Public Version

US Army Corps of Engineers®
Portland District

WATER CONTROL MANUAL
LOST CREEK LAKE

OREGON

January 2013

WATER CONTROL MANUAL

FOR

LOST CREEK LAKE, OREGON

Prepared by the

U.S. Army Corps of Engineers
Portland District
Portland, Oregon

Reservoir Regulation and Water Quality Section

January 2013

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 this manual current.

Change No.	Page / Paragraph / Section	Statement of Review or Change	Date
R0		Manual dated June 1991.	Jun 1991
R1	All	Updated all chapters in the manual and most of the associated plates and tables. Version was approved by NWD.	Jan 2013

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during duty hours, contact between Rogue River Basin Project staff and Reservoir Regulation and Water Quality staff (CENWP-EC-HR) can be made by calling the CENWP-EC-HR phone line at (503) 808-4896. If CENWP-EC-HR is unstaffed, further assistance can be achieved by contacting (in the order listed) one of the following persons assigned to be on call during non-duty hours:

1. Rogue Basin Regulator
Work: (503) 808- 4891
Cell: (503) 475-2492

2. Backup Regulator
Work: (503) 808- 4877
Cell: (503) 367-6579

3. Backup Regulator
Work: (503) 808-4887
Cell: (503) 819-4189

4. Backup Regulator
Work: (503) 808- 4869
Cell: (503) 927-4642

5. Chief, Reservoir Regulation and Water Quality Section
Work: (503) 808-4886
Cell: (503) 819-9823

6. Rogue River Basin Project
Phone: (541) 878-2255

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LOST CREEK DAM AND LAKE

PERTINENT DATA

1. Project Location:

Nearest town	McLeod, Oregon 28 miles northeast of Medford, Oregon
County and State	Jackson County, Oregon
Stream	Rogue River
Distance above mouth	157.2 river miles

2. Drainage Area:

Area above dam site	674 square miles
One inch of runoff above dam site	35,950 acre-feet

3. Project Description:

a. Dam:

Type	Rockfill shell with central impervious core
Length	3,600 feet
Height (foundation to top of dam)	345 feet
Top width of dam	24 feet

b. Spillway:

Type	Concrete gravity, gated, ogee section
Gate Size – width and height	45 feet, 51 feet
Capacity at full pool	158,000 ft^3/s
Crest elevation	1,823 feet, NGVD

c. Outlet Works:

Type	Multiple-use intake structure 271 feet high, free standing concrete tower
Type of gates	Hydraulic pressure slide
Number and size of gates	Two regulating gates 6 feet 6 inches by 12 feet 6 inches high Two emergency gates 6 feet 6 inches wide by 12 feet 6 inches high
Capacity at minimum flood control pool (El. 1,812 ft)	9860 ft^3/s
Capacity at maximum and full pool (El. 1,872 ft)	11,460 ft^3/s

d. Water Temperature Control Ports:

Type	Hoisted full open-full closed multiple-level gates (four levels)
Number and size of each level	Three, 8 feet wide by 15 feet high

e. Turbidity Conduit:

Type	Circular concrete trunk
Length and diameter	400 feet, 12 foot 6-inch diameter

f. Outlet Conduit:

Size and type	12 foot, 6-inch diameter circular concrete lined
Slope and length	1.5 percent, 943 feet

g. Fish Hatchery Warm Water Supply:

Size and length	24-inch diameter, 4,760 feet long
Discharge capability	70 ft^3/s capability at full pool

h. Penstock:

Type	Cut and cover, steel encased concrete
Diameter and length	15-foot diameter, 1,368 feet long
Capacity at minimum flood control pool (El. 1,812 ft)	2,640 ft^3/s
Capacity at maximum and full pool (El. 1,872 ft)	3,000 ft^3/s

4. Minimum Flow Requirements:

These flows will not be reduced except during periods of declared water shortages, by request of the state of Oregon, or when hydrologic conditions indicate that other primary authorized functions will be jeopardized.

1 Feb – 30 Apr	700 ft^3/s
1 May – 15 May	1,000 ft^3/s
16 May – 31 May	1,300 ft^3/s
1 Jun – 10 Jun	1,500 ft^3/s
11 Jun – 30 Jun	1,800 ft^3/s
1 Jul – 20 Aug	2,000 ft^3/s
21 Aug – 7 Sep	1,500 ft^3/s
8 Sep – 31 Jan	1,000 ft^3/s

A minimum release of 500 ft^3/s will be used during flood control operations.

5. Principal Elevations, Area, Storage, and Discharge Capability:

Feature	Elevation (feet, NGVD)	Water Surface Area (Acres)	Storage (Acre-feet)	Spillway Discharge[1] Capacity (ft^3/s)	Outlet Works Discharge[2] Capacity (ft^3/s)
Top of Dam	1,882		500,000	158,00	11,460
Maximum and Full Pool	1,872	3,430	465,000	0	9,860
Minimum Flood Control Pool (Also top of Carryover Conservation Pool)	1,812	2,600	285,000	0	8,000
Minimum Conservation Pool (also Top of Inactive Pool)	1,751	1,800	150,000	0	0
Dead Storage (Top)	1,640	620	24,000	0	0
Lowest Intake (Invert)	1,595	175	3,000	0	0
Streambed	1,550	0	0	0	0

[1]Free overflow condition
[2]Two gates full open condition

WATER CONTROL MANUAL FOR LOST CREEK LAKE, OREGON

SECTION 1

INTRODUCTION

1-1 AUTHORIZATION

Authority for preparing this manual is contained in ER 1110-2-240, Water Control Management, last updated 01 March 1994. Its preparation has been in accordance with instructions presented in EM 1110-2-3600, Reservoir Regulation, dated 30 November 1987, and with guidance provided by ER 1110-2-8156, Preparation of Water Control Manuals, dated 31 August 1995.

1-2 PURPOSE AND SCOPE

The function of this manual is twofold: (a) to document the water control plan, and (b) to provide a reference source for higher authority and for personnel responsible for the regulation of Lost Creek Project.

The manual contains a description of the river basin and project, project history, watershed characteristics, hydrometeorological facilities, forecast methods, water control plan, effects of the water control plan, and water control management. The manual provides comprehensive coverage of all important water control subjects and is intended to be the primary reference for water management of the project.

For purposes of this manual, “Lost Creek Dam” is used to refer to the structural features of the project (i.e., Lost Creek spillway, Lost Creek regulating outlet works, and Lost Creek powerhouse. “Lost Creek Lake” is used to refer to the water impounded by William L. Jess Dam (i.e., Lost Creek Lake storage, Lost Creek Lake flood control rule curve, etc.). The term “Lost Creek Lake” is also used as the geographic location of the project (i.e., “staff will be sent to Lost Creek Lake in the event of a flood”). The term “Lost Creek Project” encompasses the dam, lake, and all other facilities.

All units are given in English units. To interpret this manual in SI units, a conversion table is provided as Table 1-1.

1-3 RELATED MANUALS AND REPORTS

Design memorandums previously submitted for the Lost Creek Project are listed in table 1-2. Project authorization was given by House Document 566; that is the basis from which the operation of the Rogue River Projects is derived. The Lost Creek Lake Flood Emergency Plans are contained in a separate manual, and should be referenced for structural safety and emergency operations at Lost Creek Project.

1-4 PROCEDURES TO UPDATE AND REVISE THE WATER CONTROL MANUAL

The Engineering and Construction Division of the Portland District will make changes and revisions to this manual, as newer or revised techniques of regulation and forecasting are developed. If significant changes occur on the watershed or at the dam affecting water regulation, these changes will be included in a revision of the water control manual. Any change in the manual that affects the authorized functions of the reservoir or involves a significant deviation from the approved plan will be submitted to Northwestern Division (CENWD) for approval. All revisions will be dated and a master file will be kept by the Portland District (CENWP).

1-5 PROJECT OWNER

The project was planned, designed, built, and is operated by the U.S. Army Corps of Engineers for the public of the United States of America.

1-6 OPERATING AGENCY

The project is operated by the U.S. Army Corps of Engineers, Portland District. The project manager is responsible for the operation of three projects in the Rogue River Basin. These projects are Lost Creek Project, Applegate Project, and the partially completed Elk Creek Project. The Lost Creek Project is staffed 24 hours a day by power plant operators. The Applegate Project on the Applegate River is operated by remote control via a microwave supervisory system and conventional phone lines from the Lost Creek Project. The Applegate Project is staffed and operated on-site primarily during periods of flooding when use of the spillway may be required. The partially completed Elk Creek Project is not staffed.

1-7 REGULATING AGENCIES

Under authority contained in various legislative authorization acts, the Chief of Engineers, U.S. Army Corps of Engineers, is responsible for establishing overall policy for the regulation of reservoirs for flood control.

In accordance with the provisions of ER 1110-2-1400, functional regulation of the project is the responsibility of CENWP, with the primary responsibility delegated to Reservoir Regulation and Water Quality Section (CENWP-EC-HR). The Portland District operates the project and specifies the regulation for flood control and conservation releases throughout the year. This responsibility was previously shared with the Reservoir Control Center (RCC) of the Northwestern Division, who had the primary role for flood control releases while the Portland District had the primary role for conservation releases. Complete reservoir regulation responsibility at the District became effective 01 November 1988.

Within the Portland District, Engineering and Construction Division (CENWP-EC) has personnel assigned to water management activities related to regulation of District flood control projects. A water regulation center has been established in CENWP-EC-HR to perform this responsibility. The physical operation and maintenance of multiple-purpose projects in the Portland District are responsibilities of Operations Division under the direct supervision of the Operations Project Manager for the Rogue Project, who is, in turn, responsible to the Chief of the Operations Division.

The Northwest River Forecast Center of the National Weather Service (NWRFC) in Portland, Oregon, along with the National Weather Service (NWS) office in Medford, Oregon, are responsible for flood forecasting and issuing flood warnings. These two offices coordinate closely with Corps of Engineers for dissemination of information and forecasts. The U.S. Geological Survey (USGS) in Portland, with field assistance from their Medford office has the responsibility of collecting, calibrating, and publishing streamflow and water quality data in the basin. The Natural Resources Conservation Service (NRCS) Snow Survey monitors snow water content and cumulative precipitation at a large number of stations in southern Oregon. Data provided by these stations is used by the NRCS to develop volume runoff forecasts in the spring of each year. These data are essential to the water management of Lost Creek Lake.

The Oregon Department of Fish and Wildlife (ODFW) through the Oregon Water Resources Department (OWRD) has the responsibility for ensuring that minimum flows remain in the river for fisheries. The U.S. Fish and Wildlife Service (USFWS) and the NOAA-Fisheries provide input to the ODFW. The U.S. Bureau of Reclamation (USBR) is responsible for the sale of water stored in Federal projects for irrigation. The USBR handles all irrigation contracts, and receives all payment for the U.S. Government for irrigation water. Additional discussion on agency responsibilities is provided in Section 9, paragraph 9-1.

SECTION 2

DESCRIPTON OF PROJECT

2-1 LOCATION

Lost Creek is located at latitude 42°40', longitude 122°40' in southwestern Oregon, northeast of the city of Medford in Jackson County, Oregon. A photograph of the lake and general map of the watershed are shown on Plate 2-1. The lake is about 205 air miles south of Portland, Oregon, at river mile (RM) 157.2 on the main stem of the Rogue River, approximately 3 miles upstream from the confluence of Big Butte Creek. Lost Creek Lake controls 13 percent of the Rogue River drainage. The nearest town is Shady Cove, about 10 miles southwest of Lost Creek Lake. Shady Cove is served by Highway 62, which connects with Medford about 28 miles southwest of Lost Creek Lake.

2-2 PROJECT PURPOSES

Lost Creek Project, completed in 1976, was the first and is the largest of three multiple-purpose projects planned for the development and utilization of the water resources for the Rogue River Basin. The second project, Applegate, is located on the Applegate River. The confluence of the Applegate River with the Rogue River is at RM 96. Completed in 1980, the project is operated by personnel from the Lost Creek Project. The third project, Elk Creek, is located on Elk Creek, which joins the Rogue River at RM 152.0. Elk Creek Project is partially completed (about one third of design height) but was notched in 2008 to allow fish passage. It does not store water. If completed, personnel from Lost Creek Project will operate Elk Creek Project. The primary purposes of the Lost Creek Project are flood control, irrigation, water supply, and fisheries enhancement. Secondary purposes include power generation, water quality control, wildlife enhancement, and recreation. Lost Creek Project was the first in Portland District to have water quality and fisheries enhancement as authorized project purposes.

2-3 PHYSICAL COMPONENTS

Lost Creek Dam is a rock-fill shell embankment with a central impervious core. A gate-controlled concrete chute-type spillway is located on the left abutment. A multi-level withdrawal structure with multiple intake ports and a low-level turbidity conduit serve to provide the intake capability for the regulating outlet works and power penstock releases. A fish hatchery warm water intake mounted on the withdrawal structure provides a supplemental water supply for the downstream hatchery. The multi-level withdrawal structure, together with the regulating outlet tunnel and power penstock, is located near and extends through the right abutment. The powerhouse is located on the downstream side of the right abutment. Profiles of the embankment, spillway, regulating outlet, and plan views of Lost Creek Dam and Lake are shown on Plate 2-2. Supplementary pertinent data is tabulated in Exhibit A.

a. Embankment. The embankment is a rock fill shell with a central impervious core as shown on Plate 2-2 and in the photo on Plate 2-3. The dam has a crest width of 24 feet, a crest length of about 3,600 feet, and a height of 345 feet. The total in-place volume is 10,797,000 cubic yards (yd^3).

b. Spillway. The spillway and appurtenant components shown on Plate 2-2 consist of an unlined approach channel, a gated ogee structure, a partially lined spillway chute, and an unlined rock-stilling basin. The gated ogee structure is a concrete gravity type section with three bays, each equipped with a 45-foot-wide by 51-foot-high tainter gate as shown in the photo on Plate 2-4. The ogee crest elevation is 1,823 feet. In the closed position, the top of the gates is 2 feet higher than the full pool elevation El. 1,872 feet, to contain reservoir waves.

The spillway is operated at the gates by local manual control from the machinery control center with push-button stations located at each controller. These push buttons are momentary hold-down type and must be physically engaged to operate the gate. Each hoist has a gear-driven gate position indicator and a revolution counter, both visible from the push-button station and showing the position of the gate for its full range of travel. The revolution counter registers approximately 1/10th of a foot travel per revolution on the counter.

