, which are not considered normal reservoir regulation activities, will be required from time to time. Such reservoir regulation plans for special activities would be developed within the normal operating limits and constraints of the project, which are explained in paragraph 8-02, Major Constraints. Requests for special operations that are not within the normal operating criteria of the project will be evaluated and approved or denied by RCC in consideration of real-time or current conditions.

8-09. Public Notices. Public notices will be issued only when there is a pronounced departure from normal operating procedure or an unusual development which will require scheduled special reservoir operations that will be of concern to public activities. Public notices will not be issued for conditions which are of little significance to the public or navigation interests. Public notices pertaining to Lower Granite project will be issued by the Operations, Construction, and Readiness Division of NPW. Public information releases to newspapers, radio stations, and television stations will normally be issued by the NPW Public Affairs Officer and/or the Lower Granite Project Engineer.

8-10. Standing Instructions. The following is a list of standing instructions for reservoir regulation under normal conditions, emergency conditions, and communication outage.

a. Normal Conditions. Lower Granite will be regulated according to criteria and procedures in this Water Control Manual. The following tabulation lists key paragraphs in this Water Control Plan Section for normal operation:

Paragraph		Page
8-02.	Major Constraints.	
	a. Lake Elevation Limitations	8-1
	b. Reservoir Release Limitations	8-2
	c. Minimum Release for Levee Freeboard*	8-3
	d. Spillway Operation	8-3

* It will be the responsibility of the Granite-Goose Project Engineer to insure that minimum releases for levee freeboard are achieved. Violation of minimum release requirements for levee freeboard will require prior approval from the District Engineer. Computation and recording of this minimum release should be incorporated in the daily routine of the project operator. Procedures and sample computations are contained in Exhibit 8-1, Procedure for Minimum Project Release Determination.

Paragraph		Page
8-03.	Flood Control Plan	
	a. General	8-6
	b. Flood Period	8-6
	c. Flood Operation	8-6
	d. Extremely High Inflows	8-7
	e. Procedure for Monitoring Project Gages	8-8
8.04	Fish and Wildlife Plan	
	a. Background	8-9
	b. Lower Snake Fish and Wildlife Program	8-10
	c. Juvenile Fish Transportation Program	8-12
8.05	Power Plan	8-12
8.06	Navigation Plan	
	a. General	8-13
	b. Barge Lockages **	8-13
	c. Slack-water Navigation in the Reservoir	8-14

** Instructions and procedures for lockage of vessels are contained in Exhibit 8-2, Navigation Regulations. Table B-1, Exhibit 8-2, shows a list of personnel and companies to notify in the event of unscheduled navigation matters.

b. Emergency Conditions. Emergency conditions are unforeseen and cannot be provided for in this Water Control Manual. Should an emergency occur or appear to be developing, the Project Engineer or his representative should contact his immediate supervisor. If the nature of the emergency requires immediate action to prevent loss of life and property, the Project Engineer will take the necessary action and report all circumstances to NPW Chief, Operations, Construction, and Readiness Division, as soon as possible.

NOTE: Refer to pages iv and v (pink sheets in the front of this manual) for telephone numbers and guidelines on emergency conditions.

c. Communications Outage. In the event of normal telephone and CBT systems outage, communication between the project and the RCC will be established via the NPW radio system.

IX - EFFECT OF WATER CONTROL PLAN

9-01. General. The various water control plans are intended as a means of outlining project regulation and/or management practices that maximize benefits derived from project functions. These water control plans provide for flood control, power generation, recreation, fish and wildlife, and navigation. Overall benefits and effects from the project include:

a. Flood protection for the city of Lewiston during extreme flood conditions.

b. Coordinated plan to minimize flood damage on lower Columbia River.

c. Production of hydroelectric power.

d. Water-oriented recreational opportunities for the public.

e. Enhancement of economic productivity in the region with slack-water navigation to Lewiston.

f. Impact upon fish and wildlife habitat by altering 44 miles of free-flowing river and associated canyon bottomlands.

The benefits and effects of the various water control plans will be discussed in the following paragraphs.

9-02. <u>Flood Control</u>. Flood control, though not an authorized project function, is an important consideration in the Water Control Plan for Lower Granite. Under the flood control plan, regulation of the project is effective in maintaining the design freeboard at the Lewiston levees for floods up to standard project floodflows of 150,000 cfs in the Clearwater River and 420,000 cfs in the Snake River below its confluence with the Clearwater River. As a result, the city of Lewiston is protected from flood damage.

Since Lower Granite is operated as a run-of-river project, usable reservoir storage is small compared to the volume of flow in the river and, as a result, riverflow passing the dam would not be significantly reduced by reservoir routing. However, the cumulative effect of drawing down Lower Granite and downstream reservoirs in advance of flood peaks would have some moderating effect on the flood peak at downstream locations on the Snake and Columbia Rivers.

During an extreme flood, the forebay at Lower Granite may be drawn down as low as El. 724 to accommodate higher discharges and maintain the design freeboard at the Lewiston levees. With this type of operation, increased pool slope creates a flushing effect in upper pool areas which helps to minimize sedimentation and reduce the potential for dredging in the confluence area.

9-03. Recreation. The Lower Granite project has greatly improved the recreation opportunities for the major population centers of Lewiston-Clarkston and nearby Moscow-Pullman. The relatively stable pool levels provided by operation between El. 738 and El. 733 for primary project functions of power generation and navigation provide excellent conditions for reservoir recreation activities. Project recreation activities include boating, water skiing, swimming, picnicking, and camping. These recreation opportunities enhance the quality of life for people in the region.

9-04. Fish and Wildlife.

a. Fish Passage. The two major fish migration events in the life cycle of anadromous fish include the downstream migration to the ocean and the upstream migration to spawning grounds. Lower Granite Dam is a major physical barrier that anadromous fish must move past when migrating both up and down the Snake River. As a result, fish facilities were provided at the project to aid migrating adults and fingerlings. A fish ladder at the project is effective in providing passage past the dam for upstream migrating fish. A bypass system is also effective in moving fingerlings rapidly through the dam during their downstream migration. The fingerlings that do not go through the bypass system will either pass over the spillway if water is being spilled or be drawn through the turbines. Fingerling passage through the turbines is hazardous because fingerlings are subjected to extreme pressure differences and impacts in the turbines that can easily result in injury or death. A mechanical device called a submersible traveling screen is used to divert fish out of turbine intakes and into gatewells from where they continue their passage through the bypass system. Physical transport by truck or barge is another method of helping fingerlings downstream and improving survival rates. Fingerling survival rates will increase with improvements to the fish bypass/collection facilities and physical transport methods.

Flow Augmentation for Downstream Migrants. In addition to fish passage facilities and physical transport, well-timed and increased flows through the Lower Granite reservoir will also contribute to greater survival rates for outmigrating fish. The effects of the slow-moving current through the reservoir on fingerlings include increased migration time, increased stress, favorable conditions for predators, and warmer water conditions. Flow augmentation at Lower Granite will help to shape the flow pattern on the lower Snake River during the critical migration period (15 April to 15 June) in order to move fingerlings quickly and safely downstream.

The Corps does not plan to augment flows at Lower Granite for implementation of the Water Budget when such regulation would cause spill at Lower Granite and Little Goose Dams. Hydraulic capacity of the power-plant is approximately 130,000 cfs. However, if problems develop with the juvenile bypass and collection facilities, spill specifically separate from the Water Budget flow may be required to aid juveniles past the dam. The Water Budget's objective is to provide the requested flow in the lower Snake River during the critical downstream period. The Water Budget is not used to provide water for intentional spill at Lower Granite Dam. The volume of water required for Water Budget flow will be drawn from storage in Dworshak and Brownlee, if available. The effect on Dworshak and Brownlee is a reduction of the FELCC, which will also affect the FELCC of the entire Federal Columbia River Power System.

9-05. Water Quality. The water quality in Lower Granite reservoir is influenced mainly by the following factors:

a. The water quality of the inflows from the Snake and Clearwater Rivers.

b. The ability of the cities of Lewiston and Clarkston and the Potlatch Corporation to meet state and Federal effluent treatment standards. The regulation of Lower Granite reservoir to provide optimum conditions for primary project functions of power generation and navigation, while providing the best possible conditions for other project purposes of flood control, fish and wildlife, and recreation has not resulted in prolonged adverse effects on the water quality of the reservoir to date. The nutrient-rich character of Lower Granite reservoir is a result of agricultural and urban activities both adjacent to and upstream of the reservoir. The high nutrient levels allow growth of algae in the reservoir during the warm summer months as streamflows reach base flow levels and flow conditions in the reservoir shift from free flowing to impoundment. The growth of algae in Lower Granite reservoir has somewhat alleviated this problem in downstream reservoirs by decreasing the nutrient levels passing the dam. Water contact activities such as water skiing, swimming, and fishing have not been seriously affected as a result of the water quality in the reservoir. The water quality of Lower Granite reservoir will improve as the nutrient levels in river inflows are reduced by improved waste treatment facilities for municipal and industrial sources and by controlling the animal waste sources upstream of the dam.

9-06. Hydroelectric Power. Power produced by Lower Granite goes into the Northwest Power Pool where it is used to meet system needs. This power generation helps to meet the power needs of the Pacific Northwest region at a cost considerably lower than would be possible using fossil fuels. The addition of Lower Granite to the system also produces more dependability in the system since it can help meet power demands in the event that the generating ability of another facility is impaired.

9-07. Navigation. The regulation of Lower Granite for navigation has a considerable effect on the economy of the Lewiston-Clarkston area. Prior to the building of the lower Snake River navigation system, it was possible though difficult to navigate the river as far up as Lewiston. In the last few years before the system was finished, water traffic had almost ceased since it was more economical to ship commodities by railway or truck. However, completion of the system made it possible to easily and economically transport commodities from interior areas of the basin by water. Major shipping facilities in both Lewiston and Clarkston handle bulk commodities, such as grain and fertilizer, which are considerably cheaper to transport by barge.

9-08. Flood Frequencies.

a. Snake River at Lower Granite. Plate 9-1 shows frequency curves for natural peak discharges and regulated peak discharges for the Snake River at Lower Granite Dam. These frequencies were computed by NPDEN-WM-HES in May 1978. The frequency curve for natural discharges is based on the station record from 1894 to 1975 (81 years) which is adjusted for irrigation depletion and storage and extended by correlation with 1858 to 1975 (117 years) Columbia River at The Dalles station record. The frequency curve for regulated discharge is based on the 1975 level of storage development and 1985 level of irrigation depletions. Regulated discharges are from regulation studies for 1894, 1929 through 1958, and in addition the high runoff years of 1972 and 1974. Data from Plate 9-1, Snake River at Lower Granite Frequency Curves, are summarized in the following tabulation:

MAXIMUM ANNUAL PEAK DISCHARGE FREQUENCIES

Exceedence Probability (percent)	Average Recurrence Interval (years)	Unregulated Discharge (cfs)	Regulated Discharge (cfs)
Standard Project Flood		575,000	420,000
1	100	426,000	319,000
2	50	403,000	300,000
5	20	367,000	270,000
10	10	334,000	244,000
20	05	298,000	214,000
50	02	231,000	163,000

b. Columbia River at The Dalles. Plate 9-2 shows frequency curves for natural and regulated peak discharges for the Columbia River at The Dalles. These curves were computed by NPDEM-WM-HES in June 1987. The frequency curve for natural discharges is based on the 1858-1985 (127) years period. Observed flows have been adjusted for irrigation depletion and storage. The frequency curve for regulated discharges is based on 1985 level of storage development and 1985 level of irrigation depletions. Regulated discharges are from regulation studies for 1894, 1929 through 1958, and in addition the high runoff years of 1972 and 1974. Data from Plate 9-2, Columbia River at the Dalles, frequency curves are summarized in the following:

Maximum Annual Peak Discharge Frequencies

Exceedence Probability (Percent)	Average Recurrence Interval (years)	Unregulated Discharge (cfs)	Regulated Discharge (cfs)
Standard Project Flood		1,550,000	840,000
1	100	1,000,000	670,000
2	50	950,000	620,000
5	20	880,000	550,000
10	10	810,000	500,000
20	05	730,000	450,000
50	02	580,000	365,000

These curves were computed by NPDEM-WM-HES in May 1978. The frequency curve for natural discharges is based on the 1858-1975 (117 years) period. Observed flows have been adjusted for irrigation depletion and storage. The frequency curve for regulated discharges is based on 1975 level of storage development and 1985 level of irrigation depletions. Regulated discharges are from regulation studies for 1894, 1929 through 1958, and in addition the high runoff years of 1972 and 1974. Data from Plate 9-2, Columbia River at The Dalles, frequency curves are summarized in the following table:

MAXIMUM ANNUAL PEAK DISCHARGE FREQUENCIES

Exceedence Probability (percent)	Average Recurrence Interval (years)	Unregulated Discharge (cfs)	Regulated Discharge (cfs)
Standard Project Flood		1,550,000	840,000
1	100	1,105,000	660,000
2	50	1,040,000	625,000
5	20	955,000	570,000
10	10	875,000	520,000
20	05	790,000	460,000
50	02	635,000	360,000

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LOWER GRANITE LOCK AND DAM - WATER CONTROL MANUAL TABLES

TABLE 3-1
LOWER GRANITE MEAN UNIT PERFORMANCE

GROSS HEAD IN FEET																	
POWER OUTPUT																	POWER OUTPUT
MW	74	75	76	77	78	7+	80	81	82	83	84	85	86	87	88	89	MW
DISCHARGE IN CFS																	
24	8309	8236	8163	8084	8005	7936	7867	7811	7756	7714	7672	7628	7584	7554	7524	7498	24
25	8368	8294	8221	8142	8063	7992	7921	7867	7812	7769	7726	7682	7638	7607	7577	7550	25
26	8428	8353	8278	8200	8121	8047	7974	7922	7869	7824	7779	7736	7692	7661	7630	7603	26
27	8490	8413	8336	8257	8178	8103	8028	7977	7926	7879	7833	7790	7747	7714	7682	7655	27
28	8555	8478	8401	8321	8240	8164	8088	8036	7984	7936	7888	7845	7802	7769	7736	7708	28
29	8620	8543	8466	8384	8303	8227	8152	8098	8044	7996	7948	7905	7862	7828	7794	7766	29
30	8686	8608	8531	8448	8365	8290	8215	8159	8104	8056	8008	7965	7922	7887	7852	7824	30
31	8751	8673	8596	8512	8428	8353	8279	8221	8164	8116	8068	8025	7982	7946	7909	7882	31
32	8816	8739	8661	8576	8491	8417	8342	8243	8224	8176	8128	8085	8042	8005	7967	7939	32
33	8882	8804	8726	8639	8553	8480	8406	8345	8284	8236	8188	8145	8102	8064	8025	7997	33
34	8947	8869	8791	8703	8616	8543	8469	8406	8344	8296	8248	8205	8162	8122	8083	8055	34
35	9020	8941	8861	8772	8683	8609	8535	8469	8404	8356	8308	8265	8222	8181	8141	8113	35
36	9096	9015	8934	8847	8760	8686	8612	8544	8477	8427	8377	8333	8290	8247	8204	8175	36
37	9171	9089	9007	8922	8838	8763	8688	8619	8551	8499	8448	8405	8361	8316	8272	8241	37
38	9247	9163	9080	8997	8915	8839	8764	8694	8625	8572	8519	8476	8432	8386	8339	8307	38
39	9322	9237	9153	9072	8992	8916	8840	8770	8699	8645	8591	8547	8503	8455	8407	8373	39
40	9399	9311	9225	9147	9069	8993	8917	8845	8773	8717	8662	8618	8575	8525	8475	8439	40
41	9485	9397	9309	9230	9150	9073	8995	8922	8849	8790	8733	8689	8646	8594	8543	8505	41
42	9571	9483	9395	9315	9234	9157	9079	9007	8934	8872	8810	8765	8719	8667	8615	8575	42
43	9657	9569	9481	9400	9318	9241	9163	9092	9020	8954	8888	8841	8793	8742	8691	8648	43
44	9743	9655	9567	9485	9402	9325	9247	9177	9106	9035	8966	8917	8867	8817	8766	8720	44
45	9830	9741	9653	9570	9486	9409	9331	9261	9191	9117	9044	8993	8941	8892	8842	8793	45
46	9930	9839	9748	9663	9578	9497	9418	9347	9277	9199	9122	9069	9015	8966	8917	8866	46
47	10030	9938	9846	9760	9674	9592	9510	9437	9364	9286	9208	9152	9095	9044	8994	8940	47
48	10130	10037	9945	9857	9770	9686	9602	9527	9451	9373	9295	9236	9177	9124	9071	9015	48
49	10230	10136	10043	9954	9866	9780	9695	9616	9539	9460	9382	9321	9259	9203	9147	9091	49
50	10330	10235	10141	10051	9962	9874	9787	9706	9626	9547	9469	9405	9341	9282	9224	9166	50
51	10448	10347	10247	10154	10062	9971	9880	9796	9713	9635	9556	9489	9423	9362	9301	9241	51
52	10566	10461	10357	10262	10168	10076	9984	9899	9813	9730	9648	9578	9508	9443	9379	9316	52
53	10684	10575	10466	10370	10274	10181	10088	10002	9917	9830	9744	9672	9601	9532	9464	9399	53
54	10802	10688	10576	10478	10380	10286	10192	10106	10021	9930	9841	9767	9693	9621	9549	9483	54
55	10920	10802	10686	10585	10485	10390	10296	10210	10125	10030	9937	9861	9786	9710	9635	9567	55
56	11052	10931	10809	10701	10595	10496	10400	10314	10228	10130	10033	9956	9879	9799	9720	9650	56
57	11184	11063	10941	10828	10718	10616	10515	10426	10338	10235	10132	10050	9971	9888	9806	9734	57
58	11316	11195	11073	10956	10841	10736	10632	10541	10450	10348	10245	10160	10076	9987	9900	9824	58
59	11448	11327	11205	11083	10964	10856	10749	10656	10563	10460	10357	10270	10183	10091	10000	9923	59
60	11580	11459	11337	11211	11087	10976	10866	10771	10676	10573	10470	10379	10290	10194	10100	10021	60

TABLE 3-1 (CONTINUED)
LOWER GRANITE MEAN UNIT PERFORMANCE

GROSS HEAD IN FEET																	
POWER OUTPUT																	POWER OUTPUT
MW	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	MW
DISCHARGE IN CFS																	
61	11734	11603	11475	11342	11210	11096	10983	10885	10789	10685	10582	10489	10397	10298	10200	10119	61
62	11888	11751	11618	11482	11348	11228	11109	11005	10902	10798	10695	10599	10504	10401	10300	10218	62
63	12042	11900	11760	11623	11487	11363	11240	11132	11026	10919	10812	10712	10613	10505	10400	10316	63
64	12196	12048	11902	11763	11625	11498	11372	11260	11151	11041	10933	10831	10730	10621	10511	10422	64
65	12350	12196	12045	11904	11764	11633	11503	11388	11275	11163	11053	10949	10846	10737	10628	10535	65
66	12530	12361	12197	12046	11902	11768	11635	11516	11399	11286	11173	11067	10962	10853	10744	10649	66
67	12710	12535	12364	12209	12057	11911	11769	11644	11523	11408	11294	11186	11079	10970	10861	10763	67
68	12890	12709	12532	12372	12215	12064	11916	11784	11655	11534	11415	11304	11195	11086	10977	10876	68
69	13070	12882	12699	12535	12374	12216	12062	11925	11791	11665	11541	11428	11316	11204	11094	10990	69
70	13250	13056	12866	12698	12532	12368	12208	12066	11926	11795	11667	11552	11438	11325	11212	11107	70
71	13442	13238	13037	12861	12691	12521	12354	12207	12062	11926	11793	11676	11561	11445	11331	11224	71
72	13634	13426	13221	13037	12857	12675	12501	12347	12198	12057	11919	11800	11683	11566	11450	11340	72
73	13826	13614	13405	13217	13032	12845	12662	12498	12336	12187	12044	11924	11805	11686	11568	11457	73
74	14018	13802	13589	13396	13206	13015	12828	12661	12496	12338	12182	12052	11928	11807	11687	11574	74
75	14210	13990	13773	13575	13381	13185	12993	12823	12655	12494	12335	12201	12069	11938	11810	11691	75
76	14401	14178	13957	13754	13555	13355	13158	12986	12815	12651	12489	12349	12212	12076	11943	11821	76
77	14592	14367	14143	13937	13733	13525	13324	13148	12974	12808	12643	12498	12356	12215	12077	11950	77
78	14783	14555	14330	14121	13914	13704	13496	13313	13134	12964	12797	12647	12499	12353	12210	12080	78
79	14974	14744	14516	14305	14095	13883	13673	13486	13301	13127	12953	12795	12643	12491	12343	12209	79
80	15165	14933	14702	14488	14277	14062	13850	13658	13470	13293	13118	12955	12795	12634	12477	12338	80
81	15360	15121	14888	14672	14458	14242	14027	13831	13638	13459	13282	13117	12953	12789	12628	12480	81
82	15560	15315	15075	14856	14639	14421	14204	14003	13806	13626	13447	13278	13111	12945	12781	12630	82
83	15760	15509	15264	15039	14819	14600	14381	14176	13974	13792	13611	13439	13270	13101	12934	12780	83
84	15960	15703	15452	15221	14996	14774	14555	14349	14143	13959	13776	13601	13428	13256	13086	12930	84
85	16160	15897	15640	15404	15174	14948	14726	14519	14312	14125	13941	13762	13586	13412	13239	13080	85
86	16360	16091	15829	15587	15351	15123	14897	14689	14481	14293	14106	13924	13744	13567	13392	13230	86
87	16566	16285	16017	15770	15528	15297	15068	14859	14650	14460	14271	14086	13904	13724	13546	13380	87
88	16777	16489	16209	15953	15706	15471	15239	15029	14820	14628	14437	14249	14063	13882	13702	13533	88
89	16988	16694	16407	16144	15886	15645	15410	15199	14989	14795	14603	14412	14223	14040	13859	13688	89
90	17199	16898	16605	16337	16074	15827	15584	15369	15158	14963	14768	14574	14383	14198	14015	13843	90
91	17410	17102	16803	16530	16262	16011	15765	15545	15329	15130	14934	14737	14542	14356	14171	13998	91
92	17621	17307	17002	16722	16450	16196	15945	15722	15502	15299	15099	14899	14702	14514	14328	14153	92
93	17832	17511	17200	16915	16637	16380	16126	15899	15675	15468	15264	15062	14862	14673	14484	14308	93
94	18043	17716	17398	17108	16825	16564	16306	16075	15848	15637	15429	15224	15022	14831	14642	14463	94
95	18254	17920	17596	17301	17013	16748	16487	16252	16021	15806	15594	15387	15182	14990	14799	14618	95

TABLE 3-1 (CONTINUED)
LOWER GRANITE MEAN UNIT PERFORMANCE

GROSS HEAD IN FEET																	
POWER OUTPUT																POWER OUTPUT	
MW	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	MW
DISCHARGE IN CFS																	
96	18465	18124	17794	17494	17200	16932	16667	16429	16194	15974	15759	15549	15342	15148	14956	14773	96
97	18682	18329	17992	17687	17388	17116	16848	16605	16367	16143	15924	15712	15502	15307	15113	14929	97
98	18907	18545	18190	17880	17576	17300	17029	16782	16540	16312	16088	15874	15662	15466	15271	15084	98
99	19132	18764	18404	18078	17764	17484	17209	16959	16713	16481	16253	16036	15822	15624	15428	15239	99
100	19357	18984	18619	18287	17963	17670	17390	17136	16886	16650	16418	16199	15982	15783	15585	15395	100
101	19581	19203	18833	18496	18166	17867	17576	17312	17059	16819	16583	16361	16142	15942	15742	15550	101
102	19806	19423	19048	18705	18370	18065	17768	17499	17235	16988	16748	16524	16302	16100	15900	15705	102
103	20031	19642	19262	18914	18574	18263	17960	17687	17419	17165	16915	16686	16462	16259	16057	15861	103
104	20256	19862	19477	19123	18777	18461	18152	17874	17602	17345	17093	16855	16623	16417	16214	16016	104
105	20480	20081	19691	19332	18981	18658	18344	18062	17785	17526	17270	17028	16791	16581	16373	16171	105
106	20705	20301	19905	19541	19185	18856	18536	18250	17969	17706	17447	17200	16958	16746	16535	16330	106
107	20933	20520	20120	19750	19389	19054	18728	18437	18152	17886	17624	17372	17125	16911	16698	16491	107
108	21165	20744	20334	19959	19592	19252	18920	18625	18336	18066	17801	17544	17292	17076	16861	16651	108
109	21396	20973	20556	20168	19796	19449	19112	18813	18519	18247	17978	17716	17460	17241	17024	16812	109
110	21628	21202	20782	20386	20000	19647	19304	19000	18703	18427	18155	17888	17627	17406	17187	16972	110
111	21860	21431	21008	20607	20215	19846	19496	19188	18886	18607	18332	18060	17794	17571	17350	17132	111
112	22092	21660	21234	20829	20432	20056	19691	19376	19070	18788	18509	18232	17961	17736	17513	17293	112
113	22324	21889	21460	21050	20648	20267	19896	19570	19253	18968	18687	18404	18128	17901	17676	17453	113
114	22555	22118	21686	21271	20865	20477	20100	19769	19446	19149	18864	18576	18296	18066	17839	17614	114
115	22787	22347	21912	21493	21082	20688	20304	19969	19640	19339	19044	18748	18463	18231	18002	17774	115
116	23021	22576	22139	21714	21298	20898	20509	20168	19835	19529	19229	18927	18630	18396	18165	17934	116
117		22810	22365	21935	21515	21109	20713	20368	20030	19719	19415	19109	18808	18564	18327	18095	117
118		23045	22599	22157	21732	21319	20917	20567	20224	19909	19600	19291	18987	18738	18495	18256	118
119		23280	22835	22390	21948	21530	21122	20766	20419	20098	19785	19473	19165	18911	18663	18422	119
120			23071	22625	22181	21740	21326	20966	20613	20288	19970	19654	19343	19084	18831	18588	120
121			23306	22860	22415	21967	21532	21165	20808	20478	20156	19836	19522	19258	19000	18753	121
122				23095	22649	22194	21752	21369	21003	20668	20341	20018	19700	19431	19168	18919	122
123				23346	22886	22421	21972	21581	21202	20858	20526	20200	19878	19604	19337	19085	123
124					23141	22650	22192	21793	21407	21054	20711	20381	20057	19778	19505	19250	124
125					23396	22898	22414	22005	21612	21253	20904	20564	20235	19951	19673	19416	125
126					23651	23146	22655	22222	21817	21452	21096	20757	20418	20124	19842	19582	126
127						23394	22896	22456	22028	21651	21289	20950	20611	20307	20010	19747	127
128						23646	23137	22690	22256	21859	21482	21143	20804	20494	20191	19916	128
129							23385	22924	22483	22076	21685	21336	20996	20681	20373	20091	129
130							23662	23166	22711	22293	21892	21531	21188	20868	20554	20266	130
131								23432	22946	22510	22099	21726	21373	21054	20736	20441	131
132								23697	23201	22737	22306	21922	21557	21238	20919	20616	132
133									23455	22980	22526	22117	21742	21423	21104	20798	133
134									23709	23223	22759	22325	21926	21607	21288	20980	134
135									23985	23466	22991	22544	22123	21792	21472	21163	135

TABLE 3-1 (CONTINUED)
LOWER GRANITE MEAN UNIT PERFORMANCE

GROSS HEAD IN FEET																	
POWER OUTPUT																POWER OUTPUT	
MW	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	MW
DISCHARGE IN CFS																	
136										23735	23224	22763	22328	21987	21658	21345	136
137										24010	23485	22981	22534	22183	21845	21527	137
138											23754	23225	22739	22379	22033	22033	138
139											24023	23475	22966	22575	22220	22220	139
140												23725	23198	22791	22410	22410	140
141												23998	23431	23006	22610	22610	141
142													23693	23222	22810	22810	142
143													23999	23469	23010	23010	143
144													23405	23747	23241	23241	144
145														24025	23492	23492	145
146														24316	23744	23744	146
147															24014	24014	147
148															24327	24327	148
149																22033	149
150																22220	150

TABLE 3-1 (CONTINUED)

LOWER GRANITE MEAN UNIT PERFORMANCE

	GROSS HEAD IN FEET																	
POWER OUTPUT MW	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	POWER OUTPUT MW
	DISCHARGE IN CFS																	
24	7471	7447	7423	7396	7370	7345	7319	7300	7282	7261	7240	7225	7209	7207	7205	7203	7201	24
25	7523	7500	7476	7448	7420	7394	7369	7349	7330	7310	7290	7273	7257	7254	7251	7248	7245	25
26	7576	7552	7529	7499	7470	7444	7418	7398	7378	7359	7340	7322	7304	7300	7297	7293	7290	26
27	7628	7605	7582	7551	7520	7494	7468	7447	7427	7409	7390	7371	7351	7347	7343	7339	7334	27
28	7680	7657	7635	7602	7570	7544	7518	7497	7475	7458	7440	7419	7399	7394	7389	7384	7379	28
29	7738	7714	7690	7656	7623	7596	7569	7548	7526	7508	7490	7469	7447	7442	7436	7430	7424	29
30	7796	7770	7745	7711	7677	7650	7622	7600	7577	7559	7540	7518	7497	7490	7484	7476	7469	30
31	7854	7827	7800	7766	7731	7703	7675	7652	7629	7609	7590	7568	7547	7539	7531	7523	7514	31
32	7912	7883	7856	7820	7785	7756	7727	7704	7680	7660	7640	7618	7596	7588	7579	7569	7559	32
33	7969	7940	7911	7875	7839	7809	7780	7756	7731	7711	7690	7668	7646	7636	7627	7615	7604	33
34	8027	7997	7966	7929	7893	7863	7833	7808	7782	7761	7740	7718	7696	7685	7675	7662	7649	34
35	8085	8053	8021	7984	7947	7916	7885	7860	7834	7812	7790	7768	7745	7734	7723	7708	7694	35
36	8146	8112	8079	8040	8002	7970	7938	7912	7886	7863	7840	7818	7795	7783	7770	7755	7739	36
37	8210	8175	8140	8100	8060	8027	7995	7968	7941	7918	7894	7871	7847	7833	7819	7803	7787	37
38	8275	8238	8202	8160	8118	8085	8051	8024	7997	7973	7948	7924	7900	7884	7869	7853	7836	38
39	8339	8301	8263	8220	8177	8142	8107	8080	8053	8027	8002	7977	7952	7935	7918	7902	7886	39
40	8403	8364	8325	8280	8235	8199	8163	8136	8109	8082	8056	8030	8005	7986	7967	7951	7935	40
41	8468	8427	8387	8340	8293	8256	8219	8192	8164	8137	8110	8084	8057	8036	8016	8000	7985	41
42	8535	8492	8450	8402	8353	8315	8276	8248	8220	8192	8165	8137	8110	8087	8065	8050	8034	42
43	8605	8560	8516	8468	8419	8380	8340	8310	8280	8250	8221	8192	8164	8140	8116	8100	8083	43
44	8675	8628	8582	8534	8485	8445	8404	8372	8340	8309	8278	8248	8219	8193	8168	8150	8133	44
45	8745	8696	8648	8600	8551	8510	8468	8434	8400	8367	8335	8304	8274	8247	8220	8201	8182	45
46	8815	8764	8714	8666	8617	8575	8532	8496	8460	8426	8392	8260	8329	8300	8272	8252	8231	46
47	8887	8834	8781	8732	8683	8640	8597	8558	8520	8484	8449	8416	8384	8354	8324	8302	8280	47
48	8961	8906	8851	8801	8751	8707	8663	8624	8584	8547	8510	8476	8443	8411	8379	8356	8333	48
49	9034	8978	8921	8870	8818	8773	8729	8689	8649	8610	8572	8538	8504	8470	8436	8412	8388	49
50	9108	9050	8992	8938	8885	8840	8795	8754	8713	8673	8634	8599	8565	8529	8493	8468	8443	50
51	9182	9121	9062	9007	8952	8907	8861	8819	8778	8737	8696	8661	8626	8588	8549	8524	8498	51
52	9255	9193	9132	9076	9020	8973	8927	8885	8842	8800	8758	8722	8687	8646	8606	8580	8553	52
53	9335	9271	9207	9149	9091	9042	8994	8951	8907	8863	8820	8784	8748	8705	8663	8635	8608	53
54	9417	9351	9286	9227	9168	9117	9066	9021	8976	8931	8886	8848	8810	8768	8726	8697	8667	54
55	9499	9431	9364	9305	9245	9191	9138	9091	9045	8998	8952	8912	8873	8833	8792	8760	8729	55
56	9581	8512	9443	9383	9322	9266	9210	9162	9114	9066	9018	8977	8936	8897	8858	8824	8790	56
57	9663	9592	9521	9460	9400	9341	9282	9232	9183	9133	9084	9041	8998	8962	8925	8888	8852	57
58	9749	9674	9600	9538	9477	9415	9354	9303	9252	9201	9151	9106	9061.	9026	8991	8952	8914	58
59	9846	9769	9693	9627	9562	9497	9432	9378	9324	9271	9218	9170	9124	9090	9057	9016	8975	59
60	9942	9864	9787	9718	9650	9583	9516	9461	9406	9352	9298	9247	9197	9161	9125	9083	9041	60

TABLE 3-1 (CONTINUED)

LOWER GRANITE MEAN UNIT PERFORMANCE

	GROSS HEAD IN FEET																	
POWER OUTPUT MW	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	POWER OUTPUT MW
	DISCHARGE IN CFS																	
61	10039	9959	9880	9809	9739	9669	9600	9543	9487	9432	9377	9324	9271	9232	9194	9151	9108	61
62	10136	10054	9974	9900	9828	9756	9684	9626	9568	9512	9457	9401	9345	9304	9262	9219	9176	62
63	10232	10149	10067	9991	9916	9842	9769	9709	9649	9593	9537	9478	9420	9375	9331	9287	9244	63
64	10333	10246	10161	10082	10005	9928	9853	9791	9731	9673	9616	9555	9494	9446	9400	9355	9311	64
65	10444	10356	10268	10185	10103	10021	9940	9875	9812	9754	9696	9632	9568	9518	9468	9423	9379	65
66	10555	10466	10377	10292	10208	10124	10040	9974	9908	9846	9784	9714	9646	9592	9538	9492	9446	66
67	10666	10576	10486	10399	10314	10226	10140	10073	10007	9941	9876	9803	9732	9678	9623	9572	9521	67
68	10777	10686	10595	10507	10419	10329	10240	10172	10105	10036	9967	9892	9819	9763	9708	9652	9598	82
69	10888	10796	10704	10614	10524	10432	10340	10271	10203	10130	10059	9981	9905	9849	9793	9733	9675	69
70	11002	10906	10813	10721	10629	10534	10440	10371	10301	10225	10150	10070	9992	9934	9877	9814	9751	70
71	11117	11018	10921	10827	10734	10637	10541	10470	10399	10320	10242	10159	10078	10020	9962	9894	9828	71
72	11232	11130	11029	10934	10839	10741	10642	10569	10496	10416	10336	10251	10167	10107	10048	9975	9905	72
73	11347	11241	11137	11040	10944	10844	10744	10668	10593	10512	10431	10345	10259	10197	10135	10062	9989	73
74	11462	11353	11246	11147	11049	10947	10846	10767	10690	10608	10527	10438	10351	10287	10223	10149	10075	74
75	11577	11465	11354	11254	11154	11050	10947	10867	10787	10704	10622	10532	10443	10376	10311	10236	10161	75
76	11700	11582	11465	11361	11259	11154	11049	10966	10883	10800	10717	10626	10535	10466	10398	10323	10247	76
77	11826	11704	11583	11477	11371	11262	11154	11066	10980	10896	10812	10719	10627	10556	10486	10410	10334	77
78	11951	11825	11701	11593	11486	11376	11266	11175	11085	10998	10912	10816	10720	10646	10574	10497	10420	78
79	12077	11947	11819	11709	11600	11489	11379	11284	11190	11102	11015	10917	10820	10742	10665	10587	10508	79
80	12202	12068	11937	11825	11714	11603	11491	11392	11295	11207	11119	11019	10920	10838	10758	10680	10601	80
81	12334	12190	12055	11941	11829	11716	11604	11501	11401	11311	11222	11121	11020	10935	10851	10773	10694	81
82	12481	12335	12191	12067	11947	11829	11716	11610	11506	11416	11326	11222	11120	11032	10944	10866	10787	82
83	12628	12481	12334	12206	12081	11958	11838	11725	11614	11520	11429	11324	11220	11128	11038	10959	10880	83
84	12776	12626	12478	12345	12214	12088	11965	11848	11733	11636	11541	11432	11323	11226	11131	11052	10973	84
85	12923	12772	12622	12483	12348	12218	12091	11971	11852	11753	11655	11544	11434	11334	11234	11152	11071	85
86	13070	12917	12765	12622	12482	12348	12217	12093	11972	11869	11769	11657	11546	11442	11339	11255	11172	86
87	13217	13062	12909	12760	12616	12478	12344	12216	12091	11986	11882	11769	11657	11550	11444	11358	11273	87
88	13366	13208	13053	12899	12749	12608	12470	12339	12210	12102	11996	11882	11768	11657	11549	11461	11374	88
89	13519	13358	13199	13039	12883	12738	12596	12462	12329	12219	12110	11994	11879	11765	11654	11564	11475	89
90	13672	13508	13346	13185	13026	12874	12724	12584	12448	12335	12224	12106	11990	11873	11758	11667	11577	90
91	13826	13659	13494	13331	13170	13016	12864	12719	12575	12453	12337	12219	12101	11981	11863	11770	11678	91
92	13979	13809	13641	13477	13314	13158	13003	12858	12713	12587	12464	12339	12215	12089	11968	11873	11779	92
93	14132	13959	13789	13623	13459	13300	13143	12997	12851	12721	12593	12467	12342	12212	12084	11981	11880	93
94	14285	14110	13937	13769	13603	13442	13283	13136	12990	12855	12723	12595	12468	12337	12207	12101	11997	94
95	14439	14262	14085	13915	13748	13584	13422	13275	13128	12989	12853	12723	12595	12462	12330	12221	12114	95

TABLE 3-1 (CONTINUED)

LOWER GRANITE MEAN UNIT PERFORMANCE

GROSS HEAD IN FEET																		
POWER OUTPUT MW	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	POWER OUTPUT MW
DISCHARGE IN CFS																		
96	14592	14414	14237	14065	13894	13727	13562	13414	13266	13123	12982	12852	12722	12587	12453	12342	12232	96
97	14746	14566	14388	14215	14042	13874	13706	13554	13404	13257	13112	12980	12848	12712	12576	12462	12349	97
98	14899	14719	14539	14364	14191	14020	13851	13698	13546	13395	13245	13109	12975	12836	12699	12582	12466	98
99	15052	14871	14690	14514	14339	14167	13996	13841	13687	13534	13383	13244	13107	12965	12823	12702	12583	99
100	15206	15023	14842	14664	14487	14314	14141	13984	13829	13674	13520	13380	13241	13098	12956	12830	12707	100
101	15359	15176	14993	14814	14636	14460	14286	14128	13970	13813	13658	13516	13376	13231	13088	12960	12834	101
102	15512	15328	15144	14964	14784	14607	14431	14271	14111	13953	13795	13652	13510	13365	13220	13090	12962	102
103	15666	15480	15295	15113	14932	14754	14577	14414	14253	14092	13933	13788	13644	13498	13352	13220	13090	103
104	15819	15633	15447	15263	15081	14901	14722	14557	14394	14232	14071	13924	13778	13631	13485	13350	13217	104
105	15973	15785	15598	15413	15229	15047	14867	14701	14536	14371	14208	14060	13912	13764	13617	13480	13345	105
106	16127	15937	15749	15563	15377	15194	15012	14844	14677	14511	14346	14195	14046	13897	13749	13610	13473	106
107	16285	16092	15901	15713	15526	15341	15157	14987	14819	14650	14483	14331	14180	14031	13881	13740	13600	107
108	16443	16248	16055	15864	15675	15487	15302	15130	14960	14790	14621	14467	14314	14161	14014	13870	13728	108
109	16601	16404	16208	16015	15824	15636	15449	15274	15102	14929	14759	14603	14449	14297	14146	14000	13856	109
110	16759	16559	16362	16167	15974	15785	15596	15421	15246	15070	14896	14739	14583	14430	14278	14130	13984	110
111	16917	16715	16515	16319	16124	15933	15744	15568	15392	15213	15037	14876	14717	14563	14411	14260	14111	111
112	17075	16871	16669	16470	16273	16082	15892	15714	15537	15357	15178	15015	14854	14698	14543	14390	14239	112
113	17233	17026	16822	16622	16423	16231	16040	15861	15683	15500	15319	15154	14991	14833	14677	14522	14368	113
114	17391	17182	16976	16773	16573	16379	16187	16007	15829	15643	15461	15293	15127	14968	14810	14654	14498	114
115	17549	17338	17129	16925	16722	16528	16335	16154	15974	15787	15602	15432	15264	15103	14943	14785	14629	115
116	17707	17494	17283	17076	16872	16677	16483	16301	16120	15930	15743	15571	15401	15238	15077	14917	14759	116
117	17865	17649	17436	17228	17021	16825	16630	16447	16265	16073	15884	15710	15537	15373	15210	15049	14889	117
118	18023	17805	17590	17379	17171	16974	16778	16594	16411	16217	16025	15849	15674	15508	15343	15181	15020	118
119	18184	17961	17743	17531	17321	17123	16926	16740	16556	16360	16166	15988	15811	15643	15477	15313	15150	119
120	18347	18120	17897	17682	17470	17271	17074	16887	16702	16503	16308	16127	15948	15778	15610	15444	15280	120
121	18510	18279	18052	17836	17621	17420	17221	17034	16847	16647	16449	16265	16084	15913	15743	15576	15410	121
122	18673	18438	18207	17990	17774	17571	17370	17180	16993	16790	16590	16404	16221	16048	15877	15708	15541	122
123	18836	18597	18362	18144	17927	17722	17519	17328	17139	16933	16731	16543	16358	16183	16010	15840	15671	123
124	18999	18755	18517	18298	18080	17874	17669	17476	17285	17078	16873	16682	16494	16318	16143	15972	15801	124
125	19162	18914	18672	18452	18233	18025	17818	17624	17432	17223	17016	16823	16632	16453	16277	16103	15932	125
126	19325	19073	18827	18606	18386	18176	17968	17772	17578	17368	17160	16965	16772	16591	16411	16235	16062	126
127	19488	19232	18982	18760	18539	18327	18117	17920	17725	17513	17303	17107	16912	16730	16550	16371	16194	127
128	19651	19391	19137	18914	18692	18478	18267	18069	17872	17658	17446	17248	17052	16869	16688	16508	16329	128
129	19818	19550	19292	19068	18845	18630	18416	18217	18018	17803	17589	17390	17192	17008	16826	16644	16464	129
130	19987	19717	19450	19222	18998	18781	18566	18365	18165	17948	17733	17531	17332	17147	16964	16780	16599	130
131	20156	19885	19616	19382	19152	18932	18715	18513	18311	18093	17876	17673	17472	17286	17102	16917	16734	131
132	20325	20052	19782	19545	19312	19086	18865	18661	18458	18238	10819	17815	17612	17426	17240	17053	16868	132
133	20496	20220	19947	19708	19472	19241	19015	18809	18605	18383	18162	17956	17752	17565	17378	17190	17003	133
134	20676	20391	20113	19871	19632	19396	19165	18957	18751	18528	18306	18098	17892	17704	17516	17326	17138	134
135	20856	20566	20283	20035	19792	19551	19315	19106	18898	18674	18450	18240	18032	17843	17654	17463	17273	135

TABLE 3-1 (CONTINUED)

LOWER GRANITE MEAN UNIT PERFORMANCE

	GROSS HEAD IN FEET																	
POWER OUTPUT MW	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	POWER OUTPUT MW
	DISCHARGE IN CFS																	
136	21036	20741	20452	20200	19953	19706	19465	19254	19045	18819	18595	18382	18172	17982	17792	17599	17408	136
137	21216	20915	20622	20366	20115	19865	19618	19403	19192	18965	18740	18525	18313	18121	17931	17736	17543	137
138	21393	21090	20791	20531	20277	20024	19774	19554	19339	19111	18884	18668	18453	18261	18069	17873	17679	138
139	21569	21263	20961	20697	20438	20183	19931	19706	19486	19257	19029	18810	18594	18400	18207	18011	17815	139
140	21744	21437	21133	20865	20600	20342	20087	19857	19633	19403	19174	18954	18734	18539	18346	18148	17951	140
141	21920	21610	21304	21034	20767	20502	20243	20009	19780	19549	19319	19099	18879	18680	18484	18285	18087	141
142	22099	21784	21476	21203	20933	20664	20401	20161	19927	19694	19464	19244	19024	18823	18624	18422	18223	142
143	22280	21962	21648	21372	21100	20827	20559	20316	20077	19840	19609	19389	19169	18965	18764	18558	18356	143
144	22461	22140	21823	21542	21267	20989	20717	20472	20230	19989	19754	19534	19314	19108	18904	18694	18489	144
145	2.2642	22318	21999	21714	21434	21151	20875	20628	20384	20139	19899	19679	19459	19250	19044	18831	18621	145
146	22845	22499	22175	21885	21602	21315	21034	20784	20537	20288	20045	19825	19605	19392	19184	18967	18754	146
147	23051	22690	22351	22057	21769	21478	21193	20940	20691	20438	20190	19970	19750	19534	19322	19105	18887	147
148	23257	22882	22529	22229	21937	21642	21353	21097	20845	20589	20335	20115	19895	19676	19461	19245	19028	148
149	23485	23073	22707	22401	22103	21806	21512	21254	20999	20742	20486	20262	20041	19818	19600	19386	19170	149
150	23747	23288	22884	22574	22270	21971	21674	21411	21153	20894	20638	20409	20185	19961	19738	19526	19311	150
151	24010	23518	23080	22748	22437	22135	21837	21572	21309	21047	20789	20556	20328	20103	19879	19666	19453	151
152	24317	23754	23280	22935	22607	22300	22000	21732	21467	21203	20741	20703	20471	20246	20022	19805	19592	152
153		24041	23494	23122	22781	22473	22165	21893	21626	21358	21094	20854	20615	20389	20164	19945	19729	153
154		24329	23763	23334	22955	22646	22338	22057	21784	21514	21247	21005	20765	20534	20306	20084	19866	154
155			24032	23571	23157	22823	22511	22223	21944	21671	21400	21157	20915	20682	20451	20226	20003	155
156			24320	23808	23366	23013	22680	22390	22104	21830	21557	21308	21064	20830	20597	20371	20146	156

TABLE 3-2
LOWER GRANITE DAM GATED SPILLWAY RATING TABLE
(Flow Under One Gate in 1000 CFS
POOL ELEVATION – M.S.L.

STOP 1/	GATE 2/	REVC 3/	724.0	724.5	725.0	725.5	726.0	726.5	727.0	727.5	728.0	728.5	729.0	729.5	730.0	730.5	731.0
1	0.86	10.70	1.52	1.53	1.54	1.55	1.56	1.57	1.58	1.58	1.59	1.60	1.61	1.62	1.63	1.64	1.65
2	1.79	21.80	3.13	3.15	3.17	3.19	3.21	3.23	3.25	3.27	3.29	3.31	3.33	3.34	3.36	3.38	3.40
3	2.76	33.10	4.78	4.81	4.84	4.87	4.90	4.93	4.96	4.99	5.02	5.05	5.08	5.11	5.14	5.17	5.20
4	3.75	44.40	6.44	6.48	6.52	6.56	6.60	6.64	6.68	6.72	6.76	6.80	6.84	6.88	6.92	6.96	7.00
5	4.75	55.70	8.08	8.13	8.18	8.23	8.29	8.34	8.39	8.44	8.49	8.54	8.59	8.64	8.69	8.74	8.79
6	5.77	67.00	9.72	9.78	9.85	9.91	9.97	10.04	10.10	10.16	10.22	10.29	10.35	10.41	10.47	10.53	10.59
7	6.80	78.20	11.35	11.43	11.50	11.58	11.65	11.73	11.80	11.87	11.95	12.02	12.09	12.16	12.24	12.31	12.38
8	7.84	89.50	12.97	13.06	13.15	13.23	13.32	13.40	13.49	13.57	13.66	13.74	13.83	13.91	13.99	14.08	14.16
9	8.89	100.80	14.58	14.68	14.78	14.88	14.98	15.07	15.17	15.26	15.36	15.46	15.55	15.65	15.74	15.83	15.93
10	9.94	112.00	16.17	16.28	16.39	16.50	16.61	16.72	16.83	16.93	17.04	17.15	17.25	17.36	17.46	17.57	17.67
11	11.01	123.30	.17.77	17.89	18.01	18.13	18.25	18.37	18.49	18.61	18.73	18.85	18.96	19.00	19.20	19.31	19.43
12	12.08	134.50 •	19.34	19.47	19.61	19.74	19.87	20.00	20.14	20.27	20.39	20.52	20.65	20.78	20.91	21.03	21.16
13	13.17	145.80	20.93	21.07	21.22	21.36	21.51	21.65	21.79	21.93	22.07	22.21	22.35	22.49	22.63	22.77	22.90
14	14.27	157.10	22.51	22.67	22.82	22.98	23.14	23.29	23.44	23.60	23.75	23.90	24.05	24.20	24.35	24.50	24.65
15	15.39	168.50	24.10	24.27	24.44	24.61	24.78	24.94	25.11	25.27	25.44	25.60	25.76	25.92	26.08	26.24	26.40
16	16.51	179.80	25.68	25.86	26.05	26.23	26.41	26.58	26.76	26.94	27.11	27.29	27.46	27.63	27.80	27.97	28.14
17	17.64	191.10	27.26	27.46	27.65	27.84	28.03	28.23	28.41	28.60	28.79	28.97	29.16	29.34	29.52	29.71	29.89
18	18.77	202.30	28.83	29.04	29.24	29.45	29.65	29.85	30.05	30.25	30.45	30.65	30.85	31.04	31.23	31.43	31.62
19	19.91	213.60	30.40	30.62	30.84	31.06	31.27	31.49	31.70	31.91	32.12	32.33	32.54	32.74	32.95	33.15	33.35
20	21.06	224.90	31.98	32.21	32.44	32.67	32.90	33.13	33.35	33.57	33.80	34.02	34.23	34.45	34.67	34.88	35.09
21	22.22	236.20	33.56	33.80	34.05	34.29	34.53	34.77	35.01	35.24	35.48	35.71	35.94	36.17	36.40	36.62	36.85
22	23.39	247.50	35.15	35.41	35.66	35.92	36.17	36.43	36.68	36.92	37.17	37.41	37.66	37.90	38.14	38.37	38.61
23	24.55	258.70	36.71	36.99	37.26	37.53	37.80	38.06	38.32	38.58	38.84	39.10	39.35	39.61	39.86	40.10	40.35
	25.00	263.00	37.32	37.60	37.88	38.15	38.43	38.70	38.96	39.23	39.49	39.75	40.01	40.27	40.52	40.78	41.03
	26.00	272.60	38.67	38.96	39.25	39.54	39.82	40.10	40.38	40.66	40.93	41.20	41.47	41.74	42.01	42.27	42.53
	27.00	282.20	40.01	40.32	40.62	40.92	41.21	41.51	41.80	42.09	42.37	42.65	42.93	43.21	43.49	43.76	44.03
	28.00	291.70	41.35	41.67	41.99	42.30	42.61	42.91	43.21	43.51	43.81	44.11	44.40	44.69	44.97	45.26	45.54
	29.00	301.20	42.69	43.03	43.35	43.68	44.00	44.32	44.63	44.94	45.25	45.56	45.86	46.16	46.46	46.75	47.05
	30.00	310.70		44.38	44.72	45.06	45.39	45.72	46.05	46.37	46.70	47.01	47.33	47.64	47.95	48.25	48.56
	31.00	320.10				46.44	46.78	47.13	47.47	47.81	48.14	48.47	48.80	49.12	49.44	49.76	50.08
	32.00	329.50							48.89	49.24	49.59	49.93	50.27	50.61	50.94	51.27	51.60
	33.00	338.80										51.40	51.75	52.10	52.45	52.79	53.13
	34.00	348.20													53.96	54.31	54.66
	35.00	357.50															56.21
	Free Flow		52.96	53.98	55.01	56.05	57.10	58.16	59.23	60.31	61.39	62.49	63.59	64.70	65.82	66.95	68.09

1/ Increment stops; reading on bi-directional digital counter.
2/ Nominal gate opening, feet; vertical distance, gate seal to gate; average of eight bays. See spillway rating curves for values outside of this table.
3/ Revolution counter reading.

TABLE 3-2 (Continued)
LOWER GRANITE DAM GATED SPILLWAY RATING TABLE
(Flow Under One Gate in 1000 CFS
POOL ELEVATION – M.S.L.

STOP 1/	GATE 2/	REVC 3	731.00	731.50	732.00	732.50	733.00	733.50	734.00	734.50	735.00	735.50	736.00	736.50	737.00	737.50	738.00
1	0.86	10.70	1.65	1.66	1.67	1.67	1.68	1.69	1.70	1.71	1.72	1.73	1.74	1.74	1.75	1.76	1.77
2	1.79	21.80	3.40	3.42	3.44	3.46	3.47	3.49	3.51	3.53	3.55	3.57	3.58	3.60	3.62	3.64	3.66
3	2.76	33.10	5.20	5.23	5.26	5.28	5.31	5.34	5.37	5.40	5.43	5.45	5.48	5.51	5.54	5.56	5.59
4	3.75	44.40	7.00	7.04	7.08	7.12	7.16	7.20	7.23	7.27	7.31	7.35	7.39	7.43	7.46	7.50	7.54
5	4.75	55.70	8.79	8.84	8.89	8.94	8.99	9.04	9.09	9.14	9.19	9.24	9.28	9.33	9.38	9.43	9.48
6	5.77	67.00	10.59	10.65	10.71	10.77	10.83	10.89	10.95	11.01	11.07	11.13	11.19	11.25	11.30	11.36	11.42
7	6.80	78.20	12.38	12.45	12.52	12.59	12.66	12.73	12.80	12.87	12.94	13.01	13.08	13.15	13.22	13.29	13.36
8	7.84	89.50	14.16	14.24	14.32	14.40	14.48	14.57	14.65	14.73	14.81	14.89	14.97	15.05	15.12	15.20	15.28
9	8.89	100.80	15.93	16.02	16.11	16.20	16.30	16.39	16.48	16.57	16.66	16.75	16.84	16.93	17.02	17.11	17.20
10	9.94	112.00	17.67	17.78	17.88	17.98	18.08	18.19	18.29	18.39	18.49	18.59	18.69	18.79	18.89	18.99	19.09
11	11.01	123.30	19.43	19.54	19.65	19.77	19.88	19.99	20.11	20.22	20.33	20.44	20.55	20.66	20.77	20.88	20.99
12	12.08	134.50	.21.16	21.28	21.41	21.53	21.66	21.78	21.90	22.03	22.15	22.27	22.39	22.51	22.63	22.75	22.87
13	13.17	145.80	22.90	23.04	23.18	23.31	23.44	23.58	23.71	23.84	23.98	24.11	24.24	24.37	24.50	24.63	24.76
14	14.27	157.10	24.65	24.79	24.94	25.08	25,23	25.37	25.52	25.66	25.80	25.94	26.09	26.23	26.37	26.51	26.64
15	15.39	168.50	26.40	26.56	26.72	26.87	27.03	27.18	27.34	27.49	27.64	27.80	27.95	28.10	28.25	28.40	28.54
16	16.51	179.80	28.14	28.31	28.48	28.65	28.81	28.98	29.14	29.31	29.47	29.63	29.79	29.95	30.11	30.27	30.43
17	17.64	191.10	29.89	30.07	30.24	30.42	30.60	30.77	30.95	31.12	31.29	31.47	31.64	31.81	31.98	32.14	32.31
18	18.77	202.30	31.62	31.81	32.00	32.18	32.37	32.56	32.74'	32.92	33.11	33.29	33.47	33.65	33.83	34.01	34.18
19	19.91	213.60	33.35	33.55	33.75	33.95	34.15	34.34	34.54	34.73	34.92	35.12	35.31	35.50	35.68	35.87	36.06
20	21.06	224.90	35.09	35.31	35.52	35.73	35.93	36.14	36.34	36.55	36.75	36.95	37.15	37.35	37.55	37.74	37.94
21	22.22	236.20	36.85	37.07	37.29	37.51	37.73	37.94	38.16	38.37	38.58	38.80	39.01	39.21	39.42	39.63	39.83
22	23.39	247.50	38.61	38.84	39.07	39.30	39.53	39.76	39.98	40.21	40.43	40.65	40.87	41.09	41.31	41.52	41.74
23	24.55	258.70	40.35	40.60	40.84	41.08	41.32	41.56	41.79	42.03	42.26	42.49	42.72	42.95	43.17	43.40	43.62
	25.00	263.00	41.03	41.28	41.52	41.77	42.01	42.25	42.49	42.73	42.97	43.20	43.44	43.67	43.90	44.13	44.35
	26.00	272.60	42.53	42.79	43.05	43.30	43.55	43.80	44.05	44.30	44.54	44.79	45.03	45.27	45.51	45.74	45.98
	27.00	282.20	44.03	44.30	44.57	44.83	45.09	45.36	45.61	45.87	46.12	46.38	46.63	46.87	47.12	47.37	47.61
	28.00	291.70	45.54	45.82	46.09	46.37	46.64	46.91	47.18	47.44	47.71	47.97	48.23	48.48	48.74	48.99	49.24
	29.00	301.20	47.05	47.34	47.62	47.91	48.19	48.47	48.75	49.02	49.29	49.56	49.83	50.10	50.36	50.62	50.88
	30.00	310.70	48.56	48.86	49.16	49.45	49.74	50.03	50,32	50.60	50.89	51.17	51.44	51.72	51.99	52.26	52.53
	31.00	320.10	50.08	50.39	50.70	51.00	51.30	51.60	51.90	52.20	52.49	52.78	53.06	53.35	53.63	53.91	54.19
	32.00	329.50	51.60	51.92	52.24	52.56	52.87	53.18	53.49	53.80	54.10	54.40	54.69	54.99	55.28	55.57	55.86
	33.00	338.80	53.13	53.46	53.79	54.12	54.45	54.77	55.09	55.41	55.72	56.03	56.34	56.64	56.94	57.24	57.54
	34.00	348.20	54.66	55.01	55.36	55.70	56.03	56.37	56.70	57.03	57.35	57.67	57.99	58.30	58.61	58.92	59.23
	35.00	357.50	56.21	56.57	56.93	57.28	57.63	57.98	58.32	58.66	58.99	59.33	59.65	59.98	60.30	60.62	60.94
	Free Flow		68.09	69.24	70.39	71.56	72.73	73.92	75.11	76.31	77.52	78.74	79.97	81.20	82.45	83.70	84.96

1/ Increment stops;_reading on bi-directional digital counter.
2/ Nominal gate opening, feet; vertical distance, gate seal to gate; average of eight bays. See spillway rating curves for values outside of this table.
3/ Revolution counter reading.

TABLE 3-3

LOWER GRANITE RESERVOIR STORAGE - ELEVATION TABLE (PG 1 OF 3) COMPUTED BY SPAULDING, CENPW-PL-H, MAY 1994

THE TABULATED VALUES FOR RESERVOIR INFLOWS OF 30,000 CFS AND 100,000 CFS WERE TAKEN FROM THE STORAGE - ELEVATION CURVES SHOWN ON PLATE 3-10 OF THE LOWER GRANITE WATER CONTROL MANUAL. THE TABULATED VALUES FOR RESERVOIR INFLOWS OF 50,000 CFS AND 75,000 CFS WERE INTERPOLATED FROM THE 30,000 CFS AND 100,000 CFS CURVES. THE CURVES ON PLATE 3-10 ARE THE BASIS FOR STORAGES IN THE FOREBAY ELEVATION RANGE OF 650 TO 746.5. THE STORAGE VALUES AT FOREBAY ELEVATIONS BELOW 650 WERE COMPUTED USING THE CALIBRATED HEC-2 MODEL JLGSC89.DAT, BASED ON 1989 SEDIMENT RANGE DATA. THE COMPUTED VALUES IN THE FOREBAY ELEVATION RANGE OF 623 TO
650 WERE PROPORTIONED TO MATCH THE WATER CONTROL MANUAL VALUE AT ELEVATION 650. ALL RESERVOIR STORAGES ARE FOR THE REACH FROM LOWER GRANITE DAM UPSTREAM TO RIVER MILE 146.5 ON THE MAIN STEM OF THE SNAKE RIVER, AND UPSTREAM TO RIVER MILE 4.6 ON THE CLEARWATER RIVER TRIBUTARY.

LOWER GRANITE RESERVOIR STORAGE (AF)				
FOREBAY	@ 30 KCFS	@ 50 KCFS	@ 75 KCFS	@ 100
746.5	562,100	562,400	562,800	563,200
740.0	502,500	503,300	504,200	505,100
738.0	485,000	485,900	486,900	488,000
737.0	476,400	477,300	478,500	479,600
736.0	467,900	468,800	470,100	471,300
735.0	459,500	460,500	461,800	463,100
734.0	451,200	452,200	453,600	455,000
733.0	442,900	444,100	445,500	446,900
732.0	434,800	436,000	437,500	439,000
731.0	426,800	428,100	429,600	431,200
730.0	418,900	420,200	421,800	423,400
729.0	411,100	412,400	414,100	415,700
728.0	403,400	404,800	406,500	408,200
727.0	395,800	397,200	399,000	400,700
726.0	388,300	389,700	391,500	393,400
725.0	380,900	382,300	384,200	386,100
724.0	373,500	375,100	377,000	378,900
723.0	366,300	367,900	369,800	371,800
722.0	359,200	360,800	362,800	364,800
721.0	352,200	353,800	355,900	357,900
720.0	345,200	346,900	349,000	351,100
719.0	338,400	340,100	342,300	344,400
718.0	331,700	333,400	335,600	337,800
717.0	325,000	326,800	329,000	331,300
716.0	318,400	320,300	322,600	324,900
715.0	312,000	313,900	316,200	318,500
714.0	305,600	307,500	309,900	312,300
713.0	299,300	301,300	303,700	306,200
712.0	293,100	295,100'	297,600	300,100
711.0	287,000	289,100	291,600	294,200
710.0	281,000	283,100	285,700	288,300

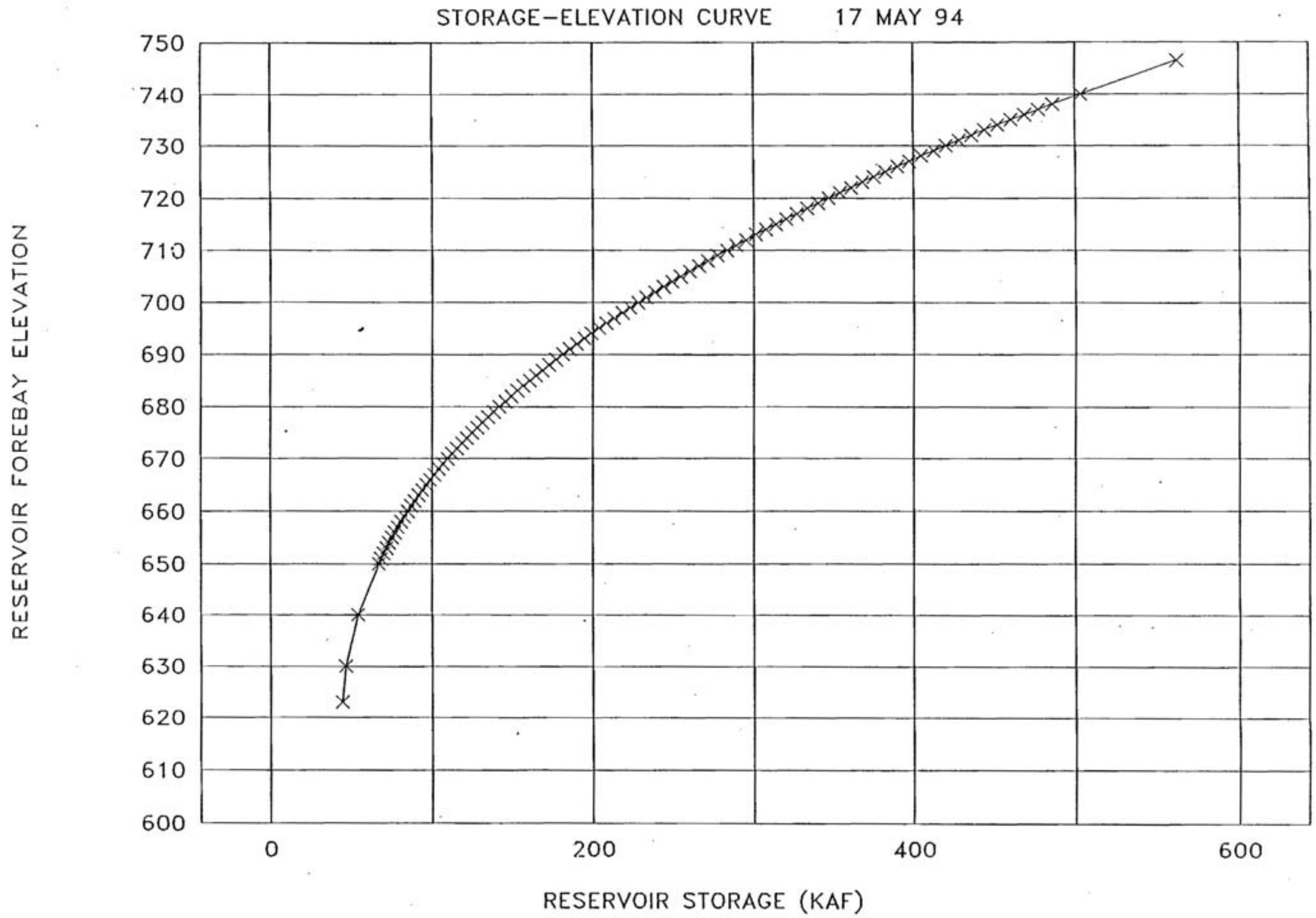
LOWER GRANITE RESERVOIR STORAGE - ELEVATION TABLE (PG 2 OF 3)
COMPUTED BY SPAULDING, CENPW-PL-H, MAY 1994

LOWER GRANITE RESERVOIR STORAGE (AF)				
FOREBAY	@ 30 KCFS	@ 50 KCFS	@ 75 KCFS	@ 100 KCFS
710.0	281,000	283,100	285,700	288,300
709.0	275,100	277,200	279,900	282,600
708.0	269,200	271,400	274,200	276,900
707.0	263,400	265,700	268,500	271,400
706.0	257,700	260,000	263,000	265,900
705.0	252,100	254,500	257,500	260,500
704.0	246,500	249,000	252,100	255,200
703.0	241,100	243,600	246,800	250,000
702.0	235,700	238,300	241,600	244,900
701.0	230,400	233,100	236,500	239,900
700.0	225,100	228,000	231,500	235,000
699.0	220,000	222,900	226,600	230,200
698.0	214,900	217,900	221,700	225,500
697.0	209,900	213,100	216,900	220,800
696.0	205,000	208,200	212,300	216,300
695.0	200,200	203,500	207,700	211,800
694.0	195,400	198,800	203,100	207,400
693.0	190,700	194,300	198,700	203,100
692.0	186,100	189,800	194,300	198,900
691.0	181,500	185,300	190,100	194,800
690.0	177,100	181,000	185,800	190,700
689.0	172,700	176,700	181,700	186,700
688.0	168,400	172,500	177,700	182,800
687.0	164,100	168,400	173,700	179,000
686.0	159,900	164,300	169,800	175,200.
685.0	155,800	160,300	165,900	171,500
684.0	151,800	156,400	162,200	167,900
683.0	147,900	152,600	158,500	164,300
682.0	144,000	148,800	154,800	160,800
681.0	140,200	145,100	151,300	157,400
680.0	136,500	141,500	147,800	154,100
679.0	132,900	138,000	144,400	150,800
678.0	129,300	134,500	141,000	147,600
677.0	125,800	131,100	137,800	144,400
676.0	122,400	127,800	134,600	141,400
675.0	119,000	124,500	131,500	138,400
674.0	115,800	121,400	128,400	135,400
673.0	112,600	118,300	125,400	132,600
672.0	109,400	115,200	122,500	129,800
671.0	106,400	112,300	119,700	127,100
670.0	103,400	109,400	116,904	124,400
669.0	100,500	106,600	114,200	121,800
668.0	97,700	103,900	111,600	119,300
667.0	95,000	101,200	109,000	116,800
666.0	92,300	98,600	106,500	114,400
665.0	89,700	96,100'	104,100	112,000

LOWER GRANITE RESERVOIR STORAGE - ELEVATION TABLE (PG 3 OF 3)
COMPUTED BY SPAULDING, CENPW-PL-H, MAY 1994

LOWER GRANITE RESERVOIR STORAGE (AF)				
FOREBAY	@ 30 KCFS	@ 50 KCFS	@ 75 KCFS	@ 100 KCFS
665.0	89,700	96,100	104,100	112,000
664.0	87,200	93,600	101,700	109,800
663.0	84,700	91,200	99,400	107,500
662.0	82,400	88,900	97,100	105,400
661.0	80,100	86,700	95,000	103,200
660.0	77,800	84,500	92,900	101,200
659.0	75,700	82,400	90,800	99,200
658.0	73,600	80,400	88,800	97,300
657.0	71,600	78,400	86,900	95,400
656.0	69,700	76,500	85,100	93,600
655.0	67,900	74,700	83,300	91,800
654.0	66,100	73,000	81,600	90,100
653.0	64,400	71,300	79,900	88,L00
652.0	62,800	69,700	78,300	86,900
651.0	61,200	68,200	76,800	85,400
650.0	59,800	66,700	75,300	84,000
640.0		53,600		
630.0		46,200		
623.0		44,000		

LOWER GRANITE RESV W/INFLOW = 50 KCFS



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RESERVOIR STORAGE - ELEVATION TABLE REVISED FROM THE FY92 TABLE USED IN THE PHASE 1 SYSTEM CONFIGURATION STUDY
RESERVOIR STORAGES COMPUTED FOR AN INFLOW OF 50,000 CFS.

LOWER GRANITE PROJECT

RESERVOIR ELEVATION NOTES	FB ELEV (FT)	RESERVOIR STORAGE (AF)	NOTES ON THE STORAGE COMPUTATIONS
DESIGN MAX SURCHARGE ELEV AT SPILLWAY DESIGN FLOOD (CRT-49)	746.50	562,400]	EXTRAPOLATED FROM WCM PLATE 3-10
MAXIMUM NORMAL OPERATING POOL	738.00	485,900]	
MINIMUM NORMAL OPERATING POOL (MOP)	733.00	444,100]	
APPROX EXISTING SPILLWAY CAPACITY AT STANDARD PROJECT FLOOD	724.00	375,100]	
INTERMEDIATE STORAGE TABLE POINT (HEC-5 POWER STUDIES)	716.00	320,300]	
TARGET DRAWDOWN ELEV PROPOSED IN 1992 OA/EIS	710.00	283,100]	WATER CONTROL MANUAL PLATE 3-10
TARGET DRAWDOWN ELEV PROPOSED FOR PHASE 1 SCS ALT. 13	705.00	254,500]	FOR FOREBAY ELEVATIONS 650 TO 740
TARGET DRAWDOWN ELEV PROPOSED IN 1992 OA/EIS	703.00	243,600]	
MAX ELEV FOR PHASE 1 SCS ALT. 5 AT 225,000 CFS INFLOW	701.00	233,100]	STORAGES WERE PICKED OFF THE PLATE
MINIMUM DRAWDOWN ELEV PROPOSED FOR PHASE 1 SCS ALT. 13	700.00	228,000]	AND DEFINED MORE PRECISELY WITH A
TARGET DRAWDOWN ELEV FOR PHASE 1 SCS ALT. 14	695.00	203,500]	LOTUS CURVE SMOOTHING TECHNIQUE.
TARGET DRAWDOWN ELEV PROPOSED IN 1992 OA/EIS	693.00	194,300]	
MINIMUM DRAWDOWN ELEV PROPOSED FOR PHASE 1 SCS ALT. 14	690.00	181,000]	
TARGET DRAWDOWN ELEV PROPOSED FOR PHASE 1 SCS ALT. 15	686.00	164,300]	
EXISTING SPILLWAY CREST, TARGET DD ELEV FOR PHASE 1 SCS ALT. 5	681.00	145,100]	
INTERMEDIATE STORAGE TABLE POINT (HEC-5 POWER STUDIES)	673.00	118,300]	
NEW SPILLWAY CREST ELEV PROPOSED FOR PHASE 1 SCS ALT. 14	671.00	112,300]	
POSSIBLE NEW SPILLWAY CREST ELEV FOR PHASE 1 SCS ALT. 15	662.00	88,900]	
POSSIBLE NEW SPILLWAY CREST ELEV FOR PHASE 1 SCS ALT. 15	657.00	78,400]	
INTERMEDIATE STORAGE TABLE POINT (HEC-5 STUDIES)	650.00	66,700]	
INTERMEDIATE STORAGE TABLE POINT (HEC-5 STUDIES)	640.00	53,600]	FROM THE CALIBRATED MODEL JLGSC89.DAT
INTERMEDIATE STORAGE TABLE POINT (HEC-5 STUDIES)	630.00	46,200]	OBTAINED FROM LES CUNNINGHAM FOR
TARGET DD ELEV FOR PHASE 1 SCS ALT. 4A (NATURAL RIVER OPTION)	623.00	44,000]	FOREBAY ELEVATIONS 615 TO 640. (2)
NATURAL WSE FOR LOW WATER INFLOW OF 10,600 CFS (DM #1, PLATE 23)	619.00	18,400]	COMPUTED VALUES FOR 623 TO 650 WERE
NATURAL WSE FOR LOW WATER INFLOW OF 10,600 CFS (PHASE 1 SCS)	615.00	18,300]	PROPORTIONED TO MATCH WCM VALUE AT 650.

NOTES:
(1) RESERVOIR VOLUMES INCLUDE BOTH POOL STORAGE AND CHANNEL STORAGE FROM THE DAM AT RIVER MILE (RM) 107.43 UPSTREAM TO RM 146.63 ON THE SNAKE RIVER AND RM 4.74 ON THE CLEARWATER RIVER TRIBUTARY. ALL RESERVOIR VOLUMES WERE COMPUTED USING AN INFLOW OF 50,000 CFS.

(2) THE CALIBRATED HEC-2 MODEL JLGSC89.DAT USES CHANNEL GEOMETRY OBTAINED FROM THE 1989 LOWER GRANITE SEDIMENT RANGE SOUNDINGS. THE TARGET DRAWDOWN ELEVATION OF 623 IS APPROXIMATELY THE NATURAL RIVER PROFILE ELEVATION AT THE DAM FOR AN INFLOW OF 50,000 CFS, AS INDICATED ON THE PHASE 1 SCS STUDY TAILWATER CURVES COMPUTED USING THE HEC-2 MODEL. THE NATURAL WATER SURFACE ELEVATION OF 615 GIVEN AN INFLOW OF 10,600 CFS WAS EXTRAPOLATED FROM THE PHASE 1 SCS STUDY TAILWATER CURVES. LOWER GRANITE DM #1, PLATE 23 (1934 GEOMETRY), SHOWS A NATURAL WATER SURFACE PROFILE ELEVATION OF 619 FOR AN INFLOW OF 10,600 CFS AT THE DAM SITE. THE ADOPTED LOW WATER DISCHARGE OF 10,600 CFS IS SPECIFIED IN THE LOWER GRANITE DM #1. THE RESERVOIR STORAGES SHOWN IN THE TABLE FOR FOREBAY ELEVATIONS OF 615 AND 619 THEREFORE REPRESENT THE LOW FLOW CHANNEL STORAGE IN THE RESERVOIR REACH.

Insert table 4-1

TABLE 4-1
CLIMATOLOGICAL DATA, LEWISTON, IDAHO

Elev. 1436 feet m.s.l.

Month	Temperatures °F Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F: Heating	Cooling	Precipitation in inches, Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs.	Year
(a)				30		30					30		30		30		30		30	
J	37.9	24.4	31.2	66	1953	-22	1950	1048	0	1.27	3.55	1970	0.42	1949	1.35	1956	26.1	1957	12.8	1966
F	46.0	30.1	38.1	66	1968	-15	1950	753	0	0.85	1.64	1974	0.21	1964	0.93	1959	14.9	1956	7.5	1956
M	52.9	32.9	42.9	76	1964	2	1955	685	0	0.96	2.70	1972	0.25	1969	0.86	1954	9.7	1955	5.4	1955
A	62.0	38.6	50.3	87	1952	20	1966	441	0	1.13	2.33	1969	0.05	1956	0.81	1969	1.1	1972	1.0	1947
M	70.6	45.5	58.1	96	1966	23	1954	232	18	1.58	4.80	1948	0.27	1964	1.63	1948	T	1975	T	1975
J	77.9	52.1	65.0	107	1973	34	1951	84	84	1.83	4.70	1950	0.24	1973	1.72	1950	0.0		0.0	
J	89.2	57.6	73.4	110	1967	41	1955	0	264	0.53	2.15	1964	T	1953	1.40	1964	0.0		0.0	
A	87.1	55.9	71.5	115	1961	42	1965	17	218	0.60	2.10	1956	T	1969	1.36	1960	0.0		0.0	
S	77.6	48.9	63.3	103	1950	28	1965	124	73	0.86	2.36	1947	T	1975	1.73	1955	0.0		0.0	
O	63.2	40.3	51.8	89	1975	16	1971	409	0	1.08	2.79	1950	0.03	1952	1.19	1950	2.5	1971	1.3	1971
N	48.0	32.9	40.5	74	1975	-3	1955	735	0	1.25	2.79	1973	0.23	1976	0.94	1973	14.4	1961	8.3	1961
D	41.0	28.6	34.8	63	1965	-22	1968	936	0	1.27	3.28	1964	0.14	1970	1.12	1958	18.7	1968	8.4	1968
YR	62.8	40.6	51.7	115	AUG 1961	-22	DEC 1968	5464	657	13.21	4.80	MAY 1948	T	SEP 1975	1.73	SEP 1955	26.1	JAN 1957	12.8	JAN 1966

Month	Relative humidity pct. Hour 04 (Local time)	Hour 10	Hour 16	Hour 22	Wind: Mean speed m.p.h.	Prevailing direction	Peak gust: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days, Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms %	Heavy fog, visibility ¼ mile or less %	Temperatures °F Max.: (b) 90° and above	32° and below	Min.: 32° and below	0° and below
(a)	30	30	30				5				30	30	30	30	30	30	18	18	30	30	30	30
JAN	81	76	72				72		1972		8.3	3	4	24	12	2	0	4	0	8	23	2
FEB	80	71	63				64		1972		8.1	3	4	21	10	1	*	4	0	2	17	*
MAR	77	62	50				55		1975		7.6	4	7	20	10	1	*	1	0	*	14	0
APR	75	55	41				53		1976		7.3	5	6	19	10	*	1	*	0	0	4	0
MAY	75	52	39				54		1976		6.5	7	8	16	9	0	3	*	1	0	*	0
JUN	74	48	36				51		1976		6.0	8	9	13	9	0	4	*	4	0	0	0
JUL	61	37	23				41		1974		3.2	19	7	5	4	0	4	0	17	0	0	0
AUG	59	39	25				51		1976		3.8	17	7	7	4	0	3	0	14	0	0	0
SEP	68	49	31				55		1974		4.6	13	8	9	5	0	1	*	3	0	*	0
OCT	81	66	51				46		1973		6.3	8	8	15	8	*	*	2	0	0	3	0
NOV	84	77	71				47		1974		8.3	3	5	22	10	*	*	4	0	1	12	*
DEC	83	78	75				60		1974		8.5	3	3	25	12	2	0	5	0	4	20	*
YEAR	75	59	48				72		JAN 1972		6.5	93	76	196	102	6	16	21	39	15	95	3

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 117 in July 1939; lowest temperature -23 in December 1919; minimum monthly precipitation 0.00 in August 1939 and earlier; maximum monthly snowfall 27.2 in February 1916.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

% Through 1964. The station did not operate 24 hours daily. Fog and thunderstorm data may be incomplete.

TABLE 4-2
SUMMARY OF RUNOFF AND DISCHARGE DATA
Snake River near Clarkston, Washington

				Mean Daily Discharge			
		Station Name		Maximum		Minimum	
Water Year	Station Name	KAF	Inches	CFS	Date	CFS	Date
1894	RIPARIA 2/			409,000 1/	5 JUN		-
1910	BURBANK 3/	49,000	8.43	252,000	23 MAR	11,800	26 AUG
1911	BURBANK	42,200	7.26	242,000	15 JUN	15,600	2 SEP
1912	BURBANK	49,100	8.45	289,000	10 JUN	15,000	6 JAN
1913	BURBANK	46,400	7.98	298,000	29 MAY	15,500	4 SEP
1914	BURBANK	36,300	6.24	175,000	25 MAY	13,000	4 SEP
1915	BURBANK	26,000	4.47	122,000	20 MAY	13,000	1 SEP
1916	RIPARIA	46,500	8.38	230,000	20 JUN	15,200	1 OCT
1917	RIPARIA	46,300	8.35	256,000	30 MAY	16,200	3 SEP
1918	RIPARIA	42,600	7.68	216,000	14 JUN	15,000	8 SEP
1919	RIPARIA	28,900	5.21	167,000	30 MAY	10,900	28 AUG
1920	RIPARIA	30,800	5.55	148,000	17 JUN	12,300	1 OCT
1921	RIPARIA	49,800	8.98	270,000	20 MAY	16,700	31 AUG
1922	RIPARIA	39,400	7.10	233,000	7 JUN	14,500	24 SEP
1923	4/	32,800	5.91	179,000	13 JUN	15,200	13 SEP
1924		24,100	4.34	136,000	14 MAY	9,800	29 AUG
1925		38,800	7.00	219,000	22 MAY	15,200	11 AUG
1926		25,400	4.58	91,000	20 APR	11,300	3 AUG
1927		41,500	7.48	245,000	9 JUN	16,800	29 AUG
1928		45,600	8.22	271,000	27 MAY	16,100	3 SEP
1929	RIPARIA	27,000	4.87	155,000	25 MAY	13,100	9 SEP
1930	RIPARIA	25,000	4.51	95,600	26 APR	13,100	2 SEP
1931	RIPARIA	20,600	3.71	107,000	2 APR	10,600	14 AUG
1932	RIPARIA	34,800	6.27	219,000	23 MAY	14,400	6 OCT
1933	RIPARIA	32,700	5.90	245,000	11 JUN	--	--
1934	RIPARIA	29,400	5.30	149,000	23 DEC	12,200	19 AUG
1935	RIPARIA	25,020	4.51	130,000	25 MAY	13,100	28 AUG
1936	CLARKSTON 5/	31,460	5.72	213,000	16 MAY	12,200	20 DEC
1937	CLARKSTON	22,310	4.06	110,000	19 MAY	10,800	10 JAN
1938	CLARKSTON	37,540	6.82	214,000	29 MAY	15,200	1 OCT
1939	CLARKSTON	27,320	4.96	144,000	4 MAY	14,000	21 AUG
1940	CLARKSTON	28,810	5.23	125,000	13 MAY	13,000	24 AUG
1941	CLARKSTON	26,290	4.78	102,000	14 MAY	15,500	16 DEC
1942	CLARKSTON	34,490	6.27	158,000	27 MAY	16,800	26 AUG
1943	CLARKSTON	49,030	8.91	208,000	20 APR	17,900	11 OCT
1944	CLARKSTON	25,500	4.63	105,600	16 MAY	16,400	13 SEP
1945	CLARKSTON	30,800	5.60	148,000	7 JUN	16,100	14 DEC
1946	CLARKSTON	37,860	6.88	166,000	20 APR	17,800	20 AUG
1947	CLARKSTON	40,410	7.34	230,000	9 MAY	19,000	21 AUG
1948	CLARKSTON	46,390	8.43	349,500	29 MAY	20,200	16 SEP
1949	CLARKSTON	48,390	6.97	243,100	17 MAY	17,200	3 SEP
1950	CLARKSTON	42,730	7.76	200,000	17 JUN	19,200	5 JAN

TABLE 4-2 (CONTINUED)
SUMMARY OF RUNOFF AND DISCHARGE DATA
Snake River near Clarkston, Washington

				Mean Daily Discharge			
		Annual Runoff		Maximum		Minimum	
Water Year	Station Name	KAF	Inches	CFS	Date	CFS	Date
1951	CLARKSTON	43,060	7.82	179,000	25 MAY	19,200	16 SEP
1952	CLARKSTON	46,590	8.46	237,000	28 APR	20,700	27 AUG
1953	CLARKSTON	37,710	6.85	226,000	14 JUN	15,600	30 NOV
1954	CLARKSTON	35,320	6.42	204,000	21 MAY	20,500	10 SEP
1955	CLARKSTON	30,890	5.61	199,000	13 JUN	17,500	10 SEP
1956	CLARKSTON	48,460	8.80	277,100	25 MAY	20,400	5 OCT
1957	CLARKSTON	42,700	7.76	293,800	20 MAY	18,300	31 JAN
1958	CLARKSTON	37,470	6.81	239,800	22 MAY	9,320 7/	3 SEP
1959	CLARKSTON	36,760	6.68	167,600	7 JUN	13,400	8 OCT
1960	CLARKSTON	35,180	6.39	157,400	5 JUN	15,900	22 AUG
1961	CLARKSTON	30,000	5.45	168,000	27 MAY	13,000	15 AUG
1962	CLARKSTON	32,680	5.94	133,000	26 MAY	17,500	10 SEP
1963	CLARKSTON	34,940	6.35	150,400	25 MAY	18,100	2 SEP
1964	CLARKSTON	37,720	6.86	240,300	9 JUN	17,900	7 OCT
1965	CLARKSTON	53,130	9.66	227,000	21 APR	20,820	22 AUG
1966	CLARKSTON	27,110	4.93	111,000	8 MAY	14,400	22 AUG
1967	CLARKSTON	33,790	6.14	205,000	24 MAY	15,500	22 AUG
1968	CLARKSTON	31,100	5.65	129,000	4 JUN	16,100	11 OCT
1969	CLARKSTON	42,010	7.63	182,000	20 MAY	17,100	29 AUG
1970	CLARKSTON	38,180	6.94	227,000	7 JUN	18,300	1 SEP
1971	CLARKSTON	54,340	9.87	253,000	30 MAY	20,000	27 AUG
1972	CLARKSTON	50,660	9.20	237,000	2 JUN	19,900	11 SEP
1973	6/	25,750	4.68	96,000	19 MAY	14,850	26 AUG
1974		57,410	10.43	332,000	18 JUN	20,750	9 SEP
Average 8/		37,000	6.65	200,000		16,000	
Maximum		57,410	10.43	409,000 1/	1894	24,100	1975
Minimum		20,600	3.71	91,000	1826	9,320 7/	1958

1/ Computed by the USGS from high water marks.
2/ Drainage area at Riparia is 104,000 square miles.
3/ Drainage area at Burbank is 109,000 square miles.
4/ Estimated from discharge records of Snake River at Oxbow, Salmon River at Whitebird, and Clearwater River at Kamiah, and from stage records at Lewiston for 1923-1928.
5/ Drainage area for Snake River near Clarkston is about 103,200 square miles.
6/ Estimated from Snake River at Anatone and Clearwater River at Spalding for 1973-1974 mean daily discharges.
7/ Minimum extreme discharge is 6,660 cfs on 2 September 1958.
8/ Average for period 1910-1974.

Notes:
1. Data source U.S. Army Corps of Engineers, Walla Walla District, Hydrology Branch.
2. Gage discontinued December 1972.

TABLE 4-2A

SUMMARY OF RUNOFF AND DISCHARGE DATA
(Lower Granite Reservoir Computed Regulated Inflows) 1/

	Annual Runoff		Mean Daily Discharge			
			Maximum		Minimum	
Water Year	KAF	Inches 3/	CFS	Date	CFS	Date
1975 ?/			177,300	7 JUN	24,100	15 AUG
1976	50,780	9.20	192,800	11 MAY	22,000	5 SEP
1977	20,430	3.7	62,200	3 MAY	10,900	21 AUG
1978	40,370	7.31	148,800	9 JUN	18,700	3 SEP
1979	30,970	5.60	141,200	25 MAY	13,700	13 AUG
1980	32,810	5.94	133,200	13 JUN	16,100	1 SEP
1981	33,920	6.15	176,100	10 JUN	15,700	24 AUG
1982	51,000	9.24	205,600	18 JUN	17,400	25 OCT
1983	48,400	8.77	194,300	29 MAY	22,800	31 AUG
1984	54,750	9.92	244,800	31 MAY	19,400	2 OCT
1985	35,280	6.39	124,400	8 JUN	28,600	6 AUG
1986	44,320	8.03	211,000	1 JUN	23,800	30 AUG
Average	40,270	7.30	168,000		19,000	
Maximum	54,750	9.92	244,800	1984	28,600	1985
Minimum	20,430	3.70	62,200	1977	10,900	1977

1/ Inflows computed at Lower Granite Dam due to abandonment of Clarkston site in 1972 because of Lower Granite Dam construction.
2/ Water year 1975 data based on March to September 1975 period of record.
3/ 1.0 basin inches = 5,520 KAF for a drainage area of 103,500 square miles above Lower Granite Dam.

Note: Data source U.S. Army Corps of Engineers, Walla Walla District, Hydrology Branch.

TABLE 4-3
SUMMARY OF MONTHLY RUNOFF
LOWER GRANITE RESERVOIR
REGULATED MONTHLY INFLOW VOLUME IN 1,000 ACRE-FEET

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1975						4019.0	4579.3	7404.6	9198.5	4872.1	1945.4	2032.7
1976	2106.5	2434.6	4217.9	3673.8	3564.9	4111.4	6799.2	9650.1	7305.8	3067.9	1926.6	1925.8
1977	1851.2	1877.4	1953.0	1955.5	1386.9	1511.4	1862.9	2525.0	2286.6	1282.3	934.0	1000.7
1978	1438.6	1644.9	3245.4	2957.4	2718.2	4030.3	4732.2	6184.8	6399.6	3454.9	1599.9	1964.9
1979	1396.0	1735.4	2289.6	2175.3	1966.2	3332.7	3383.5	6207.0	4311.1	1858.5	1150.6	1164.5
1980	1326.4	1587.8	1786.9	2020.2	1824.8	2184.4	3493.9	6566.0	6344.6	2625.8	1336.1	1711.0
1981	1475.9	1935.5	2679.7	2487.7	2477.6	2325.5	2969.5	5624.6	7093.4	2165.4	1134.2	1551.1
1982	1504.3	1680.4	2420.1	2572.0	4091.8	6300.6	5909.8	8426.3	9313.9	5117.8	1726.0	1939.9
1983	2209.4	2309.2	2939.9	3456.6	3380.3	6271.4	4783.2	7504.2	7836.6	3867.4	1895.4	1944.2
1984	1947.2	2772.9	3003.2	3626.8	2893.9	4966.1	6784.2	9539.2	11015.6	4143.9	1886.9	2166.8
1985	2195.9	2677.3	2552.0	2760.4	2356.4	2654.5	5032.7	5615.3	4446.0	1635.0	1481.9	1873.0
1986	1743.1	1978.3	2002.9	1970.8	3911.9	7798.5	5840.0	6889.3	6877.2	1912.5	1277.8	2115.2
STATISTICS												
N	11	11	11	11	11	12	12	12	12	12	12	12
AVERAGE	1745.0	2057.6	2644.6	2696.1	2779.4	4125.5	5840.0	6844.7	6869.0	3000.3	1524.6	1782.5
MAXIMUM	2209.4	2772.9	4217.9	3673.8	4091.8	7798.5	6799.2	9650.1	11015.6	5117.8	1945.4	2166.8
MINIMUM	1326.4	1587.8	1786.9	1955.5	1386.9	1511.4	1862.9	2525.0	2286.6	1282.3	934.0	1000.7

Notes:
1. Data source U.S. Army Corps of Engineers, Walla Walla District, Hydrology Branch.
2. Period of Record: March 1975 to present.