A nearly 3,000-foot-long straight and partially lined spillway chute is provided to direct flow into a stilling basin and thence to the Rogue River as shown in the photo on Plate 2-5. The spillway channel from the stilling basin enters the Rogue River downstream of the Cole M. Rivers Fish Hatchery approximately 6,660 feet downstream from the axis of the embankment dam and about 2,500 feet downstream of a fish barrier dam servicing the fish hatchery. A partially eroded dike composed of overburden material is blocking the present spillway channel access from the stilling basin to the river in order to deny fish movement into the excavated stilling basin. The dike was partially eroded during the flood of 1997 and was not repaired due to input from the Hatchery manager. The dike also prevents temperature and turbidity contamination from the stagnant pool formed by the excavated stilling basin.

The design capacity of the spillway structure is 158,000 cubic feet per second (ft^3/s). This flow corresponds to the probable maximum flood (also known as the spillway design flood) of 169,000 ft^3/s, less11,000 ft^3/s, the capacity of the regulating outlet works. Discharge rating curves for the spillway as well as tailwater rating curves are shown on Plates 2-6 and 2-7. The spillway chute is designed to contain, within sound rock, where possible, a flow of 50,000 ft^3/s (the unregulated standard project flood of 64,500 ft^3/s minus 14,000 ft^3/s through the powerhouse and regulating outlet) including air entrainment. While chute flows up to 158,000 ft^3/s, including air entrainment, will also be within the chute cross section, those greater flows will encounter rock of a lesser quality than the lower flows. Thus, some sacrificial erosion may be expected. The stilling basin at the end of the chute was designed for a project release of 64,500 ft^3/s. However, additional volume exists within the rock line downstream of the end of the horizontal floor. With usage of the stilling basin for flows in excess of 64,500 ft^3/s, floor and walls will erode as well as the chute perimeter. However, due to the very infrequent operation required and as long as the design capabilities are not exceeded, the stilling basin should retain its functional capability with only an occasional need for removal of loose material. The channel downstream of the stilling basin was excavated of overburden with the overburden being placed as a plug dike at the downstream end of the channel near the river. This channel was sized so that erosion would be minor for project flows up to 20,000 to 30,000 ft^3/s and of an acceptable degree for larger releases up to the probable maximum flood (less 11,000 ft^3/s, the capacity of the outlet works).

c. Multi-Level Withdrawal Structure. The multi-level withdrawal structure, located near the right abutment, permits selective withdrawal of flow releases, which have a direct impact on downstream water temperature and turbidity. A photo and schematic of the withdrawal structure (intake tower) are shown on Plates 2-8 and 2-9, respectively. The tower is a 271-foot-high freestanding concrete structure. Its major components are a wet well and a dry well with intakes common to the regulating outlet and power penstock. These intakes are referred to as the water temperature control ports and the turbidity conduit. The turbidity conduit is actually a low level intake designed to aid in flushing the lower levels of the reservoir or to act as a water temperature control port. All of the above intakes service the tower wet well. The tower dry well is used for access to the intake structure.

Two additional intakes are located on the tower, but neither use the tower wet well and both serve distinctively different project functions. The first, a fish hatchery warm water supply intake, supplies warm surface water to the Cole M. Rivers Fish Hatchery downstream of the project. The second, a tower bypass intake, allows releases to be diverted through the penstock bulkhead slot directly from the forebay to the penstock. Thus, the functional components of the intake tower are a 30-foot-diameter wet well, and a 25-foot-diameter dry well, the water temperature control ports, the turbidity conduit, the fish hatchery warm water supply intake, and the tower bypass intake.

(1) Wet and Dry Well Components. The 30-foot-diameter wet well of the tower acts as a water temperature-mixing chamber to both the regulating outlet system and the power generating system. The bottom invert of the well is El. 1,640, while the roof is at the bottom of the machinery deck at El. 1,877. Three intake ports are located at each of the four levels or tiers. The intake invert elevation of each tier is 1,640, 1,730, 1,790, and 1,845, respectively. Two regulating outlet openings with invert El. 1,640 provide entry to the regulating outlet conduit. A power penstock intake with centerline El. 1,690 serves as entry from the wet well to the power generating system. Elevator and stairwell facilities in the 25-foot-diameter dry well provide physical access to the gate chamber containing the regulating outlet gates and related control equipment, and to both the regulating outlet system and the power penstock for inspection and maintenance.

(2) Water Temperature Control Ports. Three 8-foot-wide by 15-foot-high intake ports at each of four levels provide both the means to select water from the reservoir at a temperature most desirable to downstream requirements and provide for a greater volume of release in case of flood control regulation. These intakes can also be used in selective withdrawal for turbidity purposes. As shown on plate 2-9, the invert of each port within the tier is at elevations 1,640, 1,730, 1,790, and 1,845. The middle port of the lowest tier is connected directly to the turbidity conduit.

Each of the 12 ports has a bulkhead type gate on the outer face of the well and is designed to withstand the full pool head against a dry well. Two additional bulkhead type intake gates have been provided to the project to be used as pressure relief gates. These gates were designed to replace two of the intake port gates at El. 1,730. Each pressure relief gate has twenty-seven 15- by 27-inch orifices that are closed by top-hinged panels. The elevation difference between forebay and wet well during normal operation will seal the panels. However, a higher wet well than forebay water surfaces will cause the panels to open, thereby relieving pressure in the wet well. Normal operating procedures include installation and use of these pressure relief gates at El. 1,730.

(3) Turbidity Conduit. The turbidity conduit was designed to aid in flushing the reservoir following storms to prevent a buildup of turbid water at lower levels and, thus, substantially improve water quality within the reservoir as well as for later releases. It also may function as a low level intake for larger releases. The turbidity conduit is shown on Plates 2-8 and 2-9. An approach channel for the turbidity conduit with its invert at El. 1,585 provides a channel for transport of the usually heavier turbid water from the lower levels of the reservoir to the intake. The conduit intake with an invert El. 1,595 is flared to develop a gross area of approximately 600 square feet. It has a trash structure with bar spacing of 5 feet on center and is expected to pass most of the debris on through the conduit, but stop that which might plug the system. The intake transitions to a 12-foot 6-inch-diameter concrete conduit about 400 feet long that connects to the middle port of the intake tower at invert El. 1,640. At the tower junction, the bulkhead gate, designed for the water temperature control port at the 1,640-tier level, serves as the entry gate for turbidity conduit flows entering the wet well. During operation of the turbidity conduit, the bulkhead gate will be raised as high as feasible above the gate slot to prevent potential vibration due to the relatively high velocity flow by the slot and possible gate jamming due to small debris carried in the area. Computations have shown that approximately 19 percent of the total flow entering the tower will enter through the open bulkhead slot and the remainder of the flow will be from the turbidity conduit.

(4) Fish Hatchery Warm Water Supply Intake. Mounted near the top of the withdrawal structure, a fish hatchery water supply intake is designed to skim warm water from the lake, screen it, and maintain a full column of water in the 30-inch standpipe within the tower. The standpipe empties into a conduit that parallels the penstock through the embankment. This variable diameter conduit (average 24 inches) continues along the left bank to the Cole M. River Fish Hatchery. The supply intake is intended to operate as a submerged weir at all times with discharge control located at the hatchery throttling valves 4,260 feet downstream. Floating debris drawn into the wet well is eliminated by use of a floating trash structure. The trash structure surrounds the tower similar to a collar and uses guides attached to the tower to ensure alignment down to El. 1,750. The system, however, is limited to operation between pool El. 1,800, and full pool El. 1,872, providing 60 ft^3/s and 70 ft^3/s, respectively. Hatchery staff has indicated that the warm water hatchery supply conduit does not function properly when the pool is below El. 1,803.

(5) Tower Bypass System. The tower bypass system is a means of diverting minimum releases through the power penstock when the tower wet well is unwatered for inspection or maintenance. Flow will be bypassed through a nominal 12-foot-wide by 6-foot-high intake port that is bell mouthed and located on the exterior of the multi-level withdrawal structure at El. 1,770. Releases through this intake will pass through the

oversized bulkhead slot, provided for the penstock closure, and empty directly into the penstock.

d. Regulating Outlet Works. The regulating outlet (RO) works components consist of twin intakes from the wet well of the tower, two conduits (each controlled by a 6-foot 6-inch wide by 12-foot 6-inch-high service gate, and protected by an upstream gate for emergency closure), a transition section, a single 12-foot 6-inch diameter circular conduit nearly 943 feet long, an open chute, and a flip bucket. An overall view of the system is shown on Plate 2-2, and a photograph of the multi-level withdrawal structure is shown on Plate 2-8. A photograph of the RO works is shown on Plate 2-11.

The twin intakes of the RO's are flared only in three directions with the invert flat at El. 1,640 to allow flushing of debris through the outlets. At full pool El. 1,872, these outlets are capable of discharging up to 11,460 ft^3/s. A discharge-rating curve for the RO gates is shown on Plate 2-12. The 54-foot-long steel-lined transition serves to combine the twin conduit component to the single circular conduit or tunnel downstream of the RO gates, and is expected to provide a satisfactory flow transition from the open-channel to full tunnel flow with discharges of 7,000 ft^3/s and 9,000 ft^3/s for both low and high pool levels, respectively.

When the tunnel approaches full flow, the hydraulic action at the valves creates waves in the flow. However, these waves do not choke off the tunnel or create any major disturbance at the exit. Full flow will begin at the downstream end and be carried as a continuous stream of heavily aerated flow along the crown of the tunnel, until the hydraulic grade line rises above the crown at the air vents. Then full, unaerated flow will occur. Variation in the amount of air received by the conduit can cause some variation in flow depth at the exit. However, neither slug flow nor gulping has been observed. Past operation has shown that excessive vibration occurs as the RO conduit transitions from open-channel flow to full tunnel flow. As a result, the RO gates should be opened to transition quickly from open-channel to full tunnel flow and not linger in the transition or unstable flow regions.

At large RO releases (greater than 10,000 $ft^{3/}s$) within a 1:40 scale model, surface waves were generated by the change from full flow in the circular tunnel to free surface flow in the downstream rectangular chute at each wall near the lower end of the transition, and waves overtopped the chute walls between 255 and 425 feet downstream of the exit portal. Those conditions observed during the model study (U.S. Army Corps of Engineers, North Pacific Division, "Outlet Works for Lost Creek Dam, Rogue River, Oregon," TR No. 140-1, Bonneville, Oregon, October 1979) have been improved by slight modification of the tunnel/chute transition and by the addition of wave suppressors added to the chute walls, between 128.3 to 146 feet downstream of the exit portal. These sloping 4-foot-side overhangs from the chute walls intercept the waves, turn them inward, and have eliminated the downstream overtopping and, in addition, a high rooster-tail seen in the model studies. The suppressor is not utilized at flows below 7,700 ft^3/s, but at flows between10,000 and 11,500 ft^3/s the suppressors are required.

The purpose of the 32-foot-wide 30 degree flip bucket is to direct the higher RO releases, which occur as high velocity jets at the bucket lip, sufficiently far enough downstream from the toe of the flip structure so that the energy can be dissipated in the tailwater of the plunge pool without endangering the dam or any appurtenant structures. Small releases will be dissipated by hydraulic jump action within the flip bucket and exit over the bucket lip as if it were a weir. The hydraulic jump is washed from the bucket basin at a flow of 560 ft^3/s and re-forms within the bucket when the discharge is reduced to 230 ft^3/s.

Some erosion of the excavated plunge pool has occurred, particularly with the higher releases. Observations indicate that debris from this action is moved about in the river resulting in buildup in the riverbed downstream of the powerhouse. This buildup has caused an increase in the powerhouse tailwater, reducing the power generating capabilities at low flows. In July of 1986 material was removed from the excavated plunge pool and the tailwater was lowered about 1.5 feet as a result.

e. Power Intake and Generating Facilities. The indoor type powerhouse facility is located immediately downstream from the toe of the embankment dam and is shown on Plate 2-13. The multi-level withdrawal tower supplies water to the powerhouse through the power penstock shown on Plate 2-14. The power intake is located in the tower wet well, with a centerline elevation of 1,690 feet. The intake has a transition extending outside the tower boundary to a 15-foot-diameter, 1,368-foot-long welded steel penstock that is encased in concrete and laid in a rock trench extending to the powerhouse. A wye branch near the powerhouse divides the penstock into two 10-foot 6-inch-diameter pipes leading to the two turbines. Each branch is controlled by a butterfly valve within the powerhouse structure. Maximum discharge through the power facilities is approximately 3,000 ft^3/s. An emergency bypass intake is mounted on the intake structure above the penstock. This setup enables use of the powerhouse during the infrequent periods when it is necessary to dewater the intake tower wet well. Within the powerhouse two Francis-type hydraulic turbines are housed and are shown on Plate 2-15. Each turbine is rated at 38,900 horsepower with a net head of 275 feet. Each generator develops up to 24,500 kW at a 0.95 power factor and is capable of continuous operation at an overload of 15 percent. Power generated is raised from 13,800 to 115,000 volts by a step-up transformer that is connected through a circuit breaker to a nearby transmission line owned by Pacific Power. Power plant operation curves are shown on Plate 2-16.

f. Tailwater Rating Curve. The tailwater-rating curve for both the powerhouse and RO were developed based on a gage located 200 feet downstream of the powerhouse. In the backwater pool for the fish barrier dam the powerhouse tailwater is determined from this gage. A powerhouse and RO tailwater rating curve are shown on Plate 2-17. In addition, some key discharges are summarized in Table 2-1.

Official river flows are determined from gage readings for the Rogue River at the McLeod and Big Butte Creek gaging stations. These stations are discussed in paragraph 5-2

Table 2-1. Lost Creek Project Tailwater Elevation Summary.

FLOW CONDITION	DISCHARGE (ft^3/s)	WATER SURFACE ELEVATION (Feet NGVD)
Minimum flood release	500	1,547.9
Maximum turbine design release	3,000	1,551.6
Normal maximum release	10,000	1,556.8
Maximum capability RO plus power	14,000	1,559.3
Spillway design flood, maximum reservoir outflow (spillway plus outlets)	169,000	1,570.0

g. Lake Capacity and Use. Total capacity of Lost Creek Lake at full pool El. 1,872 is 465,000 acre-feet. The U.S. Army Corps of Engineers has established uses for water stored in Lost Creek Lake that are consistent with project authorization. Between El. 1,872 full pool, and El. 1,812, minimum flood control pool, there is 180,000 acre-feet of storage space reserved for flood regulation and multiple-purpose use. This volume of water is referred to as "seasonal conservation storage." Between El. 1,812, minimum flood control pool, and El. 1,751, minimum conservation pool, there is another 135,000 acre-feet of storage that is referred to as "carryover conservation storage." Carryover conservation storage is used in years of water shortages. The total seasonal and carryover conservation storage is 315,000 acre-feet. Between El. 1,751, minimum conservation pool, and El. 1,550, the streambed, there is 150,000 acre-feet of inactive storage space. The inactive storage is maintained for in-lake use and is not intended for release. Oregon water use permits have been issued to allow for the storage and release of waters from Lost Creek Lake. These permits are issued for both the seasonal and carryover storage, and are in general agreement with the Corps water control plan. Copies of the permits may be obtained from the Oregon Water Resources Department (OWRD).