TABLE 4-4
SUMMARY OF MONTHLY RUNOFF
CLEARWATER RIVER AT SPALDING, IDAHO
(STATION NO. 13342500)
Regulated Monthly Discharge in 1,000 Acre-Feet
Drainage Area = 9,570 Square Miles

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1972	105.2	131.4	152.5	307.7	633.4	2139.8	1897.2	3884.9	3534.0	1140.9	311.0	198.5
1973	186.4	310.6	493.7	492.6	186.0	328.0	461.8	1241.9	868.2	424.0	245.1	446.8
1974	262.1	394.3	737.8	1679.6	1310.7	1838.3	2422.6	2415.9	4377.8	1166.4	317.8	393.1
1975	232.3	425.0	332.9	508.5	902.8	1158.4	880.4	2278.8	3509.6	1469.8	466.0	607.3
1976	507.9	714.9	1671.1	1279.0	1039.9	1301.2	1768.3	3033.4	2347.3	960.8	381.4	464.4
1977	283.3	416.8	426.3	483.5	359.9	300.0	691.8	1180.6	765.6	450.7	298.4	286.3
1978	317.8	557.3	1214.7	1099.5	1061.2	1493.6	1296.6	1880.4	2116.8	909.8	365.3	537.3
1979	203.1	421.3	734.8	614.2	363.5	939.5	1000.3	2666.4	1637.6	502.6	286.8	272.8
1980	258.1	375.9	622.9	549.5	415.5	541.0	1095.2	1950.8	1791.5	624.0	286.2	456.9
1981	244.3	504.7	926.1	821.3	668.8	639.6	1003.2	1979.3	2537.3	723.8	229.3	543.4
1982	277.4	386.4	657.6	818.9	1293.4	2089.6	1497.2	2341.1	2702.3	1188.9	331.2	467.7
1983	396.3	505.2	650.7	821.7	690.3	1333.7	904.5	1553.5	1522.9	751.6	292.9	524.8
1984	297.7	598.6	722.2	681.9	513.1	1290.5	1572.9	2345.7	3134.5	870.4	304.0	566.5
1985	278.9	475.0	518.5	751.9	657.9	470.7	1354.7	2163.8	1560.8	503.1	544.0	510.2
STATISTICS												
N	14	14	14	14	14	14	14	14	14	14	14	14
AVERAGE	275.1	444.1	704.4	779.3	721.2	1133.1	1274.8	2208.3	2314.7	834.8	332.8	448.3
MAXIMUM	507.9	714.9	1671.1	1679.6	1310.7	2139.8	2422.6	3884.9	4377.8	1469.8	544.0	607.3
MINIMUM	105.2	131.4	152.5	307.7	186.0	300.0	461.8	1180.6	765.6	424.0	229.3	198.5

TABLE 4-5
SUMMARY OF MONTHLY RUNOFF
SNAKE RIVER NEAR ANATONE, WASHINGTON
Regulated Monthly Discharge in 1,000 Acre-Feet

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1959	1148.1	1313.5	1466.2	1572.9	1457.5	1607.6	2266.0	2777.7	4083.0	1576.5	1078.0	1384.7
1960	1793.9	1414.8	1349.2	1396.4	1361.7	1967.0	2481.6	3261.9	3680.6	1249.8	1114.9	1095.1
1961	1136.7	1256.7	1299.6	1382.3	1600.9	1723.5	1597.9	2614.1	3227.9	913.8	787.4	951.9
1962	1085.6	1077.2	1239.9	1443.4	1466.4	1622.9	2944.3	3426.5	3617.9	1484.1	1107.4	1058.8
1963	1698.7	1502.3	1669.7	1512.2	1812.7	1463.4	1704.2	3961.2	4989.7	1742.9	1104.0	1212.7
1964	1219.3	1243.7	1430.5	1551.5	1318.0	1429.5	2272.5	4019.8	5850.3	2165.0	1225.0	1245.6
1965	1272.0	1304.5	2559.5	2685.9	4027.7	3374.1	4229.4	5763.1	6092.9	2849.3	1606.4	1465.0
1966	1751.2	1467.4	1577.5	1900.0	1411.1	1591.0	1771.3	2278.4	2026.7	1031.6	842.6	927.3
1967	1111.4	1154.4	1306.1	1557.0	1440.2	1451.3	1413.6	3491.8	5195.8	2161.8	1016.5	1073.1
1968	1275.6	1343.0	1505.3	1625.1	1964.1	1588.6	1609.4	2363.3	3369.4	1335.5	1260.5	1136.0
1969	1374.6	1550.1	1688.6	2319.1	2231.2	2976.8	4426.0	5296.9	3538.4	1512.8	1051.9	1110.6
1970	1296.6	1192.5	1320.2	2209.4	2243.1	1767.5	1850.0	4324.4	5762.5	2409.2	1090.5	1346.8
1971	1499.9	1684.4	2044.0	2866.2	3266.8	3223.8	4937.1	7207.8	6957.1	3223.2	1286.9	1363.5
1972	1937.9	1962.9	2007.9	2479.4	2893.7	5558.4	4004.7	4984.5	5855.5	1922.8	1173.2	1207.4
1973	1714.9	1708.6	1885.7	2049.4	1690.9	1740.5	1557.6	2586.3	2292.9	1012.8	818.6	1009.2
1974	1154.0	1839.7	1973.8	2874.7	2293.1	3649.4	5277.9	5564.7	7895.7	3312.8	1361.3	1161.1
1975	1384.9	1366.2	1462.0	1744.1	1830.8	2697.4	3625.6	5248.5	5999.3	3380.9	1336.1	1313.3
1976	1511.0	1619.7	2270.9	2201.1	2289.6	2656.1	4658.4	6282.5	4633.3	1926.4	1470.6	1400.9
1977	1471.2	1373.6	1445.4	1373.8	948.9	1148.4	1123.5	1267.5	1450.9	788.8	630.5	671.1
1978	1056.6	1048.5	1900.0	1732.2	1574.5	2418.5	3295.4	4160.8	4165.4	2467.9	1185.9	1368.4
1979	1184.5	1285.9	1526.7	1516.0	1554.7	2354.2	2388.3	3498.5	2623.0	1327.8	841.8	852.4
1980	1021.3	1159.2	1095.5	1404.7	1355.5	1587.4	2386.2	4641.0	4506.3	1936.5	1004.8	1179.4
1981	1160.7	1353.7	1649.9	1586.4	1751.2	1629.6	1956.7	3606.6	4482.9	1435.7	904.7	988.0
1982	1216.3	1297.8	1748.1	1741.5	2722.2	4042.2	4384.3	6014.6	6586.2	3926.7	1410.7	1476.5
1983	1821.6	1837.9	2318.9	2670.2	2650.0	4743.3	3813.1	5979.9	6344.2	3142.3	1627.1	1430.3
1984	1664.4	2195.5	2307.2	2966.3	2401.4	3705.6	5159.5	7299.9	7983.6	3366.4	1610.0	1607.0
1985	1939.3	2199.1	2036.9	2014.4	1714.7	2218.7	3765.7	3538.6	2910.8	1184.3	959.6	1352.0
STATISTICS												
N	22	22	22	22	22	22	22	22	22	22	22	22
AVERAGE	1403.8	1472.3	1706.9	1939.8	1973.1	2442.1	2996.3	4276.3	4671.2	2029.2	1144.7	1199.6
MAXIMUM	1939.3	2199.1	2559.5	2966.3	4027.7	5558.4	5277.9	7299.9	7983.6	3926.7	1627.1	1607.0
MINIMUM	1021.3	1048.5	1095.5	1373.8	948.9	1148.4	1123.5	1267.5	1450.9	788.8	630.5	671.1

Notes:

1. Data source U.S. Army Corps of Engineers, Walla Walla District, Hydrology Branch.
2. Period of record: 1959 to 1985.

TABLE 8-2
DISCHARGE RATING TABLE – CLEARWATER RIVER AT SPALDING, IDAHO
(USGS STATION NO. 13342500)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
2.00	1520	1530	1540	1550	1560	1570	1580	1590	1600	1610
2.10	1620	1631	1642	1653	1664	1675	1686	1697	1708	1719
2.20	1730	1742	1754	1766	1778	1790	1802	1814	1826	1838
2.30	1850	1863	1876	1889	1902	1915	1928	1941	1954	1967
2.40	1980	1994	2008	2022	2036	2050	2064	2078	2092	2106
2.50	2120	2135	2150	2165	2180	2195	2210	2225	2240	2255
2.60	2270	2286	2302	2318	2334	2350	2366	2382	2398	2414
2.70	2430	2447	2464	2481	2498	2515	2532	2549	2566	2583
2.80	2600	2618	2636	2654	2672	2690	2708	2726	2744	2762
2.90	2780	2799	2818	2837	2856	2875	2894	2913	2932	2951
3.00	2970	2989	3008	3027	3046	3065	3084	3103	3122	3141
3.10	3160	3179	3198	3217	3236	3255	3274	3293	3312	3331
3.20	3350	3370	3390	3410	3430	3450	3470	3490	3510	3530
3.30	3550	3571	3592	3613	3634	3655	3676	3697	3718	3739
3.40	3760	3782	3804	3826	3848	3870	3892	3914	3936	3958
3.50	3980	4003	4026	4049	4072	4095	4118	4141	4164	4187
3.60	4210	4234	4258	4282	4306	4330	4354	4378	4402	4426
3.70	4450	4475	4500	4525	4550	4575	4600	4625	4650	4675
3.80	4700	4726	4752	4778	4804	4830	4856	4882	4908	4934
3.90	4960	4986	5012	5038	5064	5090	5116	5142	5168	5194
4.00	5220	5247	5274	5301	5328	5355	5382	5409	5436	5463
4.10	5490	5519	5548	5577	5606	5635	5664	5693	5722	5751
4.20	5780	5809	5838	5867	5896	5925	5954	5983	6012	6041
4.30	6070	6100	6130	6160	6190	6220	6250	6280	6310	6340
4.40	6370	6401	6432	6463	6494	6525	6556	6587	6618	6649
4.50	6680	6712	6744	6776	6808	6840	6872	6904	6936	6968
4.60	7000	7035	7070	7105	7140	7175	7210	7245	7280	7315
4.70	7350	7385	7420	7455	7490	7525	7560	7595	7630	7665
4.80	7700	7735	7770	7805	7840	7875	7910	7945	7980	8015
4.90	8050	8085	8120	8155	8190	8225	8260	8295	8330	8365
5.00	8400	8435	8470	8505	8540	8575	8610	8645	8680	8715
5.10	8750	8785	8820	8855	8890	8925	8960	8995	9030	9065
5.20	9100	9135	9170	9205	9240	9275	9310	9345	9380	9415
5.30	9450	9485	9520	9555	9590	9625	9660	9695	9730	9765
5.40	9800	9840	9880	9920	9960	10000	10040	10080	10120	10160
5.50	10200	10240	10280	10320	10360	10400	10440	10480	10520	10560
5.60	10600	10640	10680	10720	10760	10800	10840	10880	10920	10960
5.70	11000	11040	11080	11120	11160	11200	11240	11280	11320	11360
5.80	11400	11440	11480	11520	11560	11600	11640	11680	11720	11760
5.90	11800	11840	11880	11920	11960	12000	12040	12080	12120	12160

TABLE 8-2 (CONTINUED)
DISCHARGE RATING TABLE – CLEARWATER RIVER AT SPALDING, IDAHO
(USGS STATION NO. 13342500)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
6.00	12200	12240	12280	12320	12360	12400	12440	12480	12520	12560
6.10	12600	12640	12680	12720	12760	12800	12840	12880	12920	12960
6.20	13000	13040	13080	13120	13160	13200	13240	13280	13320	13360
6.30	13400	13440	13480	13520	13560	13600	13640	13680	13720	13760
6.40	13800	13840	13880	13920	13960	14000	14040	14080	14120	14160
6.50	14200	14240	14280	14320	14360	14400	14440	14480	14520	14560
6.60	14600	14640	14680	14720	14760	14800	14840	14880	14920	14960
6.70	15000	15050	15100	15150	15200	15250	15300	15350	15400	15450
6.80	15500	15550	15600	15650	15700	15750	15800	15850	15900	15950
6.90	16000	16050	16100	16150	16200	16250	16300	16350	16400	16450
7.00	16500	16550	16600	16650	16700	16750	16800	16850	16900	16950
7.10	17000	17050	17100	17150	17200	17250	17300	17350	17400	17450
7.20	17500	17550	17600	17650	17700	17750	17800	17850	17900	17950
7.30	18000	18050	18100	18150	18200	18250	18300	18350	18400	18450
7.40	18500	18550	18600	18650	18700	18750	18800	18850	18900	18950
7.50	19000	19050	19100	19150	19200	19250	19300	19350	19400	19450
7.60	19500	19550	19600	19650	19700	19750	19800	19850	19900	19950
7.70	20000	20050	20100	20150	20200	20250	20300	20350	20400	20450
7.80	20500	20550	20600	20650	20700	20750	20800	20850	20900	20950
7.90	21000	21050	21100	21150	21200	21250	21300	21350	21400	21450
8.00	21500	21550	21600	21650	21700	21750	21800	21850	21900	21950
8.10	22000	22060	22120	22180	22240	22300	22360	22420	22480	22540
8.20	22600	22660	22720	22780	22840	22900	22960	23020	23080	23140
8.30	23200	23260	23320	23380	23440	23500	23560	23620	23680	23740
8.40	23800	23860	23920	23980	24040	24100	24160	24220	24280	24340
8.50	24400	24460	24520	24580	24640	24700	24760	24820	24880	24940
8.60	25000	25060	25120	25180	25240	25300	25360	25420	25480	25540
8.70	25600	25660	25720	25780	25840	25900	25960	26020	26080	26140
8.80	26200	26260	26320	26380	26440	26500	26560	26620	26680	26740
8.90	26800	26860	26920	26980	27040	27100	27160	27220	27280	27340
9.00	27400	27470	27540	27610	27680	27750	27820	27890	27960	28030
9.10	28100	28170	28240	28310	28380	28450	28520	28590	28660	28730
9.20	28800	28870	28940	29010	29080	29150	29220	29290	29360	29430
9.30	29500	29570	29640	29710	29780	29850	29920	29990	30060	30130
9.40	30200	30270	30340	30410	30480	30550	30620	30690	30760	30830
9.50	30900	30970	31040	31110	31180	31250	31320	31390	31460	31530
9.60	31600	31670	31740	31810	31880	31950	32020	32090	32160	32230
9.70	32300	32370	32440	32510	32580	32650	32720	32790	32860	32930
9.80	33000	33070	33140	33210	33280	33350	33420	33490	33560	33630
9.90	33700	33770	33840	33910	33980	34050	34120	34190	34260	34330

TABLE 8-2 (CONTINUED)
DISCHARGE RATING TABLE – CLEARWATER RIVER AT SPALDING, IDAHO
(USGS STATION NO. 13342500)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
10.00	34400	34470	34540	34610	34680	34750	34820	34890	34960	35030
10.10	35100	35170	35240	35310	35380	35450	35520	35590	35660	35730
10.20	35800	35870	35940	36010	36080	36150	36220	36290	36360	36430
10.30	36500	36570	36640	36710	36780	36850	36920	36990	37060	37130
10.40	37200	37270	37340	37410	37480	37550	37620	37690	37760	37830
10.50	37900	37970	38040	38110	38180	38250	38320	38390	38460	38530
10.60	38600	38680	38760	38840	38920	39000	39080	39160	39240	39320
10.70	39400	39480	39560	39640	39720	39800	39880	39960	40040	40120
10.80	40200	40280	40360	40440	40520	40600	40680	40760	40840	40920
10.90	41000	41080	41160	41240	41320	41400	41480	41560	41640	41720
11.00	41800	41880	41960	42040	42120	42200	42280	42360	42440	42520
11.10	42600	42680	42760	42840	42920	43000	43080	43160	43240	43320
11.20	43400	43480	43560	43640	43720	43800	43880	43960	44040	44120
11.30	44200	44280	44360	44440	44520	44600	44680	44760	44840	44920
11.40	45000	45080	45160	45240	45320	45400	45480	45560	45640	45720
11.50	45800	45880	45960	46040	46120	46200	46280	46360	46440	46520
11.60	46600	46680	46760	46840	46920	47000	47080	47160	47240	47320
11.70	47400	47480	47560	47640	47720	47800	47880	47960	48040	48120
11.80	48200	48290	48380	48470	48560	48650	48740	48830	48920	49010
11.90	49100	49190	49280	49370	49460	49550	49640	49730	49820	49910
12.00	50000	50090	50180	50270	50360	50450	50540	50630	50720	50810
12.10	50900	50990	51080	51170	51260	51350	51440	51530	51620	51710
12.20	51800	51890	51980	52070	52160	52250	52340	52430	52520	52610
12.30	52700	52790	52880	52970	53060	53150	53240	53330	53420	53510
12.40	53600	53690	53780	53870	53960	54050	54140	54230	54320	54410
12.50	54500	54590	54680	54770	54860	54950	55040	55130	55220	55310
12.60	55400	55490	55580	55670	55760	55850	55940	56030	56120	56210
12.70	56300	56390	56480	56570	56660	56750	56840	56930	57020	57110
12.80	57200	57290	57380	57470	57560	57650	57740	57830	57920	58010
12.90	58100	58190	58280	58370	58460	58550	58640	58730	58820	58910
13.00	59000	59100	59200	59300	59400	59500	59600	59700	59800	59900
13.10	60000	60100	60200	60300	60400	60500	60600	60700	60800	60900
13.20	61000	61100	61200	61300	61400	61500	61600	61700	61800	61900
13.30	62000	62100	62200	62300	62400	62500	62600	62700	62800	62900
13.40	63000	63100	63200	63300	63400	63500	63600	63700	63800	63900
13.50	64000	64100	64200	64300	64400	64500	64600	64700	64800	64900
13.60	65000	65100	65200	65300	65400	65500	65600	65700	65800	65900
13.70	66000	66100	66200	66300	66400	66500	66600	66700	66800	66900
13.80	67000	67100	67200	67300	67400	67500	67600	67700	67800	67900
13.90	68000	68100	68200	68300	68400	68500	68600	68700	68800	68900

TABLE 8-2 (CONTINUED)
DISCHARGE RATING TABLE – CLEARWATER RIVER AT SPALDING, IDAHO
(USGS STATION NO. 13342500)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
14.00	69000	69100	69200	69300	69400	69500	69600	69700	69800	69900
14.10	70000	70100	70200	70300	70400	70500	70600	70700	70800	70900
14.20	71000	71100	71200	71300	71400	71500	71600	71700	71800	71900
14.30	72000	72100	72200	72300	72400	72500	72600	72700	72800	72900
14.40	73000	73100	73200	73300	73400	73500	73600	73700	73800	73900
14.50	74000	74100	74200	74300	74400	74500	74600	74700	74800	74900
14.60	75000	75100	75200	75300	75400	75500	75600	75700	75800	75900
14.70	76000	76100	76200	76300	76400	76500	76600	76700	76800	76900
14.80	77000	77100	77200	77300	77400	77500	77600	77700	77800	77900
14.90	78000	78100	78200	78300	78400	78500	78600	78700	78800	78900
15.00	79000	79110	79220	79330	79440	79550	79660	79770	79880	79990
15.10	80100	80210	80320	80430	80540	80650	80760	80870	80980	81090
15.20	81200	81310	81420	81530	81640	81750	81860	81970	82080	82190
15.30	82300	82410	82520	82630	82740	82850	82960	83070	83180	83290
15.40	83400	83510	83620	83730	83840	83950	84060	84170	84280	84390
15.50	84500	84610	84720	84830	84940	85050	85160	85270	85380	85490
15.60	85600	85710	85820	85930	86040	86150	86260	86370	86480	86590
15.70	86700	86810	86920	87030	87140	87250	87360	87470	87580	87690
15.80	87800	87910	88020	88130	88240	88350	88460	88570	88680	88790
15.90	88900	89010	89120	89230	89340	89450	89560	89670	89780	89890
16.00	90000	90120	90240	90360	90480	90600	90720	90840	90960	91080
16.10	91200	91320	91440	91560	91680	91800	91920	92040	92160	92280
16.20	92400	92520	92640	92760	92880	93000	93120	93240	93360	93480
16.30	93600	93720	93840	93960	94080	94200	94320	94440	94560	94680
16.40	94800	94920	95040	95160	95280	95400	95520	95640	95760	95880
16.50	96000	96120	96240	96360	96480	96600	96720	96840	96960	97080
16.60	97200	97320	97440	97560	97680	97800	97920	98040	98160	98280
16.70	98400	98520	98640	98760	98880	99000	99120	99240	99360	99480
16.80	99600	99720	99840	99960	100080	100200	100320	100440	100560	100680
16.90	10080	100920	101040	101160	101280	101400	101520	101640	101760	101880
17.00	10200	102130	102260	102390	102520	102650	102780	102910	103040	103170
17.10	10330	103430	103560	103690	103820	103950	104080	104210	104340	104470
17.20	10460	104730	104860	104990	105120	105250	105380	105510	105640	105770
17.30	10590	106030	106160	106290	106420	106550	106680	106810	106940	107070
17.40	10720	107330	107460	107590	107720	107850	107980	108110	108240	108370
17.50	10850	108630	108760	108890	109020	109150	109280	109410	109540	109670
17.60	10980	109930	110060	110190	110320	110450	110580	110710	110840	110970
17.70	11110	111230	111360	111490	111620	111750	111880	112010	112140	112270
17.80	11240	112530	112660	112790	112920	113050	113180	113310	113440	113570
17.90	11370	113830	113960	114090	114220	114350	114480	114610	114740	114870

TABLE 8-2 (CONTINUED)
DISCHARGE RATING TABLE – CLEARWATER RIVER AT SPALDING, IDAHO
(USGS STATION NO. 13342500)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
18.00	115000	115130	115260	115390	115520	115650	115780	115910	116040	116170
18.10	116300	116430	116560	116690	116820	116950	117080	117210	117340	117470
18.20	117600	117730	117860	117990	118120	118250	118380	118510	118640	118770
18.30	118900	119030	119160	119290	119420	119550	119680	119810	119940	120070
18.40	120200	120330	120460	120590	120720	120850	120980	121110	121240	121370
18.50	121500	121630	121760	121890	122020	122150	122280	122410	122540	122670
18.60	122800	122930	123060	123190	123320	123450	123580	123710	123840	123970
18.70	124100	124230	124360	124490	124620	124750	124880	125010	125140	125270
18.80	125400	125530	125660	125790	125920	126050	126180	126310	126440	126570
18.90	126700	126830	126960	127090	127220	127350	127480	127610	127740	127870
19.00	128000	128140	128280	128420	128560	128700	128840	128980	129120	129260
19.10	129400	129540	129680	129820	129960	130100	130240	130380	130520	130660
19.20	130800	130940	131080	131220	131360	131500	131640	131780	131920	132060
19.30	132200	132340	132480	132620	132760	132900	133040	133180	133320	133460
19.40	133600	133740	133880	134020	134160	134300	134440	134580	134720	134860
19.50	135000	135140	135280	135420	135560	135700	135840	135980	136120	136260
19.60	136400	136540	136680	136820	136960	137100	137240	137380	137520	137660
19.70	137800	137940	138080	138220	138360	138500	138640	138780	138920	139060
19.80	139200	139340	139480	139620	139760	139900	140040	140180	140320	140460
19.90	140600	140740	140880	141020	141160	141300	141440	141580	141720	141860
20.00	142000	142150	142300	142450	142600	142750	142900	143050	143200	143350
20.10	143500	143650	143800	143950	144100	144250	144400	144550	144700	144850
20.20	145000	145150	145300	145450	145600	145750	145900	146050	146200	146350
20.30	146500	146650	146800	146950	147100	147250	147400	147550	147700	147850
20.40	148000	148150	148300	148450	148600	148750	148900	149050	149200	149350
20.50	149500	149650	149800	149950	150100	150250	150400	150550	150700	150850
20.60	151000	151150	151300	151450	151600	151750	151900	152050	152200	152350
20.70	152500	152650	152800	152950	153100	153250	153400	153550	153700	153850
20.80	154000	154150	154300	154450	154600	154750	154900	155050	155200	155350
20.90	155500	155650	155800	155950	156100	156250	156400	156550	156700	156850
21.00	157000	157160	157320	157480	157640	157800	157960	158120	158280	158440
21.10	158600	158760	158920	159080	159240	159400	159560	159720	159880	160040
21.20	160200	160360	160520	160680	160840	161000	161160	161320	161480	161640
21.30	161800	161960	162120	162280	162440	162600	162760	162920	163080	163240
21.40	163400	163560	163720	163880	164040	164200	164360	164520	164680	164840
21.50	165000	165160	165320	165480	165640	165800	165960	166120	166280	166440
21.60	166600	166760	166920	167080	167240	167400	167560	167720	167880	168040
21.70	168200	168360	168520	168680	168840	169000	169160	169320	169480	169640
21.80	169800	169960	170120	170280	170440	170600	170760	170920	171080	171240
21.90	171400	171560	171720	171880	172040	172200	172360	172520	172680	172840
22.00	173000.									

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TABLE 8-3
DISCHARGE RATING TABLE – SNAKE RIVER NEAR ANATONE, WASHINGTON
(USGS STATION NO. 13334300)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
1.50										
1.60	6450	6480	6510	6540	6570	6600	6630	6660	6690	6720
1.70	6750	6780	6810	6840	6870	6900	6930	6960	6990	7020
1.80	7050	7080	7110	7140	7170	7200	7230	7260	7290	7320
1.90	7350	7380	7410	7440	7470	7500	7530	7560	7590	7620
2.00	7650	7680	7710	7740	7770	7800	7830	7860	7890	7920
2.10	7950	7980	8010	8040	8070	8100	8130	8160	8190	8220
2.20	8250	8285	8320	8355	8390	8425	8460	8495	8530	8565
2.30	8600	8635	8670	8705	8740	8775	8810	8845	8880	8915
2.40	8950	8985	9020	9055	9090	9125	9160	9195	9230	9265
2.50	9300	9335	9370	9405	9440	9475	9510	9545	9580	9615
2.60	9650	9685	9720	9755	9790	9825	9860	9895	9930	9965
2.70	10000	10035	10070	10105	10140	10175	10210	10245	10280	10315
2.80	10350	10385	10420	10455	10490	10525	10560	10595	10630	10665
2.90	10700	10735	10770	10805	10840	10875	10910	10945	10980	11015
3.00	11050	11090	11130	11170	11210	11250	11290	11330	11370	11410
3.10	11450	11490	11530	11570	11610	11650	11690	11730	11770	11810
3.20	11850	11890	11930	11970	12010	12050	12090	12130	12170	12210
3.30	12250	12290	12330	12370	12410	12450	12490	12530	12570	12610
3.40	12650	12690	12730	12770	12810	12850	12890	12930	12970	13010
3.50	13050	13095	13140	13185	13230	13275	13320	13365	13410	13455
3.60	13500	13545	13590	13635	13680	13725	13770	13815	13860	13905
3.70	13950	13995	14040	14085	14130	14175	14220	14265	14310	14355
3.80	14400	14445	14490	14535	14580	14625	14670	14715	14760	14805
3.90	14850	14895	14940	14985	15030	15075	15120	15165	15210	15255
4.00	15300	15345	15390	15435	15480	15525	15570	15615	15660	15705
4.10	15750	15795	15840	15885	15930	15975	16020	16065	16110	16155
4.20	16200	16245	16290	16335	16380	16425	16470	16515	16560	16605
4.30	16650	16695	16740	16785	16830	16875	16920	16965	17010	17055
4.40	17100	17150	17200	17250	17300	17350	17400	17450	17500	17550
4.50	17600	17645	17690	17735	17780	17825	17870	17915	17960	18005
4.60	18050	18095	18140	18185	18230	18275	18320	18365	18410	18455
4.70	18500	18550	18600	18650	18700	18750	18800	18850	18900	18950
4.80	19000	19050	19100	19150	19200	19250	19300	19350	19400	19450
4.90	19500	19550	19600	19650	19700	19750	19800	19850	19900	19950
5.00	20000	20050	20100	20150	20200	20250	20300	20350	20400	20450
5.10	20500	20550	20600	20650	20700	20750	20800	20850	20900	20950
5.20	21000	21050	21100	21150	21200	21250	21300	21350	21400	21450
5.30	21500	21550	21600	21650	21700	21750	21800	21850	21900	21950
5.40	22000	22050	22100	22150	22200	22250	22300	22350	22400	22450

TABLE 8-3 (CONTINUED)
DISCHARGE RATING TABLE – SNAKE RIVER NEAR ANATONE, WASHINGTON
(USGS STATION NO. 13334300)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5.50	22500	22550	22600	22650	22700	22750	22800	22850	22900	22950
5.60	23000	23060	23120	23180	23240	23300	23360	23420	23480	23540
5.70	23600	23660	23720	23780	23840	23900	23960	24020	24080	24140
5.80	24200	24260	24320	24380	24440	24500	24560	24620	24680	24740
5.90	24800	24860	24920	24980	25040	25100	25160	25220	25280	25340
6.00	25400	25460	25520	25580	25640	25700	25760	25820	25880	25940
6.10	26000	26060	26120	26180	26240	26300	26360	26420	26480	26540
6.20	26600	26660	26720	26780	26840	26900	26960	27020	27080	27140
6.30	27200	27260	27320	27380	27440	27500	27560	27620	27680	27740
6.40	27800	27860	27920	27980	28040	28100	28160	28220	28280	28340
6.50	28400	28460	28520	28580	28640	28700	28760	28820	28880	28940
6.60	29000	29060	29120	29180	29240	29300	29360	29420	29480	29540
6.70	29600	29660	29720	29780	29840	29900	29960	30020	30080	30140
6.80	30200	30260	30320	30380	30440	30500	30560	30620	30680	30740
6.90	30800	30870	30940	31010	31080	31150	31220	31290	31360	31430
7.00	31500	31570	31640	31710	31780	31850	31920	31990	32060	32130
7.10	32200	32270	32340	32410	32480	32550	32620	32690	32760	32830
7.20	32900	32970	33040	33110	33180	33250	33320	33390	33460	33530
7.30	33600	33670	33740	33810	33880	33950	34020	34090	34160	34230
7.40	34300	34370	34440	34510	34580	34650	34720	34790	34860	34930
7.50	35000	35070	35140	35210	35280	35350	35420	35490	35560	35630
7.60	35700	35770	35840	35910	35980	36050	36120	36190	36260	36330
7.70	36400	36470	36540	36610	36680	36750	36820	36890	36960	37030
7.80	37100	37170	37240	37310	37380	37450	37520	37590	37660	37730
7.90	37800	37870	37940	38010	38080	38150	38220	38290	38360	38430
8.00	38500	38570	38640	38710	38780	38850	38920	38990	39060	39130
8.10	39200	39270	39340	39410	39480	39550	39620	39690	39760	39830
8.20	39900	39970	40040	40110	40180	40250	40320	40390	40460	40530
8.30	40600	40670	40740	40810	40880	40950	41020	41090	41160	41230
8.40	41300	41370	41440	41510	41580	41650	41720	41790	41860	41930
8.50	42000	42080	42160	42240	42320	42400	42480	42560	42640	42720
8.60	42800	42880	42960	43040	43120	43200	43280	43360	43440	43520
8.70	43600	43680	43760	43840	43920	44000	44080	44160	44240	44320
8.80	44400	44480	44560	44640	44720	44800	44880	44960	45040	45120
8.90	45200	45280	45360	45440	45520	45600	45680	45760	45840	45920
9.00	46000	46080	46160	46240	46320	46400	46480	46560	46640	46720
9.10	46800	46880	46960	47040	47120	47200	47280	47360	47440	47520
9.20	47600	47680	47760	47840	47920	48000	48080	48160	48240	48320
9.30	48400	48480	48560	48640	48720	48800	48880	48960	49040	49120
9.40	49200	49280	49360	49440	49520	49600	49680	49760	49840	49920

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TABLE 8-3 (CONTINUED)
DISCHARGE RATING TABLE – SNAKE RIVER NEAR ANATONE, WASHINGTON
(USGS STATION NO. 13334300)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
9.50	50000	50080	50160	50240	50320	50400	50480	50560	50640	50720
9.60	50800	50880	50960	51040	51120	51200	51280	51360	51440	51520
9.70	51600	51680	51760	51840	51920	52000	52080	52160	52240	52320
9.80	52400	52480	52560	52640	52720	52800	52880	52960	53040	53120
9.90	53200	53280	53360	53440	53520	53600	53680	53760	53840	53920
10.00	54000	54080	54160	54240	54320	54400	54480	54560	54640	54720
10.10	54800	54880	54960	55040	55120	55200	55280	55360	55440	55520
10.20	55600	55680	55760	55840	55920	56000	56080	56160	56240	56320
10.30	56400	56480	56560	56640	56720	56800	56880	56960	57040	57120
10.40	57200	57280	57360	57440	57520	57600	57680	57760	57840	57920
10.50	58000	58080	58160	58240	58320	58400	58480	58560	58640	58720
10.60	58800	58880	58960	59040	59120	59200	59280	59360	59440	59520
10.70	59600	59680	59760	59840	59920	60000	60080	60160	60240	60320
10.80	60400	60480	60560	60640	60720	60800	60880	60960	61040	61120
10.90	61200	61280	61360	61440	61520	61600	61680	61760	61840	61920
11.00	62000	62090	62180	62270	62360	62450	62540	62630	62720	62810
11.10	62900	62990	63080	63170	63260	63350	63440	63530	63620	63710
11.20	63800	63890	63980	64070	64160	64250	64340	64430	64520	64610
11.30	64700	64790	64880	64970	65060	65150	65240	65330	65420	65510
11.40	65600	65690	65780	65870	65960	66050	66140	66230	66320	66410
11.50	66500	66590	66680	66770	66860	66950	67040	67130	67220	67310
11.60	67400	67490	67580	67670	67760	67850	67940	68030	68120	68210
11.70	68300	68390	68480	68570	68660	68750	68840	68930	69020	69110
11.80	69200	69290	69380	69470	69560	69650	69740	69830	69920	70010
11.90	70100	70190	70280	70370	70460	70550	70640	70730	70820	70910
12.00	71000	71090	71180	71270	71360	71450	71540	71630	71720	71810
12.10	71900	71990	72080	72170	72260	72350	72440	72530	72620	72710
12.20	72800	72890	72980	73070	73160	73250	73340	73430	73520	73610
12.30	73700	73790	73880	73970	74060	74150	74240	74330	74420	74510
12.40	74600	74690	74780	74870	74960	75050	75140	75230	75320	75410
12.50	75500	75590	75680	75770	75860	75950	76040	76130	76220	76310
12.60	76400	76490	76580	76670	76760	76850	76940	77030	77120	77210
12.70	77300	77390	77480	77570	77660	77750	77840	77930	78020	78110
12.80	78200	78290	78380	78470	78560	78650	78740	78830	78920	79010
12.90	79100	79190	79280	79370	79460	79550	79640	79730	79820	79910
13.00	80000	80090	80180	80270	80360	80450	80540	80630	80720	80810
13.10	80900	80990	81080	81170	81260	81350	81440	81530	81620	81710
13.20	81800	81890	81980	82070	82160	82250	82340	82430	82520	82610
13.30	82700	82790	82880	82970	83060	83150	83240	83330	83420	83510
13.40	83600	83690	83780	83870	83960	84050	84140	84230	84320	84410

TABLE 8-3 (CONTINUED)
DISCHARGE RATING TABLE – SNAKE RIVER NEAR ANATONE, WASHINGTON
(USGS STATION NO. 13334300)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
13.50	84500	84590	84680	84770	84860	84950	85040	85130	85220	85310
13.60	85400	85490	85580	85670	85760	85850	85940	86030	86120	86210
13.70	86300	86390	86480	86570	86660	86750	86840	86930	87020	87110
13.80	87200	87290	87380	87470	87560	87650	87740	87830	87920	88010
13.90	88100	88190	88280	88370	88460	88550	88640	88730	88820	88910
14.00	89000	89090	89180	89270	89360	89450	89540	89630	89720	89810
14.10	89900	89990	90080	90170	90260	90350	90440	90530	90620	90710
14.20	90800	90890	90980	91070	91160	91250	91340	91430	91520	91610
14.30	91700	91790	91880	91970	92060	92150	92240	92330	92420	92510
14.40	92600	92690	92780	92870	92960	93050	93140	93230	93320	93410
14.50	93500	93590	93680	93770	93860	93950	94040	94130	94220	94310
14.60	94400	94490	94580	94670	94760	94850	94940	95030	95120	95210
14.70	95300	95390	95480	95570	95660	95750	95840	95930	96020	96110
14.80	96200	96290	96380	96470	96560	96650	96740	96830	96920	97010
14.90	97100	97190	97280	97370	97460	97550	97640	97730	97820	97910
15.00	98000	98090	98180	98270	98360	98450	98540	98630	98720	98810
15.10	98900	98990	99080	99170	99260	99350	99440	99530	99620	99710
15.20	99800	99890	99980	100070	100160	100250	100340	100430	100520	100610
15.30	100700	100790	100880	100970	101060	101150	101240	101330	101420	101510
15.40	101600	101690	101780	101870	101960	102050	102140	102230	102320	102410
15.50	102500	102590	102680	102770	102860	102950	103040	103130	103220	103310
15.60	103400	103490	103580	103670	103760	103850	103940	104030	104120	104210
15.70	104300	104390	104480	104570	104660	104750	104840	104930	105020	105110
15.80	105200	105290	105380	105470	105560	105650	105740	105830	105920	106010
15.90	106100	106190	106280	106370	106460	106550	106640	106730	106820	106910
16.00	107000	107100	107200	107300	107400	107500	107600	107700	107800	107900
16.10	108000	108100	108200	108300	108400	108500	108600	108700	108800	108900
16.20	109000	109100	109200	109300	109400	109500	109600	109700	109800	109900
16.30	110000	110100	110200	110300	110400	110500	110600	110700	110800	110900
16.40	111000	111100	111200	111300	111400	111500	111600	111700	111800	111900
16.50	112000	112100	112200	112300	112400	112500	112600	112700	112800	112900
16.60	113000	113100	113200	113300	113400	113500	113600	113700	113800	113900
16.70	114000	114100	114200	114300	114400	114500	114600	114700	114800	114900
16.80	115000	115100	115200	115300	115400	115500	115600	115700	115800	115900
16.90	116000	116100	116200	116300	116400	116500	116600	116700	116800	116900
17.00	117000	117100	117200	117300	117400	117500	117600	117700	117800	117900
17.10	118000	118100	118200	118300	118400	118500	118600	118700	118800	118900
17.20	119000	119100	119200	119300	119400	119500	119600	119700	119800	119900
17.30	120000	120100	120200	120300	120400	120500	120600	120700	120800	120900
17.40	121000	121100	121200	121300	121400	121500	121600	121700	121800	121900

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TABLE 8-3 (CONTINUED)
DISCHARGE RATING TABLE – SNAKE RIVER NEAR ANATONE, WASHINGTON
(USGS STATION NO. 13334300)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
17.50	122000	122100	122200	122300	122400	122500	122600	122700	122800	122900
17.60	123000	123100	123200	123300	123400	123500	123600	123700	123800	123900
17.70	124000	124100	124200	124300	124400	124500	124600	124700	124800	124900
17.80	125000	125100	125200	125300	125400	125500	125600	125700	125800	125900
17.90	126000	126100	126200	126300	126400	126500	126600	126700	126800	126900
18.00	127000	127100	127200	127300	127400	127500	127600	127700	127800	127900
18.10	128000	128100	128200	128300	128400	128500	128600	128700	128800	128900
18.20	129000	129100	129200	129300	129400	129500	129600	129700	129800	129900
18.30	130000	130100	130200	130300	130400	130500	130600	130700	130800	130900
18.40	131000	131100	131200	131300	131400	131500	131600	131700	131800	131900
18.50	132000	132100	132200	132300	132400	132500	132600	132700	132800	132900
18.60	133000	133100	133200	133300	133400	133500	133600	133700	133800	133900
18.70	134000	134100	134200	134300	134400	134500	134600	134700	134800	134900
18.80	135000	135100	135200	135300	135400	135500	135600	135700	135800	135900
18.90	136000	136100	136200	136300	136400	136500	136600	136700	136800	136900
19.00	137000	137100	137200	137300	137400	137500	137600	137700	137800	137900
19.10	138000	138100	138200	138300	138400	138500	138600	138700	138800	138900
19.20	139000	139100	139200	139300	139400	139500	139600	139700	139800	139900
19.30	140000	140100	140200	140300	140400	140500	140600	140700	140800	140900
19.40	141000	141100	141200	141300	141400	141500	141600	141700	141800	141900
19.50	142000	142100	142200	142300	142400	142500	142600	142700	142800	142900
19.60	143000	143100	143200	143300	143400	143500	143600	143700	143800	143900
19.70	144000	144100	144200	144300	144400	144500	144600	144700	144800	144900
19.80	145000	145100	145200	145300	145400	145500	145600	145700	145800	145900
19.90	146000	146100	146200	146300	146400	146500	146600	146700	146800	146900
20.00	147000	147100	147200	147300	147400	147500	147600	147700	147800	147900
20.10	148000	148100	148200	148300	148400	148500	148600	148700	148800	148900
20.20	149000	149100	149200	149300	149400	149500	149600	149700	149800	149900
20.30	150000	150100	150200	150300	150400	150500	150600	150700	150800	150900
20.40	151000	151100	151200	151300	151400	151500	151600	151700	151800	151900
20.50	152000	152100	152200	152300	152400	152500	152600	152700	152800	152900
20.60	153000	153100	153200	153300	153400	153500	153600	153700	153800	153900
20.70	154000	154100	154200	154300	154400	154500	154600	154700	154800	154900
20.80	155000	155100	155200	155300	155400	155500	155600	155700	155800	155900
20.90	156000	156100	156200	156300	156400	156500	156600	156700	156800	156900
21.00	157000	157110	157220	157330	157440	157550	157660	157770	157880	157990
21.10	158100	158210	158320	158430	158540	158650	158760	158870	158980	159090
21.20	159200	159310	159420	159530	159640	159750	159860	159970	160080	160190
21.30	160300	160410	160520	160630	160740	160850	160960	161070	161180	161290
21.40	161400	161510	161620	161730	161840	161950	162060	162170	162280	162390

TABLE 8-3 (CONTINUED)
DISCHARGE RATING TABLE – SNAKE RIVER AT NEAR ANATONE, WASHINGTON
(USGS STATION NO. 13334300)

	DISCHARGE IN CFS									
GAGE HT FEET	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
21.50	162500	162610	162720	162830	162940	163050	163160	163270	163380	163490
21.60	163600	163710	163820	163930	164040	164150	164260	164370	164480	164590
21.70	164700	164810	164920	165030	165140	165250	165360	165470	165580	165690
21.80	165800	165910	166020	166130	166240	166350	166460	166570	166680	166790
21.90	166900	167010	167120	167230	167340	167450	167560	167670	167780	167890
22.00	168000	168110	168220	168330	168440	168550	168660	168770	168880	168990
22.10	169100	169210	169320	169430	169540	169650	169760	169870	169980	170090
22.20	170200	170310	170420	170530	170640	170750	170860	170970	171080	171190
22.30	171300	171410	171520	171630	171740	171850	171960	172070	172180	172290
22.40	172400	172510	172620	172730	172840	172950	173060	173170	173280	173390
22.50	173500	173610	173720	173830	173940	174050	174160	174270	174380	174490
22.60	174600	174710	174820	174930	175040	175150	175260	175370	175480	175590
22.70	175700	175810	175920	176030	176140	176250	176360	176470	176580	176690
22.80	176800	176910	177020	177130	177240	177350	177460	177570	177680	177790
22.90	177900	178010	178120	178230	178340	178450	178560	178670	178780	178890
23.00	179000	179110	179220	179330	179440	179550	179660	179770	179880	179990
23.10	180100	180210	180320	180430	180540	180650	180760	180870	180980	181090
23.20	181200	181310	181420	181530	181640	181750	181860	181970	182080	182190
23.30	182300	182410	182520	182630	182740	182850	182960	183070	183180	183290
23.40	183400	183510	183620	183730	183840	183950	184060	184170	184280	184390
23.50	184500	184610	184720	184830	184940	185050	185160	185270	185380	185490
23.60	185600	185710	185820	185930	186040	186150	186260	186370	186480	186590
23.70	186700	186810	186920	187030	187140	187250	187360	187470	187580	187690
23.80	187800	187910	188020	188130	188240	188350	188460	188570	188680	188790
23.90	188900	189010	189120	189230	189340	189450	189560	189670	189780	189890
24.00	190000.									