Storage and area curves for the project are shown on Plate 2-18. Lost Creek Lake elevations, area, storage, and discharge capability are shown in Table 2-2. A capacity and area table for Lost Creek Lake is shown in Table 2-3.

Table 2-2. Lost Creek Lake Principal Elevations, Area, Storage, and Discharge Capability.

FEATURE	ELEVATION (feet NGVD)	WATER SURFACE AREA (Acres)	STORAGE (acre-feet)	SPILLWAY DISCHARGE[1] CAPACITY (ft^3/s)	OUTLET WORKS DISCHARGE[2] CAPACITY (ft^3/s)
Top of Dam	1,882		500,000		
Maximum and Full Pool	1,872	3,430	465,000	158,000	11,460
Minimum Flood Control Pool (also Top of Carryover Conservation Pool)	1,812	2,600	285,000	0	9,860
Minimum Conservation Pool (also top of Inactive Pool)	1,751	1,800	150,000	0	8,000
Dead Storage (Top)	1,640	620	21,000	0	0
Lowest Intake (Invert)	1,595	175	3,000	0	0
Streambed	1,500	0	0	0	0

[1]Free overflow condition
[2]Two gates full open condition

2-4 RELATED PROJECT FACILITIES

The fish facility, located nearly 1 mile downstream, was required by agreement to mitigate fish runs to pre-project levels. The fish facility is known as the Cole. M. Rivers Fish Hatchery and is shown on Plate 2-19. The Oregon Department of Fish and Wildlife (ODFW) operates the hatchery under contract. The purpose of the facility is to collect, hold, and spawn adult salmonids; hatch and rear sufficient anadromous species to perpetuate runs representative of pre-project levels at Lost Creek, Applegate, and Elk Creek Lakes; and rear resident fish for the reservoirs. Cole M. Rivers Fish Hatchery, the largest hatchery in Oregon, was built to produce 1,973,000 spring Chinook salmon smolts, 206,000 coho salmon smolts, and 560,000 steelhead trout smolts annually to replace natural production lost due to inundation of spawning areas and blockage of upstream migration of spawning adults. In addition, the hatchery has the capacity to produce 70,600 pounds of resident trout and kokanee to stock other project reservoirs. The hatchery facilities include 87 rearing ponds, two trout brood ponds, 26 circular outdoor starter ponds, the hatchery building complex (hatchery building, food storage building, mechanical and electrical building, and garage and shop building), two spawn buildings including a public observation deck on the Salmon Spawn Building, and residences for hatchery personnel. Support facilities are sufficient to allow the addition of another 20 rearing ponds and six circular starter ponds, if needed.

A fish barrier dam shown on Plate 2-19, together with upstream and downstream compacted gravel embankments, serve the hatchery by providing both a block to the upstream migration of fish and an impoundment for water supply. It will pass the majority of project releases directly into the river. The structure also consists of a weir section, stilling basin, fish collection facility, and vehicular bridge. The weir is a concrete gravity overflow section 100 feet wide designed to pass up to 14,000 ft^3/s of water, which is the combined capacity of the outlet works and powerhouse. The stilling basin is a conventional design capable of dissipating energy through a hydraulic jump action.

Fish collection facilities consist of two entrances from the barrier dam stilling basin leading into the fish ladder that is 8 feet wide and built on a 1V on 15H slope. The ladder leads into the collection pond that is 20 feet wide by 100 feet long by 9 feet deep. Fish enter the pond over a weir at the head of the fishway where they are crowded by a mechanical sweep to the head of the pond and into the Salmon Spawn Building. Six holding ponds are located adjacent to the spawn building.

The hatchery main water supply is gravity-drawn from the impoundment of the fish barrier dam and passes through traveling screens into the hatchery water supply system. The design capacity of the system is 300 ft^3/s. The gravity drainage system includes an upstream drainage system that discharges at the fish barrier, and a downstream drainage system that carries the flow from ponds being dewatered or operated at a low water level and discharges at the downstream drainage structure. The downstream drainage system is equipped with pumps for use during project releases in excess of 10,000 ft^3/s. An additional water supply intake, discussed in paragraph 2-3c, is located on the main dam multi-level withdrawal tower, to provide a source of warm water for hatchery water temperature control. The warm water supply conduit has a capacity of 60 ft^3/s at pool El. 1,800 and 70 ft^3/s at pool El. 1,872.

2-5 REAL ESTATE ACQUISITION

The general criterion for establishing the taking line for real estate at Lost Creek Lake was 300 feet horizontally from the maximum and full pool El. 1,872. A line approximately 100 feet horizontally from full pool was used near the upper fork of the reservoir where the land lies in a deep gorge. Land requirements for public use, roads, slides, operation and maintenance, and permanent structures dictated the procurement of additional lands. Finally, where Government lands were involved, a block-type perimeter to the smallest practical subdivision line was used for acquiring reservoir lands.

2-6 PUBLIC FACILITIES

Public use areas are provided by the Corps of Engineers at Stewart State Park, McGregor Park, Takelma Park Boat Access, River Edge, and Right Bank Day Use Area, and a project trail system at Lost Creek Lake. The Lost Creek Lake Marina is shown on Plate 2-20, and Stewart State Park is shown on Plate 2-21. The Recreation Access Project Plan is shown on Plate 2-22.

The Corps manages recreation sites at Lost Creek Lake except for Stewart State Park, which is operated and maintained by the State of Oregon. A project visitor's information center has been constructed, in addition to the other day facilities, at McGregor Park.

Major recreational facilities located in Stewart State Park include camping units, a swimming beach, and a boat launch ramp in addition to other related support facilities. The boating facilities are operational from full pool El. 1,872 down to El. 1,812. The project provides a wide range of day-use activity opportunities at the other project sites including picnicking and water-associated activities.

At Takelma Park boating facilities are available and operational from full pool (generally 1 May) to well below minimum flood control pool (generally 1 November). The operational range is between full pool El. 1,872 down to El. 1,752. Project activity opportunities are listed in Table 2-4.

Table 2-4. Recreational Facilities Available at Lost Creek Lake

ACTIVITY	AVAILABLE RESOURCES
Camping	435 spaces
Picnicking	270 spaces
Boating	500 boats
Fishing (river)	2.5 miles
Swimming	2 acres
Trails:	
Hiking	28 miles
Interpretive	3.5 miles

SECTION 3

HISTORY OF PROJECT

3-1 AUTHORIZATION

The Flood Control Act of 1962, Public Law 87-874, 23 October 1962, authorized the Rogue River Basin Project that consists of Lost Creek, Elk Creek, and Applegate Lakes. The project was approved substantially in accordance with the recommendations of the Chief of Engineers as described in House Document 566. The authorization language states that the projects are to be located, constructed, and operated to achieve the benefits as set forth and described in the report and its appendixes. In the years of short water supply, all water users will share the available water in the same proportions that they would share the total supply when it is available, and that no further water-use allocations would be made from the authorized storage so as to retain the maximum possible benefits for authorized uses.

3-2 PLANNING AND DESIGN

a. Project Planning. Flood mitigation planning began as a result of basin flooding in the 1860s, 1890s, 1930s, and the severe economic losses due to the December 1955 flood. In November 1956 (in Grants Pass, Oregon) the U.S. Army Corps of Engineers held the first of 22 public meetings between November 1956 and September 1961 to discuss the proposed flood control project. Public testimony emphasized the water resource needs of the basin in terms of flood damage prevention, fisheries enhancement, irrigation, power, and recreation. Environmental issues, especially stream temperature and its potential effect upon the fishery resources in the basin if dams were built, were a major concern. Federal and State agencies, firmly supported by local groups, stated that the flood control plan for the basin must be compatible with the Rogue River Basin fishery resources. An interagency river temperature study was conducted and the public commented on the results. In 1962 the Corps recommended Lost Creek, Applegate, and Elk Creek Dams for authorization as part of the Rogue River Basin Project. The document that described the three-dam system was a survey report written by the Portland District. The survey report was submitted to Congress as House Document 566.

The Rogue River Basin Project, authorized by House Document 566, provided for the construction of a three-dam system to achieve the primary purposes of flood control, fish and wildlife enhancement, irrigation, and water supply, and secondary purposes of power generation, recreation, and water quality enhancement. The House Document provided authorization that was substantially the same as the Corps survey report and henceforth referred to as the Project Document Plan.

b. Project Design. Lost Creek Dam, as proposed for authorization, was to be a rock and gravel embankment about 360 feet in height from foundation to crest with an overall length of about 8,130 feet. The top width would be 24 feet at crest El. 1,920. The spillway was to be a concrete ogee section with a net length of 95 feet and located on the right abutment. Discharges would be controlled by two electrically operated gates capable of releasing 102,000 ft^3/s at a 45-foot head with the pool at El. 1,915. A channel excavated in rock would return flow to a side canyon leading to the Rogue River.

The outlet works would consist of a tower with six sets of three intake ports each to provide water temperature regulation. The outlet works would have a design discharge of 10,000 $ft^{3/}s$. A powerhouse would be located on the right abutment that would house two Francis-type turbines with installed capacity of 26,000 kilowatts each. Lost Creek Lake at full pool El. 1,915 would store 465,000 acre-feet, 315,000 acre-feet of which would be usable. Fish production facilities would be provided as compensation for the loss of spawning and rearing areas in and upstream of the pool. No fish passage facilities would be provided.

c. Departure from Project Design. The plan adopted for the Lost Creek Project included several major changes from the original project document plan. Major changes were as follows:

(1) The dam was relocated at a site approximately 0.6 miles downstream from the original project document location.

(2) Crest elevation of the dam was lowered from El. 1,920 to 1,877 feet, resulting in substantial embankment quantity reduction. Storage capacity of the lake was not changed.

(3) The spillway section was moved from the right abutment to the left abutment. Other changes indicated by the site change were also made.

(4) The power plant was changed from two 26,000-kilowatt units to two 24,500-kilowatt units.

(5) Road relocations were not appreciably changed in the upper reaches of the reservoir, but additional mileage was required because the dam site was farther downstream. Also, shifting of State Highway 62 relocation from the right to the left bank occurred.

(6) A low-level turbidity conduit was incorporated into the intake tower for the purpose of selective water withdrawal for turbidity control.

The General Design Memorandum (GDM) No. 4, dated June 1966, outlined the studies and justification for the changes made to the original project document plan. The Office of the Chief of Engineers approved the changes with certain comments and recommendations that were incorporated into other design memorandums. Table 1-2 provides a list of design memorandums and the dates when they were prepared. Congress appropriated construction funds of Lost Creek Lake in 1967. An environmental impact statement was found necessary, and after public review the final environmental impact statement was filed with the Council of Environmental Quality in 1972.

3-3 CONSTRUCTION

Construction of Lost Creek Project began on 10 April 1970 with the relocation of 2.75 miles of Oregon State Highway 62 and the construction of a viewpoint above the impoundment area. During the next 69 months, major contracts were awarded for the main dam, fish hatchery, powerhouse and service building, bridges, clearing, road construction, drilling and grouting, visitors center power line relocation, erosion control, recreation facilities, and landscaping. Construction at the main dam was started in February 1974 and power was on line in July 1977. Table 3-1 lists significant construction dates.

Table 3-1. Significant Construction Dates for Lost Creek Project.

EVENTS	DATES
Construction start	10 April 1970
Stream diversion	8 June 1973
Impoundment start	18 February 1977
Minimum conservation pool (1,751 feet) attained	14 June 1977
Minimum flood control (1,812 feet) attained	27 December 1977
Full pool attained	12 May 1978

3-4 RELATED PROJECTS

The Flood Control Act of 1962 authorized Lost Creek, Elk Creek, and Applegate Projects. The Elk Creek Project on Elk Creek was only partially completed while awaiting resolution of litigation. Part of the spillway was removed, or "notched", in 2008 to allow fish passage. The Applegate Project on the Applegate River was completed in 1980 and is currently in operation.

Emigrant Dam and Lake, a U.S. Bureau of Reclamation multiple-purpose project on Emigrant Creek southeast of Ashland, Oregon, provides 20,000 acre-feet of season flood control storage space. Flood control benefits from Emigrant Lake are primarily from the dam downstream through the Ashland area and the city of Medford, and have a lesser effect on Rogue River floods.

3-5 MODIFICATION TO REGULATIONS

Major changes have occurred in the water management plan as first described in the authorizing document. The most significant changes are with regard to the timing of flood control storage space, volume of flood control storage space, and minimum flood releases from the project to be made available each year.

a. <u>Timing of Flood Control Storage</u>. Initially, flood control storage space was required to be available from 15 November to 31 January of each year. A constant maximum filling rate beginning on 1 February and ending 30 April was also specified. After analysis of the December 1964 flood, additional storage space was determined to be necessary during the entire month of November, changing the major flood control portion of the schedule to 1 November to 31 January. Changes in the timing of the filling portion of the flood control space in 1977 after an unpublished hydrology study indicated desirable conservation benefits. This schedule, which is presently in use, requires maximum flood control space being made available 1 November to 31 December, after which non-uniform filling takes place between 1 January and 30 April. The schedule is discussed in detail in Section 7, paragraph 7-3.

b. Volume of Flood Control Storage. The initial volume of storage space required at Lost Creek Lake was 105,000 acre-feet, which could be increased to a “maximum” amount of storage of 165,000 acre-feet if snow pack conditions on the watershed indicated a potentially high flood threat. After analysis of the December 1964 flood, the amount of storage allocated for flood control was increased to the maximum amount (165,000 acre-feet) plus an additional 15,000 acre-feet for a total of 180,000 acre-feet. This storage space was to be maintained through 31 December of the flood control season and is the basis for the present flood control rule curve discussed in Section 7, paragraph 7-3.

c. Minimum Flow Releases from the Project. The minimum flow release from Lost Creek Lake during flood control operations was originally 200 ft^3/s. However, due to the possibility of dewatering salmon spawning areas downstream the minimum release during flooding has been increased to 500 ft^3/s. This increase only affects releases performed during flooding since releases at all other times are at or above 700 $ft^{3/}s$.

SECTION 4

WATERSHED CHARACTERISTICS

4-1 GENERAL CHARACTERISTICS

The Rogue River headwaters are in the Cascade Range near the Oregon/California border and northwest of Crater Lake, shown on Plate 4-1. The headwaters begin near the crest line of the Cascade Mountains, most of which range in elevation from 6,000 to 8,000 feet. The Rogue River flows south and west 210 miles to the Pacific Ocean at Gold Beach. The total Rogue River drainage area above the mouth is 5,080 square miles. The 674-square-mile area tributary to Lost Creek Lake is situated in the upper section of the basin and is mountainous and heavily timbered. Nearly all of the drainage area lies in southwestern Oregon, with a small portion of the Illinois and Applegate River tributaries located in northern California.

4-2 STREAMS

The stream system of the upper and middle Rogue River Basin is shown on Plate 4-1. The South Fork Rogue River, a principal tributary, and the Rogue River join about 10 miles upstream from Lost Creek Dam and within the Lost Creek Project area. There are also smaller tributaries that enter the lake that flow from small canyons and have steep gradients.

Stream gradients vary from several hundred feet per mile in the headwater reaches to 70 feet per mile above the lake and 20 feet per mile immediately below the dam. Most streams above Lost Creek Lake flow through narrow channels, cutting deeply into underlying volcanic rock. Profiles for the Rogue River and major tributaries downstream of Lost Creek Lake are shown on Plate 4-2.

4-3 VEGETATION

Much of the area above Lost Creek Dam is forested with Douglas fir, white and Shasta red fir, ponderosa and sugar pine, hemlock, and red cedar as the prominent conifers. Hardwoods make up a small percentage of the watershed vegetation. About 65 percent of the basin is administered by the Forest Service, 15 percent by Crater Lake National Park, 5 percent by Bureau of Land Management (BLM), and 15 percent is held in private ownership.

4-4 TOPOGRAPHY

The drainage area tributary to Lost Creek Lake is about 13 percent of the total area of Rogue River Basin. Topography of the basin above the lake ranges in elevation from about 1,500 feet at the dam to a maximum of 8,356 feet. The average elevation of the basin tributary to Lost Creek is 4,110 feet. An area-elevation curve is shown on Plate 4-3.

4-5 GEOLOGY AND SOILS

The Rogue River above Grants Pass occupies two physiographic provinces, each with distinctly different geological features. These physiographic provinces are the High Cascades Province and the Western Cascades Province.

a. High Cascades Province. The High Cascades Province is located several miles east of Lost Creek Lake and is characterized by extensive andesite lava flows, high mountain peaks, and rugged topography. Approximately 80 percent of the Rogue River Basin above Lost Creek Lake lies within the province. Only the lower slopes of the province are forest covered with the timberline at approximately El. 6,000. Most areas of the province were subjected to intense glaciations during the Pleistocene and Holocene epochs. The glacial erosion and deposition have altered drainage patterns and created steep-sided valleys. In the High Cascades the degree of erosion has progressed only through early youth. This stage of erosion is characterized by stream valleys with narrow floodplains, steep sidewalls, and poorly defined drainage. Drainage from the High Cascades alternately flows through areas with gradients of 20 feet per mile and areas with gradients of 50 feet or less per mile. The stream patterns developed in these areas are highly variable with courses and profiles dominated by features of glacial erosion and deposition.

Soils in the High Cascades Province are primarily basaltic, andesitic, and pumice in origin. The former two have soil depths up to 20 and 10 feet deep, respectively, below timberline, but tend to have shallow or even no soil development in the unweathered mountains above timberline. Pumice rock produces extensive weathered pumice soils in the northeastern section of the basin. Deposits of sand-sized pumice may be found up to 50 feet deep due to the ease of which pumice is transported. These deposits have little ability to retain moisture to support vegetation.

b. Western Cascades Province. The northwestern portion of the Upper Rogue River Basin occupies the Western Cascades Province. About 20 percent of the Rogue River Basin above Lost Creek lies within it. This province is typically composed of older rock units and has been subjected to extensive folding and faulting. The physiographic features resulting from this combination of old weathered rocks and geologic deformation is low, deeply dissected mountains with well-developed stream patterns. Nearly the entire province is densely vegetated. An exception is the sparsely vegetated pyroclastic rock units, which weather to relatively infertile soil with only limited ability to retain moisture through the dry season.

Stream erosion has removed most of the evidence of glaciation in the Western Cascades Province with the only remaining glacial features located in the northwestern corner of the Rogue River drainage. In contrast to the High Cascades Province, the Western Cascades Province has a well-defined drainage pattern dominated by the underlying rock type and its degree of weathering. The stream valleys have moderately steep side slopes and are in a mature stage of erosion. They have wide floodplains and have stream gradients of about 50 feet per mile. Rock types control the stream profiles. This feature is demonstrated by the Rogue River at RM 195, where the river crosses the boundary between a younger, resistant flow basalt and the older, less resistant pyroclastics and flow breccias lying directly beneath it.

Soils of the Western Cascades Province are primarily andesitic or pyroclastic in origin. Soils overlying andesitic rocks may be 5 to 30 feet thick. Soils overlying the pyroclastic rocks are shallower at 1 to 15 feet thick. The pyroclastic soils weather to relatively infertile soil and do not retain moisture well, resulting in sparse vegetation. The other soils in the Western Cascades Province support dense vegetation.

4-6 LAKE SEDIMENTATION

a. Lake Sediment Deposition. The Lost Creek Lake drainage basin yield in sediment is estimated to be 0.3 acre-feet per year per square mile. This yield introduces an average of 202 acre-feet of sediment to the lake per year. Of this volume the lake will retain about 95 percent or 192 acre-feet per year. The 95 percent trap estimate is derived by the capacity-inflow method. The 95 percent trap estimated average lake sediment deposit would be 1,920 acre-feet after 10 years of operation and 19,200 acre-feet in 100 years. The deposits will initially occur primarily in two locations: in or near the inactive pool where the fines will settle out of the inflow waters and in deltas formed near full pool where the gravels and heavy materials enter the lake during floods. Eventually these deltas are expected to be mostly re-washed to cause deposition near or below the inactive pool.

b. Lake Deposition Impact. The total storage space in Lost Creek Lake is 465,000 acre-feet. In 100 years the sediment accumulation is estimated that it will amount to 19,200 acre-feet or about 4 percent of the original volume. The inactive pool, with a capacity of 129,000 acre-feet, will contain all of the lake sedimentation. This estimate of lake sedimentation deposition will be verified by scheduled surveys. The evaluation will be performed by CENWP-EC-H.

c. Lake Sedimentation Monitoring.

(1) Facilities. A system of 22 sedimentation ranges has been established at Lost Creek Lake. The ranges provide a systematic means of obtaining data for evaluating degradation and aggradations of the river channel above and below the lake as well as future silting of the lake.

Plate 4-4 shows a layout of the sediment ranges established at Lost Creek Lake. Ranges 1C and 2C are degradation ranges located downstream from Lost Creek lake, above and below Big Butte Creek. Ranges 1A through 18A are sedimentation ranges located across the lake. Ranges number 4A and 12A will be used as index ranges. They will be periodically surveyed to determine if sedimentation is of a magnitude to warrant a survey of all the ranges. Ranges 1B and 2B are aggradations ranges, located near where the Rogue River and the South Fork Rogue River enter the lake, and will be used to measure aggradations in those reaches.

Permanent concrete monuments were established, as needed, at each end of the range lines above the maximum pool. Each monument contains a capped galvanized pipe which is to be used for two purposes: (1) to serve as a holder of a range marker for use when future surveys are made, and (2) to contain a brass disk which is stamped with the elevation of the monument.

(2) Reporting. It is anticipated that reconnaissance surveys of Category A, B, and C Ranges will be made after each major flood by CENWP-EC-H to determine if detailed surveys are required. Complete or partial surveys will be made as deemed necessary on the basis of reconnaissance surveys.

4-7 CLIMATE

The climate for the Upper Rogue River Basin is characterized by mild, wet winters and hot, dry summers due to maritime influences. The general southward displacement of the Aleutian Low results in a predominance of westerly flow of moist air from the Pacific Ocean during the winter months. Temperatures are generally such that a large portion of the precipitation at high levels occurs as snow with mostly rain at low elevations. On rare occasions polar continental air masses invade the area resulting in short periods of subfreezing temperatures and snowfall at all elevations. During the summer months the Pacific High resulting in hot, dry summers dominates the area. Short duration summer rainstorms occasionally occur. Generally, they develop into localized thunderstorm activity. Climate during the spring and fall months is transitional between summer and winter extremes.

a. Air Temperatures. The closest long-term climatologic station to Lost Creek Lake is located at Prospect, Oregon, El. 2,482. The Prospect, Oregon, station is shown on Plate 4-5 which shows the hydrometeorological data stations used for regulation of Lost Creek Lake. Monthly average temperatures at Prospect range from 35.7°F (1.9°C) in January to 66.4°F (19°C) in July. Average July maximums and minimums are approximately 88° and 46°F (30 and 7.8°C), respectively. Extremes of record at Prospect, Oregon, are –12°F (-24.4°C) in January for minimum daily temperature and 106°F (41.1°C) in July and September for maximum daily temperature. Temperatures at the higher elevations decrease at the rate of about 3°F per 1,000 feet. Tables 4-1 through 4-3 show climatologic data summaries for Prospect, Medford, and selected stations in the Rogue River Basin, respectively.

b. Precipitation. The normal annual precipitation above Lost Creek Lake is approximately 60 inches, ranging from less than 40 inches at the dam site to nearly 80 inches in the headwaters area. About one half of the annual precipitation occurs during the November through January period, at which time the flow of moist air from the west is most pronounced. By contrast, less than 2 percent of the annual precipitation occurs during July and August when the Pacific High dominates the area and the westerly flow of air is at a minimum. A map of the Rogue River Basin normal annual precipitation is shown on Plate 4-6. The effect of topographical barriers is seen by the variation in annual precipitation amounts. Precipitation frequency depth-duration curves for Lost Creek Lake are shown on Plate 4-7. These curves indicate the frequency of precipitation occurring for specified depths and durations.

c. Snow. Precipitation in the form of snow is a significant hydrologic factor in the area above Lost Creek Lake. At Prospect, El. 2,482, the annual snowfall is 63.2 inches with a water equivalent of almost 8 inches or 18 percent of the annual precipitation. Snow at this level is transient and usually does not remain on the ground all winter. At the 5,000- and 7,000-foot levels about one half and three fourths of the annual precipitation, respectively occurs as snow that accumulates to considerable depths during the winter months. About three fourths of the annual snowfall occurs during the December through February period. At middle to high elevations in the basin the snow pack reaches its maximum water equivalent about 1 April. Lower elevation snow courses such as Silver Burn (El. 3,720) show an average water equivalent of 9.8 inches on the first of April and melt out by the end of April. Middle elevation snow courses such as Billie Creek Divide (El. 5,300) show average water equivalent of 22 inches for 1 April and tend to melt out by the end of May. High elevation snow courses such as Annie Springs (El. 6,018) show average water equivalent of 45.2 inches for 1 April and tend to melt out by mid-June. Table 4-4 shows a snow survey summary for selected stations in or near the Rogue River Basin.

d. Evaporation. The climate of the Rogue River Basin is conducive to high rates of evaporation. At Medford, Oregon, located in the central valley, the mean annual pan evaporation is 44.8 inches based upon 43 years of record. Approximately 73 percent of the annual evaporation occurs during the 5 summer months, May through September, inclusive. There is a gradual increase in evaporation rates during the spring increasing to a maximum of 9 inches in July. During the fall, evaporation rates decrease until they become negligible by December and January.

Lake evaporation rates are approximately 60 percent of pan evaporation rates during the summer months. Table 4-5 shows evaporation and related data at Medford, Oregon, and Lost Creek Lake.

e. Wind. High winds occur infrequently in the Rogue River Basin above Lost Creek Lake and are seldom of destructive proportions. High winds are generally associated with the winter storms over the valley floor. Average monthly wind speed range from 3 miles per hour in November to about 6 miles per hour in April, with normal daily speeds between 0 to 10 miles per hour. For short intervals, however, velocities occasionally reach 30 miles per hour while maximum winds rarely exceed 50 miles per hour. On 12 October 1962, western Oregon experienced gusts in excess of 100 miles per hour as part of the most widespread and disastrous windstorm of record in the Pacific Northwest. Greater wind speeds occur at the higher elevations as evidenced by pilot balloon weather observations that frequently show wind speeds exceeding 60 miles per hour at the 5,000 to 10,000-foot level.

f. Fog. Fog occurs in all months of the year, but occurs most frequently during the October to March time frame and particularly in the valley areas around Medford. It is generally confined to late night and early morning hours, but occasionally may persist during the entire day. Lower elevations in the valleys and higher elevations are more susceptible than intermediate areas. In the valleys the fog layer is normally several hundred feet in thickness.

4-8 RUNOFF CHARACTERISTICS

The stream flow regime of the Rogue River and tributaries is similar to the precipitation pattern. Low flows normally prevail from July through October, the season of low precipitation. Moderate to high flows, which may fluctuate widely, prevail during the remainder of the year. Except for the extensive areas of porous pumice rock and soil types along the eastern boundary, the topography and geology of the basin is conducive to rapid runoff. Runoff from many of the tributaries produces peak flows within hours after passage of a storm front. During the December 1964 flood, the Rogue River at Lost Creek rose from base flow to peak flow in about 48 hours because of the intense precipitation and snowmelt. Daily discharge hydrographs for Lost Creek Lake are shown on Plates 4-8a through 4-8f. Plate 4-9 shows the annual runoff in inches at Lost Creek Lake for water years 1929 to 1989 and Plate 4-10 shows the minimum, mean, and maximum discharge by month at Lost Creek lake of the same period of record. Plate 4-11 is a summary hydrograph for the Rogue River at Lost Creek Lake, period of record 1929 through 2011, which includes minimum daily discharges, maximum daily discharges, and exceedence probabilities. Data used to generate Plates 4-8 through 4-11 are from the USGS Station 14335000, Rogue River below South Fork Rogue River, near Prospect, Oregon, period of record 1928 to 1965 (adjusted for watershed area); correlated data with USGS Station 14339000, Rogue River at Dodge Bridge, period of record 1965 to 1968; the USGS Station 14334700, South Fork Rogue River, south of Prospect, Oregon, period of record 1968 to 1977, and Station 14330000, Rogue River below Prospect, Oregon, combined and adjusted for watershed area, period of record 1968 to 1977; and stream flow based on change of content at Lost Creek Lake, period of record 1977 to 2011. Table 4-6 provides a concise tabular summary of runoff at Lost Creek Lake.

Table 4-6. Runoff Summary for Lost Creek Lake (Period of Record Water Years 1929-2011).

	Mean Daily	Mean Annual	Annual	
	$Ft^{3/}s$		Acre-Ft	Inches
Maximum	36,930	2,940	2,129,470	58.2
Mean	----	1,890	1,371,720	37.5
Minimum	535	980	710,230	19.4

A normal annual precipitation of 60 inches per year and annual runoff of about 39 inches indicates an annual basin loss of about 21 inches.