Sheet 6 of 6

PLATES

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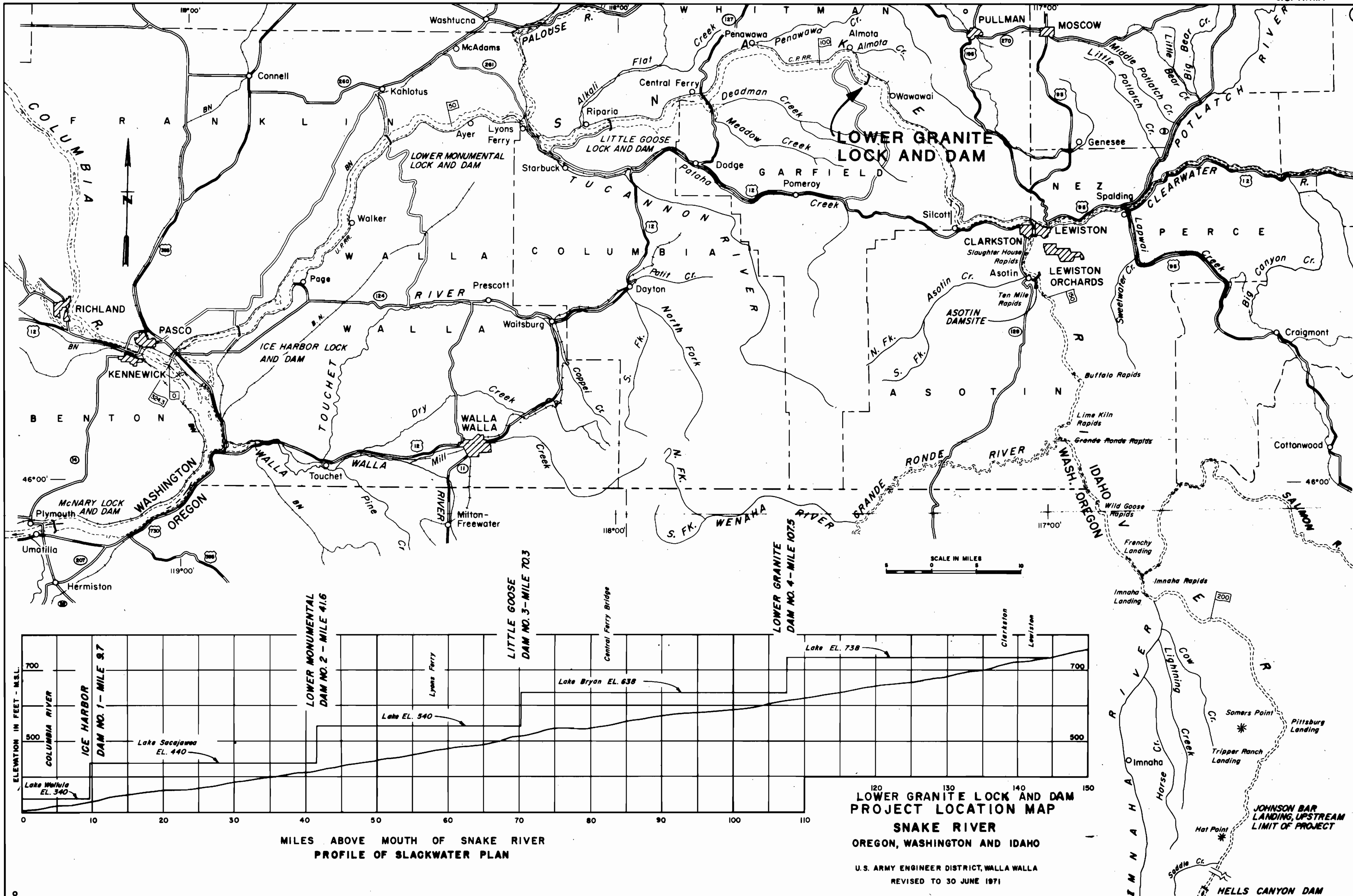
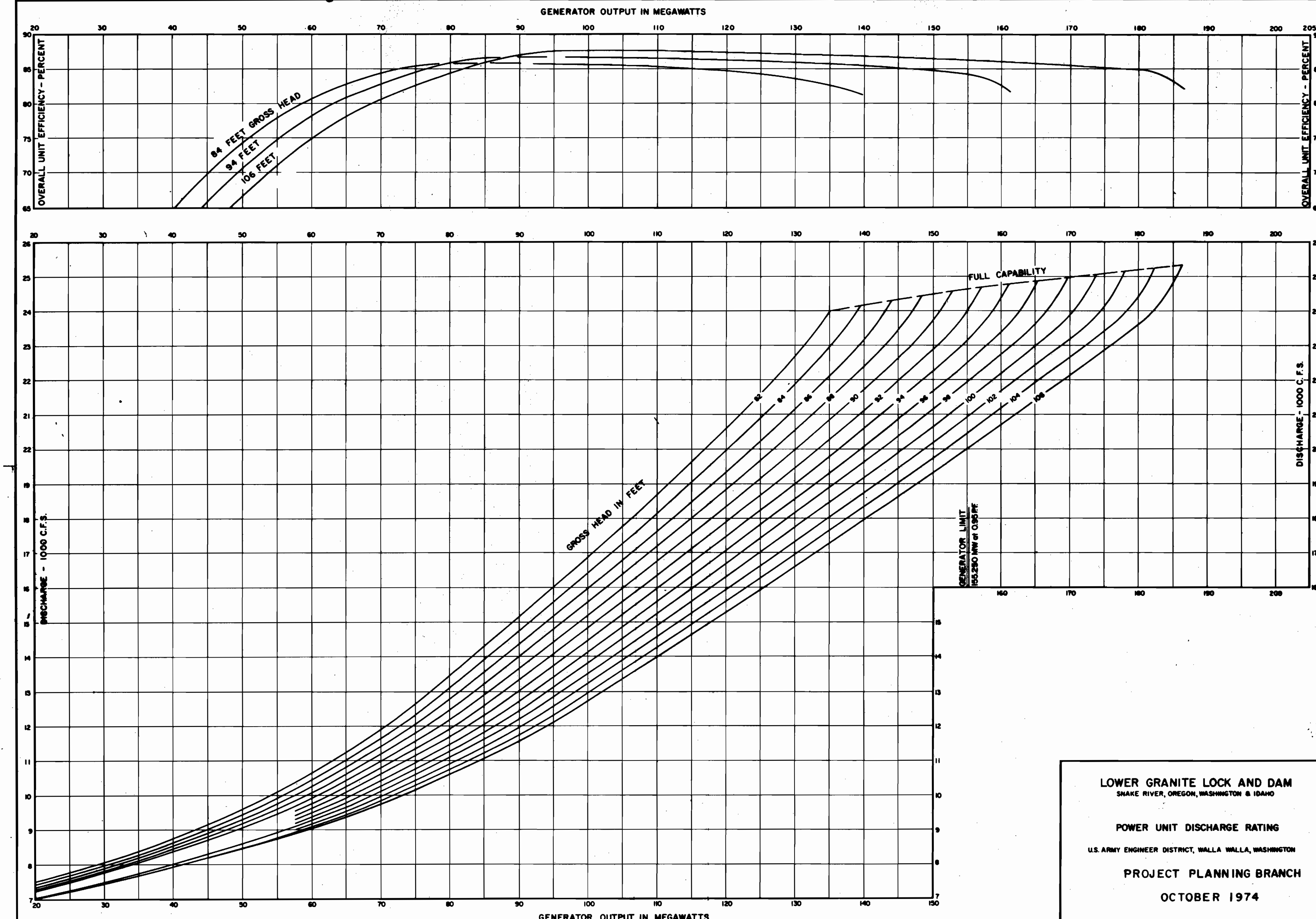


4
LOWER GRANITE LOCK AND DAM
PROJECT LOCATION MAP
SNAKE RIVER
OREGON, WASHINGTON AND IDAHO
U.S. ARMY ENGINEER DISTRICT, WALLA WALLA
REVISED TO 30 JUNE 1971
LOWER GRANITE LOCK AND DAM
LITTLE GOOSE LOCK AND DAM
LOWER MONUMENTAL LOCK AND DAM
ICE HARBOR LOCK AND DAM
McNARY LOCK AND DAM
ASOTIN DAMSITE
HELLS CANYON DAM
JOHNSON BAR LANDING, UPSTREAM LIMIT OF PROJECT
FRANKLIN
WALLA WALLA
COLUMBIA
GARFIELD
WHITMAN
ASOTIN
NEZ PERCE
BENTON
WASHINGTON
OREGON
IDAHO
COLUMBIA R.
SNAKE RIVER
TUCANNON RIVER
CLEARWATER R.
POTLATCH RIVER
SALMON R.
GRANDE RONDE RIVER
IMNAHA RIVER
WALLA WALLA RIVER
TOUCHET RIVER
PALOUSE R.
Washtucna
McAdams
Connell
Kahlotus
Ayer
Lyons Ferry
Starbuck
Riparia
Central Ferry
Penawawa
Almota
Wawawai
Dodge
Pomeroy
Silcott
Clarkston
Lewiston
Lewiston Orchards
Asotin
Pullman
Moscow
Genesee
Spalding
Craigmont
Cottonwood
Walker
Page
Prescott
Waitsburg
Dayton
Walla Walla
Touchet
Milton-Freewater
Richland
Pasco
Kennewick
Plymouth
Umatilla
Hermiston
Imnaha
Slaughter House Rapids
Ten Mile Rapids
Buffalo Rapids
Lime Kiln Rapids
Grande Ronde Rapids
Wild Goose Rapids
Frenchy Landing
Imnaha Rapids
Imnaha Landing
Somers Point
Pittsburg Landing
Tripper Ranch Landing
Hat Point
SCALE IN MILES
46°00'
119°00'
118°00'
117°00'
PROFILE OF SLACKWATER PLAN
MILES ABOVE MOUTH OF SNAKE RIVER
ELEVATION IN FEET - M.S.L.
COLUMBIA RIVER
ICE HARBOR DAM NO. 1 - MILE 9.7
LOWER MONUMENTAL DAM NO. 2 - MILE 41.6
LITTLE GOOSE DAM NO. 3 - MILE 70.3
LOWER GRANITE DAM NO. 4 - MILE 107.5
Lyons Ferry
Central Ferry Bridge
Clarkston
Lewiston
Lake Wallula EL. 340
Lake Sacajawea EL. 440
Lake EL. 540
Lake Bryan EL. 638
Lake EL. 738
500
700
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150



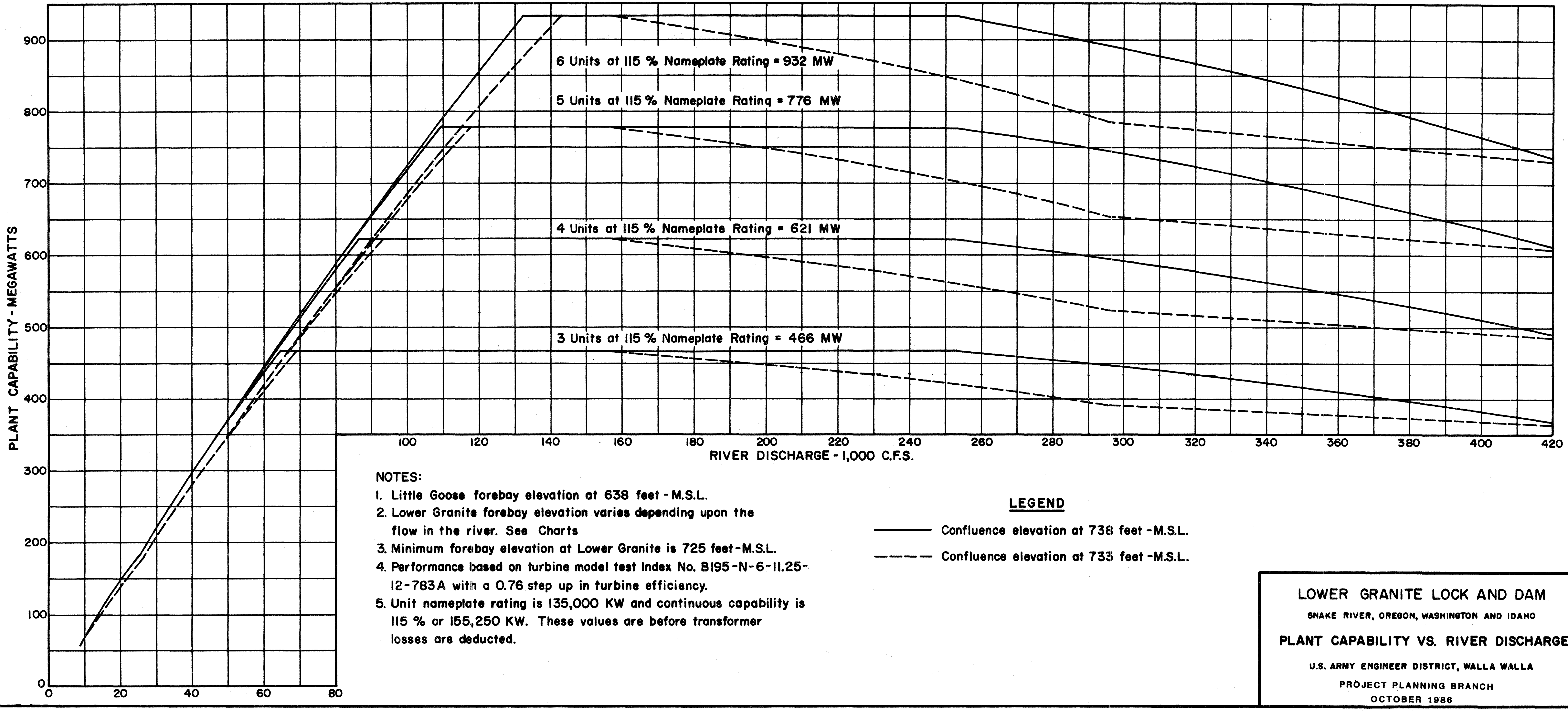
LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO

POWER UNIT DISCHARGE RATING

U.S. ARMY ENGINEER DISTRICT, WALLA WALLA, WASHINGTON

PROJECT PLANNING BRANCH

OCTOBER 1974



NOTES:

1. Little Goose forebay elevation at 638 feet - M.S.L.
2. Lower Granite forebay elevation varies depending upon the flow in the river. See Charts
3. Minimum forebay elevation at Lower Granite is 725 feet - M.S.L.
4. Performance based on turbine model test Index No. B195-N-6-11.25-12-783A with a 0.76 step up in turbine efficiency.
5. Unit nameplate rating is 135,000 KW and continuous capability is 115 % or 155,250 KW. These values are before transformer losses are deducted.

LEGEND

——— Confluence elevation at 738 feet - M.S.L.

– – – Confluence elevation at 733 feet - M.S.L.

LOWER GRANITE LOCK AND DAM

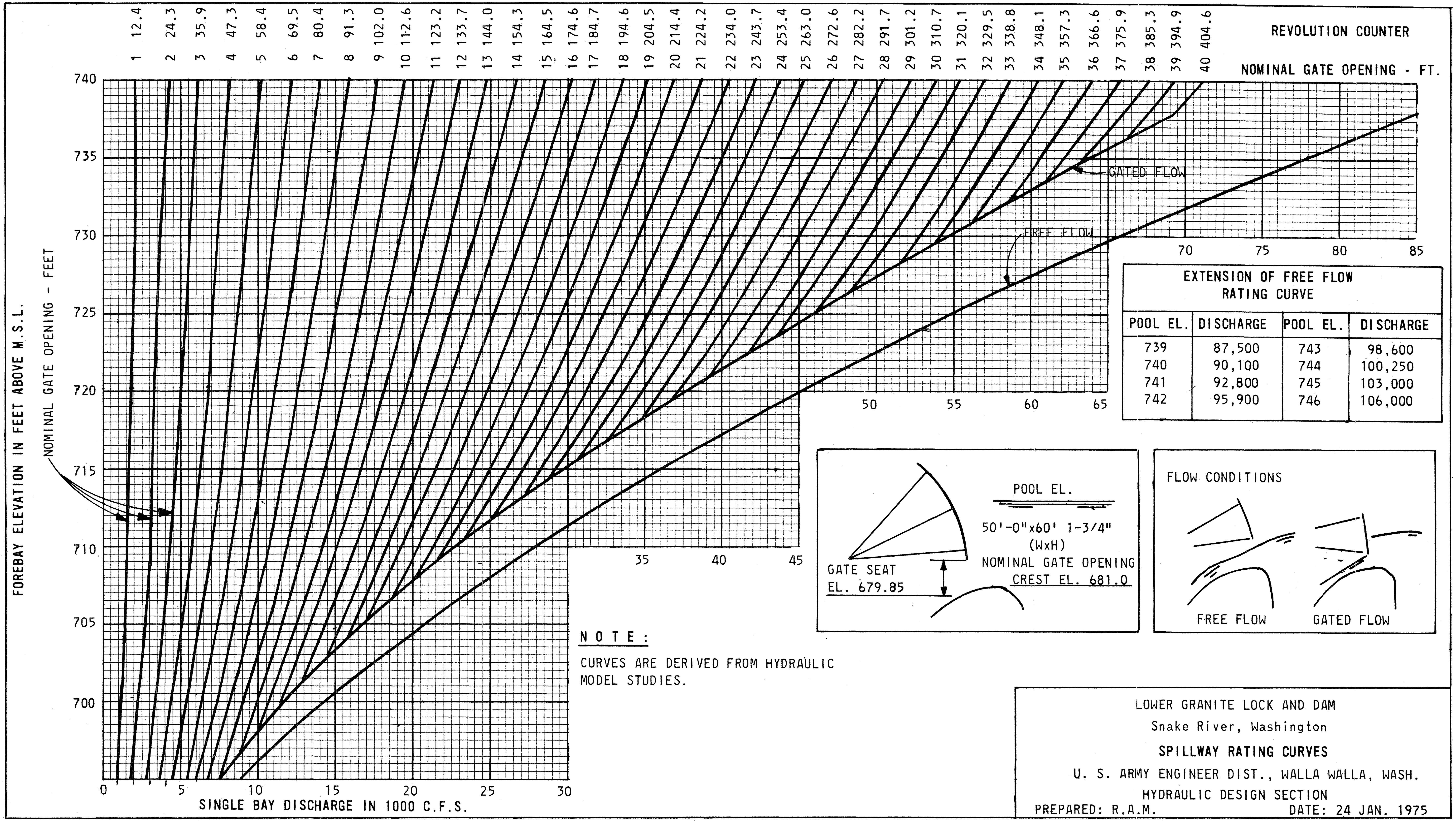
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

PLANT CAPABILITY VS. RIVER DISCHARGE

U.S. ARMY ENGINEER DISTRICT, WALLA WALLA

PROJECT PLANNING BRANCH

OCTOBER 1986



EXTENSION OF FREE FLOW RATING CURVE

POOL EL.	DISCHARGE	POOL EL.	DISCHARGE
739	87,500	743	98,600
740	90,100	744	100,250
741	92,800	745	103,000
742	95,900	746	106,000

NOTE:

CURVES ARE DERIVED FROM HYDRAULIC MODEL STUDIES.

LOWER GRANITE LOCK AND DAM

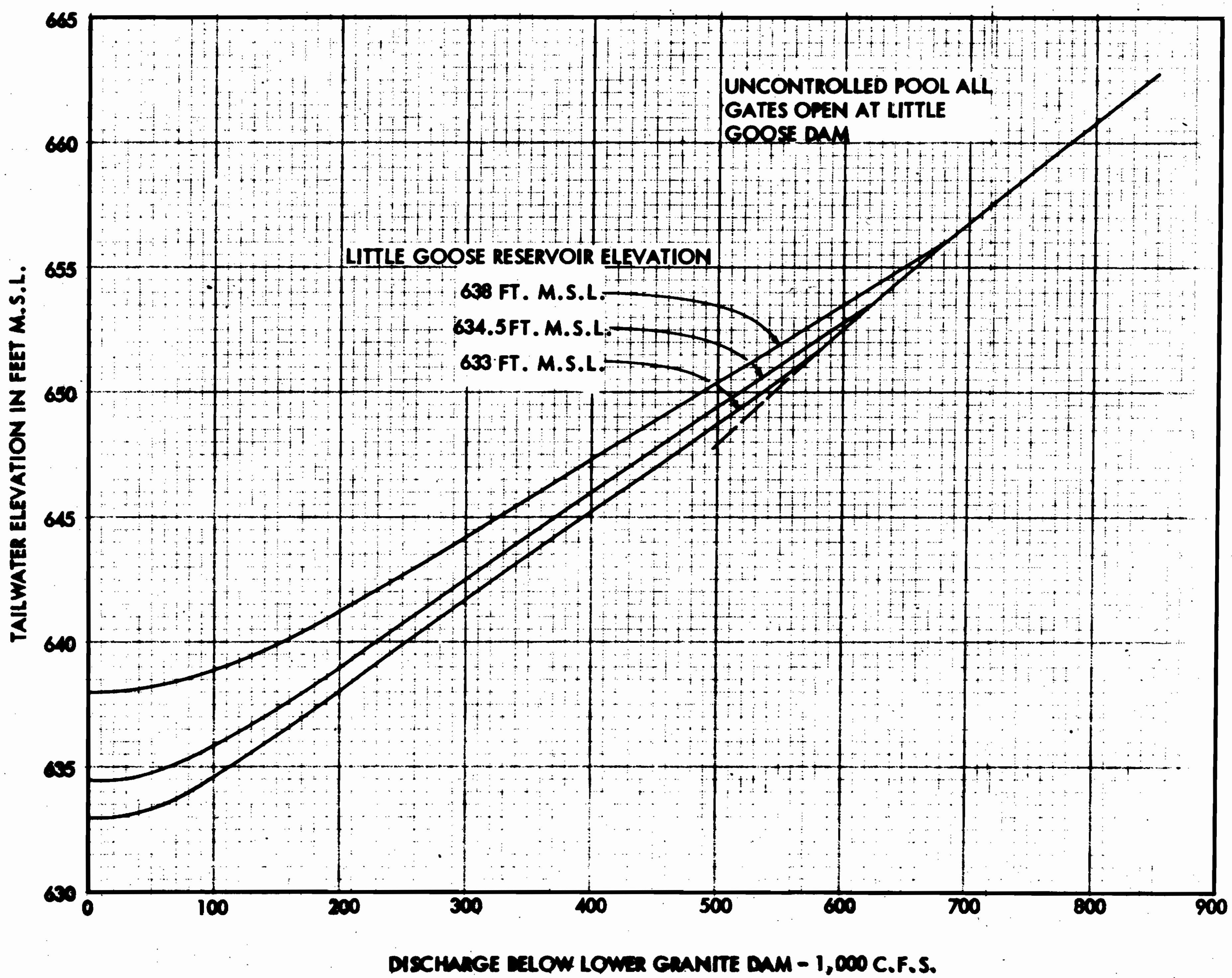
Snake River, Washington

SPILLWAY RATING CURVES

U. S. ARMY ENGINEER DIST., WALLA WALLA, WASH.

HYDRAULIC DESIGN SECTION

PREPARED: R.A.M. DATE: 24 JAN. 1975



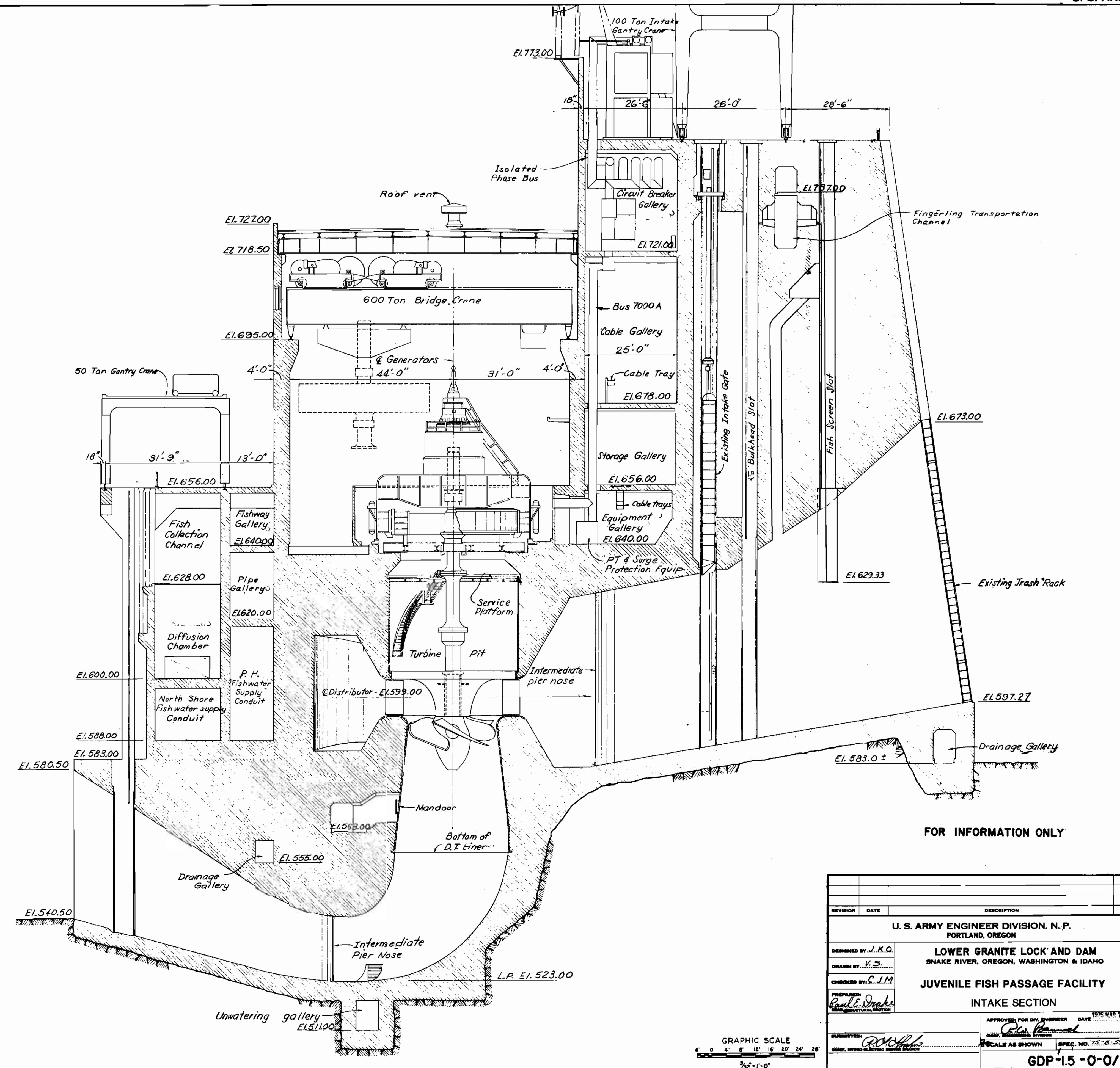
NOTES:

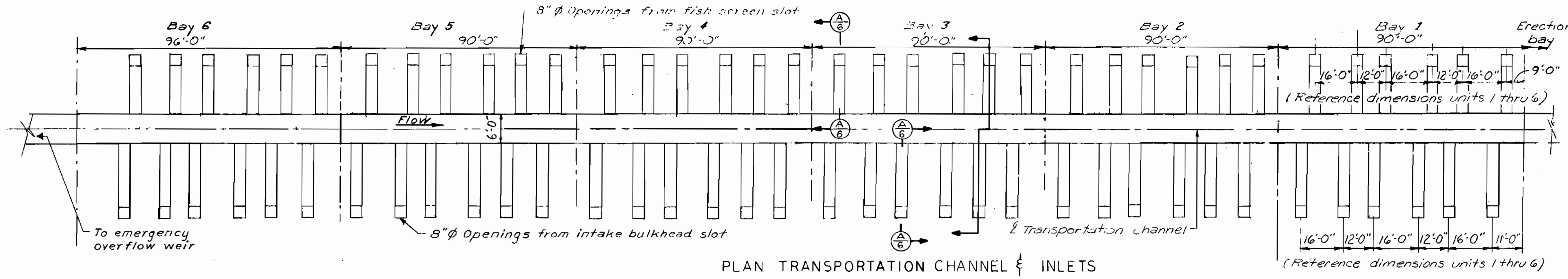
1. LOWER GRANITE TAILWATER CURVES ARE BASED ON BACKWATER PROFILES COMPUTED FROM LITTLE GOOSE AT RIVER MILE 70.3 AND REFLECT CONDITIONS AT RIVER MILE 107.38 (470 FEET BELOW THE AXIS OF LOWER GRANITE DAM).
2. EFFECTS OF VARIOUS COMBINATIONS OF FLOWS THROUGH THE POWERHOUSE AND SPILLWAY ARE NOT SHOWN. REFER TO TECHNICAL REPORT NO. 121-1, LOWER GRANITE DAM, SNAKE RIVER, WASHINGTON, AUGUST 1984 FOR DETAILS ON FLOW CONDITIONS FOR SELECTED DISCHARGES AND METHODS OF PROJECT OPERATION.
3. TAILWATER ELEVATION FOR THE SPILLWAY DESIGN FLOOD (850,000 CFS AT LOWER GRANITE DAM IS 662.9 FEET M.S.L. AND CORRESPONDS TO A MAXIMUM ELEVATION OF 646 FEET AT LITTLE GOOSE DAM).

LOWER GRANITE LOCK AND DAM
Snake River, Ore., Wash. & Ida.

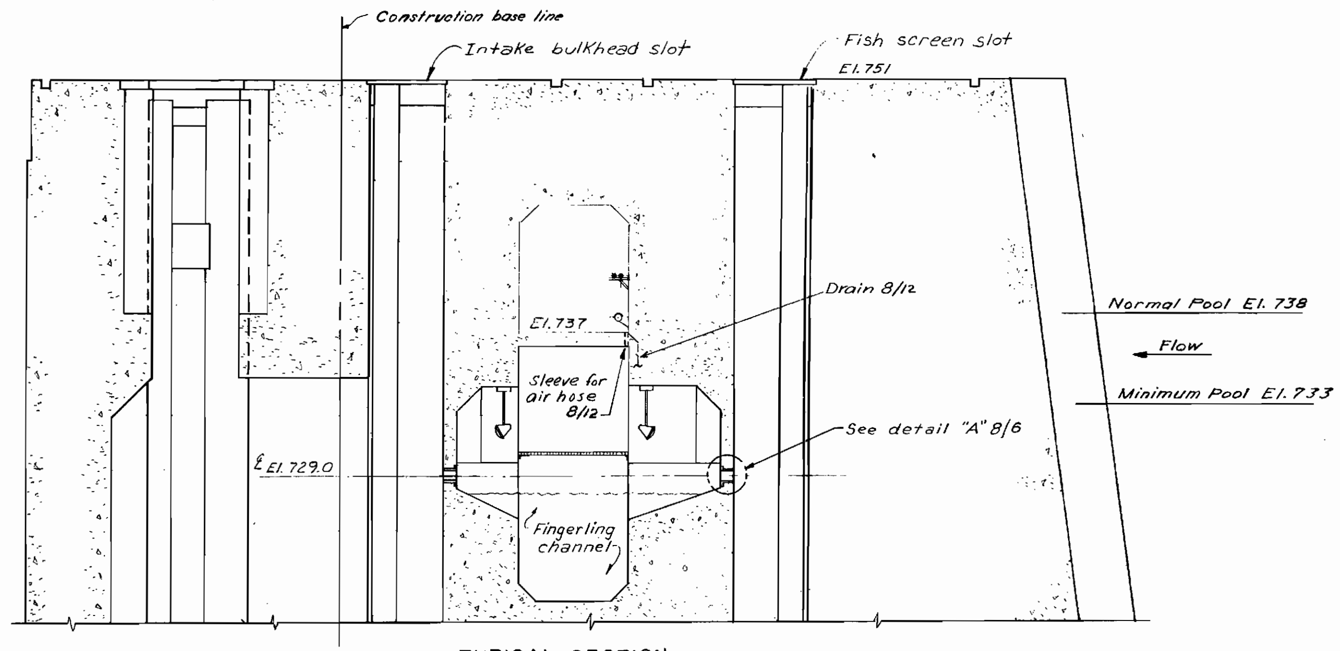
LOWER GRANITE TAILWATER RATING CURVES WITH BACKWATER FROM LITTLE GOOSE DAM

U.S. Army Engr. Dist., Walla Walla
Water Control Section
Prepared: J.A.A. Date: Aug. 1961


100 Ton Intake Gantry Crane
El. 773.00
18"
26'-6"
26'-0"
28'-6"
Isolated Phase Bus
Circuit Breaker Gallery
El. 757.00
Fingerling Transportation Channel
Roof vent
El. 727.00
El. 718.50
El. 721.00
600 Ton Bridge Crane
Bus 7000 A
Cable Gallery
25'-0"
El. 695.00
℄ Generators
44'-0"
31'-0"
4'-0"
4'-0"
Cable Tray
El. 678.00
50 Ton Gantry Crane
Existing Intake Gate
℄ Bulkhead Slot
Fish Screen Slot
El. 673.00
18"
31'-9"
13'-0"
El. 656.00
Storage Gallery
El. 656.00
Cable trays
Equipment Gallery
El. 640.00
Fish Collection Channel
Fishway Gallery
El. 640.00
PT & Surge Protection Equip.
El. 628.00
Pipe Gallery
El. 629.33
Existing Trash Rack
El. 620.00
Service Platform
Diffusion Chamber
Turbine Pit
Intermediate pier nose
El. 600.00
P. H. Fishwater Supply Conduit
North Shore Fishwater supply Conduit
℄ Distributor - El. 599.00
El. 597.27
El. 588.00
El. 583.00
El. 583.0 ±
Drainage Gallery
El. 580.50
Mandoor
El. 563.00
Bottom of D.T. Liner
El. 555.00
Drainage Gallery
El. 540.50
Intermediate Pier Nose
L.P. El. 523.00
Unwatering gallery
El. 511.00
FOR INFORMATION ONLY
GRAPHIC SCALE
3/32" = 1'-0"
REVISION DATE DESCRIPTION BY
U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON
DESIGNED BY J. K. Q.
DRAWN BY V. S.
CHECKED BY C. J. M.
LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO
JUVENILE FISH PASSAGE FACILITY
INTAKE SECTION
APPROVED: FOR DIV. ENGINEER DATE 1975 MAR 7
SCALE AS SHOWN
SPEC. NO. 75-8-55
GDP-1.5-0-0/3



PLAN TRANSPORTATION CHANNEL ℄ INLETS
NO SCALE



TYPICAL SECTION
SCALE: 1/4" = 1'-0"

LIST OF MATERIAL

PART NO.	MAT'L	QTY	DESCRIPTION	BID ITEM

NOTES:
1. For general notes see GDP-1-3-8/1.

AS CONSTRUCTED
HYDRO ELECTRIC DESIGN BRANCH, NPD
DATE 1977 DEC 31 BY Robert N. Dietl

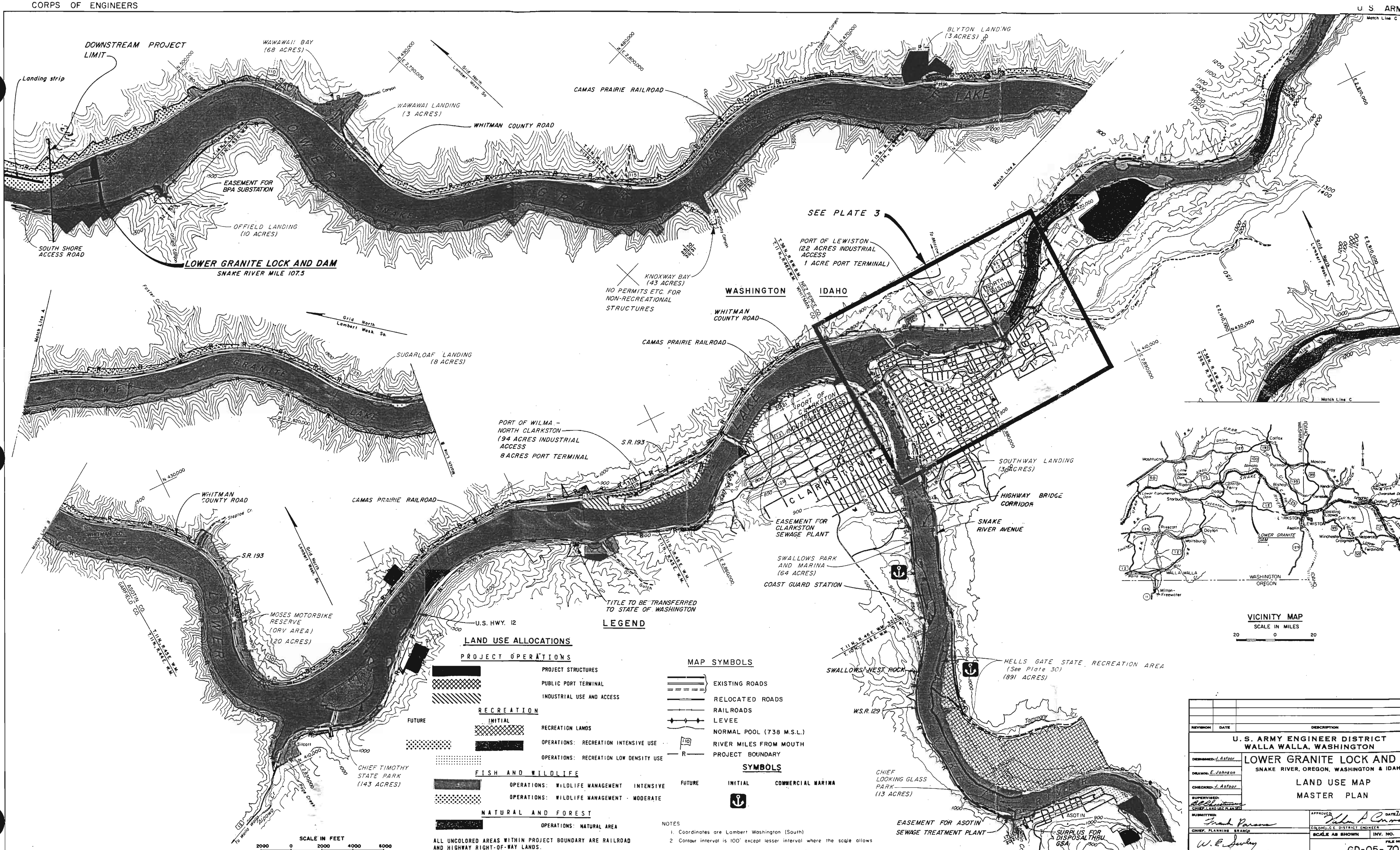
REVISION	DATE	DESCRIPTION	BY
C	77 Dec 30	As constructed. Added El. 737	RND
B	71 Sep 124	General revision	WWM
A	70 Apr 3	Revised notes and finish requirements	CED

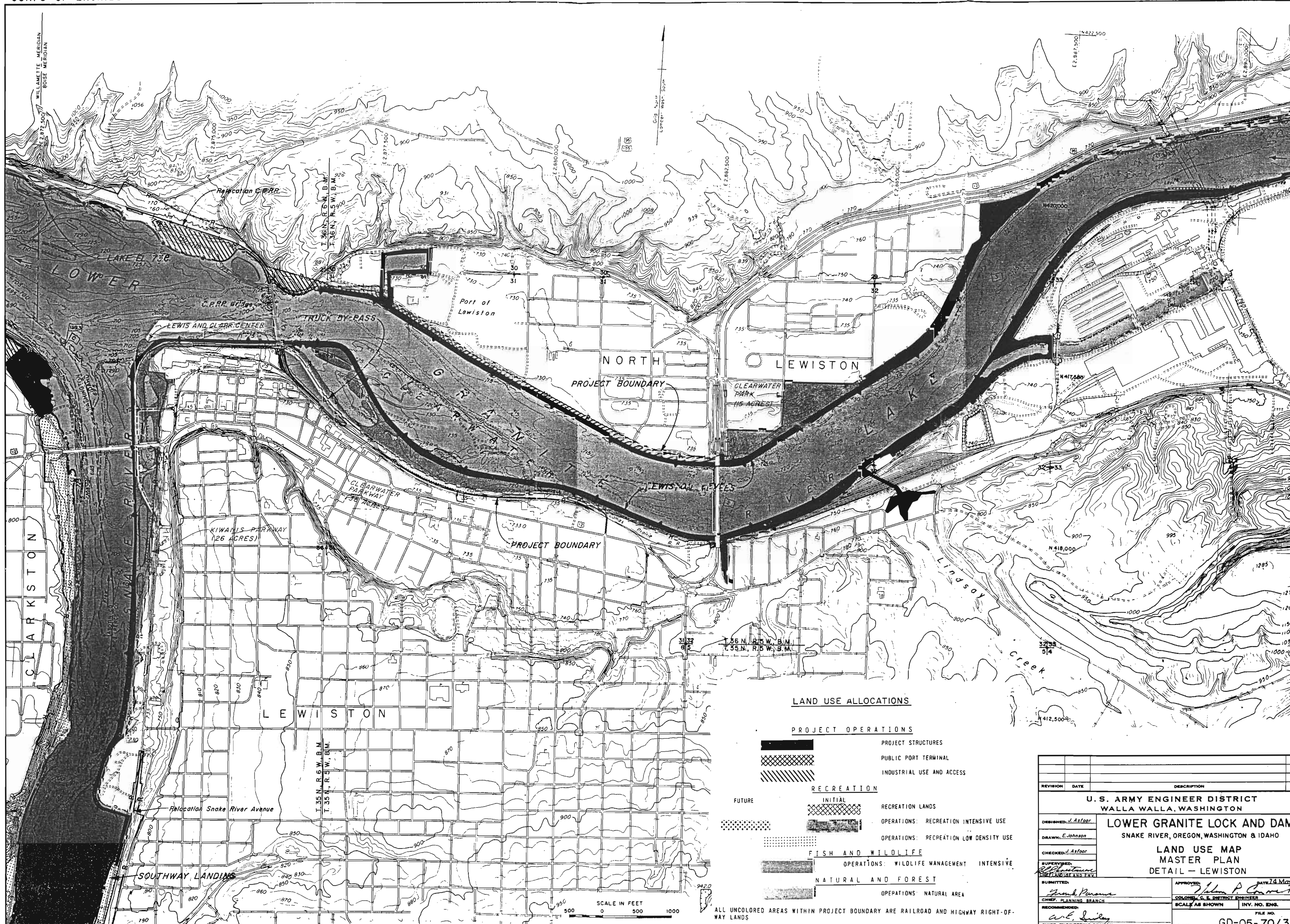
U. S. ARMY ENGINEER DIVISION, N. P.
PORTLAND, OREGON

DESIGNED BY T.T.T.
DRAWN BY DBW
CHECKED BY LBF
PREPARED: [signature]

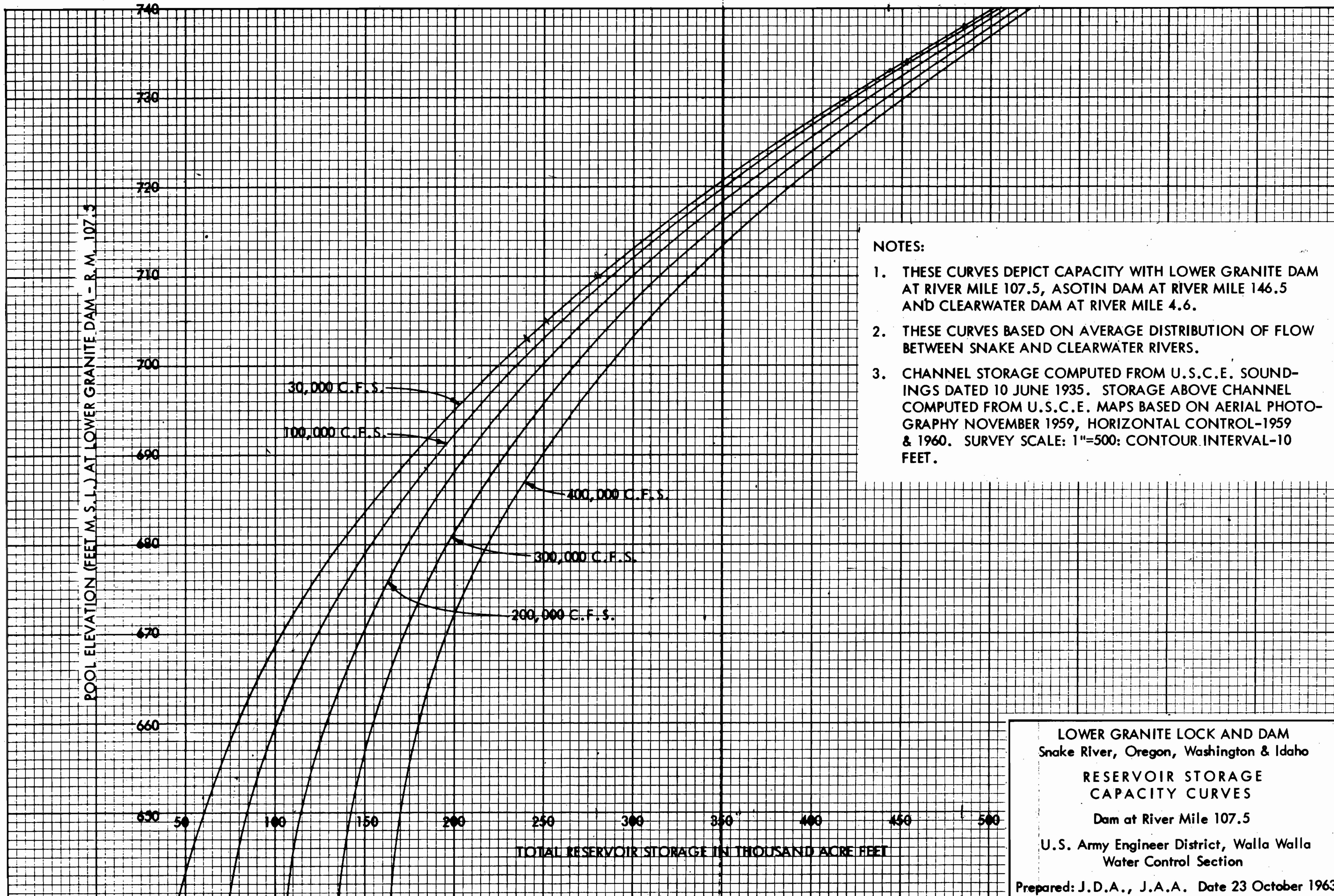
LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO
JUVENILE FISH PASSAGE FACILITY
COLLECTION CHANNEL
PLAN AND SECTION

SUBMITTED: [signature] CHIEF, HYDRO-ELECTRIC DESIGN BRANCH
APPROVED: FOR DIV. ENGINEER [signature] DATE 69 Nov 1
SCALE AS SHOWN SPEC. NO.
GDP-1-3-8/5
SHEET 104


DOWNSTREAM PROJECT LIMIT
Landing strip
WAWAWAI BAY (68 ACRES)
WAWAWAI LANDING (3 ACRES)
WHITMAN COUNTY ROAD
CAMAS PRAIRIE RAILROAD
BLYTON LANDING (3 ACRES)
EASEMENT FOR BPA SUBSTATION
OFFIELD LANDING (10 ACRES)
SOUTH SHORE ACCESS ROAD
LOWER GRANITE LOCK AND DAM
SNAKE RIVER MILE 107.5
KNOXWAY BAY (43 ACRES)
NO PERMITS ETC. FOR NON-RECREATIONAL STRUCTURES
SEE PLATE 3
PORT OF LEWISTON (22 ACRES INDUSTRIAL ACCESS 1 ACRE PORT TERMINAL)
WASHINGTON
IDAHO
WHITMAN COUNTY ROAD
CAMAS PRAIRIE RAILROAD
SUGARLOAF LANDING (8 ACRES)
PORT OF WILMA - NORTH CLARKSTON (94 ACRES INDUSTRIAL ACCESS 8 ACRES PORT TERMINAL)
S.R. 193
PORT OF CLARKSTON
CLARKSTON
LEWISTON
NORTH LEWISTON
SOUTHWAY LANDING (30 ACRES)
HIGHWAY BRIDGE CORRIDOR
SNAKE RIVER AVENUE
EASEMENT FOR CLARKSTON SEWAGE PLANT
SWALLOWS PARK AND MARINA (64 ACRES)
COAST GUARD STATION
WHITMAN COUNTY ROAD
S.R. 193
CAMAS PRAIRIE RAILROAD
MOSES MOTORBIKE RESERVE (ORV AREA) (20 ACRES)
TITLE TO BE TRANSFERRED TO STATE OF WASHINGTON
U.S. HWY. 12
SWALLOWS NEST ROCK
HELLS GATE STATE RECREATION AREA (See Plate 30) (891 ACRES)
W.S.R. 129
CHIEF TIMOTHY STATE PARK (143 ACRES)
CHIEF LOOKING GLASS PARK (13 ACRES)
EASEMENT FOR ASOTIN SEWAGE TREATMENT PLANT
SURPLUS FOR DISPOSAL THRU GSA
ASOTIN
LOWER GRANITE LAKE
SNAKE RIVER
LEGEND
LAND USE ALLOCATIONS
PROJECT OPERATIONS
PROJECT STRUCTURES
PUBLIC PORT TERMINAL
INDUSTRIAL USE AND ACCESS
RECREATION
FUTURE
INITIAL
RECREATION LANDS
OPERATIONS: RECREATION INTENSIVE USE
OPERATIONS: RECREATION LOW DENSITY USE
FISH AND WILDLIFE
OPERATIONS: WILDLIFE MANAGEMENT INTENSIVE
OPERATIONS: WILDLIFE MANAGEMENT - MODERATE
NATURAL AND FOREST
OPERATIONS: NATURAL AREA
ALL UNCOLORED AREAS WITHIN PROJECT BOUNDARY ARE RAILROAD AND HIGHWAY RIGHT-OF-WAY LANDS.
MAP SYMBOLS
EXISTING ROADS
RELOCATED ROADS
RAILROADS
LEVEE
NORMAL POOL (738 M.S.L.)
RIVER MILES FROM MOUTH
PROJECT BOUNDARY
SYMBOLS
FUTURE
INITIAL
COMMERCIAL MARINA
NOTES
1. Coordinates are Lambert Washington (South)
2. Contour interval is 100' except lesser interval where the scale allows
SCALE IN FEET
2000 0 2000 4000 6000
VICINITY MAP
SCALE IN MILES
20 0 20
U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
LOWER GRANITE LOCK AND D
SNAKE RIVER, OREGON, WASHINGTON & IDAHO
LAND USE MAP
MASTER PLAN
DESIGNED: J. Asfoor
DRAWN: E. Johnson
CHECKED: J. Asfoor
SCALE AS SHOWN
GD-05-70



LOWER GRANITE LAKE
LOWER
GRANITE
LEWISTON LEVEES
RIVER LAKE
SNAKE RIVER
NORTH LEWISTON
LEWISTON
CLARKSTON
Port of Lewiston
PROJECT BOUNDARY
CLEARWATER PARK (15 ACRES)
CLEARWATER PARKWAY (35 ACRES)
KIWANIS PARKWAY (26 ACRES)
LEWIS AND CLARK CENTER
TRUCK BY-PASS
Relocation C.P.R.R.
C.P.R.R. Bridge
Relocation Snake River Avenue
SOUTHWAY LANDING
Lindsay Creek
WILLAMETTE MERIDIAN
BOISE MERIDIAN
T.36N., R.5W., B.M.
T.35N., R.5W., B.M.
LAND USE ALLOCATIONS
PROJECT OPERATIONS
PROJECT STRUCTURES
PUBLIC PORT TERMINAL
INDUSTRIAL USE AND ACCESS
RECREATION
FUTURE
INITIAL
RECREATION LANDS
OPERATIONS: RECREATION INTENSIVE USE
OPERATIONS: RECREATION LOW DENSITY USE
FISH AND WILDLIFE
OPERATIONS: WILDLIFE MANAGEMENT INTENSIVE
NATURAL AND FOREST
OPERATIONS: NATURAL AREA
ALL UNCOLORED AREAS WITHIN PROJECT BOUNDARY ARE RAILROAD AND HIGHWAY RIGHT-OF-WAY LANDS
SCALE IN FEET
500 0 500 1000
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
DESIGNED: J. Asfoor
DRAWN: E. Johnson
CHECKED: J. Asfoor
SUPERVISED:
CHIEF LAND USE AND ENV.
LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO
LAND USE MAP
MASTER PLAN
DETAIL — LEWISTON
SUBMITTED:
CHIEF, PLANNING BRANCH
RECOMMENDED:
CHIEF, ENGINEERING DIVISION
APPROVED:
DATE 74 May 28
COLONEL, C. E. DISTRICT ENGINEER
SCALE AS SHOWN
INV. NO. ENG.
FILE NO.
SHEET
GD-05-70/3



NOTES:

1. THESE CURVES DEPICT CAPACITY WITH LOWER GRANITE DAM AT RIVER MILE 107.5, ASOTIN DAM AT RIVER MILE 146.5 AND CLEARWATER DAM AT RIVER MILE 4.6.
2. THESE CURVES BASED ON AVERAGE DISTRIBUTION OF FLOW BETWEEN SNAKE AND CLEARWATER RIVERS.
3. CHANNEL STORAGE COMPUTED FROM U.S.C.E. SOUNDINGS DATED 10 JUNE 1935. STORAGE ABOVE CHANNEL COMPUTED FROM U.S.C.E. MAPS BASED ON AERIAL PHOTOGRAPHY NOVEMBER 1959, HORIZONTAL CONTROL-1959 & 1960. SURVEY SCALE: 1"=500: CONTOUR INTERVAL-10 FEET.