4-9 STORMS AND FLOODS

a. Storms. Flood-producing storms occur chiefly during the winter months and are not uncommon in late fall and early spring. Nearly all major storms are of Pacific origin and are associated with a strong on-shore flow of moist air from the west and southwest. Satellite images help locate low-pressure storm systems showing them with a counterclockwise cyclonic movement as shown on Plate 4-12. Orographic and frontal activities are the principal factors producing precipitation in the Rogue River Basin. Major storms are associated with a quasi-stationary front with minor waves moving inland at intervals ranging from 12 to 48 hours. Additional precipitation often results from lifting caused by the cyclonic curvature of the airflow associated with low centers passing over the area.

Geographic location and physical features have a significant influence on the duration and intensity of storms over the Rogue River Basin. At Gold Beach near the coast and at Crater Lake in the Cascades Range, precipitation depths during a storm may exceed 10 inches, whereas only 3 to 4 inches may occur during the same storm on the valley floor near Grants Pass. Storm intensities vary somewhat in accordance with the normal annual precipitation pattern, but considerable variation may occur in individual storms. A typical major storm is generally of 3- to 5-day duration, but some may persist for as long as 10 days.

In addition to the typical winter storms, convective-type storms, generally occurring during the late spring and early summer months, are quite common to the area. Because of the small area that they affect and the short duration, such storms are rarely productive of floods except in localized areas. Intensity of precipitation in convective-type storms is high. Lightning and hail often are associated with convective-type storms.

b. Flood History. From the standpoint of peak discharge and volume, the largest recent flood on the Rogue River at Lost Creek Lake occurred in December 1964. It is estimated that the peak discharge at Prospect, below the South Fork gaging station, was 55,000 ft^3/s, equivalent to flows associated with a 150-year recurrence interval flood. The total 8-day volume of the flood was 350,000 acre-feet. The historical floods of 1861 and 1890 had estimated maximum discharges of 45,000 and 41,000 ft^3/s, respectively, and are based on very limited hydrographic data.

Other more recent floods on the Upper Rogue River occurred in November 1953 and December 1955. The November 1953 flood had a peak discharge of 20,500 ft^3/s and a 5-day volume of 80,000 acre-feet near the dam site. The December 1955 flood had a peak discharge of 34,000 ft^3/s and an 8-day total volume of 156,000 acre-feet. The largest flood event post dam construction occurred in late December 1996 and early January 1997. This event had a peak discharge of 26,200 ft^3/s near the dam site and a 5-day volume of 160,000 acre-feet.

c. Flood Characteristics. Primarily heavy rains augmented by snowmelt runoff that will vary from storm to storm cause floods on the Rogue River and its tributaries. Peak annual flows on the Rogue River and tributaries have occurred as early as October and as late as March. After the ground is saturated, runoff from heavy rains occurs almost immediately and the resulting floods are generally of short duration, 2 to 4 days, with relatively high peak discharges. Spring freshets resulting from melting snow are of longer duration and peak discharges are generally not high enough to cause damage. About 75 percent of the floods of record have occurred during the months of December, January, and February. The maximum mean daily discharge at Lost Creek Lake has occurred during every month from October through June. Table 4-7 shows by month, for the period 1929 through 2011, a summary of the maximum mean daily discharges that have occurred at Lost Creek Lake. A cumulative frequency curve for Lost Creek Lake, based on maximum annual discharges is shown on Plate 4-13. Cumulative frequency curves for maximum annual discharges for other downstream stations are found on Plates 4-14 through 4-16. Maximum annual discharges for the observed period of record (specified on each plate) were used to derive the cumulative frequency curves for maximum annual discharges shown on Plates 4-13 through 4-16. Table 4-8 shows maximum annual discharges at Lost Creek Lake for unregulated and regulated conditions.

Table 4-7. Maximum Mean Daily Discharge by Month for Lost Creek Lake (Period of Record 1929 to 2011).

MAXIMUM MEAN DAILY DISCHARGE (ft^3/s)	OCCURENCES									TOTAL
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	
above 40,000	----	----	----	----	----	----	----	----	----	0
35-40,000	----	----	1	----	----	----	----	----	----	1
30-35,000	----	----	----	----	----	----	----	----	----	0
25-30,000	----	----	1	----	----	----	----	----	----	1
20-25,000	----	----	----	1	----	----	----	----	----	1
15-20,000	----	1	2	2	----	1	----	----	----	6
10-15,000	1	----	5	7	4	1	----	----	----	18
5-10,000	----	3	7	6	5	5	5	4	4	39
less than 5,000	----	1	4	1	6	1	0	3	1	17
TOTALS	1	5	20	17	15	8	5	7	5	**83**

Table 4-8. Unregulated and Regulated Discharge by Month for Lost Creek Lake (Period of Record 1932 to 1990).

Average Recurrence Intervals in Years	Maximum Annual Peak Discharge in Ft^3/s (Unregulated)	Maximum Annual Peak Discharge in Ft^3/s (Regulated)
2	9,360	8,470
5	15,800	9,770
10	21,500	10,000
50	39,400	10,000
100	49,900	21,700

d. Flood Stages. Three downstream locations are used for flow regulation of Lost Creek Lake: Rogue River at Dodge Bridge, Rogue River at Raygold, and Rogue River at Grants Pass, Oregon. Flood stages are 10.0 feet, 12.0 feet, and 20.0 feet, respectively. These locations are discussed in more detail in Section 5.2.

4-10 CHANNEL AND FLOODPLAIN CHARACTERISTICS

a. Downstream Flood Regulation Stations. Areas subject to flooding are located along the 90-mile reach of the Rogue River from the mouth of Big Butte Creek to a point near where the Rogue River enters Hellgate Canyon (west of Merlin, Oregon). Within this 90-mile reach of the Rogue River, target flow rates have been established for use during and after flood control operations. These target flow rates are called “flood regulation goals.” Flood regulation goals have been established at the Rogue River at Dodge Bridge, the Rogue River at Raygold, and the Rogue River at Grants Pass and are 20,000, 34,000, and 45,000 ft^3/s, respectively. Flood regulation goals at these locations are shown in Table 4-9. The regulation of Lost Creek Lake is based on river conditions within the 90-mile reach using the three stream gaging stations as control stations. Since Lost Creek Lake controls only 28 percent of the area above Grants Pass, the channel capacity of 45,000 ft^3/s will frequently be exceeded by runoff from the uncontrolled area.

Table 4-9. Downstream Flood Control Stations on the Rogue River

Station	River Mile	Drainage Area	Flood Regulation Goals	
			Discharge	Stage
	Miles	Square Miles	($Ft^{3/}s$)	(Feet)
Dodge Bridge	138.6	1,215	20,000	8.9
Raygold	125.8	2,053	34,000	11.6
Grants Pass	101.8	2,459	45,000	16.8

b. Downstream Channel Velocities. The Rogue River, near the head of Lost Creek Lake, has a slope of approximately 70 feet per mile. In the reach just below the dam site the slope of the river is about 20 feet per mile. Table 4-10 shows average stream velocities at the Rogue River near McLeod stream gage, 4.4 miles below the dam site.

Maximum velocity near the dam site for any specific flow may be as much as 50 percent greater than the average velocity. The normal maximum release from Lost Creek Lake is about 10,000 ft^3/s.

Table 4-10. Discharge Velocity Relationship for the Rogue River near McLeod (USGS Station 14337600) Stream Gage.

Discharge ft^3/s	Average Velocity (feet/second)
1,000	1.6
2,000	2.5
3,000	3.3
4,000	4.0
5,000	4.6
6,000	5.0
7,000	5.5
8,000	6.6
9,000	6.3
10,000	6.6
15,000	8.5
20,000	10.0

c. Travel Time to Key Downstream Stations. The travel time for normal maximum releases (10,000 ft^3/s) from Lost Creek Dam to the Rogue River at Dodge Bridge, the Rogue River at Raygold, and the Rogue River at Grants Pass is approximately 4, 6, and 10 hours, respectively. These travel times will be used in scheduling releases from Lost Creek to obtain optimum flood regulation. The travel time for discharges during conservation regulation, typically in the range of 1,000 to 2,000 ft^3/s, is 15, 24, and 42 hours, at the three control points respectively, at an average velocity of 2 feet per second.

d. Floodplain Characteristics. The Rogue River floodplain below Lost Creek Lake consists of several distinct geomorphic zones. The first zone lies in a stream valley and extends from the project to approximately Shady Cove, Oregon, a distance of about 12 miles. Within this zone the floodplain is relatively narrow, confined by steep hillsides. Widespread residential development has occurred in this zone.

Beyond Shady Cove for a distance of approximately 60 miles, exists a region known as the Central Valley. In this broad, open valley the Rogue River is no longer confined. All three downstream control points for the project (Rogue River at Dodge Bridge, Rogue River at Raygold, and Rogue River at Grants Pass) are within this zone. Development in the floodplain of the central valley ranges from no development to heavily populated towns and small cities.

The third zone extends from the Central Valley into the Rogue River Canyon, eventually meeting the Pacific Ocean at Gold Beach, Oregon. Steep walls and lack of a well-defined floodplain characterize the canyon. Congress has classified much of the Rogue River in this zone as a "wild and scenic river." Development is very limited in this reach of the Rogue River.

4-11 DROUGHTS

a. General. In the Rogue River Basin water is used for irrigation, municipal and domestic water supply, fishing and fishery enhancement, lake and river recreation, power generation, and a host of other associated activities. During periods of below-average runoff the supply of water is reduced causing impacts to a wide variety of users. Storage of water at Lost Creek Lake helps to minimize these impacts by increasing summer and fall stream flow. Even with the release of stored water, dry conditions may persist in downstream tributaries, resulting in low flows on the Rogue River and significant socioeconomic damages.

The goal of the U.S. Army Corps of Engineers water storage projects during droughts is to proactively respond so that drought-related damages can be minimized. To achieve this goal several hydrologic components must be understood. These components are drought identification, drought analysis, and drought response. Each is discussed in the following paragraphs.

b. Drought Identification. Drought identification is related to three primary variables in a regulated river system. These variables are stream flow; volume of stored water; and demand for stored water. Understanding each of these variables assists in a more accurate assessment of drought identification.

Stream flow can be readily identified as normal or below normal by comparison to mean monthly values or exceedence probability curves. An extended period of below-normal stream flow serves as an indicator of an increased risk of drought. In the Rogue River Basin stream flow may originate from rainfall, snowmelt, ground water (base flow), or any combination of the three. Runoff from rainfall occurs primarily from November through March and is highly variable. Runoff from snowmelt generally begins in April and continues through June. Snowmelt runoff is more predictable than rainfall runoff, which helps make volume runoff forecasting possible. The NRCS Snow Survey generates estimates of the February through September and April through September volume runoff in early February and April, respectively. Base flow conditions, an important variable in runoff forecasting, are predictable during the late spring and summer, being a function of antecedent rainfall and snowmelt conditions. Use of both snowmelt runoff forecasts and base flow analysis provides the best indicators of impending drought conditions.

The volume of stored water is a variable in the drought identification procedure, which can reduce or eliminate the negative effects of low stream flow. Lost Creek Lake is seasonally filled with 180,000 acre-feet of water, and has an additional 135,000 acre-feet of "carryover storage. This storage is well in excess of that required to meet in full the contracted storage requirements and minimum flow releases for even the worst of water years. If the seasonal storage space does not refill, however, the lake may need to be drafted below the minimum flood control pool elevation (1,812 feet) to meet downstream flow requirements. In a prolonged drought where even the carryover storage becomes depleted or is expected to be depleted, contracted water and fishery releases may not be met in full and a water shortage would be declared by CENWP-EC-HR.

The demand for stored water from Lost Creek Lake is primarily for fishery enhancement. Irrigation and municipal users have not contracted available storage in significant numbers. Demand also exists for water to remain in the lake to support recreation and power generation though it has a lower priority than the preceding uses.

During a low flow or "drought" year, lake and downstream water needs cannot be met in full, and conflicts arise. Recognizing this conflict, drought conditions at Lost Creek Lake are defined as "inadequate stream flow and stored water to meet in full lake and downstream water demands."

c. Drought Analysis. The analysis of drought conditions occurring in the Rogue River Basin focuses on stream flow. The other two variables, lake storage and demands, are more easily evaluated and do not require advanced analysis.

Evaluation of stream flow during the springtime should begin by comparing observed reservoir inflow to the monthly flow summary (Plate 4-10) and summary hydrograph (Plate 4-11) for Lost Creek Lake. If relatively low stream flows are indicated, which continue through April, a drought may be developing and volume forecasts of spring and summer runoff are required. The NRCS Snow Survey volume runoff forecasts performed in February and April are the principal forecasts used in drought analysis. For the regulation of Lost Creek Lake, only the April and later forecasts are used for purposes of declaring shortages. The high variability of winter rainfall runoff causes earlier forecasts to have insufficient accuracy for this important function. Given the April forecasts, preliminary plans for reservoir releases can be developed. By late May snowmelt runoff is most likely peaking, rainfall is declining, and base flow begins to predominate. At this time a final forecast can be developed using the Corps and NRCS Snow Survey forecasts in addition to observed stream flow. By 1 June conservation forecasts for stream flow should be reliable and final reservoir release plans determined. The Portland District can initiate water management actions for drought response at this time with a high degree of confidence.

d. Drought Response. After a drought has been identified and analyzed as described in the previous paragraphs, proactive water management actions should be taken to minimize negative effects. During the springtime CENWP-EC-HR should keep the OWRD, ODFW, and other interested agencies and individuals informed and prepared to take action should dry conditions continue. The primary action that should be considered is the reduction of minimum flow releases in the May-September period, which can only be performed with approval of the OWRD or by the declaration of a shortage by CENWP-EC-HR. The appropriate time frame for a shortage declaration is recommended no earlier than 1 April (due to the possibility of late spring rains) and no later than 31 May (due to the decreasing stream flows) to be most effective. The conservation of water during late spring and early summer allows for summer and fall releases which otherwise would not be possible. During this period communication between the Corps, and other Federal, State, and local agencies should be heightened. The general public should be kept progressively informed regarding actions that the Corps is taking. Through continuous monitoring of hydrometeorological conditions, appropriate use of runoff forecast procedures, and professional and effective communication between agencies and the public, droughts in the Rogue River Basin will be effectively moderated.

4-12 WATER QUALITY

Water quality control is authorized as a secondary purpose of the Lost Creek Project. Although no water is specifically allocated for this purpose from conservation storage, water released for other purposes helps to provide water quality control. The water quality of Lost Creek Lake is generally very good. Releases from the lake in the summer and fall, which are both cooler and greater than natural stream flow, result in improved water quality conditions downstream. The following provides a brief discussion of the water quality of Lost Creek Lake, the Rogue River, and water quality monitoring of Lost Creek Lake. Additional information is also provided in the Water Quality Investigation Reports by CENWP-EC-HR.

a. <u>Water Quality of Lost Creek Lake</u>. Lost Creek Lake water quality can be characterized by examining lake temperature, dissolved oxygen, pH, specific conductance (conductivity), water clarity, and lake trophic status. These parameters have been monitored by CENWP-EC-HR since 1976 as part of the water quality and limnological monitoring program for Lost Creek Lake. Each parameter is briefly discussed in the following paragraphs.

The temperature of Lost Creek Lake follows a seasonal pattern beginning with isothermal and vertically mixed waters during the winter and early spring, and lending way to thermal stratification in the middle to late spring. During the summer the lake reaches a period of maximum thermal stratification. As the summer progresses and cool, hypolimnetic water is removed by the use of low-level outlets; the thermal stratification is decreased leading to restoration of isothermal conditions in the fall. Uniform lake temperatures then prevail with typical winter lake circulation.

Concentrations of dissolved oxygen are high during the winter and spring at Lost Creek Lake. In 1989 concentrations of dissolved oxygen were found to be 10 mg/liter or higher. Factors contributing to well oxygenated conditions include relatively cold water, mostly less than 10°C; restricted microbial activity owing to low temperatures and a lack of oxidizable dissolved and particulate matter; and vertical mixing of aerated surface waters throughout the water column. During the summer lake stratification increases until a well-defined thermal lake profile is established. During 1989, dissolved oxygen concentration was measured between 7 mg/liter and 10 mg/liter. Cooler epilimnetic temperatures and reestablished vertical mixing during the fall restore dissolved oxygen to all depths of the impoundment and continue through the winter.

Lake water pH generally ranges from 6.0 to 8.0. As with temperature and dissolved oxygen, variations can be expected seasonally. Specific conductance (conductivity) readings are highest in summer and early fall due to more concentrated (i.e., less dilute, chemically) inflow and the mineralization of organic water in the impoundment.

Water clarity is generally excellent in Lost Creek Lake. The only period of reduced water clarity, measured by turbidity in nephelometric turbidity units (NTU's) and Secchi disk transparency depth, occurs in winter or spring when high flows bring turbid water into the impoundment. These flows generally pass through the lake in a brief and spatially defined manner. Other than this period, the water clarity of Lost Creek Lake can be expected to remain excellent.

Lake trophic status ranges from oligotrophic in the fall, winter, and spring to mesotrophic or even eutrophic in the summer. Higher inflows during the fall assist in returning the lake to an oligotrophic state.

b. Water Quality of the Rogue River. The two most important water quality parameters in the Rogue River are water temperature and turbidity because of their relationship with the river fisheries. Before the construction of Lost Creek Lake, turbid flows produced by storm events were short-term events. Turbidity produced during winter storms now occur in the Rogue River for longer periods of time below the project due to the attenuation affect of Lost Creek Lake. The affect of Lost Creek Lake's regulation on downstream water temperature has not been clearly established. Evidence indicates that water temperature affects are most pronounced from the dam downstream to Dodge Bridge (20 miles), beyond which the affects are gradually diminished.

The upper basin, with a small population of about 1,000 people, has excellent water quality and so does not have a detrimental influence on the reservoir quality except during winter storms. Large-event storms, usually occurring during the winter months, are associated with more turbid water. The lake is regulated so that the turbid water is passed through the project over as short a period as possible after the event. A turbidity conduit was constructed with the multiple-level withdrawal structure to draw turbid water from the bottom of the reservoir. Use of the turbidity conduit helps to evacuate turbid water from the lake preventing long-term releases of turbid water.

c. Water Quality Monitoring of Lost Creek Lake. The Corps of Engineers is responsible for monitoring the quality of Lost Creek Lake. A water quality-monitoring program has been underway since November 1976 to obtain data for use in regulation of the project and for special water quality investigations. Monitoring is conducted above Lost Creek Lake for temperature, turbidity, and flow at the Rogue River below Prospect (USGS gaging station No. 14330000).

Within the lake three types of water quality assessments are performed: routine water quality monitoring; data collection for reservoir eutrophication assessments; and determination of the fate and distribution of suspended solids causing turbidity.

For routine water quality monitoring dissolved oxygen, pH, specific conductance, and temperature are measured at three stations in the lake. Measurements are taken at 1-meter intervals to a depth of 20 meters, then at 5-meter intervals to the lake bottom. This monitoring has provided a database of basic water quality parameters and is currently used in a variety of water management applications.

For reservoir eutrophication assessments, six parameters are measured and include total phosphate, orthophosphate, total Kjeldahl nitrogen, nitrate nitrogen, ammonium nitrogen, and silica. Samples are taken from five depths that include the reservoir surface, mid-epilimnetic, midmetalimnetic, mid-hypolimnetic, and near-reservoir bottom. Eutrophication assessments help make possible the evaluation of lake trophic status that is important for recreation, fishery, and water supply uses.

For determining the fate and distribution of suspended solids causing turbidity, a monitoring program has been developed which consists of obtaining the hourly pre-storm, in-storm, and post-storm turbidity for inflows and outflows to the project. Also, measurements of lake turbidity at several representative stations have been performed. The information collected during these storm periods is expected to be used for improved reservoir regulation during high turbidity storm events.

4-13 UPSTREAM STRUCTURES

The Pacific Power and Light (PP&L) Company has four diversion dams and four generators upstream of the Lost Creek Lake Project, one each on the South Fork of the Rogue, the Middle Fork Rogue, the Red Blanket River, and the North Fork of the Rogue River. Water is diverted from the South and Middle Fork of the Rogue River and enters the main stem upstream of Lost Creek Lake.

4-14 DOWNSTREAM STRUCTURES

Savage Rapids Dam **(**RM 107.3), removed in 2009, was a major water control structure downstream of the Lost Creek Lake Project on the Rogue River. Savage Rapids Dam was a run-of-the-river dam owned and operated by the Grants Pass Irrigation District as a diversion and storage facility. Power generated at this 50-acre reservoir was used to operate water-transporting devices on the canal. The dam was replaced with a series of pumps.

The city of Gold Hill owned the Gold Hill (RM 120.5) diversion and generation facility. It was removed in 2008.

The Gold Ray Dam (RM 125.5) and generation facility, removed in 2010, was owned by Jackson County. The project had been closed since 1972, except for minor regulation of fish ladder flows.

With the removal of Savage Rapids, Gold Hill and Gold Ray Dams and the notching of Elk Creek Dam, over 330 miles of the Rogue and its tributaries were opened to steelhead and salmon.

4-15 ECONOMIC DATA

a. Population. Most of the Rogue River Basin population is distributed along the main streams in Jackson and Josephine Counties. The remainder of the basin population is located in Curry County, with some in the fringe areas in Klamath County, Oregon, and in northern California. The populations of the principal cities (2000 census) are Medford 63,154, Grants Pass 23,003, and Central Point 12,493; the 1960 populations for these same areas were 24,425, 10,118, and 2,289, respectively.

b. Agriculture. Major agricultural enterprises in the basin are limited generally to the irrigated lands in Jackson and Josephine Counties. The farms produce beef, poultry, hay, fruits, and vegetables; dairy farming is also practiced. The nonirrigated lands are used principally for pasture. Grazing capacity of the forestland is limited. Only about 10,000 head of cattle are provided summer grazing on public forestlands. Pear trees were introduced into the Rogue Basin about the year 1900 and acreage in pear orchards increased rapidly during the early part of the century. About 10,000 acres were devoted to the production of pears in 1972; however, pear production is expected to decrease due to urbanization of the prime orchard areas.

c. Industries and Resources. The Rogue River Basin encompasses one of the largest concentrations of virgin forests remaining in the United States, outside of Alaska. Harvest of forest products comprises, by far, the largest industry in the basin at the present time.

The tourist trade and outdoor recreational facilities contribute significantly to the basin's economy. The national forests, Crater Lake National Park, the Oregon Caves National Monument, the scenic attractions of the Rogue River (particularly the "wild and scenic” river area), the excellent state parks, and the numerous private facilities combined with excellent fishing and hunting make the Rogue River Basin a nationally renowned tourist attraction.

Mining was one of the first industries in the region and has long influenced the economy of Jackson County and downstream Josephine County. Although cement, sand and gravel, and crushed stone account for the major portion of the production value, other mining products such as gold, silver, copper, lead, zinc, mercury, tungsten, chromite, clay, pumice, and soapstone have also been produced.

d. Power Transmission. Power developed at Lost Creek Lake is integrated into the Pacific Northwest Federal Power System and marketed by the Bonneville Power Administration (BPA). Since BPA has no transmission lines in the Lost Creek area, the powerhouse is connected to the nearby 115-kilovolt line (Line 19 North between Prospect and Lone Pine) owned by PP&L. BPA has contracted with PP&L to transmit the power through their lines and deliver it to the BPA system.

e. Transportation. Lost Creek Lake is served by State and county roads. State Highway 62 extends north from Interstate 5 near Medford to Shady Cove, where it then follows the right bank of the Rogue River. Downstream of Lost Creek, near McLeod, Highway 62 has been relocated to follow the left bank or the south side of the lake. The highway crosses Peyton Bridge at the upper end of the reservoir and continues to Prospect and then to Crater Lake.

f. Flood Damages. Average annual flood control benefits for the Lost Creek Project are estimated to be $23,002,7640 (based on a 2012 price level and 100-year project life). Flood control benefits consist of reduction in damage, increased land use, and improved drainage that are dependent on value of agriculture products, the cost of repair of residential and commercial properties, interruption of industry, and other losses. Discharge versus damage curves are shown on Plates 4-17 through 4-20.

Data concerning damages and damages preventable by Lost Creek Project for various floods on the Rogue River are contained in Table 4-11.

Table 4-11. Flood Damage Reduction Preventable by Lost Creek Project.

Date of Flood	Damages at Time of Flood (Natural Conditions)	Damages Preventable by Project at time of Flood[1]	Damage Preventable by Project under Present Conditions[1,2]
January 1997	$32,946,700	$22,466,639	$45,706,000
January 1974	2,891,000	1,260,000	6,160,000
March 1972	2,128,000	1,051,000	5,824,000
January 1972	1,768,000	1,051,000	5,824,000
January 1971	2,000,000	1,060,000	6,518,000
January 1970	274,000	131,000	1,770,000
January 1966	320,000	223,000	1,422,000
December 1964	12,161,000	6,918,000	61,358,000
December 1962	1,130,000	402,000	4,480,000
December 1955	3,030,000	1,630,000	32,406,000
January 1953	720,000	375,000	4,570,000
December 1945	335,000	182,000	3,248,000
February 1927	Not Avail.	Not Avail.	33,190,000
November 1909	Not Avail.	Not Avail.	21,265,000
February 1907	Not Avail.	Not Avail.	4,570,000

[1]Project share of total damages prevented based on system analysis.
[2]2012 price levels, 1975 development.

CHAPTER 5

DATA COLLECTION AND COMMUNICATION NETWORKS

5-1 HYDRO-METEOROLOGICAL STATIONS

Evaluation of real-time hydrological and meteorological information is essential for the Corps to manage the Project to realize all the project benefits to meet the authorized purposes. Within the basin, hydro-meteorological (meaning both hydrological and meteorological) data is collected by several agencies, transmitted to and stored at the Portland District (NWP) and the Northwest Division office in Portland, OR (NWDP).

The District is responsible for making appropriate arrangements to ensure adequate hydrological data coverage within its respective boundaries. In addition to the requirements for regulating the system, this data is essential for the District to accomplish its water resources mission, discharge forecasting, and emergency operations.

Data collected at monitoring sites for regulation of the Project may include reservoir and tailwater elevations, river stage and flow, weather data, and/or snow data. A list and description of the stations associated with this Project can be found in Table 5-1 and the Project Station Description Report. River monitoring stations are characterized as inflow, outflow, control point, or supplemental sites. A combination of data from all of these monitoring stations provides the reservoir regulators and operators with the information needed to safely and effectively manage the Project.

a. Reservoir and Dam. Monitoring equipment is located in the tailrace (El. 1,543 feet), wet well (El. 1,670 feet), and at the gates in the intake tower. The gated openings in the intake towers are at elevations 1,650 feet, 1,675 feet, 1,700 feet, 1,725 feet, 1,750 feet, 1,775 feet, 1,800 feet, 1,825 feet, 1,850 feet. Water surface elevation, gate openings and water temperature data are collected at these locations and water temperature is also collected at the water surface and 5 feet below the surface. Both pool elevation and temperature data are continuously available to the dam operator. To verify electronic sensors measuring reservoir elevations are correct a staff gage is visible from the tower bridge and is attached to the intake tower.

b. Inflow Stations. The inflow to the project is calculated value from change in reservoir storage and outflow. Stations upstream of the reservoir are also used to provide indicators of inflow magnitude and changes. Depending on available funding, stations are located on major streams feeding the reservoir and data is automatically collected to assist in regulating and operating the Project.

c. Reservoir Outflow. The outflow from the Project can be determined using several methods. Reservoir head and gate openings can be used with known hydraulic equations to determine the outflow. Also river monitoring sites strategically located downstream of the Project can provide a close approximation of outflow.

d. Control Point Stations. In the authorization of the Project, control points were established so prescribed actions could be specified for various conditions at these locations along the river. The main actions associated with these control points relate to flood control, such as reducing flow out of the reservoir to limit flooding downstream. However other conditions are also monitored and controlled such as, but not limited to, rate of change, minimum/maximum stages and flows, and water temperatures. Table 5-2 lists the control points associated with this Project.

Table 5-2. Streamflow Gaging Stations Used in the Regulation of Lost Creek Lake.

Name	Corps ID	USGS Number	National Weather Service ID	River Mile (RM)
Rogue River at Dodge Bridge near Eagle Point	EGLO	14339000	EGLO3	RM 138.6
Rogue River at Raygold	RYGO	14359000	RYGO3	RM 125.8
Rogue River at Grants Pass	GRAO	14361500	GRAO3	RM 101.8
Rogue River at Agness	AGNO	14372300	AGNO3	RM 29.7

e. Supplemental Monitoring Stations. Additional monitoring sites may be required to supplement the monitoring at inflow, reservoir, outflow, and control point locations. The main need for supplemental monitoring stations is to monitor the contribution of water from significant tributaries of the main river system. Without these stations it would be difficult to properly regulate the Project during the various flow regimes throughout the year.

f. Weather Stations. Knowing the weather conditions within the basin is necessary for regulating and operating the Project in a manner that balances all the Project purposes. Weather information that might be collected includes precipitation, wind, and air temperature. These are used to forecast near-term and further out planning activities.

g. Reporting. Data collected at remote monitoring sites (inflow, outflow, control point, supplemental, and weather stations) is logged onsite and automatically transmitted to the Project and the District office in near real-time via redundant methods. Hydro-meteorological data collected at the Project is also logged onsite and automatically transmitted to the District office. In addition Project personnel at the control room transmit a collection of hydro-meteorological and power generation data on a regular basis. This data is received at Corps offices as well as to partner agencies in support of their missions.

h. Maintenance. The Corps performs all maintenance on instrumentation and data collection equipment that control facilities and gates at the Project. The USGS/Corps Co-operative Stream Gaging Program is an agreement with the USGS, which is renegotiated annually, to maintain the hydro-meteorological monitoring stations owned by the Corps. Most of the hydro-meteorological monitoring sites are covered under this Program. Most of the weather stations are owned and maintained by the National Weather Service though the Corps does own and maintain a few weather stations in support of the Project.