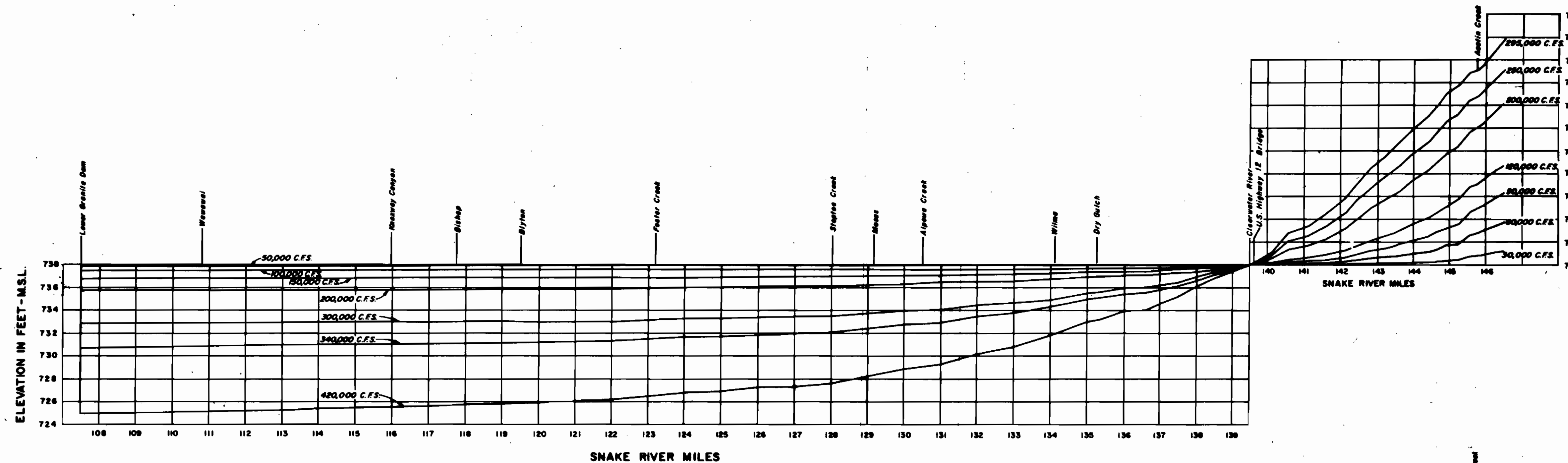
LOWER GRANITE LOCK AND DAM
Snake River, Oregon, Washington & Idaho

RESERVOIR STORAGE CAPACITY CURVES

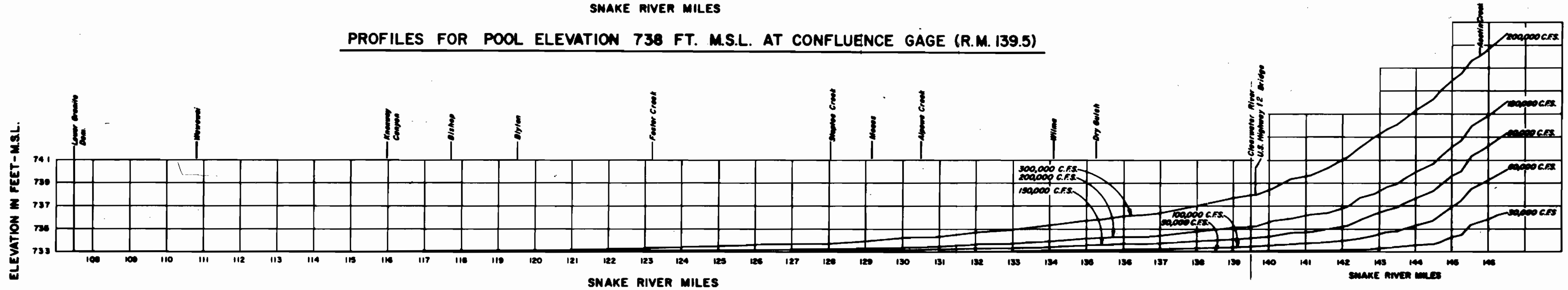
Dam at River Mile 107.5

U.S. Army Engineer District, Walla Walla
Water Control Section

Prepared: J.D.A., J.A.A. Date 23 October 1963



PROFILES FOR POOL ELEVATION 738 FT. M.S.L. AT CONFLUENCE GAGE (R.M. 139.5)



PROFILES FOR FOREBAY ELEVATION 733 FT. M.S.L. AT LOWER GRANITE DAM (R.M. 107.5)

MEAN SECTIONAL VELOCITIES AT SELECTED LOCATIONS IN LOWER-GRANITE RESERVOIR
738 FOOT POOL ELEVATION AT SNAKE RIVER MILE 139.5

SNAKE RIVER BELOW CLEARWATER								SNAKE RIVER ABOVE CLEARWATER							
	DISCHARGE - 1000 C.F.S.								DISCHARGE - 1000 C.F.S.						
	50	100	150	200	300	340	420		30	60	90	120	200	250	295
RIVER MILE	VELOCITIES IN FEET/SECOND							RIVER MILE	VELOCITIES IN FEET/SECOND						
107.5	0.2	0.4	0.6	0.8	1.2	1.4	1.8	139.61	0.9	1.8	2.7	3.6	6.1	7.6	9.8
110.0	0.3	0.6	0.9	1.2	1.9	2.2	2.9	140.08	1.1	2.2	3.2	4.3	7.1	8.8	10.3
115.0	0.3	0.6	0.9	1.2	1.8	2.1	2.8	140.59	0.8	1.7	2.5	3.3	5.3	6.5	7.4
120.0	0.4	0.8	1.1	1.5	2.4	2.8	3.8	141.10	0.9	1.8	2.6	3.5	5.6	6.8	7.8
125.0	0.6	1.1	1.7	2.4	3.7	4.3	5.9	143.20	1.5	2.9	4.1	5.2	7.5	8.7	10.0
130.0	0.6	1.2	1.9	2.5	4.0	4.7	6.3	144.65	2.1	3.9	5.4	6.5	8.7	9.6	10.2
135.0	0.7	1.4	2.1	2.9	4.5	5.2	6.8	145.25	2.6	4.9	6.4	7.5	9.2	9.8	10.1
137.5	1.0	2.0	3.0	4.0	6.1	7.0	9.0	145.88	2.9	5.2	6.7	7.8	10.0	11.0	11.8
139.0	0.8	1.6	2.4	3.1	4.8	5.4	6.7	146.27	3.0	5.0	6.4	7.4	9.6	10.5	11.0

MEAN SECTIONAL VELOCITIES AT SELECTED LOCATIONS IN LOWER GRANITE RESERVOIR
733 FOOT POOL ELEVATION AT LOWER GRANITE DAM - RIVER MILE 107.5

SNAKE RIVER BELOW CLEARWATER						SNAKE RIVER ABOVE CLEARWATER					
	DISCHARGE - 1000 C.F.S.						DISCHARGE - 1000 C.F.S.				
	50	100	150	200	300		30	60	90	120	200
RIVER MILE	VELOCITIES IN FEET/SECOND					RIVER MILE	VELOCITIES IN FEET/SECOND				
107.5	0.2	0.4	0.6	0.8	1.2	139.61	1.1	2.2	3.1	4.0	6.1
110.0	0.3	0.6	1.0	1.3	1.9	140.08	1.3	2.5	3.7	4.7	7.1
115.0	0.3	0.6	0.9	1.2	1.8	140.59	1.1	2.1	2.9	3.7	5.3
120.0	0.4	0.8	1.2	1.6	2.4	141.10	1.1	2.1	3.0	3.8	5.6
125.0	0.6	1.2	1.9	2.5	3.7	143.20	1.9	3.6	4.8	5.7	7.5
130.0	0.7	1.4	2.0	2.7	4.0	144.65	2.9	4.9	6.1	7.0	8.7
135.0	0.8	1.6	2.4	3.1	4.5	145.25	3.5	5.8	7.3	8.0	9.2
137.5	1.1	2.2	3.3	4.4	6.1	145.88	3.9	5.9	7.2	8.2	10.0
139.0	0.9	1.8	2.7	3.5	4.8	146.27	3.7	5.6	6.8	7.7	9.6

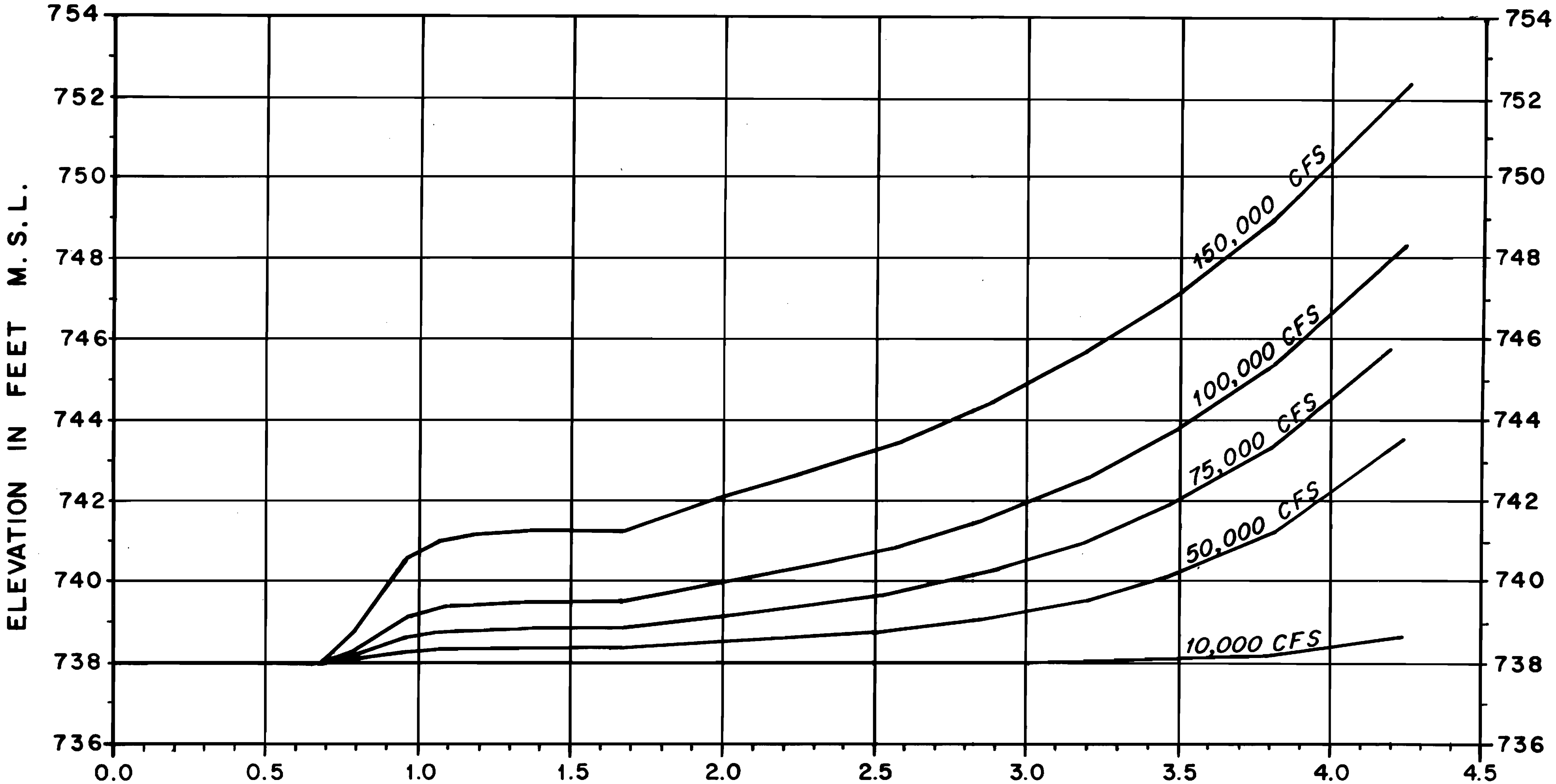
NOTES:

1. CONTROL POINT FOR THE MAXIMUM POOL ELEVATIONS IS AT THE CONFLUENCE OF SNAKE AND CLEARWATER RIVERS. (MILE 139.5 ON SNAKE RIVER.)
2. CONTROL POINT FOR MINIMUM POOL IS AT FOREBAY OF LOWER GRANITE DAM (MILE 107.5 SNAKE RIVER).

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED Anderson
DRAWN R Shinbo
CHECKED Conway

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON, & IDAHO
RESERVOIR BACKWATER PROFILES
738 FT. POOL EL. AT R.M. 139.5
AND 733 FT. POOL EL. AT R.M. 107.5



CLEARWATER RIVER MILES
(POOL ELEVATION 738 FT. M.S.L. AT
CONFLUENCE GAGE, SNAKE RIVER MILE 139.5)

RIVER MILE	DISCHARGE - 1000 CFS 10	50	75	100	150
	VELOCITIES IN FEET/SECOND				
0.28	0.4	2.0	3.0	4.0	6.0
0.41	0.5	2.4	3.6	4.8	7.2
0.53	0.6	2.9	4.4	5.9	8.8
0.59	0.7	3.6	5.4	7.2	10.9
0.67	0.8	3.9	5.9	7.8	11.7
0.78	0.8	3.9	5.8	7.6	11.1
0.92	0.5	2.5	3.6	4.7	6.6
1.06	0.4	1.9	2.8	3.7	5.1
1.16	0.4	1.8	2.6	3.4	4.7
1.26	0.4	1.9	2.7	3.5	4.9
1.36	0.4	1.9	2.7	3.6	4.9

RIVER MILE	DISCHARGE - 1000 CFS 10	50	75	100	150
	VELOCITIES IN FEET/SECOND				
1.47	0.4	2.2	3.2	4.1	5.6
1.56	0.5	2.6	3.9	5.0	6.9
1.66	0.6	3.1	4.5	5.9	8.1
1.99	0.6	3.1	4.5	5.7	7.7
2.34	0.7	3.4	4.9	6.1	8.1
2.58	0.8	3.9	5.6	6.9	8.9
2.89	1.0	4.4	6.1	7.5	9.6
3.20	1.2	5.3	7.1	8.4	10.3
3.48	1.4	5.9	7.7	9.1	11.2
3.85	2.1	7.1	8.8	10.0	11.7
4.30	2.7	6.2	7.2	8.0	9.2

NOTES:

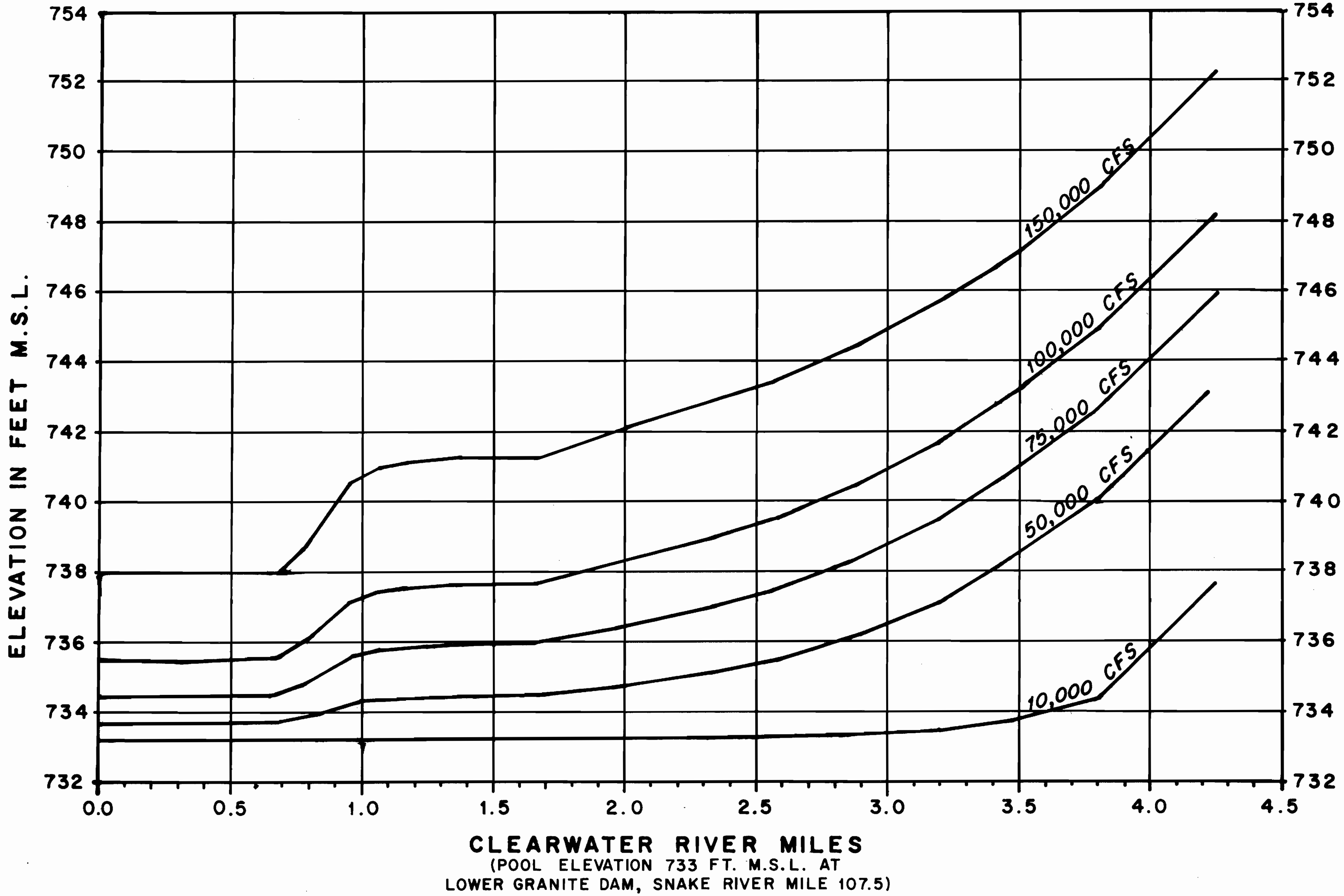
1. Minimum channel elevation of 717 feet mean sea level was assumed for sediment deposition and dredging from river mile 0 to river mile 1.99.
2. Cross section data obtained from the 1986 sediment range surveys.
3. Control point for the minimum pool is at Lower Granite Forebay (Snake River Mile 107.5).

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, WASHINGTON

RESERVOIR BACKWATER PROFILES
CLEARWATER RIVER, IDAHO

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA
HYDROLOGY BRANCH

MAXSON / SCHUSTER APRIL 1987



CONCURRENT FLOWS	
SNAKE RIVER BELOW CONFL.	CLEARWATER RIVER
300,000 CFS	150,000 CFS
200,000 CFS	100,000 CFS
150,000 CFS	75,000 CFS
100,000 CFS	50,000 CFS
50,000 CFS	10,000 CFS

RIVER MILE	DISCHARGE - 1000 CFS 10	50	75	100	150
	VELOCITIES IN FEET/SECOND				
0.28	0.5	2.5	3.6	4.5	6.0
0.41	0.6	3.0	4.3	5.4	7.2
0.53	0.8	3.7	5.3	6.7	8.8
0.59	1.0	4.6	6.6	8.3	10.9
0.67	1.0	5.0	7.1	8.9	11.8
0.78	1.0	4.9	6.9	8.6	11.2
0.92	0.7	3.1	4.2	5.2	6.6
1.06	0.5	2.4	3.3	4.0	5.1
1.16	0.5	2.2	3.0	3.7	4.7
1.26	0.5	2.3	3.2	3.9	4.9
1.36	0.5	2.3	3.2	3.9	4.9

RIVER MILE	DISCHARGE - 1000 CFS 10	50	75	100	150
	VELOCITIES IN FEET/SECOND				
1.47	0.6	2.7	3.7	4.5	5.7
1.56	0.7	3.3	4.5	5.5	6.9
1.66	0.8	3.8	5.3	6.4	8.1
1.99	0.9	4.0	5.3	6.3	7.7
2.34	1.0	4.4	5.7	6.7	8.1
2.58	1.3	5.1	6.5	7.5	8.9
2.89	1.5	5.5	7.0	8.0	9.6
3.20	2.2	6.7	8.0	8.9	10.3
3.48	2.4	6.8	8.3	9.5	11.2
3.85	4.5	8.1	9.3	10.3	11.7
4.30	3.6	6.4	7.4	8.1	9.2

NOTES:

1. Minimum channel elevation of 717 feet mean sea level was assumed for sediment deposition and dredging from river mile 0 to river mile 1.99.
2. Cross section data obtained from the 1986 sediment range surveys.
3. Control point for the maximum pool elevations is at the confluence of Snake and Clearwater Rivers (Snake River Mile 139.5).

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, WASHINGTON

RESERVOIR BACKWATER PROFILES
CLEARWATER RIVER, IDAHO

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA
HYDROLOGY BRANCH

MAXSON/SCHUSTER APRIL 1987

CLIMATOLOGICAL STATIONS

STA. NO.	STATION	STA. EL. FT. M.S.L.
	WASHINGTON	
1	ANATONE	3,750
2	DAYTON	1,610
3	KAHLOTUS	1,350
4	LACROSSE 3 ESE	1,546
5	POMEROY	1,890
6	PULLMAN	2,545
7	WALLA WALLA	949
	IDAHO	
8	BIG CREEK	5,686
9	BOISE	2,842
10	BURLEY	4,180
11	CHALLIS	5,171
12	COUNCIL	2,930
13	DEADWOOD DAM	5,375
14	DUBOIS C.A.A. - A.P.	2,717
15	GOODING C.A.A. - A.P.	3,696
16	GRANGEVILLE	3,355
17	HAILEY	5,322
18	IDAHO CITY	3,965
19	IDAHO FALLS C.A.A. - W.B.	4,730
20	KOOSKIA	1,261
21	LEWISTON	1,436
22	OBSIDIAN	6,875
23	PAYETTE	2,110
24	PIERCE R.S.	3,175
25	POCATELLO W.B. A.P.	4,444
26	RIGGINS R.S.	1,801
27	ST. ANTHONY	4,968
28	SALMON	3,949
	OREGON	
29	BAKER	3,368
30	HARPER	2,518
31	HUNTINGTON	2,150
32	LA GRANDE	2,805
33	OWYHEE DAM	2,400
34	WALLOWA	2,923
35	WARM SPRINGS RES.	3,332
	WYOMING	
36	MORAN	6,798
	NEVADA	
37	OWYHEE	5,396

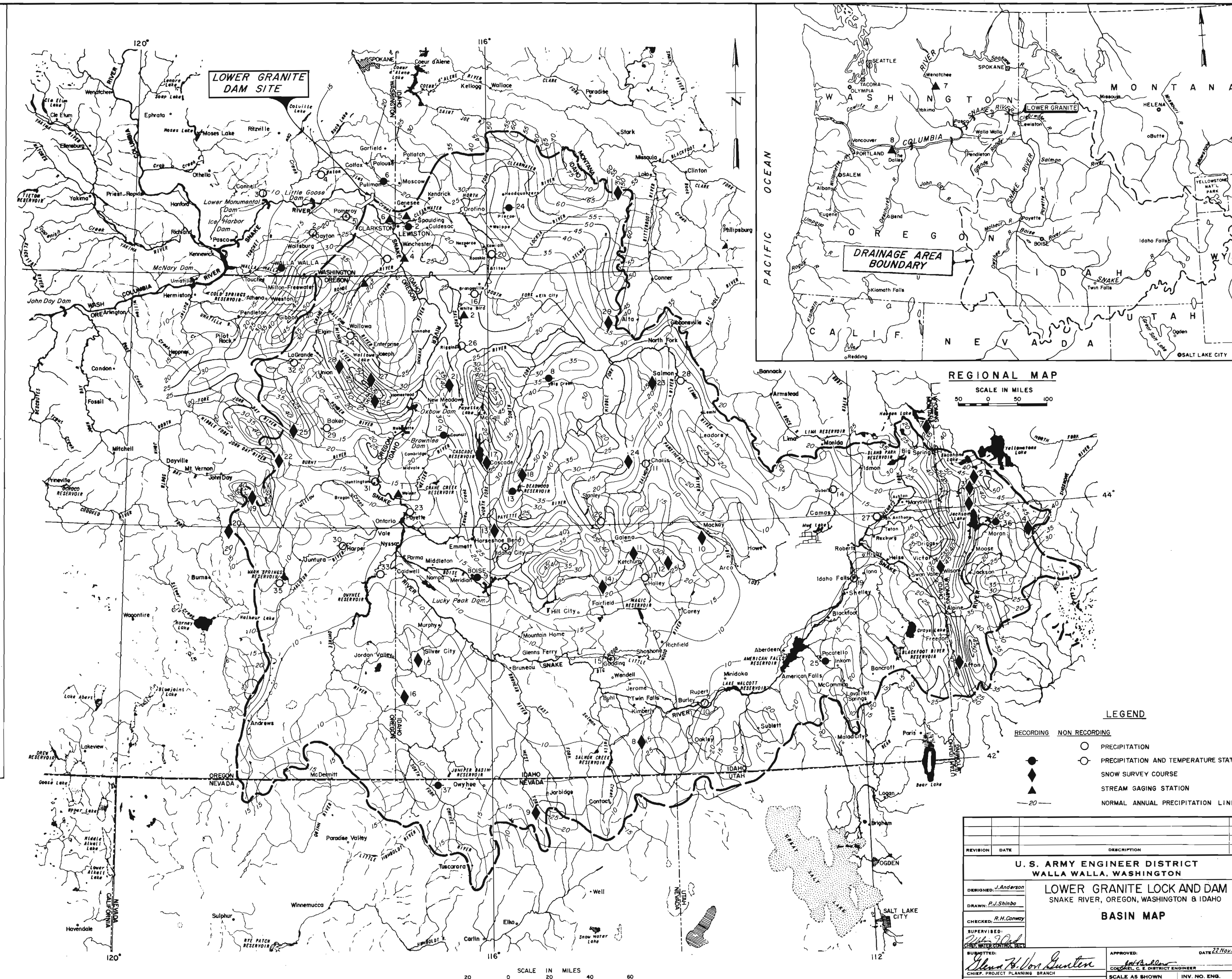
SNOW COURSES

STA. NO.	COURSE	STA. EL. FT. M.S.L.
1	ARIZONA, WYOMING	6,850
2	ASTER CREEK, WYOMING	7,700
3	SNAKE RIVER STATION, WYOMING	6,780
4	BLACKROCK, WYOMING	8,600
5	AFTON RANGER STATION, WYOMING	6,200
6	BECHLER RANGER STA., WYOMING	6,400
7	WEST YELLOWSTONE, MONTANA	6,700
8	MAGIC MOUNTAIN, IDAHO	6,700
9	BEAR CREEK MEADOWS, NEVADA	7,800
10	WHITE KNOB, IDAHO	7,700
11	GRAHAM RANCH, IDAHO	6,200
12	MASCOT MINE, IDAHO	7,900
13	BOGUS BASIN, IDAHO	6,400
14	COUCH SUMMIT, IDAHO	7,000
15	JACK CREEK, IDAHO	7,000
16	SOUTH MOUNTAIN NO. 2, IDAHO	5,100
17	CRAWFORD RANGER STA., IDAHO	4,800
18	DEADWOOD RIVER DAM, IDAHO	5,500
19	BLUE MTN. SPRINGS, OREGON	5,900
20	ROCK SPRINGS, OREGON	5,100
21	BOULDER CREEK, IDAHO	5,500
22	BLUE MTN. SUMMIT, OREGON	5,098
23	WILLIAMS CR. SUMMIT, IDAHO	8,710
24	MILL CREEK SUMMIT, IDAHO	8,870
25	EILERTSON MEADOWS, OREGON	5,400
26	SCHNEIDER MEADOWS, OREGON	5,400
27	ANEROID LAKE NO. 1, OREGON	7,480
28	MOSS SPRING, OREGON	5,850
29	NEZ PERCE PASS, IDAHO	6,575
30	PACKERS MEADOW, IDAHO	5,700

STREAM GAGING STATIONS

STA. NO.	STREAM AND LOCATION
1	SNAKE RIVER AT WEISER, IDAHO
2	SALMON RIVER AT WHITEBIRD, IDAHO
3	GRANDE RONDE RIVER AT TROY, OREGON
4	SNAKE RIVER NEAR ANATONE, WASHINGTON
5	CLEARWATER RIVER AT SPALDING, IDAHO
6	SNAKE RIVER NEAR CLARKSTON, WASHINGTON
7*	COLUMBIA RIVER AT TRINIDAD, WASHINGTON
8*	COLUMBIA RIVER NEAR THE DALLES, OREGON

* SHOWN ON REGIONAL MAP



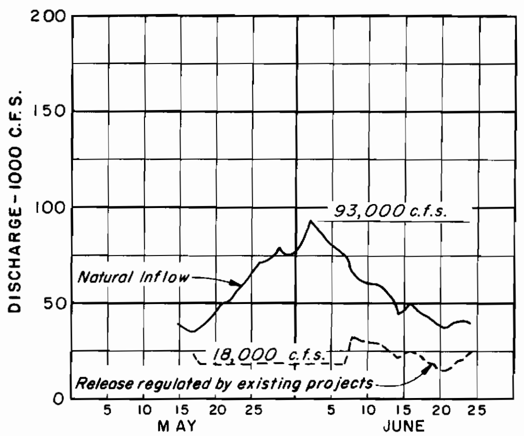
REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

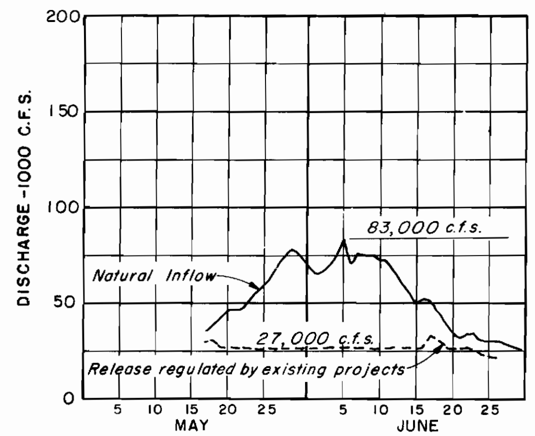
LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO

BASIN MAP

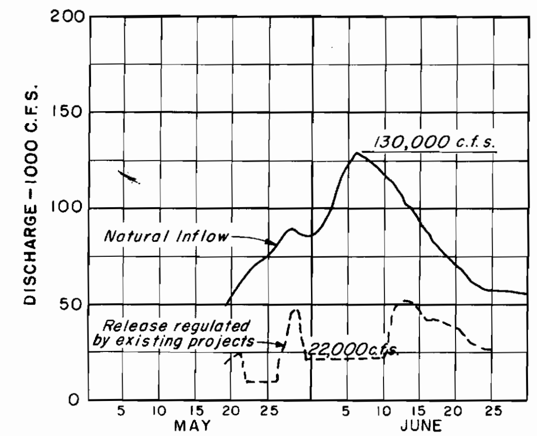
DESIGNED: J.Anderson
DRAWN: P.J.Shinbo
CHECKED: R.H.Conway
SUPERVISED: [signature] CHIEF, WATER CONTROL SECT.
SUBMITTED: Glenn H. Von Gunten — CHIEF, PROJECT PLANNING BRANCH
RECOMMENDED: E. C. [signature] — CHIEF ENGINEERING DIVISION
APPROVED: [signature] COLONEL, C. E. DISTRICT ENGINEER — DATE 22 Nov. 1963
SCALE AS SHOWN — INV. NO. ENG.
SHEET — FILE NO. GD-05-3/3



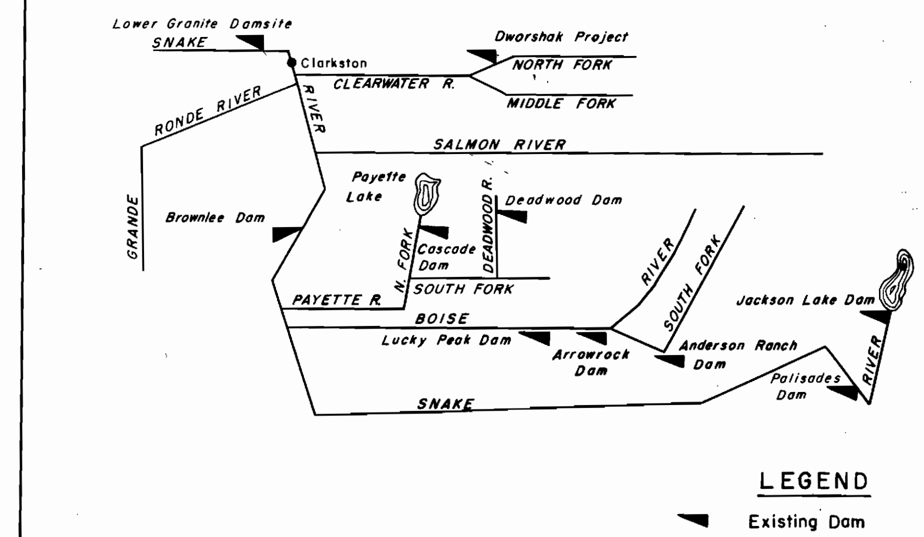
SNAKE RIVER AT BROWNLEE-1956



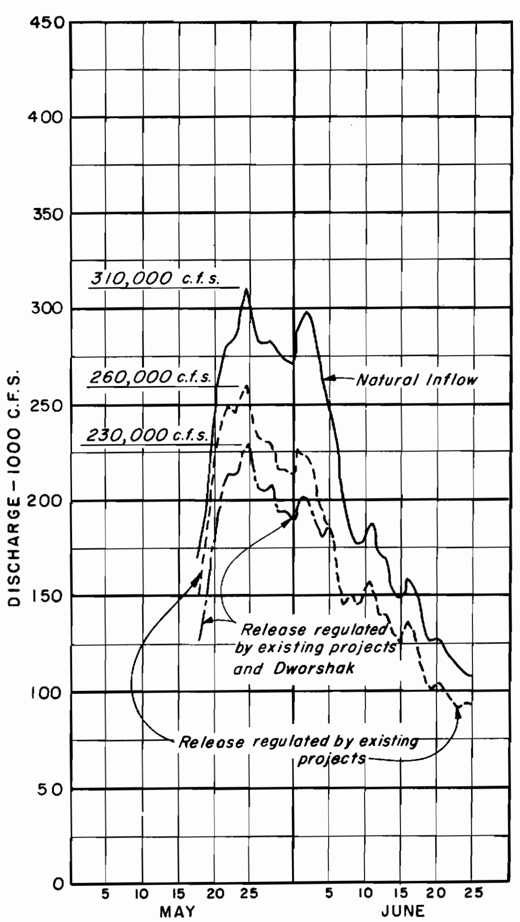
SNAKE RIVER AT BROWNLEE-1948



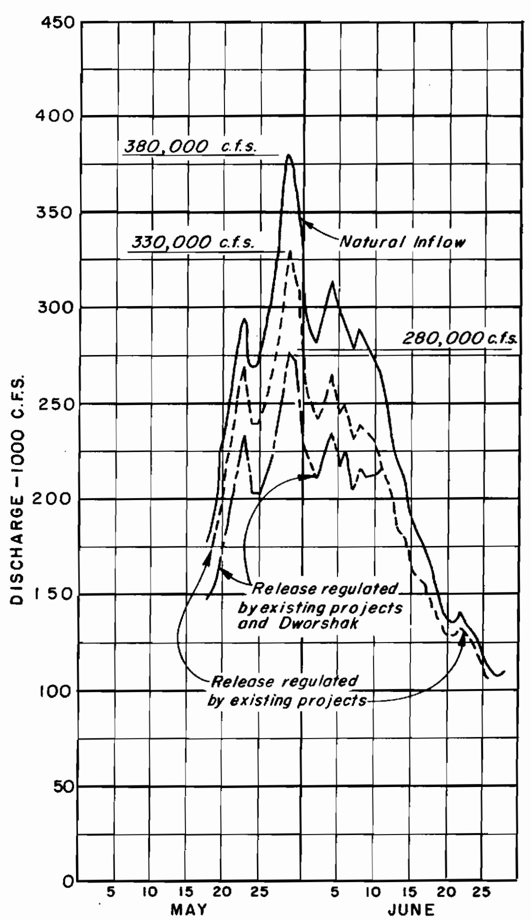
SNAKE RIVER AT BROWNLEE-1894



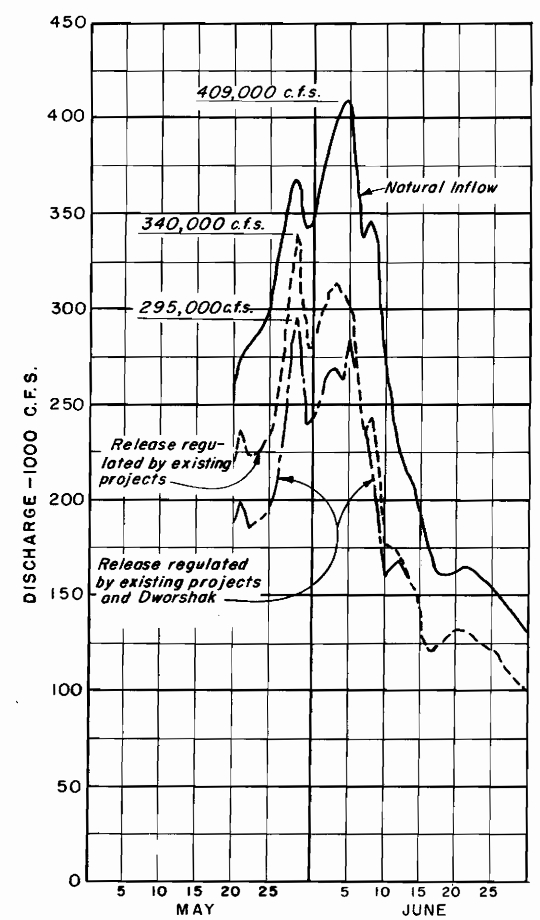
SCHEMATIC DIAGRAM OF MAJOR PROJECTS WITH FLOOD CONTROL STORAGE



SNAKE RIVER AT CLARKSTON-1956



SNAKE RIVER AT CLARKSTON-1948



SNAKE RIVER AT CLARKSTON-1894

MAJOR PROJECTS AND FLOOD CONTROL STORAGE

EXISTING PROJECTS	GROSS USABLE ACRE-FEET
UPPER SNAKE RIVER	
JACKSON LAKE AND PALISADES	1,400,000
BOISE RIVER	
ANDERSON RANCH	418,000
ARROWROCK	286,000
LUCKY PEAK	279,000
PAYETTE RIVER	
CASCADE	653,000
DEADWOOD	160,000
MIDDLE SNAKE RIVER	
BROWNLEE	980,000
TOTAL	4,176,000
NORTH FORK CLEARWATER	
DWORSHAK	2,000,000
TOTAL EXISTING AND DWORSHAK	6,176,000

NOTES:

1. REGULATION BY EXISTING PROJECTS IS BASED ON REGULATION PROCEDURES USED IN "JUNE 1958 REVIEW REPORT OF HOUSE DOCUMENT 531."
2. DWORSHAK REGULATION PROCEDURES ARE OUTLINED IN APPENDIX A OF THE 15 SEPTEMBER 1961 "BRUCES EDDY DAM AND RESERVOIR GENERAL DESIGN MEMORANDUM."