5-2 WATER QUALITY STATIONS

A water quality data collection program has been incorporated in the regulation plan for the Project. Engineering Regulation 1110-2-8154 specifies the requirement for water quality monitoring. Collection of water quality data consists of automated data collection sites and water quality samples collected manually. A list and description of the water quality monitoring stations can be found in the Water Quality Station Description Product.

a. Automated Data Collection. Automated collection of water quality data in near real-time occurs at specific river monitoring sites and in the reservoir. Water temperature, turbidity, total dissolved oxygen, pH, and/or other water quality parameters may be measured at these river sites. In the reservoir the temperature profile of the reservoir is monitored using temperature probes attached to the intake tower. The water temperature is monitored at the intake openings (1,650 feet, 1,675 feet, 1,700 feet, 1,725 feet, 1,750 feet, 1,775 feet, 1,800 feet, 1,825 feet, 1,850 feet) and 5 feet below the water surface. Water temperature readings are also being collected at the tailrace (El. 1,543 feet) and at the bottom of the wet well (El. 1,670 feet).

b. Manual Data Collection. Field water quality samples are collected manually in support of the monitoring required for Corps Projects. Samples are taken from designated locations on a routine basis. The data collected from these grab samples are used for studies of long term changes and impacts of the Project. As water quality parameters of interest change the water quality monitoring program changes to accommodate changing requirements and understanding of the environment. Sample collection and analyses are performed by either Corps staff or by contract labor.

c. Reporting. Time-series water quality data is available on the Corps Water Management web site. Water quality data collected from stations maintained by the USGS under the USGS/Corps Co-operative Stream Gaging Program or similar program are also available on the USGS web site. Data on the USGS web site are also published annually by the USGS in the Water Resources Data for Oregon Report. Also, periodically, reports are prepared that evaluate routine water quality data and the data from special studies dealing with specific water quality problems such as Harmful Algae Blooms (HABs).

d. Maintenance. Equipment used to monitor the reservoir and effects of the Project at locations along the river system are maintained by the Corps, by the USGS through an agreement with the Corps, or in a few cases maintained by a private contractor of the Corps.

5-3 SNOW COURSES AND SNOTEL STATIONS

a. Facilities. The U.S. Department of Agriculture NRCS operates high elevation SNOTEL and snow course sites in and around the basin. A list and description of snow sites supporting the operation and regulation of the Project can be found in the Snow Station Description Product.

b. Reporting. Data collected and transmitted from the remote snow station is received by the NRCS. The Corps has automated processes in place to obtain this data from the NRCS. This information is available in near real-time and is used to assess the impact of snow on the Project and alert the Project operators and regulators to any rapidly changing snowpack conditions. Snow water content data obtained from these sites are utilized in estimating a profile of the snow water equivalent in the basin for volume forecasts. If deemed advisable, field or aerial snow reconnaissance is made to supplement collected data for delineating the areal distribution of the snowpack, thereby increasing the accuracy of the seasonal runoff forecasts.

c. Maintenance. All snow courses and SNOTEL sites are maintained by the NRCS Snow Survey.

5-4 RECORDING HYDROLOGIC DATA

a. Data Collection and Transmission. Data from the reservoir and dam, river monitoring stations, weather stations, snow monitoring stations, and water quality sites are collected by several methods: the Geostationary Operational Environmental Satellite (GOES) data collection system; the Corps of Engineers Data Collection Systems; the USGS data collection system; the NWS data collection and forecasting system; the Snow Telemetry (SNOTEL) system; and manual methods. Multiple transmission methods are used at sites where near real-time data, critical to the mission of the Corps, is obtained. Descriptions of the reporting systems are as follows:

(1) Corps of Engineers Data Collection Systems.

(a) Corps Portland District Hydromet System. The primary purpose of this system is to get data back to the operator and regulator as quickly as possible and as often as needed. Therefore this is the primary means for transmitting data to the operator and regulator. To accomplish this, the Corps Portland District Hydromet System transmits data collected at the monitoring sites in the basin via line-of-sight radio to the Project and to the Columbia River Operational Hydromet and Management System (CROHMS). Radio repeater sites are often required to get the data to the desired destination. For further details of the Hydromet System see the document "Description of the Corps Portland District Hydromet System".

(b) Columbia Basin Telecommunications (CBT) Network. The CBT system, formerly the Columbia Basin Teletype system (CBTT), is one method for exchanging data and text messages between projects in the Pacific Northwest and their operating agency. The CBT system exists to provide to these projects the current reservoir and hydrometeorological data necessary for their efficient, economic, and safe operation. The CBT Web Messenger system provides a client-server system based on web pages that are available to the user for both the creation of new CBT messages and the reading of current messages. Computer-to-computer automated message delivery and retrieval is also supported. The Corps maintains the CBT web site on a web server platform. Elevation, storage, outflow, and other parameters are manual entered and reported every hour by Project personnel through the CBT network.

(c) Supervisory Control and Data Acquisition (SCADA) System. Data and commands in the SCADA system are used to monitor, control, and operate gates and other equipment at the dam. The SCADA system consists of a specialized personal computer located in the control room at Lost Creek Project. The SCADA system receives, stores, and transmits data used to operate the Lost Creek and Applegate dams. Data in SCADA that supports Lost Creek Reservoir operations includes lake and tailwater elevation, key information from various river monitoring sites, and gate opening and pertinent operating data for the regulating outlet works and the powerhouse. Operation of the spillway gates at Lost Creek Lake is a manual process and does not use the SCADA system.

(2) GOES Data Collection System. Transmission of data using GOES provides a backup to transmission of the data via the Corps Hydromet System. The GOES data collection system is operated by the National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA). The Corps HQ nominally funds (approximately $30K in fiscal year 2011) this program and there is no cost to Corps district offices associated with number of stations or amount of data transmitted. Therefore purchasing transmission and power equipment, as well as maintenance are the only costs of this transmission method. The power used during transmission is quite high but then the equipment can go into quiescent mode to conserve power until the next scheduled transmission. Random transmission can also be initiated if preprogrammed thresholds or criteria are met. GOES transmitters at each monitoring site transmit the data to a GOES satellite. Direct Readout Ground Stations (DRGS) monitor and receive the messages coming from the GOES satellites. The NESDIS DRGS at Wallops Island, VA receives and repackages the messages so the rebroadcasted information can be received using less expensive equipment then what is needed for a DRGS. The rebroadcasted data can be collected into the Columbia River Operational Hydromet and Management System (CROHMS) from a satellite receiver and/or via the Internet.

(3) USGS Data Collection System. The USGS maintains the Corps network of monitoring stations and automatically ingests the data from these sites via GOES and the Corps Hydromet System. The USGS also collects data from the data collections sites periodically using telephone modem software for automatically retrieving the data. The streamflow and water quality data are analyzed and published yearly in the USGS publication entitled Water Resources Data for Oregon.

(4) National Weather Service Data Collection and Forecasting System. The National Weather Service owns and operates a large number of precipitation stations which are used to assist in flood forecasting. The Weather Service also has telemetry equipment installed at selected river monitoring stations. The Weather Service office in Portland operates the

Advanced Weather Interface Process Systems (AWIPS) system which is a national communication network linking Weather Service offices. Pertinent Weather Service data, information, and products are pulled into CROHMS. Streamflow forecasts are generated using the Weather Service's Community Hydrologic Prediction System (CHPS). The Corps dam regulators use the hydro-meteorological data and forecasts from CHPS in formulating reservoir regulation instructions to be issued to the Project operators. The regulators coordinate with the Weather Service Northwest River Forecast Center with regard to producing forecast values from CHPS and then the responsible Weather Forecast Office (WFO) makes any adjustments necessary before publishing the official National Weather Service forecasts. These forecasts are then pulled into CROHMS.

(5) The SNOTEL System. The SNOTEL system is an automated data collection network of snow measurement stations which transmits data to a master station via meteor-burst telemetry. Pertinent data from the NRCS web site is pulled into CROHMS.

(6) Manual Methods. During periods when automated data collection and transmission are not functional, project personnel will make necessary observations to facilitate proper regulation of the project.

b. Data Storage. Hydrologic data for the basin are available from the Corps Columbia River Operational Hydromet and Management System (CROHMS). CROHMS acquires and stores real-time or near real-time data, and is used for day-to-day regulation of the project. The Corps' Hydrologic Engineering Center (HEC) has developed the Corps Water Management System (CWMS). CWMS is used within CROHMS to accomplish some of the necessary function of CROHMS.

(1) Columbia River Operational Hydromet and Management System (CROHMS). CROHMS is a near real-time water resource management system used by Water Management offices in the Northwestern Division Northwest Region. Project and basin information is stored in this system. Data acquired from other agencies and partners is also placed in this system and the system is used to distribute information to partners. Some of the functionality required in CROHMS is being accomplished by the Corps Water Management System (CWMS).

(2) Corps Water Management System (CWMS). CWMS is a client-server system developed by the Corps' Hydrologic Engineering Center (HEC). The Northwestern Division and northwest region district water management offices have been incorporating CWMS into CROHMS since the 1990s. CWMS updates are provided by HEC on a regular basis. CWMS includes, but is not limited to, the storage and retrieval of time-series data, verification and transformation of the data, data display applications, and applications for interacting with HEC models. CWMS provides a way to run HEC hydrologic models individually or as a series of specific models.

(3) Other Methods. In addition to CROHMS, hydro-meteorological data are permanently stored at the following locations:

(a) USGS NWIS Database. The USGS National Water Information System (NWIS) stores streamflow, water temperature, and water quality data that meet USGS quality standard.

(b) NCDC Database. The National Climatic Data Center is the official storage archive of climatological data.

(c) NRCS National Water and Climate Center Database. Snow course data collected by the Natural Resources Conservation Service (NRCS) in the National Water and Climatic Data Center database.

5-5 COMMUNICATION NETWORK

Communication networks are used to automatically transfer data as well as provide a means for pertinent agencies to exchange information and communicate on a regular and ad hoc basis. Networks used to automatically transfer data are described in Section 5-4. Some of the primary agencies that exchange data and communicate during particular situations associated with the project include:

- USACE
- BPA – Power generation at Corps projects
- USGS – Maintains USACE gages and stores hydro-meteorological data
- National Weather Service – Collects precipitation data and provides weather and river forecasts
- Fishery Agencies – State and National fishery agencies with regard to environmental impact
- NRCS – Collects snow data and produces the Seasonal Water Supply Forecasts
- USBR – Has some Section 7 dams that USACE is responsible for regulating during high flow events
- Emergency Management Entities – Coordinate response with respect to supporting persons and property in high flow affected areas

Voice radio communication is also available between the Project and the district office. For more information on this capability refer to the Voice Radio Communication Manual.

5-6 COMMUNICATION WITH PROJECT

Regulation of the Project is performed by CENWP-EC-HR and they originate all flood control and conservation regulation actions. In the event of a complete communication disruption between the Project Office and the District Office, the Operations Manager will assume regulation responsibilities and carry out flood control or conservation actions, as described in Chapter 7, until communications are restored.

a. Communication Between District and Division Regulation Offices. CENWP-EC-HR and the NWD Portland Reservoir Control Center communicate by telephone briefing twice a week. These briefings also involve BPA and the National Weather Service, and are limited to the reporting of major reservoir regulation actions. Detailed actions or additional discussion is carried out through telephone communication or by direct meetings. Important reservoir regulation actions are recorded in memorandums for the record. Flow and temperature regulation actions are to be issued only by District hydrologists or hydraulic engineers. If a hydrologist or hydraulic engineer is not available, regulation responsibility at the District will be assumed by the Chief of CENWP-EC-H.

b. Communication Between District Regulating Office and Project Office. Reservoir regulation instructions for the Project originate from CENWP-EC-HR. These instructions may be sent either by CBT, email, or telephone. When telephone communication is used, CBT or email confirmation of the instructions will be sent as soon as possible.

c. Communication Between Project Office and Others. The Project Office communicates changes in reservoir operation with downstream interests. These communications are normally done by telephone, and are usually limited to providing observed or scheduled reservoir information. Discussion of reservoir regulation and/or water management should be referred to the District Office.

5-7 PROJECT REPORTING INSTRUCTIONS

Specifically identified data available in the Project control room is entered into a morning report that is relayed by CBT to the Portland District office and other CBT users. Other data may be obtained from the CROHMS database or from the National Weather Service Office in Medford, OR. During flood emergencies or abnormal conditions the reports can be made available more frequently at the request of CENWP-EC-HR.

Written complaints and suggestions received by the Project regarding reservoir regulation should be directed to CENWP-EC-HR. Personnel from CENWP-EC-HR will evaluate these complaints, recommend operation changes if feasible, and answer questions in writing to the concerned individual or organization. CENWP-EC-HR will inform the Lost Creek Project Office of both the specific complaint and the response.

5-8 WARNINGS

In carrying out water control activities, the Corps of Engineers must recognize and observe the legal responsibility of the National Weather Service for issuing weather forecasts and flood warnings, including river discharges and stages. River forecasts prepared by the Corps of Engineers in the execution of its responsibilities should not be released to the general public unless the Weather Service is willing to make the release or agrees to such dissemination. However, release to interested parties of factual information on current storms or river conditions and properly quoted Weather Service forecasts is permissible. Corps district offices are encouraged to provide assistance to communities and individuals regarding the impact of forecasted floods. Typical advice would be to provide approximate water surface elevations at locations upstream and downstream of the National Weather Service forecast points.

During periods of high water or flooding, significant changes in reservoir release rates shall be announced to the general public as far in advance as possible. The instructions will originate at CENWP-EC-HR; however, announcements of rapidly changing reservoir releases should be made by the Operations Project Manager or his authorized representative.

In the event that large releases from the Project become necessary, such as those in excess of the normal maximum release, the Public Affairs Office of the Portland District, Corps of Engineers (CENWP-PA), will notify the organizations listed in Table 5-8. Prior to notifying any organization, CENWP-PA shall contact CENWP-EC-HR to obtain current information and to ensure full coordination with the National Weather Service.

Table 5-8. Organization to be Notified Prior to Large Releases from Lost Creek Dam.