REVISION	DATE	DESCRIPTION	BY

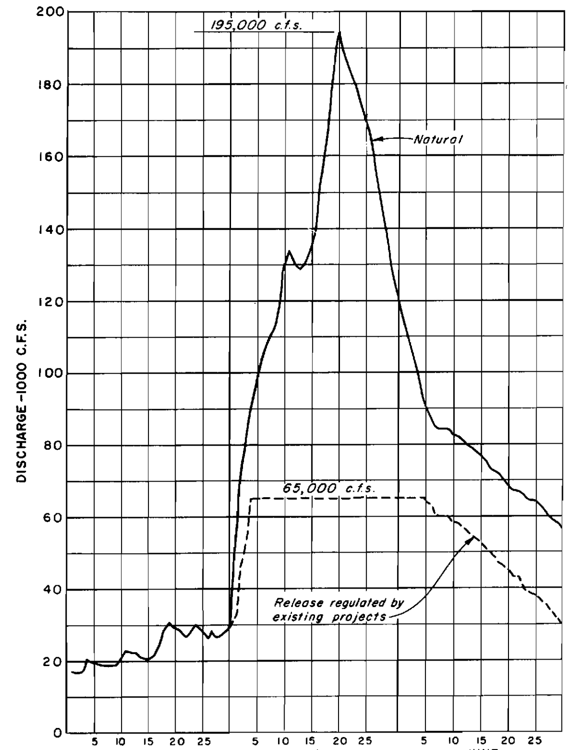
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: K. Armacost
DRAWN: R. L. G.
CHECKED: R. Conway

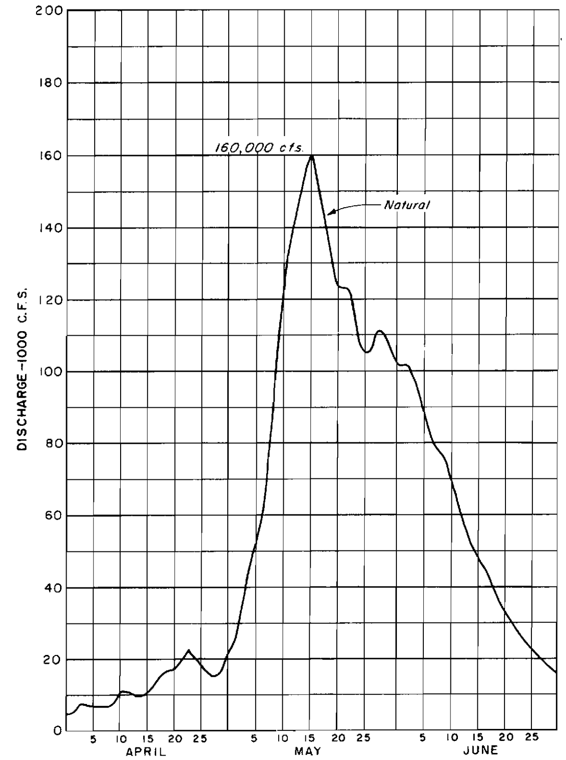
LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

REGULATION OF LARGE SNAKE RIVER FLOODS

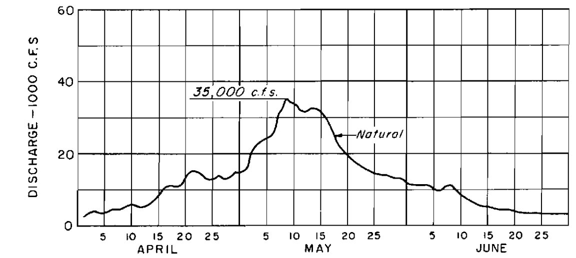
PREPARED: CHIEF, WATER CONTROL SEC.
SUBMITTED: Glenn H. Von Gunten, CHIEF, PROJECT PLANNING BRANCH
RECOMMENDED: E. C. Tramp, CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C. E. DISTRICT ENGINEER
DATE 22 Nov. 1963
SCALE AS SHOWN
INV. NO. ENG.
FILE NO. GD-05-3/18
SHEET



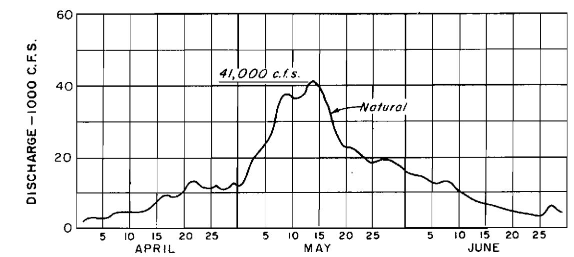
CONTRIBUTION FROM SNAKE RIVER AT BROWNLEE



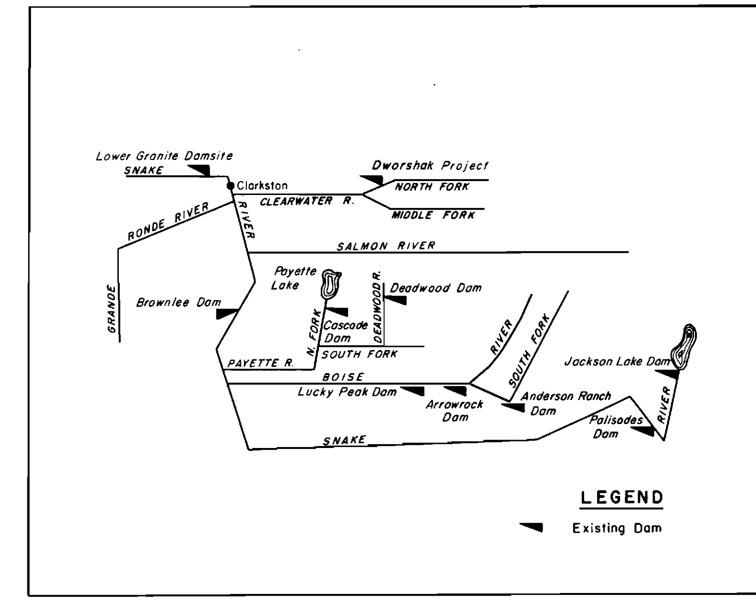
CONTRIBUTION FROM SALMON RIVER AT WHITEBIRD



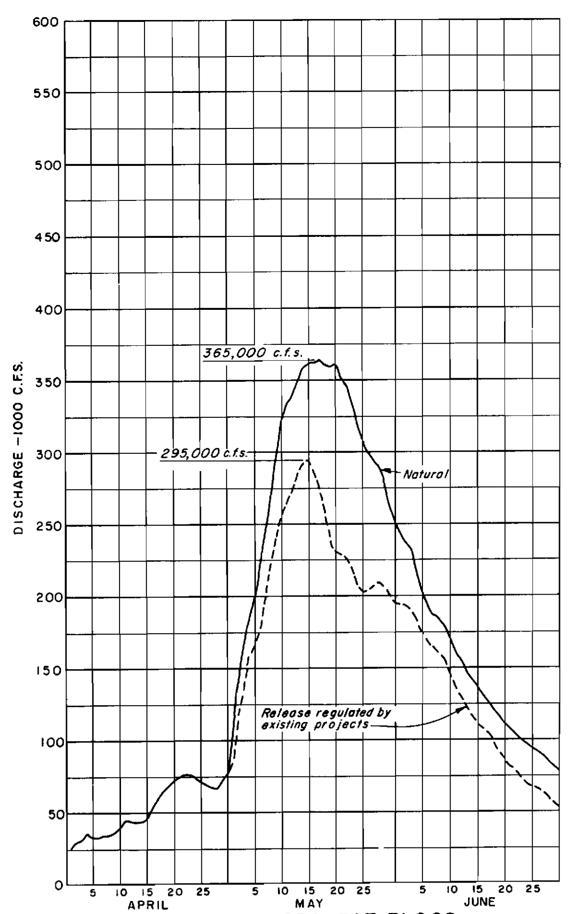
CONTRIBUTION FROM UNGAGED AREAS BETWEEN BROWNLEE AND CLEARWATER CONFLUENCE



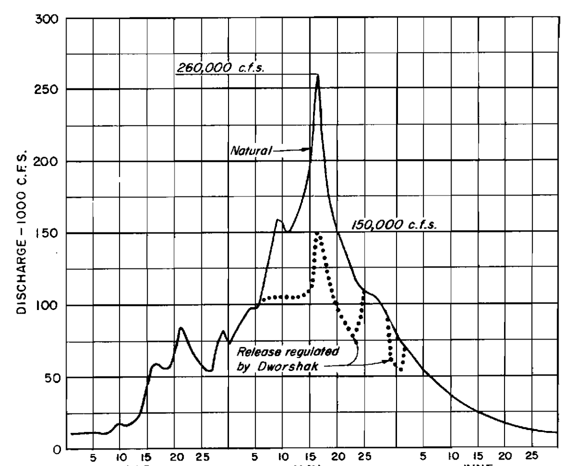
CONTRIBUTION FROM GRANDE RONDE RIVER AT TROY



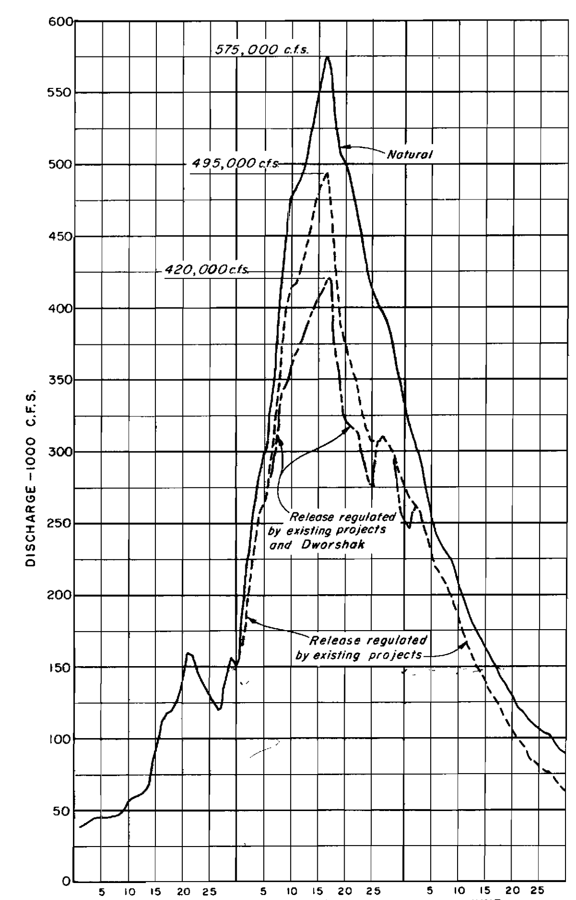
SCHEMATIC DIAGRAM OF MAJOR PROJECTS WITH FLOOD CONTROL STORAGE



STANDARD PROJECT FLOOD SNAKE RIVER ABOVE CLEARWATER RIVER CONFLUENCE



CLEARWATER RIVER STANDARD PROJECT FLOOD AT SPALDING



STANDARD PROJECT FLOOD-SNAKE RIVER AT LOWER GRANITE DAMSITE

BASIN	DRAINAGE AREA SQ. MI.
SNAKE RIVER AT BROWNLEE	72,500
SALMON RIVER AT WHITEBIRD	13,550
GRANDE RONDE AT TROY	3,275
UNGAGED AREA BETWEEN BROWNLEE AND CLEARWATER CONFLUENCE	4,175
SNAKE RIVER ABOVE CLEARWATER CONFLUENCE	93,500
CLEARWATER RIVER AT SPALDING	9,570
AREA BETWEEN SPALDING AND LOWER GRANITE DAMSITE (ASSUMED NON-CONTRIBUTING DURING FLOOD)	430
SNAKE RIVER AT LOWER GRANITE DAMSITE	103,500

NOTE

THE FLOODS SHOWN AS CONTRIBUTIONS FROM SNAKE RIVER AT BROWNLEE, SALMON RIVER AT WHITEBIRD, GRANDE RONDE RIVER AT TROY, AREA ON SNAKE RIVER BETWEEN BROWNLEE AND CLARKSTON, AND CLEARWATER RIVER AT SPALDING ARE NOT STANDARD PROJECT FLOODS FOR THE INDIVIDUAL AREAS BUT CONTRIBUTIONS FROM THESE AREAS TO THE LOWER SNAKE RIVER STANDARD PROJECT FLOODS.

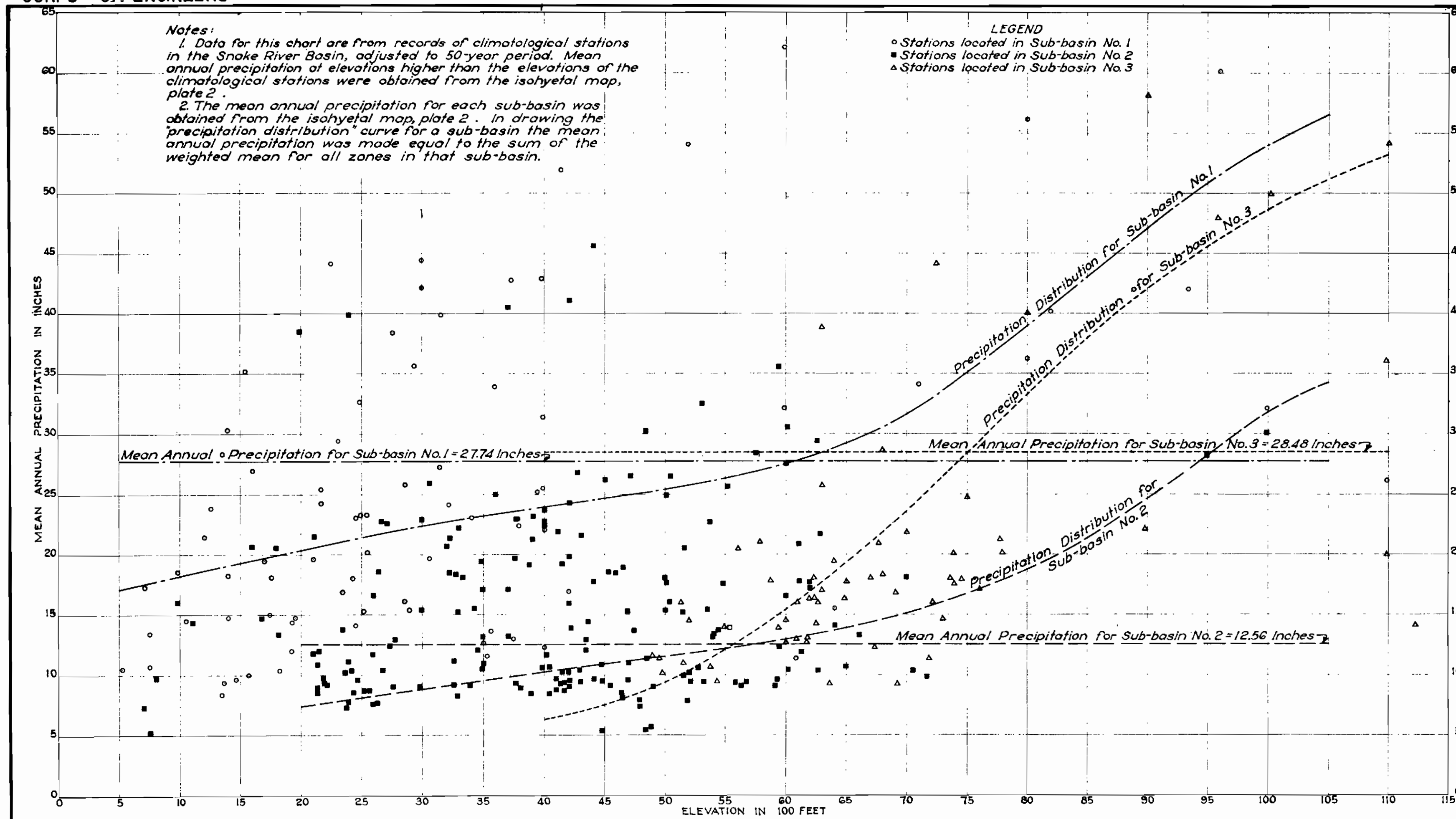
REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: Armacost
DRAWN: R.L.G.
CHECKED: Conway
SUPERVISED: [signature] CHIEF, WATER CONTROL SECT.

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, ORE., WASH. & IDA.
STANDARD PROJECT FLOODS AND CONTRIBUTIONS

SUBMITTED: Glenn H. Von Gunten, CHIEF, PROJECT PLANNING BRANCH
RECOMMENDED: E. C. [signature], CHIEF, ENGINEERING DIVISION
APPROVED: [signature], COLONEL, C. E. DISTRICT ENGINEER
DATE 22 Nov. 1963
SCALE AS SHOWN | INV. NO. ENG.
SHEET | FILE NO. GD-05-3/17



Notes:

1. *Data for this chart are from records of climatological stations in the Snake River Basin, adjusted to 50-year period. Mean annual precipitation at elevations higher than the elevations of the climatological stations were obtained from the isohyetal map, plate 2.*
2. *The mean annual precipitation for each sub-basin was obtained from the isohyetal map, plate 2. In drawing the "precipitation distribution" curve for a sub-basin the mean annual precipitation was made equal to the sum of the weighted mean for all zones in that sub-basin.*

FIG. 1 - PRECIPITATION - ELEVATION DISTRIBUTION GRAPH

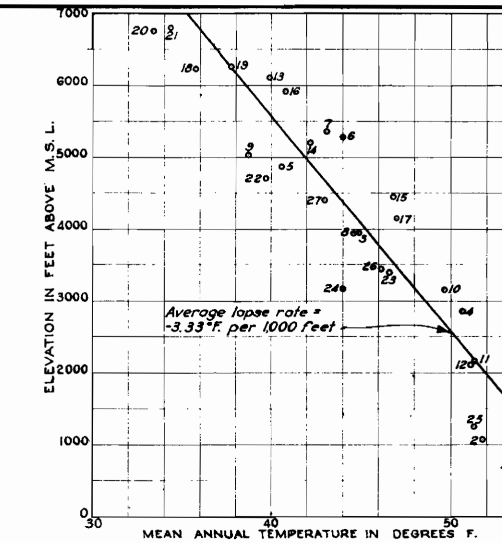


FIG. 2 - TEMPERATURE - ELEVATION CORRELATION

STATION INDEX			
No.	Location	No.	Location
1	Lewiston, Idaho	16	Mackay, Idaho
2	Orofino, "	17	Burley, "
3	Salmon, "	18	Afton, Wyo.
4	Boise, "	19	Jackson, "
5	Cascade, "	20	Moran, "
6	Challis, "	21	Snake River, Wyo.
7	Hailey, "	22	Alpha, Idaho
8	Idaho City, "	23	Grangeville, Idaho
9	Mc Call, "	24	Pierce, Idaho
10	Mountain Home, Idaho	25	Kooskia, "
11	Payette, Idaho	26	Baker, Oregon
12	Weiser, "	27	Joseph, "
13	Driggs, "		
14	Irwin, "		
15	Pocatello, "		

Note:

1. *Similar curves which were drawn for monthly mean temperatures of individual years indicated that the mean annual temperature lapse rate of -3.33 degrees F. per 1,000 feet is also representative of monthly mean temperature lapse rates.*

Sub-basin	Drainage Area in Sq. Mi.	Mean Annual Precip.	Factor from Curves	Max. 7-Month Precip.
No. 1	45,200	27.74	137	38.0
No 2	50,200	12.56	180	22.6
No. 3	8,800	28.48	147	41.9

Notes:

1. *Data for this graph were obtained from report titled "Tentative Estimates of Maximum Possible Flood Producing Meteorological conditions in the Columbia River Basin," by the Hydrometeorological Section of the U.S. Weather Bureau, dated January 25, 1945.*
2. *Maximum 7-month precipitation for each sub-basin is given in table above.*

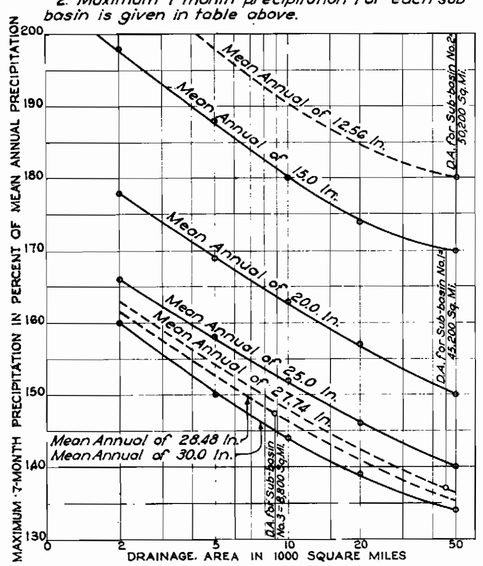


FIG. 3 - MAX. POSSIBLE 7-MONTH PRECIPITATION

Notes:

1. *Seven-month (Nov-May) precipitation was obtained for each year studied from U.S. Weather Bureau records at the following stations:*

Sub-basin No. 1

a. Baker, Oregon
b. Boise, Idaho
c. Challis, "
d. Grimes Pass, Idaho
e. Kooskia, Idaho
f. Orofino, "
g. Moscow, "
h. Salmon, "

Sub-basin No. 2

a. Idaho Falls, Idaho
b. Pocatello, "
c. Riverside, Oregon
d. Soldier's Creek, Idaho
e. Twin Falls, Idaho

Sub-basin No. 3

a. Afton, Wyoming
b. Moran, Wyoming

2. *The mean 7-month precipitation for each year in each sub-basin for stations studied was multiplied by the ratio of station mean annual to basin mean annual precipitation to obtain the 7-month precipitation for each year.*
3. *The annual run-off was obtained from U.S. Geological Survey records corrected for irrigation depletions and base flow.*

TABULATION OF LOSSES										
Sub-basin	Annual Losses			Oct. - Feb. Losses			Net Accumulation of Snow on Mar. 1	March - Sept. Losses		
	Max. 7-Month Precip., In.	Min. Loss Inches	Direct Run-off Inches	Ground-water Discharge, In.	Evap., Trans. and Soil Moisture, In.	Total		Ground-water Discharge, In.	Evap., Trans. and Soil Moisture, In.	Total
No. 1	38.0	20.2	17.8	2.1	3.2	5.3	32.7	3.8	11.1	14.9
No. 2	22.6	19.5	3.1	1.1	5.0	6.1	16.5	1.8	11.6	13.4
No. 3	41.9	16.8	25.1	1.8	2.5	4.3	37.6	6.6	5.9	12.5

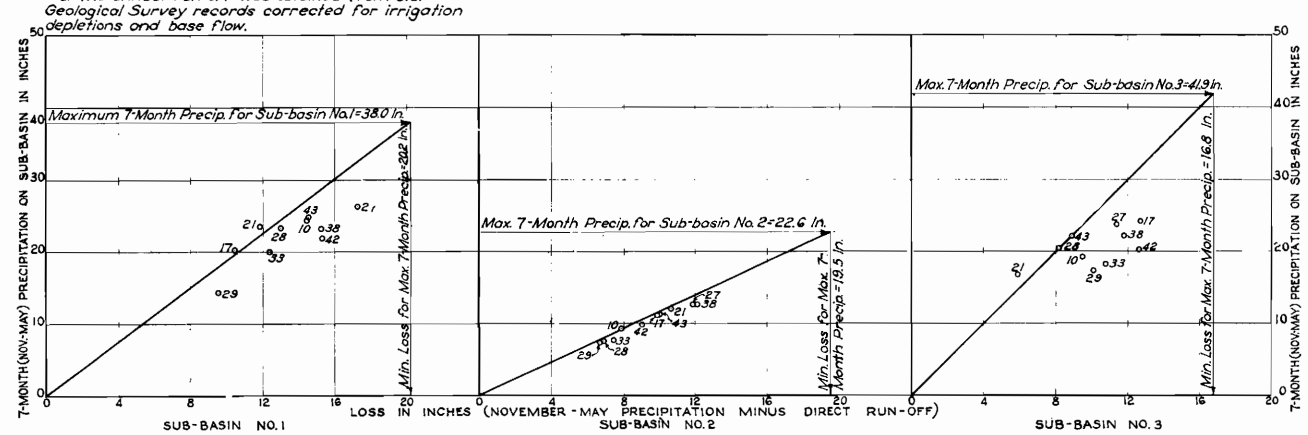
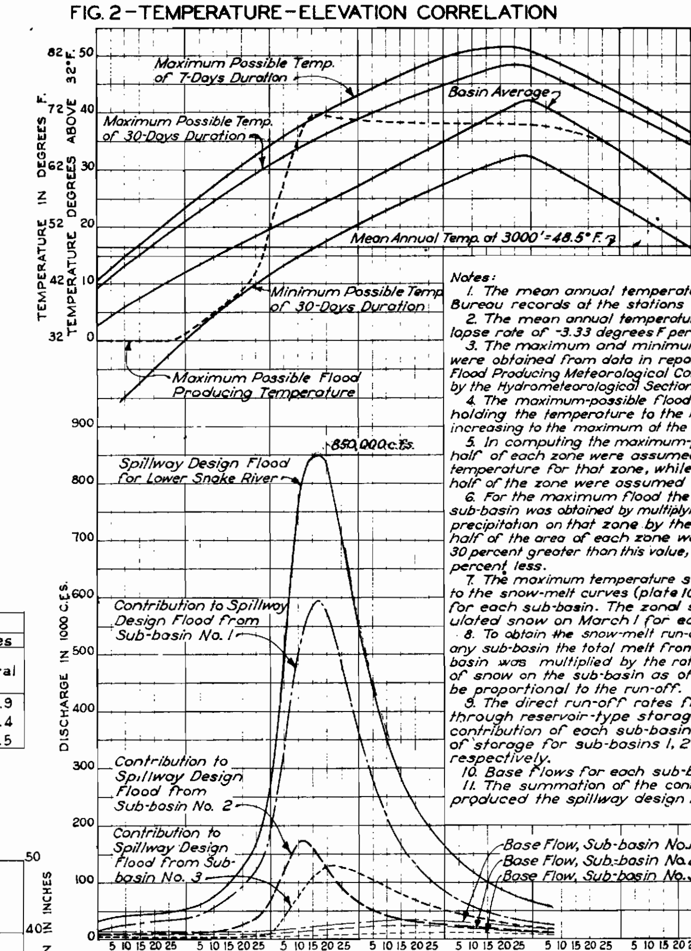


FIG. 4 - PRECIPITATION - LOSS CURVES



Notes:

1. *The mean annual temperature was determined from U.S. Weather Bureau records at the stations listed in table of figure 2.*
2. *The mean annual temperature for each station was adjusted by the lapse rate of -3.33 degrees F per 1,000 feet to obtain the mean at 3,000 ft.*
3. *The maximum and minimum possible temperature envelope curves were obtained from data in report titled, "Tentative Estimates of Maximum Flood Producing Meteorological Conditions in the Columbia River Basin," by the Hydrometeorological Section of the U.S. Weather Bureau.*
4. *The maximum-possible flood producing temperature sequence is holding the temperature to the minimum up to the last week in April, and increasing to the maximum at the beginning of the third week in May.*
5. *In computing the maximum-possible flood the temperatures for one-half of each zone were assumed to be 2 degrees F above the mean temperature for that zone, while the temperatures for the other one-half of the zone were assumed to be 2 degrees F below the mean.*
6. *For the maximum flood the accumulated snow on each zone in a sub-basin was obtained by multiplying the percent of the mean annual precipitation on that zone by the accumulated snow as of March 1. One-half of the area of each zone was assumed to have snow accumulated 30 percent greater than this value, while the other half was assumed 30 percent less.*
7. *The maximum temperature sequence was applied by 5-day periods to the snow-melt curves (plate 10, figures 2, 3, & 4) commencing with March 1 for each sub-basin. The zonal snow melt continued until the accumulated snow on March 1 for each zone was melted.*
8. *To obtain the snow-melt run-off rates during the flood period from any sub-basin the total melt from all contributing zones in that sub-basin was multiplied by the ratio of direct run-off to water equivalent of snow on the sub-basin as of March 1. Losses were assumed to be proportional to the run-off.*
9. *The direct run-off rates from each sub-basin were routed through reservoir-type storage by Snyder's method to obtain the contribution of each sub-basin to the spillway design flood. The times of storage for sub-basins 1, 2 and 3 are 7.5, 8.8, and 10 days respectively.*
10. *Base flows for each sub-basin were added as shown.*
11. *The summation of the contributions from each sub-basin produced the spillway design flood for the lower Snake River.*

FIG. 5 - SPILLWAY DESIGN FLOOD

REVISION	DATE	DESCRIPTION	BY

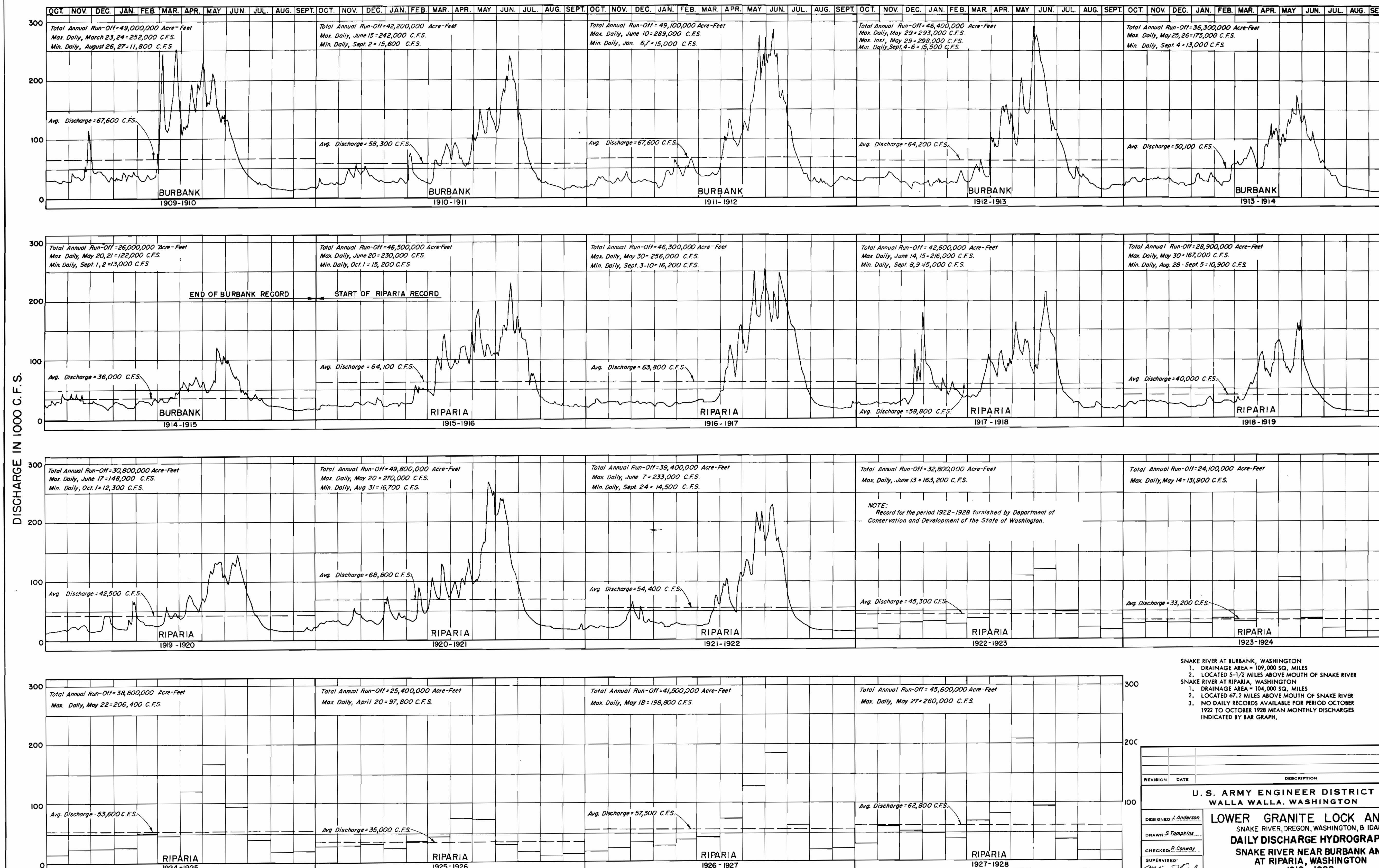
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: C.D., D.M.R., & J.A.A.
DRAWN: S. Tompkins
CHECKED: R. H. Conway
SUPERVISED: [signature] CHIEF, WATER CONTROL SECT.

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO

SPILLWAY DESIGN FLOOD

SUBMITTED: Glenn H. Von Gunten, CHIEF, PROJECT PLANNING BRANCH
RECOMMENDED: E. C. Franzen, CHIEF, ENGINEERING DIVISION
APPROVED: [signature] COLONEL, C. E. DISTRICT ENGINEER — DATE 22 Nov 1963
SCALE AS SHOWN — INV. NO. ENG.
SHEET — FILE NO. GD-05-3/20



SNAKE RIVER AT BURBANK, WASHINGTON
1. DRAINAGE AREA = 109,000 SQ. MILES
2. LOCATED 5-1/2 MILES ABOVE MOUTH OF SNAKE RIVER

SNAKE RIVER AT RIPARIA, WASHINGTON
1. DRAINAGE AREA = 104,000 SQ. MILES
2. LOCATED 67.2 MILES ABOVE MOUTH OF SNAKE RIVER
3. NO DAILY RECORDS AVAILABLE FOR PERIOD OCTOBER 1922 TO OCTOBER 1928 MEAN MONTHLY DISCHARGES INDICATED BY BAR GRAPH.

REVISION	DATE	DESCRIPTION	BY

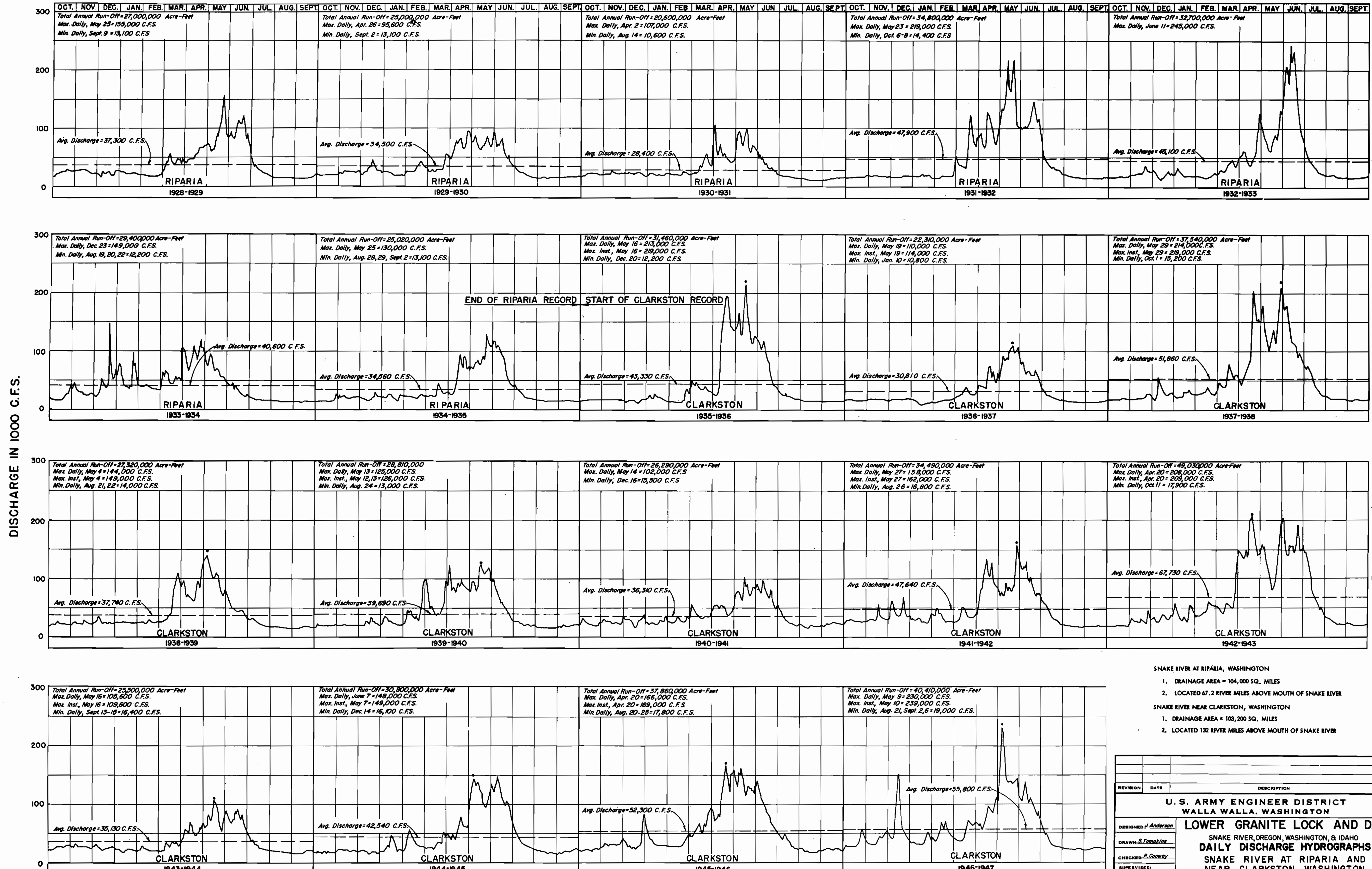
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: J. Anderson
DRAWN: S. Tompkins
CHECKED: R. Conway
SUPERVISED: [signature] CHIEF, WATER CONTROL SECT.

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON, & IDAHO

DAILY DISCHARGE HYDROGRAPHS
SNAKE RIVER NEAR BURBANK AND AT RIPARIA, WASHINGTON
1910–1928

SUBMITTED: Glenn H. Von Gunten, CHIEF PROJECT PLANNING BRANCH
APPROVED: [signature] COLONEL, C. E. DISTRICT ENGINEER DATE 22 Nov. 1963
RECOMMENDED: E. C. [signature], CHIEF, ENGINEERING DIVISION
SCALE AS SHOWN | INV. NO. ENG.
SHEET | FILE NO. GD-05-3/6



SNAKE RIVER AT RIPARIA, WASHINGTON

1. DRAINAGE AREA = 104,000 SQ. MILES
2. LOCATED 67.2 RIVER MILES ABOVE MOUTH OF SNAKE RIVER

SNAKE RIVER NEAR CLARKSTON, WASHINGTON

1. DRAINAGE AREA = 103,200 SQ. MILES
2. LOCATED 132 RIVER MILES ABOVE MOUTH OF SNAKE RIVER

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: J. Anderson
DRAWN: S. Tompkins
CHECKED: R. Conway
SUPERVISED: [signature] CHIEF, WATER CONTROL SECT.

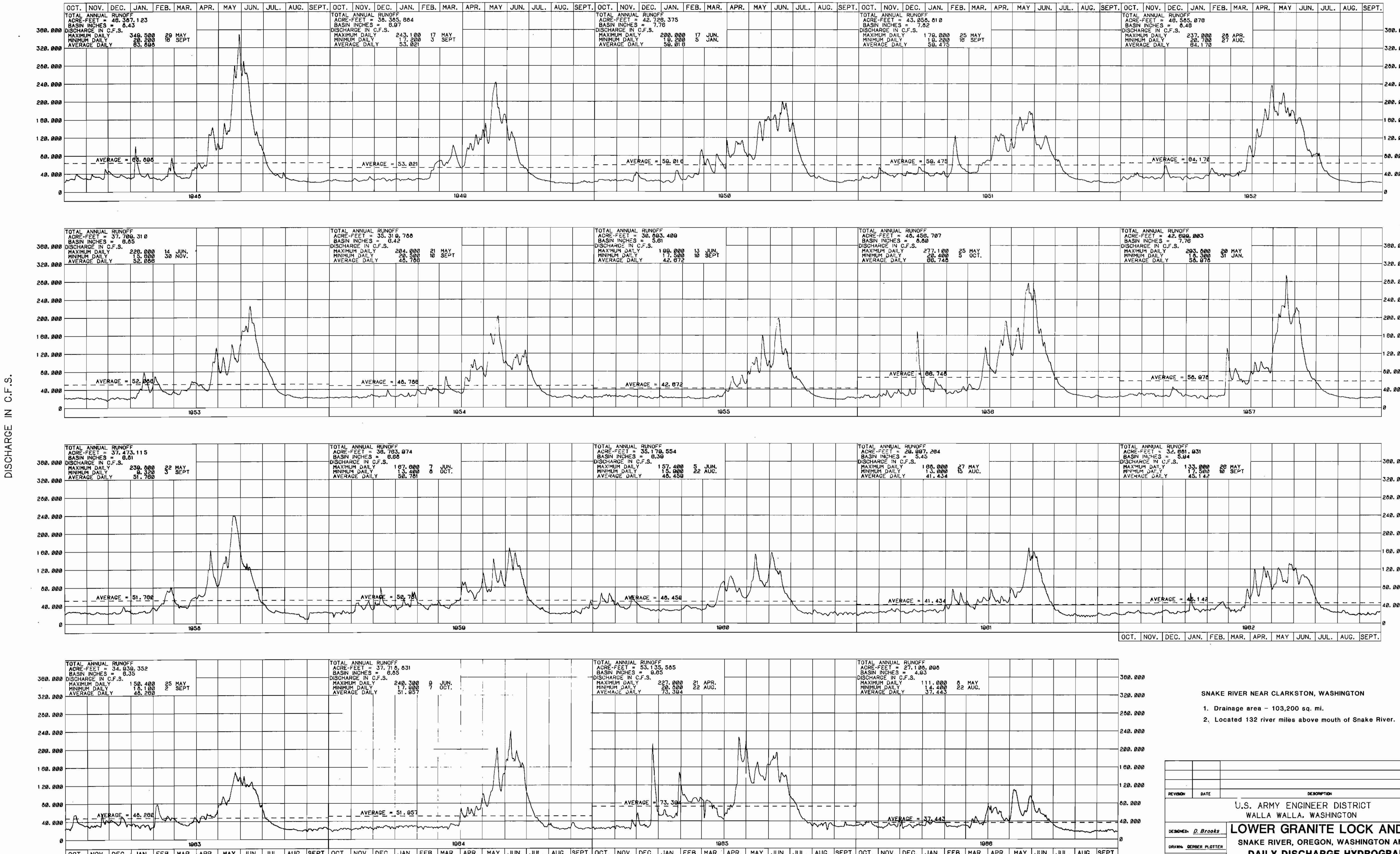
LOWER GRANITE LOCK AND DAM

SNAKE RIVER, OREGON, WASHINGTON, & IDAHO

DAILY DISCHARGE HYDROGRAPHS

SNAKE RIVER AT RIPARIA AND NEAR CLARKSTON, WASHINGTON
1929 – 1947

SUBMITTED: Glenn B. Von Gunten, CHIEF, PROJECT PLANNING BRANCH
RECOMMENDED: E. C. [signature], CHIEF, ENGINEERING DIVISION
APPROVED: [signature], COLONEL, C. E. DISTRICT ENGINEER — DATE 22 Nov. 1963
SCALE AS SHOWN — INV. NO. ENG.
SHEET — FILE NO. GD-05-3/7



SNAKE RIVER NEAR CLARKSTON, WASHINGTON

1. Drainage area – 103,200 sq. mi.
2. Located 132 river miles above mouth of Snake River.

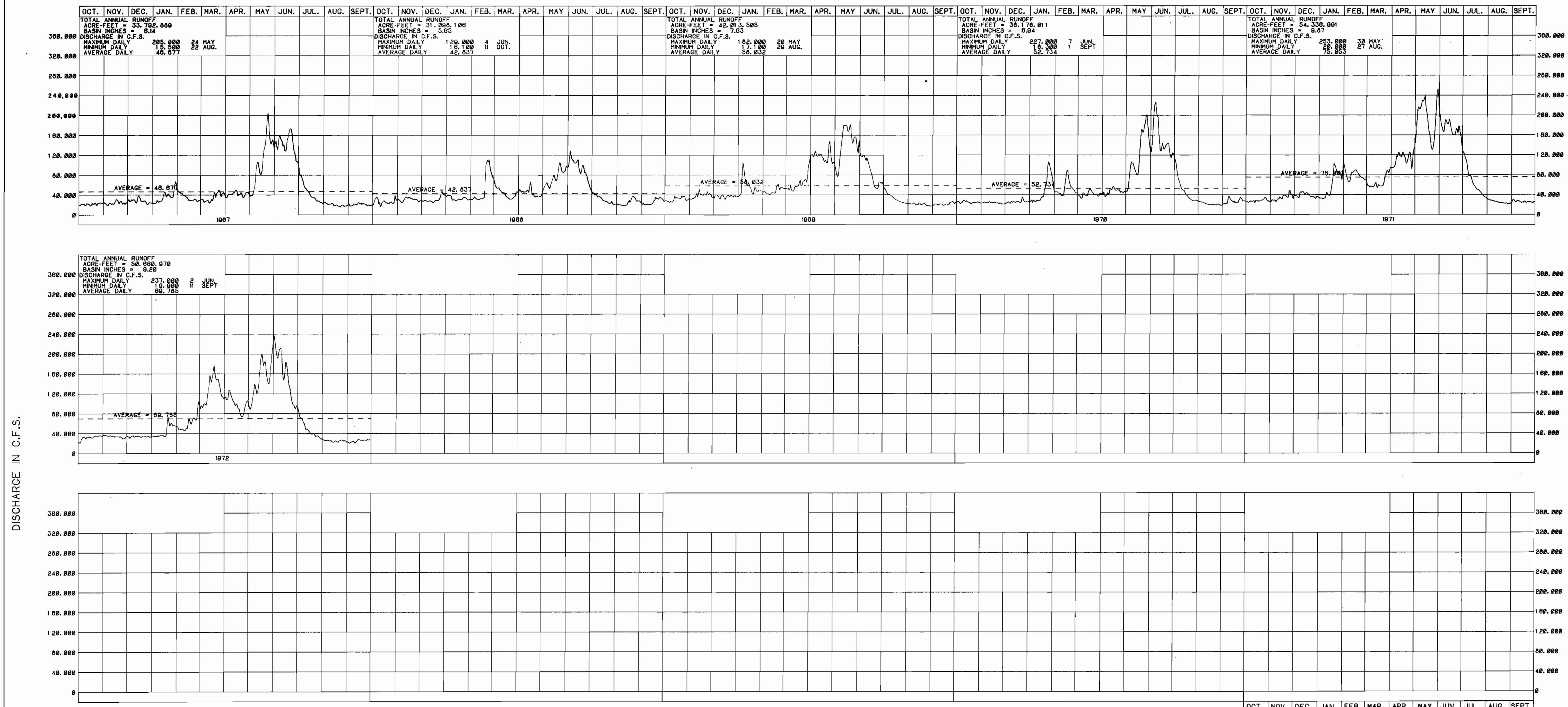
REVISION	DATE	DESCRIPTION	BY

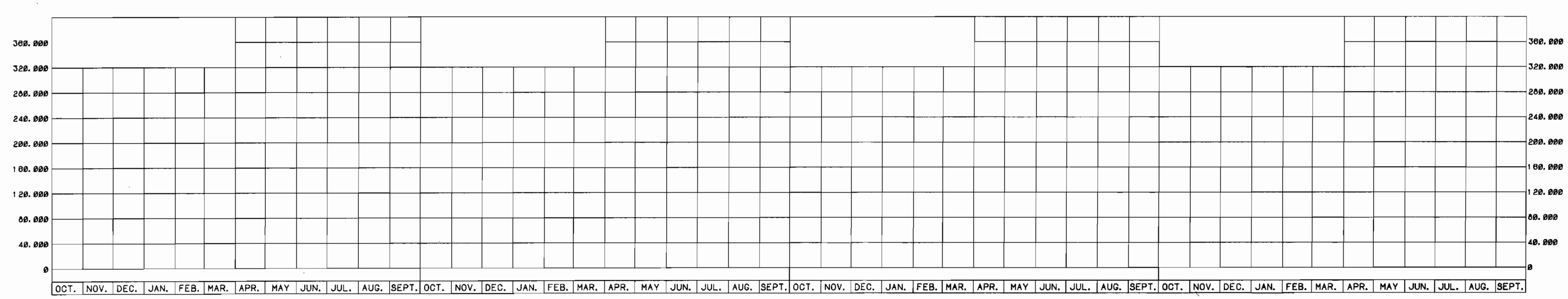
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: D. Brooks
DRAWN: GERBER PLOTTER
CHECKED: E. Kim
PREPARED:

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
DAILY DISCHARGE HYDROGRAPHS
SNAKE RIVER NEAR CLARKSTON, WASH.
1948 – 1966

SUPERVISED: R.E. Richel — CHIEF, HYDROLOGY BRANCH
SUBMITTED: [signature] — CHIEF, PLANNING DIVISION
APPROVED: DATE:
SCALE AS SHOWN | INV. NO. ENG. | FILE NO.
SHEET





SNAKE RIVER NEAR CLARKSTON, WASHINGTON

1. Drainage area – 103.200 sq. mi.
2. Located 132 river miles above mouth of Snake River.
3. December 1972 gage discontinued.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: D. Brooks
DRAWN: GERBER PLOTTER
CHECKED: E. Kim
PREPARED:

LOWER GRANITE LOCK AND DAM

SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

DAILY DISCHARGE HYDROGRAPHS

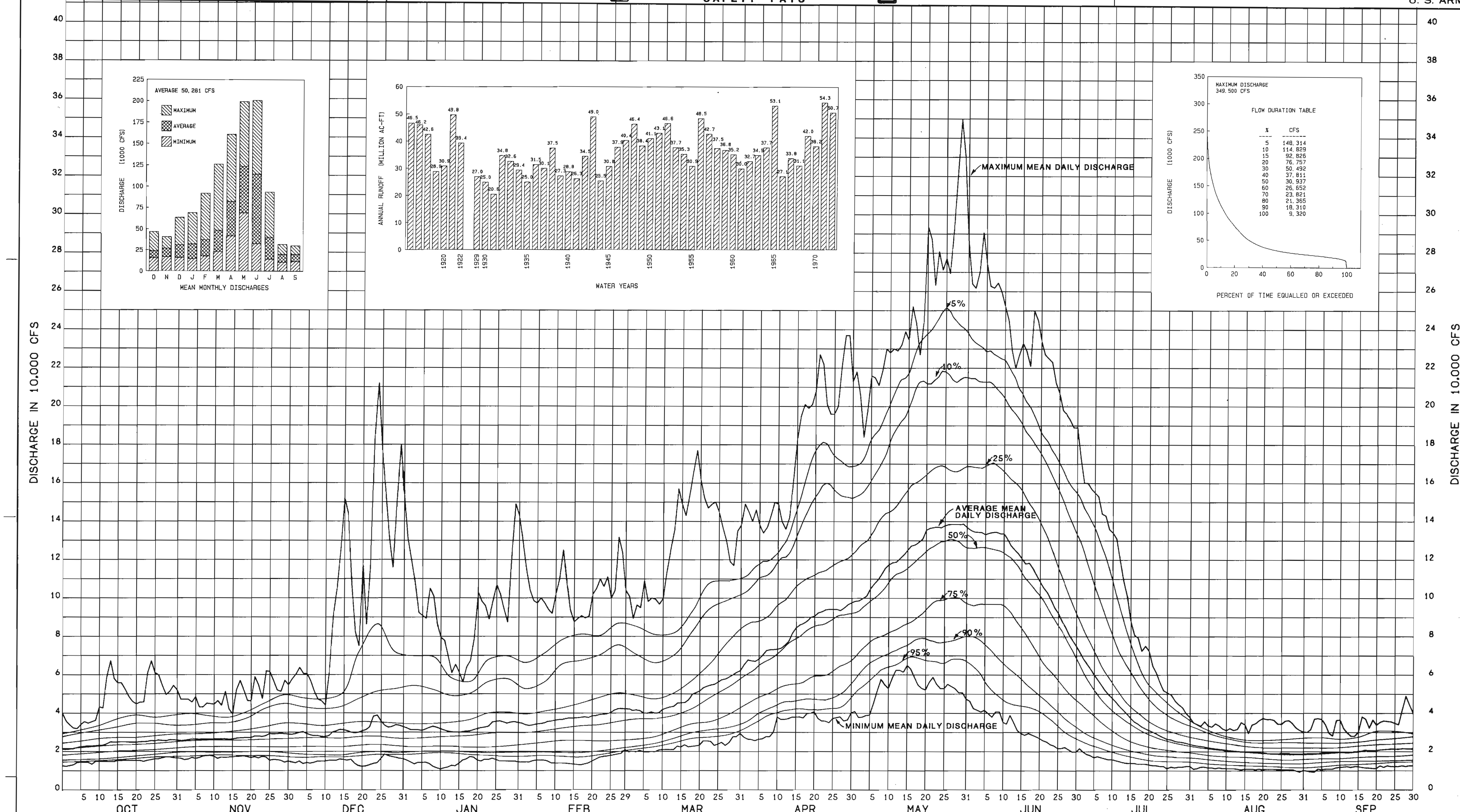
SNAKE RIVER NEAR CLARKSTON, WASH.

1967 – 1972

SUPERVISED: [signature]
CHIEF, HYDROLOGY BRANCH
SUBMITTED: (actg) [signature]
CHIEF, PLANNING DIVISION

APPROVED: DATE

SCALE AS SHOWN | INV. NO. ENG. | FILE NO. | SHEET



NOTES:

1. RECORDS USED:
   a. WATER YEARS 1916-1922 AND 1929-1935, OBSERVED DISCHARGES AT RIPARIA, WASHINGTON. DRAINAGE AREA IS 104,000 SQUARE MILES.
   b. WATER YEARS 1936-1972, OBSERVED DISCHARGES AT CLARKSTON, WASHINGTON. DRAINAGE AREA IS 103,200 SQUARE MILES.
   c. DISCHARGE RECORDS USED ARE FROM DATA PUBLISHED BY U.S.G.S.
2. DISCHARGE RECORDS AT CLARKSTON AND RIPARIA HAVE BEEN CONSIDERED COMPARABLE AND HAVE BEEN USED WITHOUT CORRECTIONS FOR INCIDENTAL INFLOW BETWEEN THESE STATIONS.
3. DISCHARGES USED ARE THOSE OBSERVED AT THE TIME AND REFLECT VARYING EFFECTS OF PROGRESSIVE IRRIGATION AND RESERVOIR STORAGE DEVELOPMENTS.
4. CURVES OF PERCENT CHANCE OF OCCURRENCE REPRESENT THE AVERAGE DAILY DISCHARGE FOR THAT DAY. A POINT ON AN EXCEEDENCE CURVE REPRESENTS THE AVERAGE DAILY DISCHARGE FOR A SPECIFIC DAY WHICH HAS BEEN EXCEEDED THE GIVEN PERCENTAGE OF TIME.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

WATER YEAR	DATE	CFS		WATER YEAR	DATE	CFS
1916	JUN 20	230,000		1942	MAY 27	158,000
1917	MAY 30	256,000		1943	APR 20	208,000
1918	JUN 14	216,000		1944	MAY 16	105,600
1919	MAY 30	167,000		1945	JUN 7	148,000
1920	JUN 17	148,000		1946	APR 20	166,000
1921	MAY 20	270,000		1947	MAY 9	23,000
1922	JUN 7	233,000		1948	MAY 29	349,500
1929	MAY 25	155,000		1949	MAY 17	243,100
1930	APR 26	95,600		1950	JUN 17	200,000
1931	APR 2	107,000		1951	MAY 25	179,000
1932	MAY 23	219,000		1952	APR 28	237,000
1933	JUN 11	245,000		1953	JUN 14	226,000
1934	DEC 23	149,000		1954	MAY 21	204,000
1935	MAY 25	130,000		1955	JUN 13	199,000
1937	MAY 19	110,000		1956	MAY 25	277,100
1938	MAY 29	214,000		1957	MAY 20	293,800
1939	MAY 4	144,000		1958	MAY 22	239,800
1940	MAY 13	125,000		1959	JUN 7	167,600
1941	MAY 14	102,000		1960	JUN 5	157,400

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

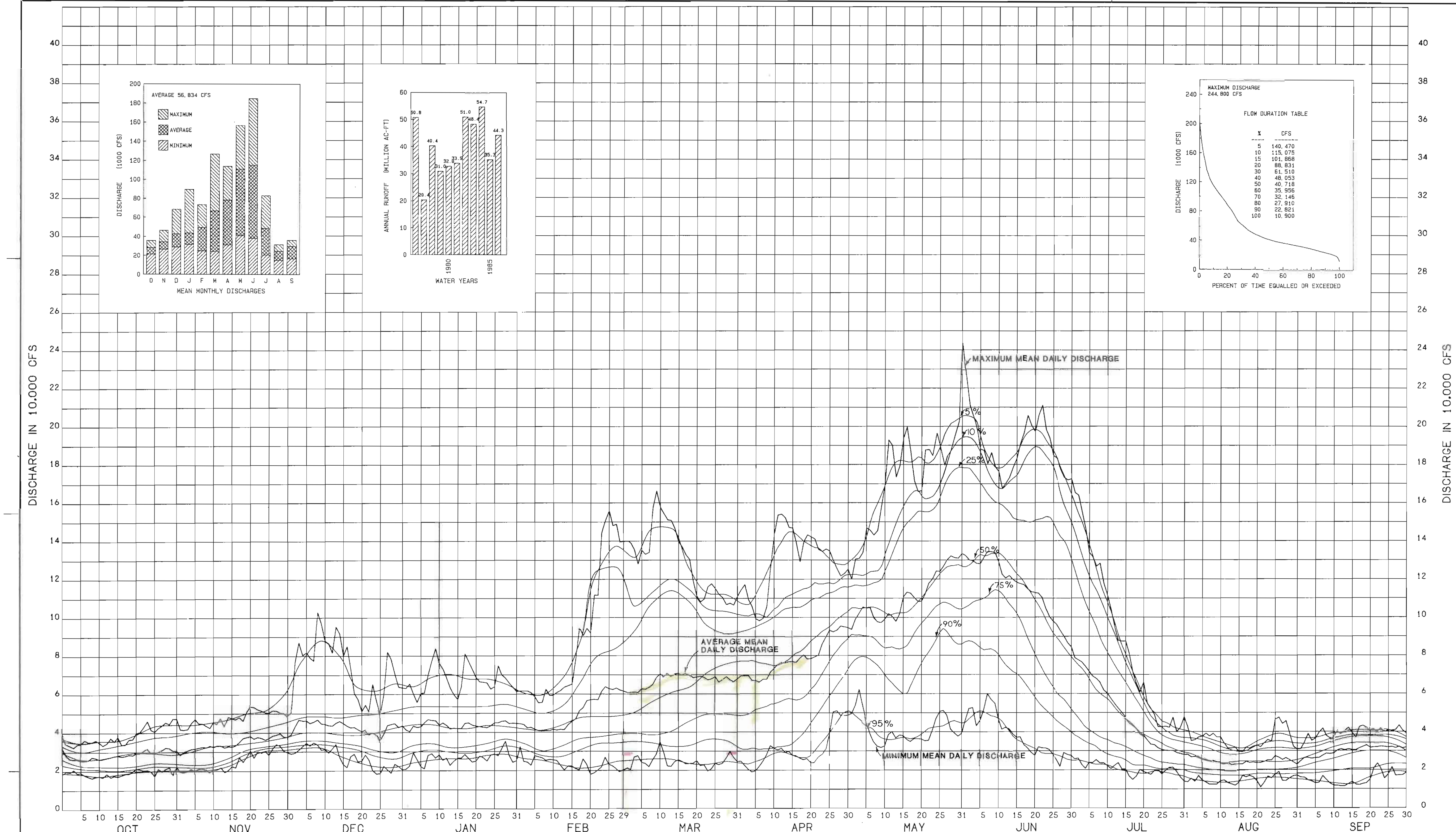
WATER YEAR	DATE	CFS		WATER YEAR	DATE	CFS
1961	MAY 27	168,000				
1963	MAY 25	150,400				
1964	JUN 9	240,300				
1965	APR 21	227,000				
1966	MAY 8	111,000				
1967	MAY 24	205,000				
1968	JUN 4	129,000				
1969	MAY 20	182,000				
1970	JUN 7	227,000				
1971	MAY 30	253,000				
1972	JUN 2	237,000				

REVISION	DATE	DESCRIPTION	CHKD	APPR

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON, & IDAHO
SUMMARY HYDROGRAPHS
SNAKE RIVER NEAR CLARKSTON, WASH.

D. Brooks — DESIGNED BY
Gerber Plotter — DRAWN BY
E. Kim — CHECKED BY
SUPERVISED: [signature] CHIEF HYDROLOGY BR
SUBMITTED: (Acting) Brian Beechie — CHIEF PLANNING DIVISION
RECOMMENDED: CHIEF
APPROVED DATE
SCALE AS SHOWN | INV. NO.
SHEET NO | FILE NO



NOTES:

1. RECORDS USED:
   WATER YEARS MARCH 1975-1986, LOWER GRANITE REGULATED INFLOWS COMPUTED BY THE CORPS OF ENGINEERS, WALLA WALLA DISTRICT.
2. DRAINAGE AREA IS 103,500 SQUARE MILES.
3. COMPUTED REGULATED INFLOWS REFLECT THE EFFECTS OF UPSTREAM IRRIGATION AND RESERVOIR STORAGE.
4. CURVES OF PERCENT CHANCE OF OCCURRENCE REPRESENT THE AVERAGE FLOW FOR THAT DAY. A POINT ON AN EXCEEDENCE CURVE REPRESENTS THE AVERAGE DAILY DISCHARGE FOR A SPECIFIC DAY WHICH HAS BEEN EXCEEDED THE GIVEN PERCENTAGE OF TIME.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

WATER YEAR	DATE	CFS		WATER YEAR	DATE	CFS
1976	MAY 11	192,800				
1977	MAY 3	62,200				
1978	JUN 9	148,800				
1979	MAY 25	141,200				
1980	JUN 13	133,200				
1981	JUN 10	176,100				
1982	JUN 18	205,600				
1983	MAY 29	194,300				
1984	MAY 31	244,800				
1985	JUN 8	124,400				
1986	JUN 1	211,000				

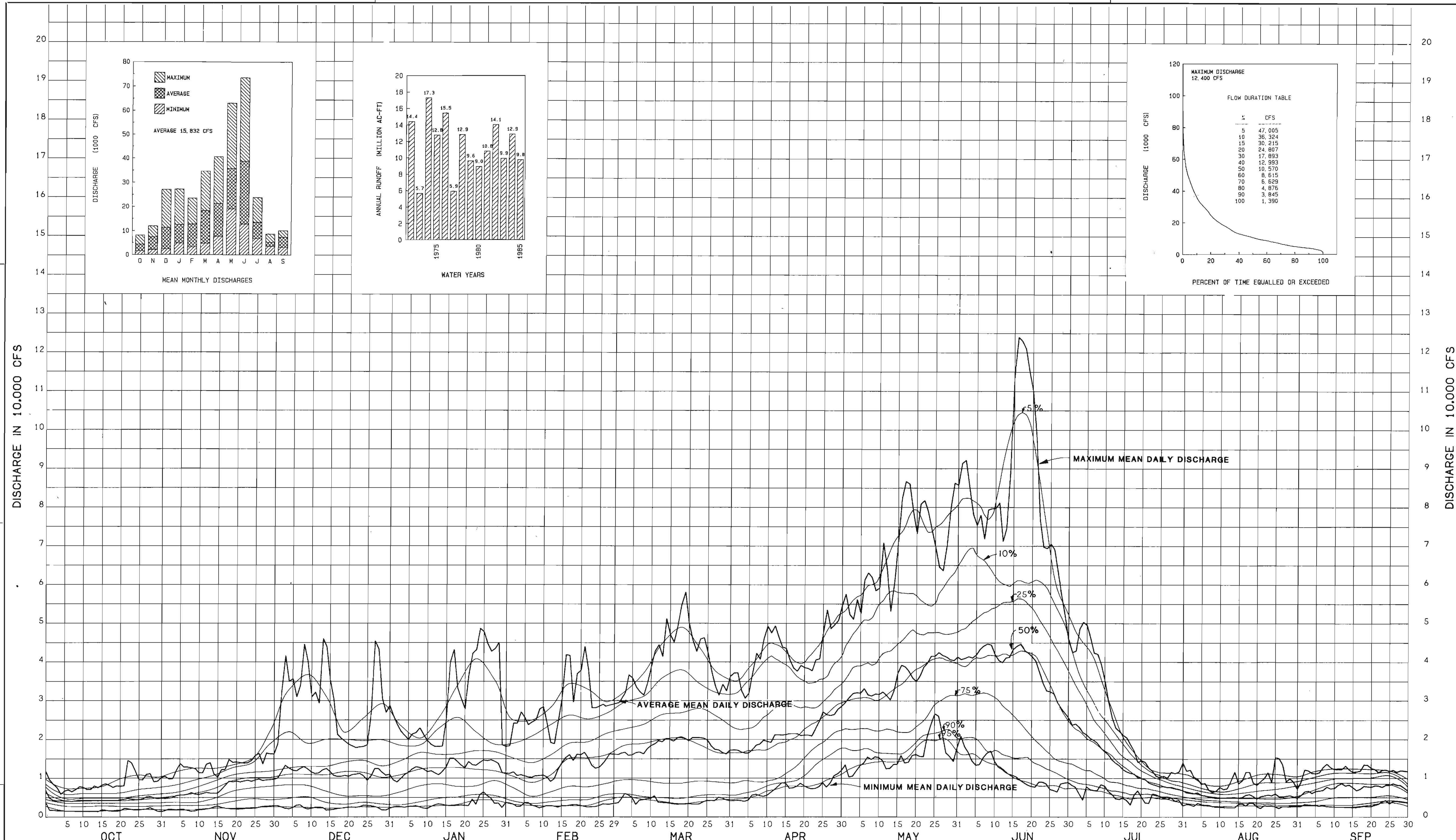
REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: D. Brooks
DRAWN: Gerber Plotter
CHECKED: E. Kim
SUPERVISED: [signature] CHIEF HYDROLOGY BR
SUBMITTED: (acting) Brian J. Beckie CHIEF, PLANNING DIVISION

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON, & IDAHO
SUMMARY HYDROGRAPHS
LOWER GRANITE RESERVOIR
COMPUTED REGULATED INFLOWS

DATE
SCALE AS SHOWN | INV. NO.
FILE NO.
SHEET



NOTES:

1. RECORDS USED:
   WATER YEARS 1972-1985, OBSERVED DISCHARGES FOR THE CLEARWATER RIVER AT SPALDING, IDAHO.
   DISCHARGE RECORDS USED ARE FROM DATA PUBLISHED BY U.S.G.S.
2. DRAINAGE AREA IS 9,570 SQUARE MILES.
3. CURVES OF PERCENT CHANCE OF OCCURRENCE REPRESENT THE AVERAGE FLOW FOR THAT DAY. A POINT ON AN EXCEEDENCE CURVE REPRESENTS THE AVERAGE DAILY DISCHARGE FOR A SPECIFIC DAY WHICH HAS BEEN EXCEEDED THE GIVEN PERCENTAGE OF TIME.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES						
WATER YEAR	DATE	CFS		WATER YEAR	DATE	CFS
1972	JUN 2	92,200				
1973	MAY 18	34,200				
1974	JUN 16	124,000				
1975	JUN 3	74,200				
1976	MAY 11	70,800				
1977	MAY 3	28,500				
1978	JUN 7	54,000				
1979	MAY 24	60,700				
1980	MAY 26	48,200				
1981	JUN 20	64,000				
1982	JUN 17	62,500				
1983	MAY 28	54,800				
1984	MAY 31	75,700				
1985	JUN 8	55,100				

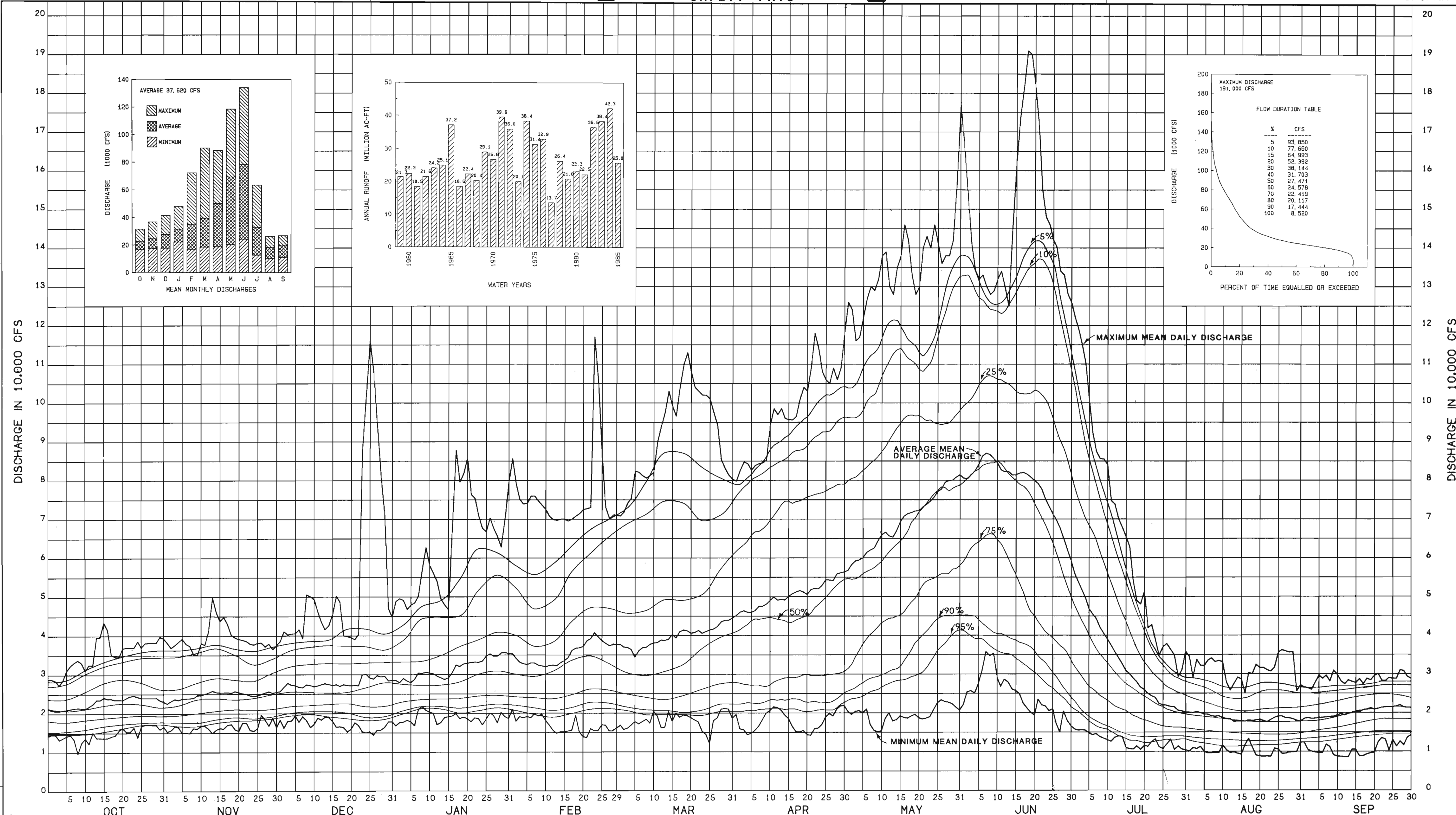
REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: D. Brooks
DRAWN: Gerber Plotter
CHECKED: E. Kim
SUPERVISED: K. Kuehl
CHIEF, HYDROLOGY BRANCH
SUBMITTED: (acting) Brian Beechie
CHIEF, PLANNING DIVISION

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, ORE., WASH. AND IDAHO
SUMMARY HYDROGRAPHS
CLEARWATER RIVER AT SPALDING, IDAHO
REGULATED DISCHARGE

DATE
SCALE AS SHOWN
INV. NO.
FILE NO.
SHEET



NOTES:

1. RECORDS USED:
   WATER YEARS 1959-1985, OBSERVED DISCHARGES FOR SNAKE RIVER NEAR ANATONE, WASHINGTON.
   DISCHARGE RECORDS USED ARE FROM DATA PUBLISHED BY U.S.G.S.
2. DRAINAGE AREA IS 92,960 SQUARE MILES.
3. DISCHARGES USED ARE THOSE OBSERVED AT THE TIME AND REFLECT VARYING EFFECTS OF PROGRESSIVE IRRIGATION AND RESERVOIR STORAGE DEVELOPMENTS.
4. CURVES OF PERCENT CHANCE OF OCCURRENCE REPRESENT THE AVERAGE DAILY DISCHARGE FOR THAT DAY. A POINT ON AN EXCEEDENCE CURVE REPRESENTS THE AVERAGE DAILY DISCHARGE FOR A SPECIFIC DAY WHICH HAS BEEN EXCEEDED THE GIVEN PERCENTAGE OF TIME.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

WATER YEAR	DATE	CFS		WATER YEAR	DATE	CFS
1959	JUN 8	89,800		1976	MAY 15	122,000
1960	JUN 5	88,200		1977	JUN 7	36,000
1961	JUN 3	81,600		1978	JUN 9	93,000
1962	MAY 26	74,500		1979	MAY 25	78,600
1963	JUN 17	99,100		1980	JUN 12	92,400
1964	JUN 17	117,000		1981	JUN 10	120,000
1965	MAY 1	126,000		1982	JUN 18	145,000
1966	MAY 30	52,200		1983	MAY 31	148,000
1967	JUN 22	114,000		1984	MAY 31	177,000
1968	JUN 4	71,300		1985	APR 11	81,200
1969	MAY 20	109,000				
1970	JUN 7	130,000				
1971	MAY 30	147,000				
1972	JUN 2	135,000				
1973	MAY 19	61,800				
1974	JUN 18	191,000				
1975	JUN 8	118,000				

REVISION	DATE	DESCRIPTION	CHKD	APPR

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM

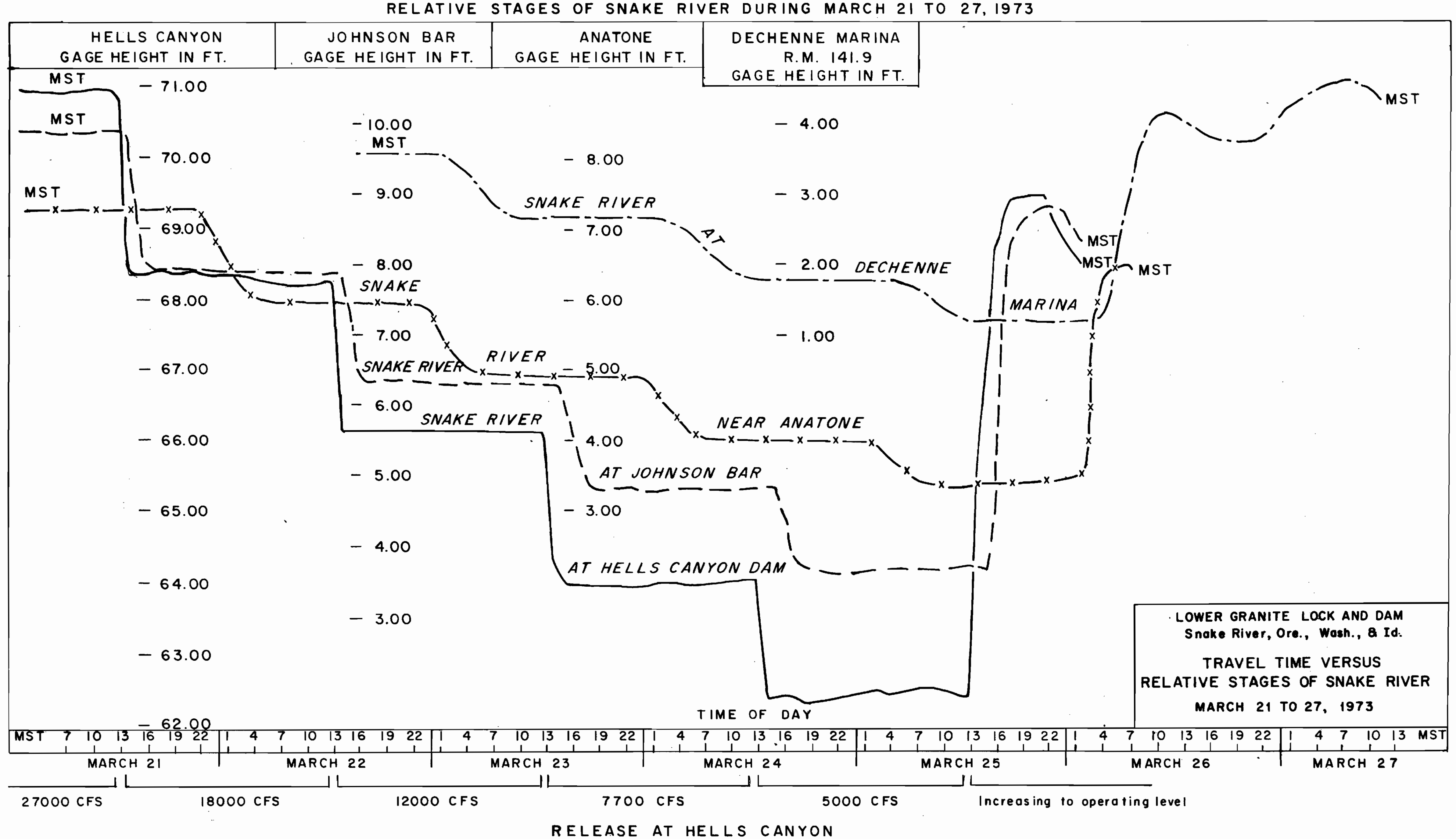
SNAKE RIVER, OREGON, WASHINGTON, & IDAHO

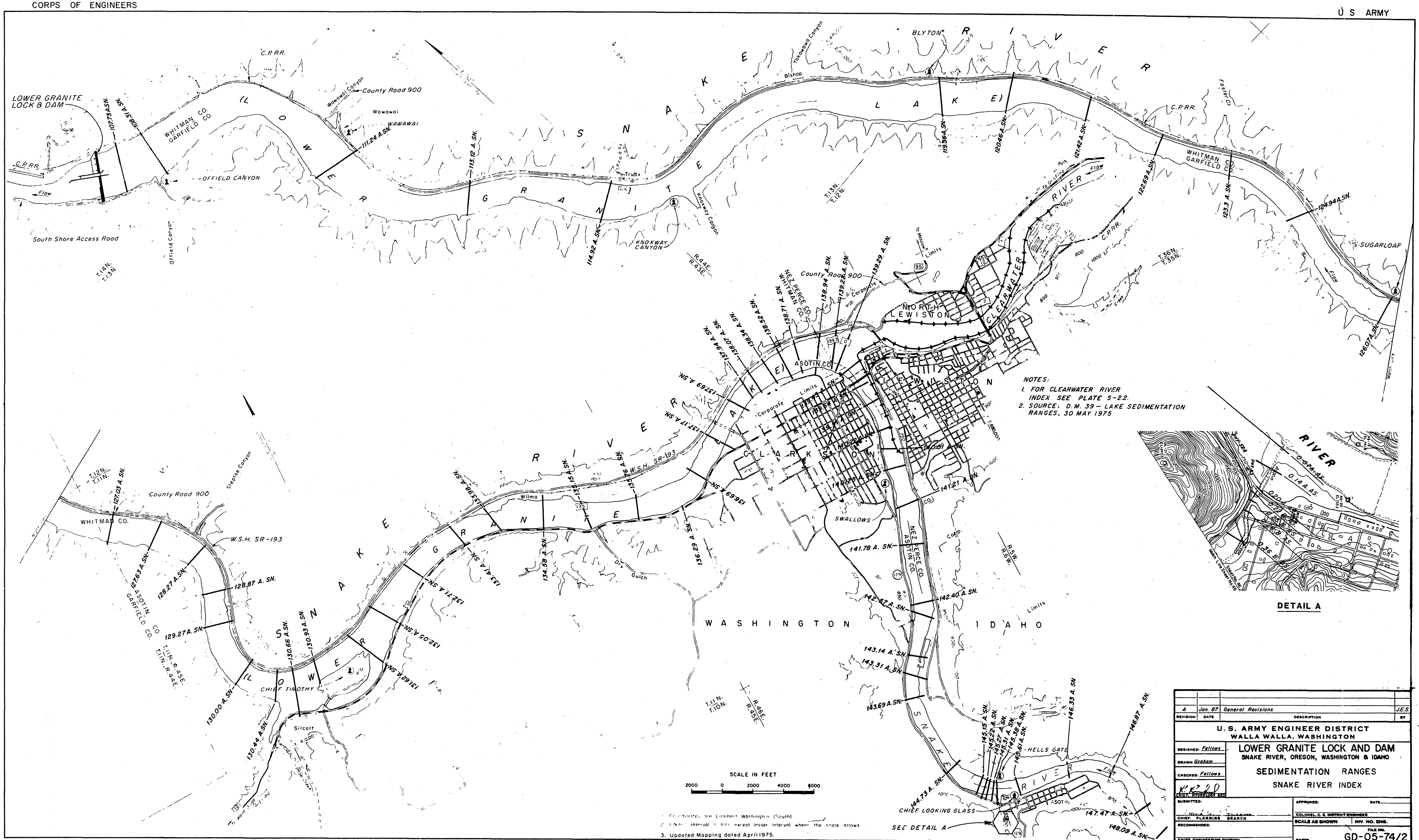
SUMMARY HYDROGRAPHS

SNAKE RIVER NEAR ANATONE, WASH.
REGULATED DISCHARGE

D. BROOKS — DESIGNED BY
Gerber Plotter — DRAWN BY
E. KIM — CHECKED BY
SUPERVISED: R S Kuhl — CHIEF HYDROLOGY BR
SUBMITTED: (acting) Brian Beechie — CHIEF PLANNING DIVISION
RECOMMENDED: — CHIEF
APPROVED — DATE
SCALE AS SHOWN — INV. NO.
SHEET NO — FILE NO

RELATIVE STAGES OF SNAKE RIVER DURING MARCH 21 TO 27, 1973





A	Jan. 87	General Revisions	J.E.S.
REVISION	DATE	DESCRIPTION	BY

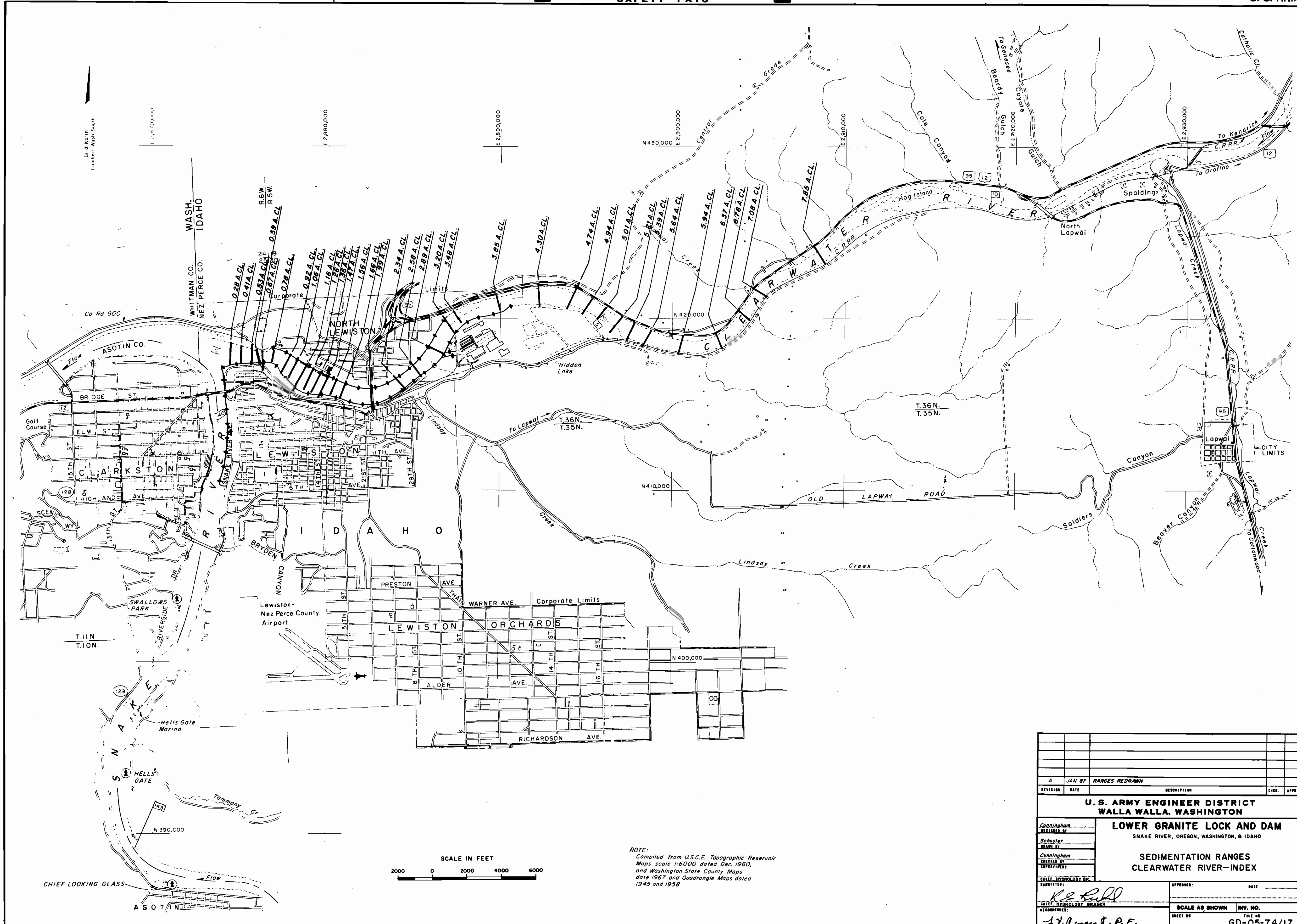
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED: Fellows
DRAWN: Graham
CHECKED: Fellows

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO

SEDIMENTATION RANGES
SNAKE RIVER INDEX

CHIEF, HYDROLOGY SEC.
SUBMITTED:
CHIEF, PLANNING BRANCH
RECOMMENDED:
CHIEF, ENGINEERING DIVISION
APPROVED: DATE:
COLONEL, C. E. DISTRICT ENGINEER
SCALE AS SHOWN | INV. NO. ENG.
SHEET | FILE NO. GD-05-74/2



NOTE:
Compiled from U.S.C.E. Topographic Reservoir Maps scale 1:6000 dated Dec. 1960, and Washington State County Maps date 1967 and Quadrangle Maps dated 1945 and 1958

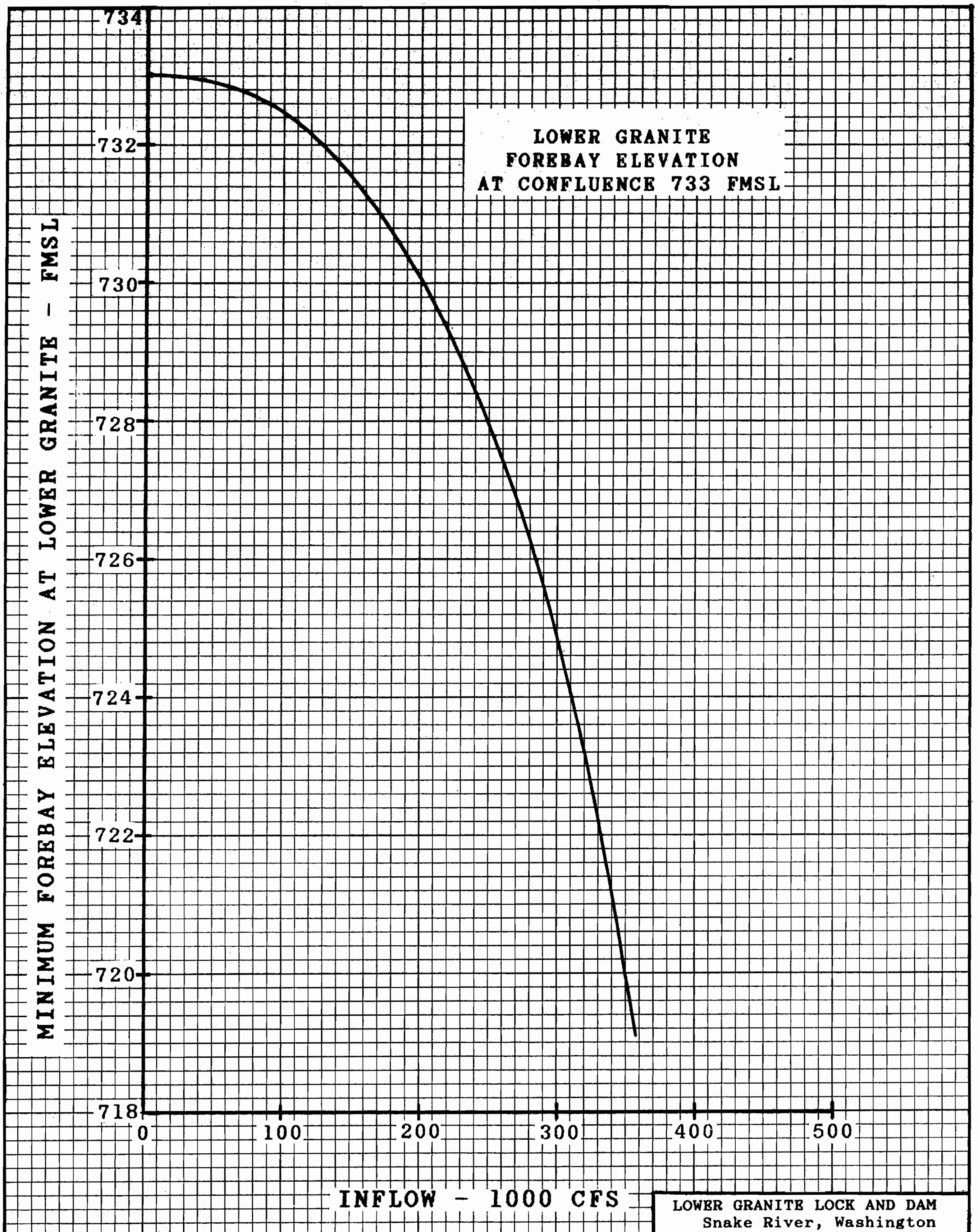
REVISION	DATE	DESCRIPTION
A	JAN 87	RANGES REDRAWN

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON, & IDAHO

SEDIMENTATION RANGES
CLEARWATER RIVER-INDEX

Designed by: Cunningham
Drawn by: Schuster
Checked by: Cunningham
Chief, Hydrology Branch
Chief, Planning Division: L.Y. Amacast, P.E.
SCALE AS SHOWN
File No. GD-05-74/17

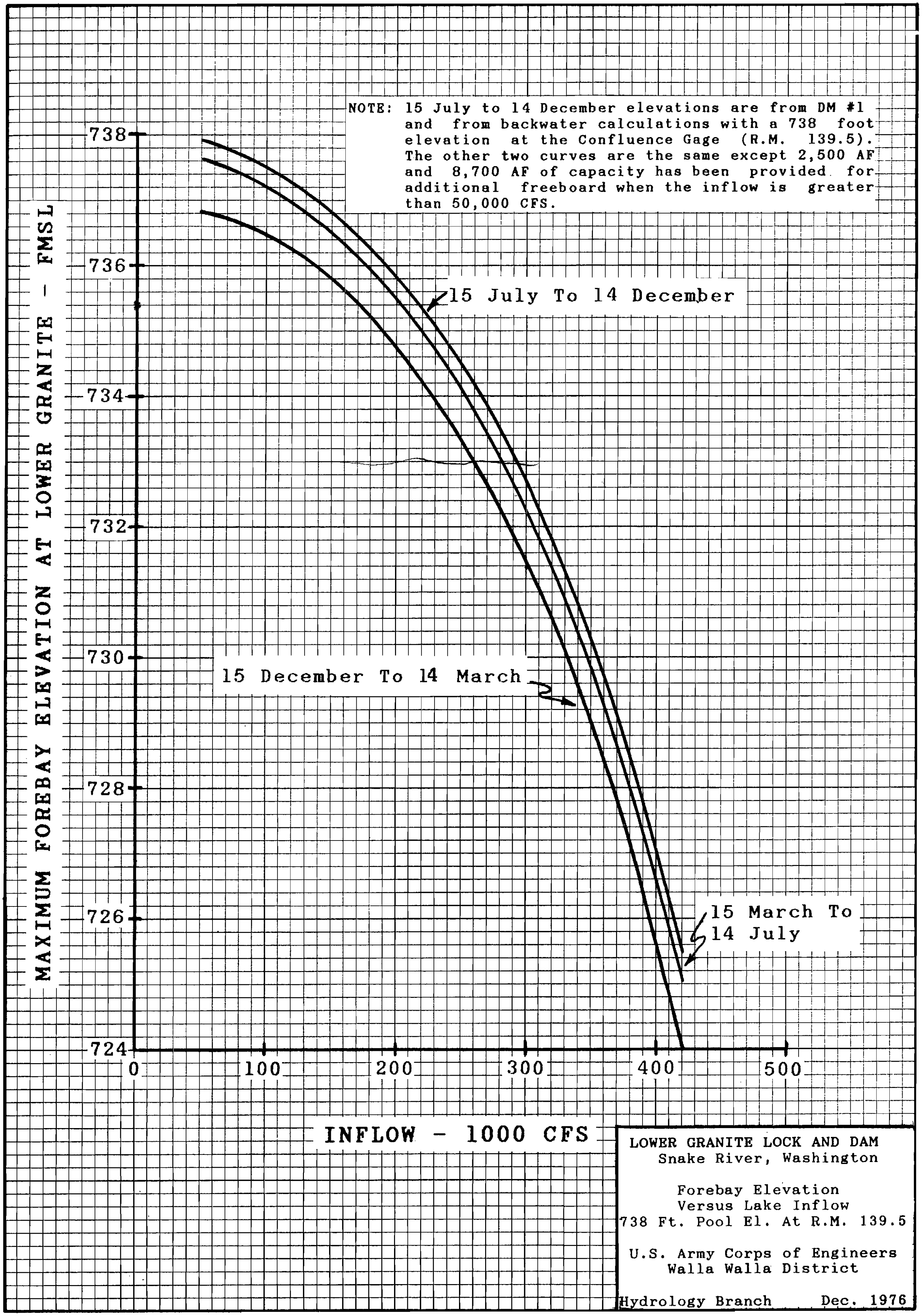


LOWER GRANITE LOCK AND DAM
Snake River, Washington

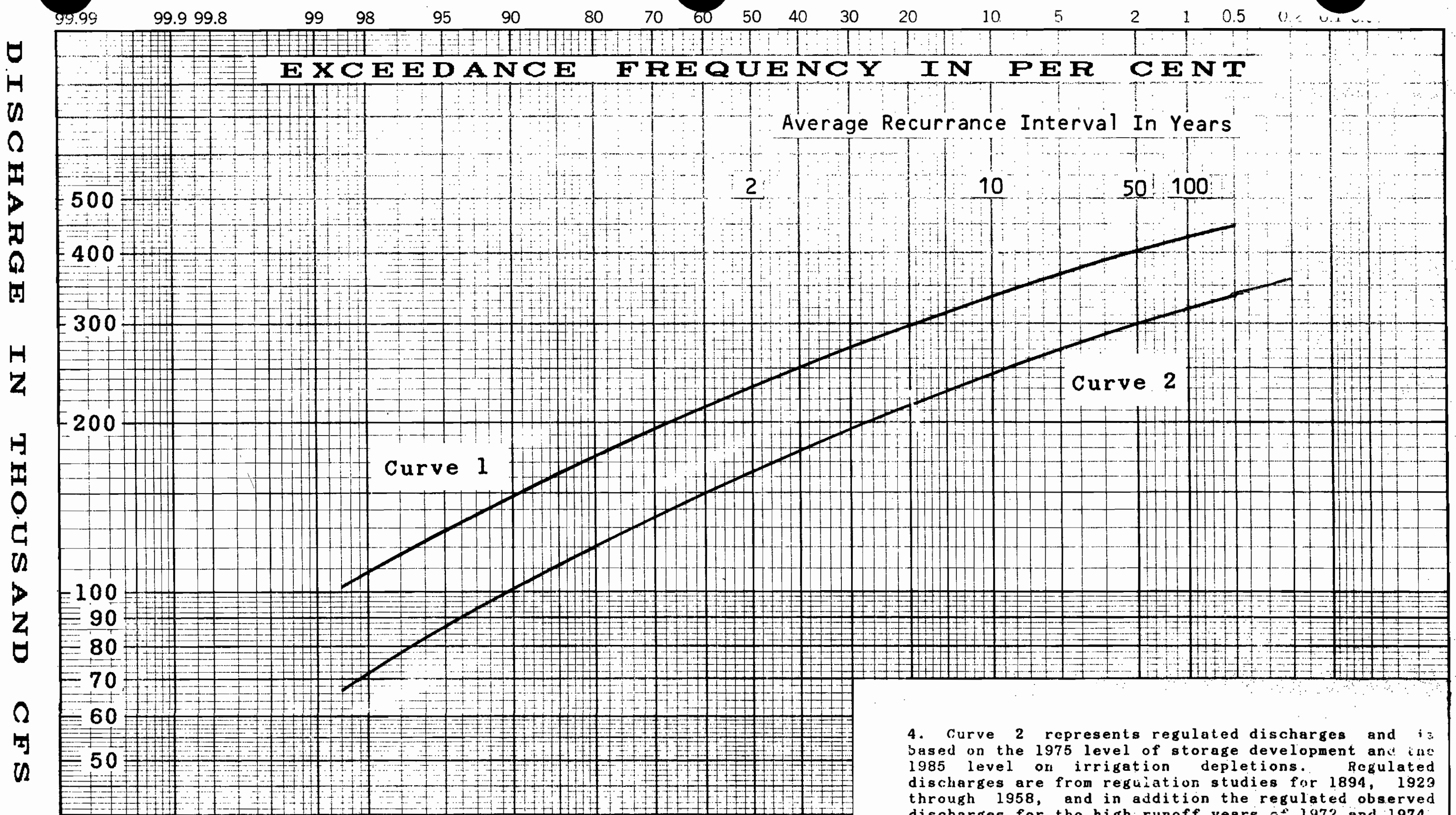
Forebay Elevation
Versus Lake Inflow
733 Ft. Pool El. At R.M. 139.5

U.S. Army Corps of Engineers
Walla Walla District

Hydrology Branch Dec. 1976



NOTE: 15 July to 14 December elevations are from DM #1 and from backwater calculations with a 738 foot elevation at the Confluence Gage (R.M. 139.5). The other two curves are the same except 2,500 AF and 8,700 AF of capacity has been provided for additional freeboard when the inflow is greater than 50,000 CFS.
MAXIMUM FOREBAY ELEVATION AT LOWER GRANITE - FMSL
738
736
734
732
730
728
726
724
0
100
200
300
400
500
INFLOW - 1000 CFS
15 July To 14 December
15 December To 14 March
15 March To 14 July
LOWER GRANITE LOCK AND DAM
Snake River, Washington
Forebay Elevation
Versus Lake Inflow
738 Ft. Pool El. At R.M. 139.5
U.S. Army Corps of Engineers
Walla Walla District
Hydrology Branch
Dec. 1976



NOTES

1. Drainage area equals 103,200 sq. mi.

2. This is a preliminary graph subject to revision.

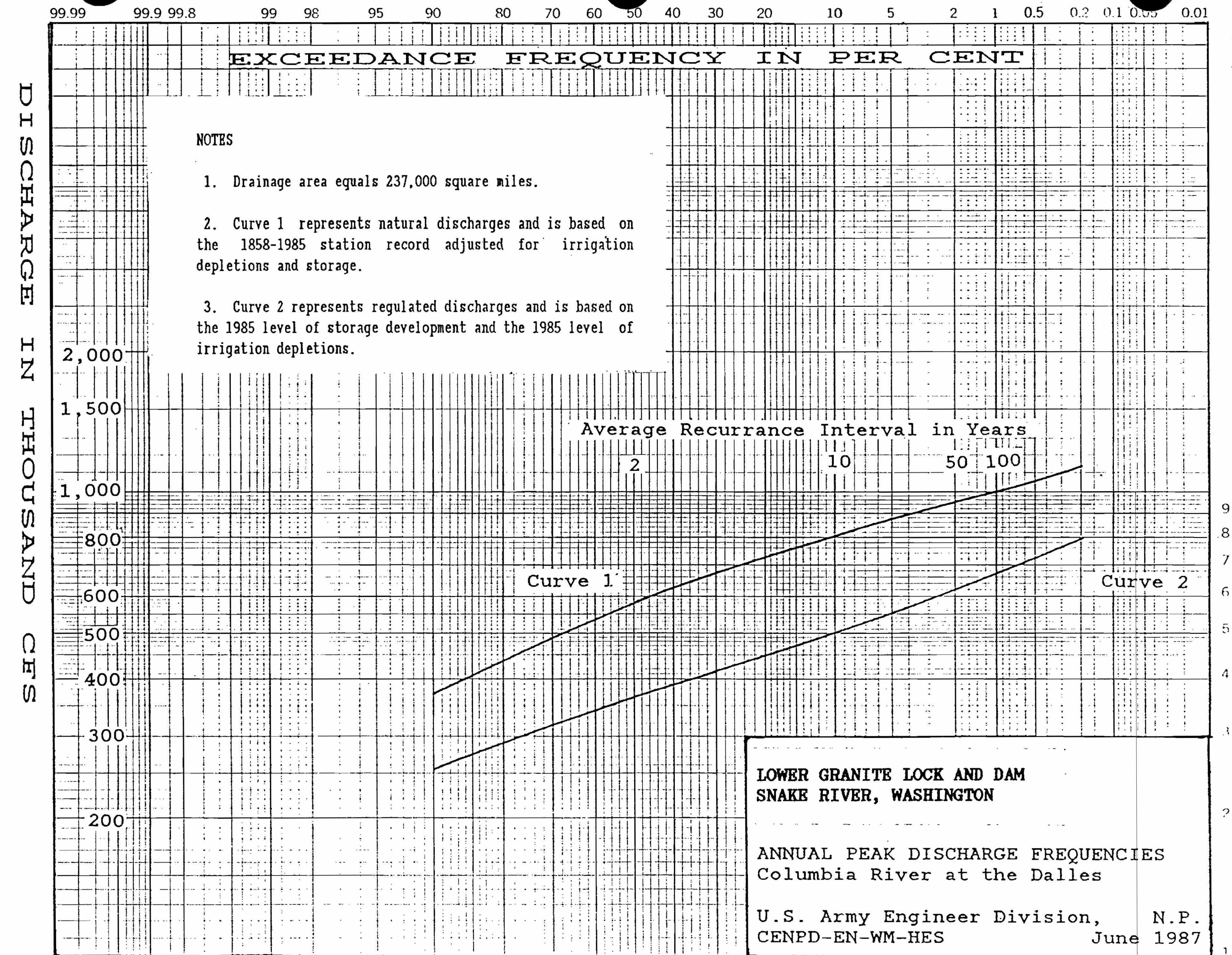
3. Curve 1 represents natural discharges and is based on the 1894-1975 station record adjusted for irrigation depletions and storage and extended by correlation with the 1858-1975 Columbia River at The Dalles station record. It includes an expected probability adjustment. The station and adopted skew is -0.5. Natural discharges for the 1894-1975 period of record are plotted based on their ranking within the extended record. The median plotting position method was utilized.

4. Curve 2 represents regulated discharges and is based on the 1975 level of storage development and the 1985 level on irrigation depletions. Regulated discharges are from regulation studies for 1894, 1929 through 1958, and in addition the regulated observed discharges for the high runoff years of 1972 and 1974. The plotting positions for the regulated event years are for the natural frequency curve. Curve 2 is a graphical fit of the regulated data.

LOWER GRANITE LOCK AND DAM
Snake River, Ore., Wash., & Ida.

ANNUAL PEAK DISCHARGE FREQUENCIES
Snake River At Lower Granite Dam

U.S. Army Engineer Division, N.P.
NPDEN-WM-HES May 1978



NOTES

1. Drainage area equals 237,000 square miles.

2. Curve 1 represents natural discharges and is based on the 1858-1985 station record adjusted for irrigation depletions and storage.

3. Curve 2 represents regulated discharges and is based on the 1985 level of storage development and the 1985 level of irrigation depletions.

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, WASHINGTON

ANNUAL PEAK DISCHARGE FREQUENCIES
Columbia River at the Dalles

U.S. Army Engineer Division, N.P.
CENPD-EN-WM-HES June 1987

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LOWER GRANITE LOCK AND DAM - WATER CONTROL MANUAL

EXHIBITS

No.

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EXHIBIT 1-1
LOWER GRANITE LOCK AND DAM
DESIGN MEMORANDUMS
NOTE THIS IS THE CURRENT 2002 VERSION - NOT FROM MANUAL

No.	Title	Cover Date
1	Hydrology	December 1963
2	Upper Pool Determination	12 April 1963
3	General Design Memorandum (4 Volumes)	January 1964 Revised 13 March 1964
	Supplement 1, Boundary Surveys and Markings	26 June 1974
	Letter Supplement 2, Project Instrumentation	4 November 1974
4	Concrete Aggregate Investigations	21 January 1966
5.1	South Shore Access Road	13 September 1965 Revised 18 November 1965
	Supplement 1, Road Completion	13 November 1969
5.2	North Shore Access Road	10 December 1969
5.3	North Shore Access Road, Section 1 (Combined with 5.2 – withdrawn 12-11-1969)	September 1969
6	First-Step Cofferdam and Diversion Channel	5 April 1965
7	Resident Office Facilities	12 January 1966
8	Part 1 - Real Estate - Dam site Construction Area, North and South Shore Access Roads, Partial Relocation of the Camas Prairie Railroad, Related Borrow Areas, Partial Flowage, and Partial Public Use Areas	3 November 1964
	Letter Supplement 1	24 February 1966
8	Part 2 - Real Estate - Right Bank Requirements between River Mile 110 and 137, Left Bank Requirements between River Mile 110.5 and 130.5	30 June 1965
	Letter Supplement 1	6 November 1970
8	Part 3 - Real Estate - Left Bank Requirements between River mile 141.5 and 147.5	8 July 1966
8	Part 4 - Real Estate - Right Bank Requirements between Snake River Mile 137 and 139.3 and between Clearwater River Mile 0 and 4.5	27 October 1966
8	Part 5 - Real Estate - Remainder of Project, Left Bank Requirements between Snake River Mile 130.5 and 141.5, Right Bank Requirements between Snake River Mile 139.3 and 147.5, Left Bank Requirements between Clearwater River Mile 0 and 4.5	1 December 1967
	Letter Supplement 1	14 August 1968

No.	Title	Cover Date
	Letter Supplement 2	2 July 1971
9.1	Grading and Drainage Camas Prairie Railroad Relocation Almota to Wawawai, and Damsite Shoofly	8 March 1965
9.2	Camas Prairie Railroad Relocation, Including Supplement 1	9 August 1966
9.3	Camas Prairie Railroad Bridge, Clearwater River, Lewiston, Idaho, Preliminary Designs and Cost Estimates	31 August 1966 Revised 28 February 1967
	Supplement 1, Preliminary Designs and Cost Estimates	February 1972
10	Permanent Operators' Quarters	6 June 1966
11	Deleted	
12	Relocation, Whitman County Road No. 900	31 October 1966
	Supplement 1, Design and Cost Revisions	19 October 1970 Revised 23 November 1971
	Letter Supplement 2, Railroad Grade Raise Near County Road	14 March 1972
	Letter Supplement 3, Maintenance of Electrified Signal Crossings of Camas Prairie Railroad at Wawawai and Sugar Loaf	11 July 1972
	Letter Supplement 4, Paving Whitman County Road 9000, Wawawai to Steptoe Canyon	26 August 1976
13	Nez Perce County Road No. 505, Protection and Relocation	21 December 1971
14	Relocation Washington State Route 12, Alpowa Creek to Clarkston	24 March 1972
14.1	Grade Raise and Protection of Washington State Route 129 and Asotin County Road Connection	13 January 1972
15	Deleted	
16	Deleted	
17	Deleted	
18.1	Deleted	
18.2	Utility Modifications, Clarkston, Washington	15 January 1971
18.3	Relocation and/or Abandonment of Power, Telephone, Television Cable, Domestic Water Pumping Plants, and Natural Gas Facilities	27 March 1972
18.4	Utility Modifications, Lewiston, Idaho	11 May 1971
	Supplement 1 Lewiston Water Intake Corrective Action Report	March 1993
18.5	Utility Modifications, Asotin, Washington	15 July 1971
18.6	Clarkston Sewage Treatment Plant	12 June 1969

No.	Title	Cover Date
18.7	Relocation of Power and Telephone Lines, River Mile 108 to River Mile 123	22 January 1970
18.8	Deleted	
18.9	Relocation of Hatwai Irrigation Pumping Plant	6 February 1973
19	Spillway	24 February 1966
20	Navigation Lock	7 April 1966
	Supplement 1, Miter Gate Operating Machinery	11 August 1966
	Supplement 2, Stability Analysis, Upper Gate Bay, Monolith No. 4	22 April 1968
	Supplement 3, Hydraulic Model Studies, Filling and Emptying System	5 August 1969
	Letter Supplement 4, Navigation Lock Bridge	19 December 1980
21	Fish Facilities	6 September 1966
	Supplement 1, Redesign of Fish Ladder and Visitor Facilities	16 December 1969
	Supplement 2, Adult Fish Trapping Facilities	29 May 1973
	Supplement 3, Juvenile Fish Support Facilities Improvements	June 1989
22	Concrete Non-overflow Dams	30 March 1966
23	Powerplant, Letter Report	November 1965
	Supplement 1, Design and Cost Revision	17 April 1970
	Letter Report, Handrail Modifications and Fingerling Facility Walkway by SBA-8A Contract	24 June 1980
23.1	Powerplant, Units 4-6, Letter Report	31 October 1973
24	Foundation Grouting and Drainage	12 June 1967
25	Deleted	
26	North Abutment Embankment and Second-Step Cofferdam	21 January 1966
27	Domestic Water Supply System	11 October 1966 Revised 29 April 1970
28A	Preliminary Master Plan	2 April 1965
	Supplement 1, Land Requirements Plan – Public Use, Tammany State Park Lands	2 July 1971
28	Master Plan	June 1974
	Letter Supplement 1, Allocation of Project Lands	October 1977
	Supplement 1, Visitors Facilities	April 1979
	Letter Supplement 2 Reclassification of Portion of Hells Gate State Recreation Area	19 July 1984
28.1	Part 1 - Temporary Marina, Tammany (Hells Gate) State Park	12 September 1972
	Part 2 - Hells Gate State Recreation Area	May 1974
	Letter Supplement 1, Contributed Funds	3 December 1974

No.	Title	Cover Date
	Letter Supplement 2, Deficiencies Correction by SBA-8a Contract	2 July 1980
28.2	Swallows Park and Green Belt	March 1974 Revised July 1974
28.3	Chief Lookingglass Park	May 1974
28.4	Recreational Facilities and Public Use Areas for Lower Granite Lock and Dam, Chief Timothy State Park and Developments at Wilma, Wawawai Offield Canyon, Knoxway, Blyton, and Sugarloaf	14 March 1974
28.5	Wawawai Bay Park	14 February 1977
29	Lewiston Levee Operation and Maintenance Facilities	8 March 1974 Revised 3 December 1968
29	Lewiston Levee Operation and Maintenance Facilities	Revised December 1974
29.1	East Lewiston Levee	4 August 1972
	Letter Supplement 1, Improvements to Lindsay Creek Intake Structure	14 March 1980
29.2	West Lewiston Levee	28 April 1972
29.3	North Lewiston Levee	18 September 1970
29.4	Deleted	
29.5	Bank Protection at Clarkston, Washington	14 July 1972
29.6	Concrete Aggregate Investigation, Levee Area	13 July 1972
29.7	Lewiston Levee Parkways	May 1972
	Supplement 1, Land Acquisition Adjustments	30 November 1972
	Supplement 2, Pedestrian Underpass Location Change	February 1973
29.8	Levee Instrumentation	26 February 1973
29.9	Washington Water Power Company Tailrace Plug Dike	13 June 1972
29.10	Modification, Clarkston Country Club Golf Course	11 April 1973
30	Aircraft Landing Strip	12 October 1965
31	Buildings, Landscaping, and Grounds	
32	Architectural Treatment	16 November 1965
33	Lake Clearing	22 January 1974
34	Debris Disposal Facilities Part A - Feasibility Study	January 1983
	Part B - Trash Shear Boom at Powerhouse Intake	December 1982 Revised April 1983
	Part C - Feature Design Memorandum,	Trash Shear Booms on Upper Reservoir
	Part D - Debris Removal and Disposal Facilities	

No.	Title	Cover Date
35	Detailed Plan for Relocation Offield Bar Cemetery, Garfield County, Washington	14 February 1967
	Final Report on the Relocation of Offield Bar Cemetery, Garfield County, Washington	28 August 1968
36	Detailed Plan for Relocation Isolated Burials at Silcott, Asotin County, Washington	11 September 1968
	Final Report on the Relocation of Isolated Burials at Silcott, Asotin County, Washington	
37	Grading, Drainage, and Surfacing Camas Prairie Railroad and Washington State Route 193, Steptoe Canyon to Wilma	5 November 1970
38	Removal of Washington Water Power Company Spillway	18 April 1972
39	Lake Sedimentation Ranges	30 May 1975
40	Cost Allocation	August 1976
41	Lewiston-Clarkston Bridge	October 1978
	Letter Supplement 1 - 16th Avenue Approach, Clarkston, Washington	January 1984
	Supplemental Report - 16th Avenue Approach, Clarkston, Washington	14 October 1983
42	Turbine Intake Screening System	December 1994
43	Juvenile Bypass/Holding and Loading Facilities	May 1996
	Supplement 1, Evaluation Separator	July 1997

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EXHIBIT 8-1

PROCEDURE FOR MINIMUM PROJECT RELEASE DETERMINATION

a. Computation Interval. When the project is being operated under this procedure, minimum release computation must be made each hour.

b. Procedure. The following outlines the steps necessary to determine the minimum project release required to control the lake elevation at the confluence below a maximum value each hour. (Worksheet for computations found on sheet 7, following minimum release example computations.)

(1) Determine the project inflow by adding the instantaneous discharges recorded from the Spalding and Anatone gages 1 hour previously. Discharge Rating Tables for Spalding and Anatone gages are shown on Tables 8-1 and 8-2, respectively.

(2) Determine the elevation at the confluence gage (RM 139.5) at the time the computation is being made.

(3) Determine the water volume in terms of cfs-hours necessary to correct the confluence to the maximum elevation value by using Table A-1, sheet 4, the inflow from step b.(1), and the confluence elevation from step b.(2).

(4) Determine the additional freeboard requirement in effect at the time of the calculation. This value may be zero, depending on the inflow and the season. The freeboard requirement may be found from Table A-2, sheet 6. When inflow is expected to be less than 50,000 cfs, additional freeboard will not be required and when greater, the additional freeboard will be used. SSARR streamflow forecasts will be used as a guide that inflows will be greater than 50,000 cfs for an extended period of time in order to justify the additional freeboard.

(5) Determine the minimum release for elevation control at the confluence gage by adding the correction, step b.(3), to the inflow, step b.(1), and adding the additional freeboard, step b.(4).

c. Apply the minimum release, computed above, as the average project release for the next hour if the scheduled release is less than this value. In other words, the average project release will always be equal to or greater than the value computed in step b.(5) above. Please note that the value of the computed release may be a negative number, meaning that a minimum release for elevation control at confluence is not required for the next hour and its value is therefore zero.

d. Examples of the computation of the minimum release for elevation control at the confluence are shown on the following pages.

EXAMPLE 1

a. Given Conditions
1200 hour 10 February

1100 hour Spalding flow	15,000	cfs
1100 hour Anatone flow	+45,000	cfs
Total Inflow	60,000	cfs b.(1)
1200 hour Confluence Gage	736.8	ft. b.(2)

b. Elevation Correction and Additional Freeboard

Elevation Correction from Table A-1, sheet 4	-132,000	cfs-hours b.(3)
Additional Freeboard (Table A-2, sheet 6)	105,000	cfs-hours b.(4)

c. Computation of Minimum Average Release 1200 to 1300 hours 10 February:

60,000	Inflow b.(1)
-132,000	Correction b.(3)
-72,000	
+105,000	Freeboard b.(4)
33,000	cfs Minimum Release b.(5)

EXAMPLE 2

a. Given Conditions
0800 hour 10 August

0700 hour Spalding flow	5,000	
0700 hour Anatone flow	+10,000	
Total Inflow	15,000	cfs b.(1)
0800 hour Confluence Gage	738.0	ft. b.(2)

b. Elevation Correction and Additional Freeboard

Elevation Correction from Table A-1, sheet 4	0
Additional Freeboard (Table A-2, sheet 6)	0

c. Computation of Minimum Average Release 0800 to 0900 hours 10 August:

15,000	Inflow b.(1)
+0	Correction b.(3)
15,000	
+0	Freeboard b.(4)
15,000	cfs Minimum Release b.(5)

EXAMPLE 3

a. Given Conditions

1600 hour 16 March	
1500 hour Spalding flow	10,000 cfs
1500 hour Anatone flow	+20,000 cfs
Total Inflow	30,000 cfs b.(1)
1600 hour Confluence Gage	738.3 ft. b.(2)

b. Elevation Correction and Additional Freeboard

Elevation Correction (Table A-1, sheet 4)	+33,000 cfs-hours
Additional Freeboard (Table A-2, sheet 6)	0

c. Computation of Minimum Average Release 1600 to 1700 hours 16 March:

30,000 Inflow b.(1)
+33,000 Correction b.(3)
63,000
+0 Freeboard b.(4)
63,000 cfs Minimum Release b.(5)

EXHIBIT 8-1
Sheet 3 of 7

TABLE A-1

CONFLUENCE GAGE ELEVATION VOLUME CORRECTION
LOWER GRANITE LOCK AND DAM

	INFLOW (CFS)				
ELEVATION AT CONFLUENCE GAGE	0 To 200,000	200,000 to 250,000	250,000 to 300,000	300,000 to 350,000	350,000 to 420,000
	CHANGE IN STORAGE (1,000 CFS-HOURS) TO CORRECT CONFLUENCE GAGE TO ITS MAXIMUM ELEVATION				
740.0	220	240	250	280	320
739.9	209	228	238	266	305
.8	198	216	225	252	290
.7	187	204	212	238	275
.6	176	192	200	224	260
.5	165	280	188	210	245
.4	154	168	175	196	230
.3	143	156	162	182	215
.2	132	144	150	168	200
.1	121	132	138	154	185
739.0	110	120	125	140	170
738.9	99	108	112	126	153
.8	88	96	100	112	136
.7	77	84	88	98	119
.6	66	72	75	84	102
.5	55	0	62	70	85
.4	44	48	50	56	68
.3	33	36	38	42	51
.2	0	0	0	0	0*
.1	0	0	0	0	0*
738.0	0	0	0	0	0
737.9	-11	-12	-12	-13	-14
.8	-22	-24	-24	-26	-29
.7	-33	-36	-36	-39	-44
.6	-44	-48	-48	-52	-58
.5	-55	-60	-60	-65	-72
.4	-66	-72	-72	-78	-87
.3	-77	-84	-84	-91	-102
.2	-88	-96	-96	-104	-116
.1	-99	-108	-108	-117	-130
737.0	-110	-120	-120	-130	-145

* Revised 30 July 1975.

Exhibit 8-1
Sheet 4 of 7

TABLE A-1 (CONTINUED)

CONFLUENCE GAGE ELEVATION VOLUME CORRECTION
LOWER GRANITE LOCK AND DAM

	INFLOW (CFS)				
ELEVATION AT CONFLUENCE GAGE	0 To 200,000	200,000 to 250,000	250,000 to 300,000	300,000 to 350,000	350,000 to 420,000
	CHANGE IN STORAGE (1,000 CFS-HOURS) TO CORRECT CONFLUENCE GAGE TO ITS MAXIMUM ELEVATION				
736.9	-121	-131	-132	-144	-160
.8	-132	-142	-145	-158	-175
.7	-143	-153	-158	-172	-190
.6	-154	-164	-170	-186	-205
.5	-165	-175	-182	-200	-220
.4	-176	-186	-195	-214	-235
.3	-187	-197	-208	-228	-250
.2	-198	-208	-220	-242	-265
.1	-209	-219	-232	-256	-280
736.0	-220	-230	-245	-270	-295
735.9	-231	-242	-258	-283	-310
.8	-242	-253	-270	-296	-325
.7	-253	-264	-282	-309	-340
.6	-264	-276	-295	-322	-355
.5	-275	-288	-307	-335	-370
.4	-286	-299	-320	-348	-385
.3	-297	-310	-332	-361	-400
.2	-308	-322	-345	-374	-415
.1	-319	-334	-358	-387	-430
735.0	-330	-345	-370	-400	-445
734.9	-341	-356	-382	-414	-462
.8	-352	-367	-393	-428	-480
.7	-363	-378	-404	-442	-498
.6	-374	-389	-416	-456	-515
.5	-385	-400	-428	-470	-532
.4	-396	-411	-439	-484	-550
.3	-407	-422	-450	-498	-568
.2	-418	-433	-462	-512	-585
.1	-429	-444	-474	-526	-602
734.0	-440	-455	-485	-540	-620
733.9	-451	-467	-498	-554	-640
.8	-462	-478	-510	-569	-660
.7	-473	-489	-522	-584	-680
.6	-484	-501	-535	-598	-700
.5	-495	-512	-548	-612	-720
.4	-506	-524	-560	-627	-740
.3	-517	-536	-572	-642	-760
.2	-528	-547	-585	-656	-780
.1	-539	-558	-598	-670	-800
733.0	-550	-570	-610	-685	-820

EXHIBIT 8-1
Sheet 5 of 7

TABLE A-2
ADDITIONAL FREEBOARD

	Max. W.S. Elev. at Confluence Gage (ft. msl)	Additional Freeboard (feet)	Volume in Additional Freeboard (cfs-hours)
15 Jul to 14 Dec	738.0	0	0
15 Dec to 14 Mar	737.0 1/	1.0	105,000
15 Mar to 14 Jul	737.7 1/	0.3	30,000

1/ For inflows greater than 50,000 cfs; otherwise, maximum elevation is 738.0 feet msl.

EXHIBIT 8-1
Sheet 6 of 7

LOWER GRANITE MINIMUM RELEASE COMPUTATION SHEET
To Be Computed Hourly

Date__________________ Time__________Hour To ________Hour

Project Inflow = Spalding Gage Flow + AnatoneGage flow (previous hour)

Project Inflow = ____________ + ____________

Elevation at Confluence Gage = _____________

Water Volume Correction for Confluence Gage Elevation (from Table A-1)

Confluence Gage Elevation Correction = ____________

Additional Freeboard Requirements (from Table A-2)* ___________

Volume Requirement for Additional Freeboard = ____________

Average Minimum Release = Inflow + Confluence Gage Volume Correction + Additional Freeboard Volume Requirement

Average Minimum Release = ________ + ________ + ________ = ________ cfs

If computed minimum release is negative value, minimum release is 0.

* Additional freeboard will be used only when extended forecasted project inflow is greater than 50,000 cfs.

EXHIBIT 8-1
Sheet 7 of 7

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EXHIBIT 8-2
PART 207 - NAVIGATION REGULATIONS

207.718 Navigation Locks and Approach Channels, Columbia and Snake Rivers, Oregon and Washington.

a. General. All locks, approach channels, and all lock appurtenances, shall be under the jurisdiction of the District Engineer, U.S. Army Corps of Engineers, in charge of the locality. His representative at the locks shall be the Project Engineer, who shall issue orders and instructions to the Lock Master in charge of the lock. Hereinafter, the term "Lock Master" shall be used to designate the person in immediate charge of the lock at any given time. In case of emergency and on all routine work in connection with the operation of the lock, the Lock Master shall have authority to take action without waiting for instructions from the Project Engineer.

b. Lockage Control. The Lock Master shall be charged with the immediate control and management of the lock and of the area set aside as the lock area, including the lock approach channels. Upstream and downstream approach channels extend to the end of the wing or guide wall, whichever is longer. At Bonneville Lock, the upstream approach channel extends to the upstream end of Bradford Island and the downstream approach channel extends to the downstream end of the lower moorage. The Lock Master shall demand compliance with all laws, rules, and regulations for the use of the lock and lock area and is authorized to issue necessary orders and directions, both to employees of the Government or to other persons within the limits of the lock or lock area, whether navigating the lock or not. Use of lock facilities is contingent upon compliance with regulations, Lock Master instructions, and the safety of people and property.

c. No one shall initiate any movement of any vessel in the lock or approaches except by or under the direction of the Lock Master. ("Vessel" as used herein includes all connected units, tugs, barges, tows, boats, or other floating objects.)

d. Signals.

(1) Radio. All locks are equipped with two-way FM radio operating on channel 14, frequency of 156.700 MHz, for both the calling channel and the working channel. Vessels equipped with two-way radio desiring a lockage shall call WUJ 33 Bonneville, WUJ 34 The Dalles, WUJ 35 John Day, WUJ 41 McNary, WUJ 42 Ice Harbor, WUJ 43 Lower Monumental, WUJ 44 Little Goose, or WUJ 45 Lower Granite at least one-half hour in advance of arrival since the Lock Master is not in constant attendance of the locks. Channel 14 shall be monitored constantly in the vessel pilot house from the time the vessel enters the approach channel until its completion of exit. Prior to entering the lock chamber, the commercial freight or log-tow vessel operator

shall report the nature of any cargo, the maximum length, width, and draft of the vessel and whether the vessel is in any way hazardous because of its condition or the cargo it carries or has carried.

(2) Pull-cord Signal Stations. Pull-cord signal stations marked by large instructional signs and located near the end of the upstream and downstream lock entrance walls may be used in place of radios to signal the Lock Master for a lockage.

(3) Entering and Exit Signals. Signal lights are located outside each lock gate. When the green (go) light is on, all vessels will enter in the sequence prescribed by the Lock Master except at Bonneville where freight and log-tow vessels will enter on the amber light. When the red (stop) light is on, the lock is not ready for entrance and vessels shall stand clear. In addition to the above visual signals, the Lock Master will signal that the lock is ready for entrance by sounding one long blast on the lock air horn. The Lock Master will signal that the lock is ready for exit by lighting the green exit light and sounding one short blast on the air horn.

e. Permissible Dimensions of Vessels. Nominal overall dimensions of vessels allowed in the lock chamber are 84 feet wide and 650 feet long, except at Bonneville where these dimensions are 74 feet wide and 500 feet long. Depth of water in the lock depends upon river levels which may vary from day to day. Staff gages showing the minimum water level depth over gate sills are located inside the lock chamber near each lock gate and outside the lock chamber near the end of both upstream and downstream guide walls. Vessels which do not have a draft of at least 1 foot less than a gage reading shall not pass that gage. Information concerning allowable draft for vessel passage through the locks may be obtained from the Lock Master. Minimum lock chamber water level depth is 15 feet except at Ice Harbor where it is 14 feet and at Bonneville where it is 24.2 feet. When the riverflow at Lower Granite exceeds 330,000 cfs, the normal minimum 15-foot depth may be decreased to as little as 8 feet. At Bonneville, a tow may be rearranged to less than clear lock dimensions (74 feet by 500 feet) prior to entering the lock and be passed in one lockage. Such rearrangements at Bonneville may be done at the moorage in the downstream lock approach channel or above the upstream guide wall and with the Lock Master's permission at the upstream guide wall. In consideration of river and swing bridge traffic at Bonneville, the Lock Master may authorize rearrangement of vessels within the lock chamber only when both miter gates at the open end of the lock are in their recesses in the lock walls and rearrangement will not be hazardous to them. Vessels wider than 50 feet will not be permitted to enter the Bonneville lock during extreme high water when tailwater at the lock is higher than 35 feet above msl since the downstream guide wall will be inundated.

f. Precedence at Lock. Ordinarily, the boat arriving first at the lock will be locked through first; however, depending upon whether the lock is full or empty, this precedence may be modified at the discretion of the Lock Master. When several vessels are waiting for a lockage, precedence shall be given as follows:

First. Vessels owned or operated by the United States whose mission requires immediate passage.

Second. Commercial freight and log-tow vessels.

Third. All other vessels.

g. Loss of Turn. Boats that fail to enter the lock with reasonable promptness, after being authorized to do so, shall lose their turn.

h. Lockage.

(1) Multiple Lockage. The Lock Master shall decide whether one or more vessels or tows may be locked through at the same time. Vessels with flammable or highly hazardous cargo will be passed separately from all other vessels. Hazardous materials are described in Part 171, Title 49, Code of Federal Regulations. Flammable materials are defined in the National Fire Code of the National Fire Protection Association.

(2) Small Craft. At the discretion of the Lock Master, the lockage of pleasure, fishing, and other small vessels may be coordinated with the lockage of commercial vessels. If no commercial craft is scheduled to be locked through within a reasonable time, not to exceed 1 hour after arrival of the small craft at the lock, separate lockage will be made for such small craft.

i. Mooring in Approaches Prohibited. Mooring or anchoring in the approaches to the lock is prohibited where such mooring will interfere with navigation.

j. Waiting for Lockage. Vessels waiting for lockage shall wait in the clear outside of the lock approach channel, or contingent upon permission by the Lock Master may, at their own risk, lie inside the approach channel at a place specified by the Lock Master. At Bonneville vessels may, at their own risk, lay-to at the downstream moorage facility on the south shore downstream from the guide wall provided that a 100-foot-wide open channel is maintained, and vessels upstream may lay-to against the guide wall, at their own risk, provided they remain not less than 400 feet upstream of the upstream lock gate or contingent upon prior radio clearance by the Lock Master they may, at their own risk, tie to the upstream guide wall.

k. Mooring in Lock. All vessels must be moored within the lock chamber so that no portion of any vessel extends beyond the lines painted on the lock walls. Moorage within the lock chamber will be to floating mooring bits only and will be accomplished in a proper no-slip manner. Small vessels will not be locked with a large vessel unless the large vessel is so moored (two mooring bits) that no lateral movement is possible. The vessel operator will constantly monitor the position of his vessel and his mooring bit ties to assure that there is no fore-or-aft movement of his vessel and lateral movement is minimized. Propulsion by vessels within the lock chamber will not be permitted during closure operation of a lock chamber gate or as otherwise directed by the Lock Master.

l. Crew to Move Craft. During the entire lockage, the vessel operator shall constantly attend the wheelhouse, be aware of the vessel's position, and monitor radio channel 14 on frequency 156.700 MHz, or otherwise be constantly able to communicate with the Lock Master. At a minimum, vessels shall be as vigilantly manned as if underway.

m. Speed. Vessels shall be adequately powered to maintain a safe speed and be under control at all times. Vessels shall not be raced or crowded alongside another in the approach channels. When entering the lock, speed shall be reduced to a minimum consistent with safe navigation. As a general rule, when a number of vessels are entering the lock, the following vessel shall remain at least 200 feet astern of the vessel ahead.

n. Delay in Lock. Vessels shall not unnecessarily delay any operation of the locks.

o. Landing of Freight. No freight, baggage, personnel, or passengers shall be landed on or over the walls of the lock, except by permission and direction of the Lock Master.

p. Damage to Lock or Other Structures. The regulations in this section shall not relieve the liability of the owners and/or operators of vessels from liability for any damage to the lock or other structures or for the immediate removal of any obstruction. No vessel in less than stable floating condition or having unusual sinking potential shall enter the locks or its approaches. Vessels must use great care not to strike any part of the lock, any gate or appurtenance thereto, or machinery for operating the gates, or the walls protecting the banks of the approach channels. All vessels with projecting irons or rough surfaces which may damage the gates or lock walls shall not enter the lock unless provided with suitable buffers and fenders. Vessels having chains, lines, or drags either hanging over the sides or ends or dragging on the bottom for steering or other purposes will not be permitted to pass.

q. Tows. Prior to a lockage, the person in charge of a vessel towing a second vessel by lines shall, at a safe distance outside of the incoming approach channel, secure the second vessel to the towing vessel and keep it secured during the entire course of a lockage and until safely clear of the outgoing approach channel.

r. Violation of Regulations. Any violation of these regulations may subject the owner or master of any vessel to any or all of the following: (1) penalties prescribed by law of the U.S. Government (33 U.S.C. 1); (2) report of violation to the titled owner of the vessel; (3) report of the violation to the U.S. Coast Guard; and/or (4) refusal of lockage at the time of violation.

s. Refuse in Locks. No material of any kind shall be thrown or discharged into the lock or be deposited in the lock area. Vessels leaking or spilling cargo will be refused lockage and suitable reports will be made to the U.S. Coast Guard. Deck cargo will be so positioned so as not to be subject to falling overboard.

t. Handling Valves, Gates, Bridges, and Machinery. No person, unless authorized by the Lock Master, shall open or close any bridge, gate, valve, or operate any machinery in connection with the lock. However, the Lock Master may call for assistance from the master of any vessel using the lock, should such aid be necessary, and when rendering such assistance, the men so employed shall be directly under the orders of the Lock Master. Masters of boats refusing to give such assistance when it is requested of them may be denied the use of the lock by the Lock Master.

u. Statistics. On each passage through the lock, masters or pursers of vessels shall furnish to the Lock Master a written statement of passengers, freight, and registered tonnage and other information as indicated on forms furnished boat operators by the Lock Master.

v. Hazardous Areas. At McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams, all water from the downstream face of the dam to a line straight across the river at the downstream end of the downstream lock guide wall is considered hazardous and vessels may enter only at their own risk.

w. Restricted Areas. No vessel shall enter or remain in any restricted area at any time without first obtaining permission from the District Engineer, U.S. Army Corps of Engineers, or his duly authorized representative.

(1) At Bonneville Dam. The waters restricted to only Government vessels are described as all waters of the Columbia River and Bradford Slough within 1,000 feet above and 2,000 feet below the powerhouse. The restricted areas will be designated by signs.

(2) At the Dalles Dam. The waters restricted to only Government vessels are described as all downstream waters other than those of the navigation lock downstream approach channel which lie between the Wasco County Bridge and the project axis including those waters between the powerhouse and the Oregon shore and all upstream waters other than those of the navigation lock upstream approach channel which lie between the project axis and a line projected from the upstream end of the navigation lock guide wall to the junction of the concrete structure with the earthfill section of the dam near the upstream end of the powerhouse.

(3) At the John Day Dam. The waters restricted to only Government vessels are described as all of the waters within a distance of about 1,000 yards above the dam lying south of the navigation channel leading to the lock and bounded by a line commencing at the upstream end of the guide wall and running in a direction 54° 01' 37" true for a distance of 771 yards, thence 144° 01' 37" true across the river to the south shoreline. The downstream limit is marked by orange and white striped monuments on the north and south shores.

(4) At McNary Dam. The waters restricted to only Government vessels are described as all of the waters within a distance of about 1,000 yards above the dam lying south of the navigation channel leading to the lock and bounded by a line commencing at the upstream end of the guide wall and running in a direction 93° 30' true for a distance of 495 yards, thence 175° 15' true for 707 yards, thence 179° 00' true for 441 yards, thence 235° 00' true for 585 yards, thence 268° 00' true for 146 yards to the head of the fish ladder.

(5) At Ice Harbor Dam. The waters restricted to only Government vessels are described as the waters within a distance of about 800 yards upstream of the dam lying south of the navigation channel leading to the lock and bounded by a line commencing at the upstream end of the guide wall and running a direction 83° 00' true for a distance of 600 yards, thence 175° 00' true for a distance of 250 yards, thence 241° 00' true to the upstream face of the dam.

(6) At Lower Monumental Dam. The waters restricted to only Government vessels are described as the waters within a distance of about 1,200 yards upstream of the dam lying north of the navigation channel leading to the lock and bounded by a line commencing at the upstream end of the fixed guide wall and running in a direction 48° 00' true for a distance of 340 yards, thence 326° 00' true for a distance of 366 yards, thence 260° 00' true for a distance of 160 yards, thence 270° 00' true to the north shore.

(7) At Little Goose Dam. The waters restricted to only Government vessels are described as those within a distance of 800 yards above the dam lying north of

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the guide wall and bounded by a line commencing at the upstream end of the guide wall and running in a direction 64° 13' true for a distance of 567 yards, thence 349° 03' true for a distance of 610 yards to the north shoreline.

(8) At Lower Granite Dam. The waters restricted to only Government vessels are described as those within a distance of 800 yards above the dam lying south of the guide wall and upstream end of the guide wall and running in a direction 136° true for a distance of ±586 yards, thence 214° true for a distance of 250 yards to the south shoreline.

Drawings which depict the hazardous and restricted areas in paragraphs v. and w. of this section are available from the District Engineers for areas within their respective jurisdictions.

TABLE B-1

NOTIFICATION LIST IN CASE OF UNSCHEDULED LOCK CLOSURES
OR
OTHER NAVIGATION MATTERS

WALLA WALLA DISTRICT OFFICE - Operations, Construction, and Readiness Division

Primary Contact: Joe Murar 522-6701
or Larry Pfefferle 522-6699

Who will in turn notify:

1. Chief, Project Operations Branch, Walla Walla District Office, Operations, Construction, and Readiness Division

2. Public Affairs Office, Walla Walla District Office

3. Chief, Project Operations, North Pacific Division

4. Columbia River Towboat Association

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