PORTLAND DISTRICT	
The Public Affairs Office will notify the following if large releases of water become necessary from Lost Creek Lake:	
KRWQ-FM/Medford	KTVL-TV/Medford
KMED-AM/Medford	KSYS-TV/Medford
KCMX-AM MEDFORD	Cablevision
KDRV-TV MEDFORD	Daily Courier/Grants Pass
KDOV-FM MEDFORD	Mail Tribune/Medford
KAJO-AM/Grants Pass	Curry County Reporter/Gold Beach
KLDR-FM GRANTS PASS	Tidings/Ashland
KFMJ-AM/Grants Pass	Oregon Water Resources Department
KOBI-TV/Medford	Oregon Department of Fish and Wildlife

SECTION 6

HYDROLOGIC FORECASTS

6-1 GENERAL

Effective regulation of Lost Creek Lake is dependent upon accurate runoff forecasts for flood control and conservation purposes. The Corps of Engineers, NRCS Snow Survey, and NWS-RFC are the primary agencies responsible for performing and/or using hydrologic forecasts. The role of the Corps and other agencies are discussed in the following paragraphs.

a. Role of the Corps. CENWP-EC-HR has the hydrologic forecast responsibility for the Corps at Lost Creek Lake. This responsibility requires the use of both flood control and conservation purpose forecasts. Flood control forecasts performed by CENWP-EC-HR are described in paragraph 6-2. Conservation purpose forecasts performed by CENWP-EC-HR are described in paragraph 6-3.

b. Role of Other Agencies. In addition to the Corps, the NWS-RFC and the NRCS are agencies responsible for hydrologic forecasts.

The NWS has the responsibility of furnishing the public with flood warning services while the Corps is involved in regulating flows from storage projects. There is a need for an interchange of information so that both agencies can carry out their responsibilities effectively. This has resulted in a joint cooperative program between the Corps of Engineers and the NWS. The NWS generates flood forecasts, which include the effects of reservoir releases from Corps dams. The Corps, in turn, uses NWS flood forecasts as an aid in reservoir regulation.

The NRCS provides snow water content data for use in forecasting runoff volumes for both winter floods and spring snowmelt runoff. The NRCS in cooperation with the NWS also provides a publication titled "Water Supply Outlook for Oregon," published monthly from January through June. The water supply outlook is a volume forecast of runoff for the spring and summer periods.

6-2 FLOOD CONDITION FORECASTS

a. General. The objective of reservoir regulation for flood control is to reduce downstream flood damage to the greatest extent possible with available lake storage. Attainment of this objective depends on the location and type of damage to be prevented, the amount of lake storage capacity, flood characteristics, and the effect of runoff from the uncontrolled drainage area below Lost Creek Lake.

b. Requirements. The primary requirements for flood control forecasts at Lost Creek Lake are to forecast project inflow and estimate when the downstream flood control points of Dodge Bridge, Raygold, and Grants Pass streamflow stations might exceed their flood regulation goals of 20,000 ft^3/s, 34,000 ft^3/s, and 45,000 ft^3/s, respectively. With this information, maximum releases from the project can be scheduled without exceeding any of the downstream flood regulation goals. Through this operation use of flood storage space in Lost Creek Lake is maximized and the highest level of flood protection is achieved.

c. Methods. At Lost Creek Lake inflow to the project should be calculated from the observed storage change and reservoir release on an hourly basis. Projections of inflow should be made based on observed rainfall, analysis of the inflow hydrograph, and use of other information such as the NWS Community Hydrologic Prediction System (CHPS) model. Projections of discharge at the downstream control points (Dodge Bridge, Raygold, and Grants Pass) should be based upon an analysis of the hydrograph for those stations and forecasts issued by the NWS. It is necessary to project a minimum travel time for flood control releases from the project of 4, 6, and 10 hours, respectively, for each of the downstream control points.

Flood regulation graphs are provided in Exhibit B to assist in flood regulation operations. Computations of reservoir inflow and discharge at downstream control points should be plotted on an hourly basis during a flood control operation.

6-3 CONSERVATION PURPOSE FORECASTS

a. General. The storage of water for conservation uses such as irrigation, fishery enhancement, water supply, water quality enhancement, power generation, and recreation is an integral part of the Lost Creek Project. Stored water is especially important to users during low flow years. Conservation purpose forecasts contribute to effective use of stored water and are important to the successful operation of Lost Creek Lake.

b. Requirements. There are two overlapping periods for which volume runoff forecasts are required for Lost Creek Lake: 1 February through 30 September, and 1 April through 30 September.

The February through September forecast is used to initiate preliminary water management planning for the spring and summer. The forecast is considered a preview of possible future runoff conditions. Both a total volume runoff forecast and a monthly distribution of this runoff forecast is required.

The April through September forecast is used to initiate final water management planning for the summer and fall. The April forecast is significantly more accurate than the February forecast, and represents the most probable summer and fall runoff conditions. A monthly distribution of forecasted runoff is also required for this forecast.

c. Methods. Conservation purpose forecasts are performed by calculating a water budget using as input the NRCS forecasted volume runoff. Since the NRCS forecast provides a total volume but not monthly flows, monthly values may be derived by distributing the forecasted volume relative to historical mean monthly flow distributions. The basic procedure for developing the volume runoff forecast for either the February or April forecasts at Lost Creek Lake has three steps:

(1) Obtain the NRCS volume runoff forecast.

(2) Distribute the NRCS volume runoff forecast by month using the historical mean monthly flow distribution. Table 6-1 shows a monthly flow distribution by percent of runoff for Lost Creek Lake.

(3) Adjust the forecast based upon field observations. Visit the upper watershed area and the primary snow courses used in the forecast. These are Fourmile Lake (El. 5970), Cold Springs Camp (El. 5940) Sevenmile Marsh (El. 5700), Billie Creek Divide (El. 5280), and Fish Lake (El. 4660). Field observations should include snow water content and distribution, tributary runoff, and soil moisture conditions.

In 1989 the NRCS revised its volume runoff forecasts for the Rogue River Basin. The new forecast equations were tested on observed runoff data for the period 1961 to 1989. The NRCS 1 February forecast was found to have an average error of plus or minus 13 percent, and the NRCS 1 April forecast was also found to have an average error of plus or minus 13 percent. These new forecast procedures are a marked improvement over previous methods and will be used in future water management.

Table 6-1. Distribution of Observed Monthly Runoff by Percent, Lost Creek Lake, Oregon, Period of Record WY 1929-2011

Month	Percent of Flow	
	Feb – Sep	Apr – Sep
Feb	13	----
Mar	15	----
Apr	16	23
May	19	26
Jun	14	20
Jul	9	13
Aug	7	10
Sep	7	9
TOTALS	100	100

6-4 LONG-RANGE FORECASTS

Long-range forecasts extending beyond one season are not produced. Refer back to paragraph 6-3 for conservation forecasts.

6-5 DROUGHT FORECASTS

Long-range forecasts extending beyond one season are not produced. Refer back to paragraph 6-3 for conservation forecasts. The Drought Monitor Index is supplied by the National Drought Mitigation Center in Lincoln, Nebraska and is updated every week. Refer to the Drought Contingency Plan in Exhibit D.

SECTION 7

WATER CONTROL PLAN

7-1 GENERAL OBJECTIVES

Lost Creek Lake is operated to provide maximum gross benefits from the primary purposes of flood control, irrigation, water supply, and fish enhancement. The latter three conservation uses necessitate equal consideration so that each function receives the same percentage of full supply in infrequent water-short years. There is no storage specifically for secondary purposes of power generation, wildlife enhancement, water quality control, or recreation. Of these latter four functions, the first three utilize flows released specifically for other purposes. Recreation depends on use of facilities provided and on water availability that results from operation for other purposes.

7-2 MAJOR CONSTRAINTS

Several operational constraints exist in the operation of Lost Creek Lake, both to the project and downstream locations as described below. It should not be implied that in each case the constraints are absolute. Under certain conditions these constraints may be waived. However, in the interest of project safety as well as downstream property, operation should be considered restricted within the guidelines imposed below. Authority to deviate should only be granted after consultation with CENWP-EC-H.

a. Project Limitations.

(1) Spillway. Spillway operation requires that an operator must physically be at the spillway structure in order to open or close the gates. Access is another constraint as the shortest road distance from the powerhouse is 4 miles. Unless spillway releases are anticipated and an operator can be either on-site or dispatched ahead of planned gate operation, mobilization and travel time will be required to position an operator. If spillway releases are anticipated, a 30-minute mobilization and travel time is considered reasonable during most normal weekday working hours when there are two or more operations personnel at the project. If only a single operator is on duty, at least 2 hours should be allocated to call in an off duty or standby person to perform the required service.

The spillway gates at Lost Creek Dam have been operated during various test conditions, and once for flood reduction purposes to a gate height of 3-feet per gate. However, based on model studies for other similar spillways (Kaysinger Bluff and Tocks Island) it is assumed that the three bay spillway for Lost Creek Dam could develop a similar harmonic surging for large gate openings at high pools. Due to the short center pier, it is believed that surging will be less than the 6-foot surge reported in those studies. The potential for surging is included within this discussion so that operators will be aware of its potential and not resort to unscheduled gate openings or closures to eliminate the surging should it occur. Any surging observed during spillway use should be noted and reported to CENWP-EC-H.

As noted in paragraph 2-3.b, some erosion within the unlined portion of the spillway chute and stilling basin is expected. Spillway releases will result in some or all of the following:

(a) Sacrificial erosion within the spillway chute, especially at flows above 50,000 ft^3/s.

(b) Removal of an overburden dike between the stilling basin and the river at any sustained spillway release.

(c) Introduction of additional turbidity into the Rogue River at any sustained spillway release.

(d) Potential damage to fish spawning areas if sediment movement is excessive.

(2) Turbine Generating Capability. Powerhouse turbines are sized such that power generation is limited to flows of between 700 and 2,700 ft^3/s. At a generation of 10 to 15 MW a "rough zone" may be encountered. Long-term operation of the turbines in this or any other "rough" zone should be avoided.

(3) Regulating Outlet Works. The RO gates are designed to operate at openings greater than 0.5 feet and at high (over 150 feet) head. The RO gates should not be used when the reservoir elevation is below El. 1790 feet. According to the US Army Corps of Engineers Hydraulic Design Criteria (HDC 320-1), regulating outlet gates should only be operated at greater than 10% openings and less than 80% openings. Therefore, the minimum opening to which these gates should be operated is 1.25 feet (10% of the gate height). Gate openings below this setting could result in gate vibration or cavitational erosion. This is larger than the minimum gate opening of 0.5 feet specified in previous versions of the Water Control Manual. Operating the regulating outlet gates at full open is allowed, but gate openings between 10 feet and 12.5 feet (80% and 100%) should be avoided.

The regulating outlets are designed to be operated in a balanced condition (two gates open equally). There should not be a problem operating with only one gate open less than 4 feet; however, the operators should monitor for any unusual conditions (such as vibration) around a 4 foot opening. Because of the excessive vibration observed in the past, the project has placed an operating restriction on the gates that they not be opened greater than 4 feet when operating one gate alone.

If either gate is going to be opened greater than 7 feet, a hydraulic engineer should be on site. The outlet tunnel transitions from open channel to pressurized flow between 7,000 and 9,000 ft^3/s. This level is reached with both gates open between 7 and 10 feet depending on pool elevation. With one gate full open (12.5 feet), the approximate discharge would be 5,500 ft^3/s or less, well below the transition threshold. Therefore, you can operate one gate wide open without pressurizing the downstream tunnel.

Erosion of the excavated plunge pool downstream of the flip bucket, at high releases, may result in a buildup of material downstream of the powerhouse. This transfer of material can raise the tailwater, reducing the effectiveness of power generation capability. Such a condition has been relieved by periodic excavation of loose material downstream of the powerhouse.

(4) Tower Bypass System. The tower bypass system, briefly described in paragraph 2.3.c(5), was designed to function as a means to divert water to the penstock when the intake wet well is dewatered for inspection or maintenance. Several constraints need to be observed for the system to function as designed. Those constraints are as follows:

(a) A mobile crane and crew will be required at the tower to change bulkhead gates.

(b) The two pressure relief gates must be replaced with full head designed intake gates. Pressure relief gates are only designed for 20 feet of differential head.

(c) The power penstock bulkhead gate must be repositioned from its downstream slot to the upstream slot.

(d) The bypass intake gate must be raised and left in the slot (minimum 6 feet, maximum 12 feet).

(e) Maintaining a constant flow release during the changeover operation will require use of both the power and regulating outlet facilities.

(f) The time frame for the changeover can be up to 6 hours (most of the time is required for changing gates).

(g) The maximum planned discharge of the bypass system is 2,000 ft^3/s. Bypass releases below El. 1,826 must be reduced due to potential air draw into the penstock (see U.S. Army Engineer Division, Northwestern Division, CE, HEDB Study No. 072275 "Lost Creek Emergency Bypass," dated 22 July 1975, and "Outlet Works for Lost Creek Dam, Rogue River, Oregon," TR No. 140-1, Bonneville, Oregon, October 1979). At pool El. 1,789 the discharge is limited to 700 ft^3/s.

(h) The most difficult phase of the bypass operation is restoring the tower intake system back to normal. Since the pressure differential between the forebay and penstock bulkhead (within the slot) during bypass operations can be as high as 43 feet (see U.S. Army Engineering Division, North Pacific, CE, HEDB Study No. 011475 "Lost Creek Turbidity Conduit," Appendix D, Letter from NPPEN to HEDB, NPD, dated 11 June 1975), the wet well water surface must be raised to within 4 feet of the forebay before opening an intake port. Bypass releases must be reduced sufficiently to allow filling of the wet well to a point that either the penstock bulkhead can be opened (filling well by use of bypass intake) or the tower intake gate can be opened (filling well directly from forebay). Significant release fluctuations should be anticipated during this operation.

(5) Multilevel Withdrawal Structure. The multilevel withdrawal structure is designed to operate in either of two modes. One mode limits operation to a forebay intake well differential of 3 feet or less, considered the "normal" mode, as it assumes flow through each port is limited to approximately 1,000 ft^3/s. This limitation results in a normal head loss through the intake ports of approximately 2 feet. Electrical control circuits are set to sound an alarm to the powerhouse if the head loss reaches 3 feet. The 3-foot limit was installed since the gates are designed to act as bulkheads (become sealed to guides) when the head loss exceeds 4 feet. This mode of operation limits turbidity operation to a 3-foot differential, considered inadequate for turbidity withdrawal requirements.

The second or "turbidity operation" mode will provide for operation with a maximum differential head of 20 feet between forebay and intake well. This limit was based primarily on vibration concerns, but additional practicalities of structural design and power loss capabilities firmly established the limitation. This mode will allow a maximum turbidity conduit intake flow of 3,000 ft^3/s. During this mode the turbidity conduit bulkhead gate must be raised above the conduit to allow free entry of water through the gate slot providing an additional 700 ft^3/s. The resulting maximum flows for total project releases are 3,700, 7,400, and 11,000 ft^3/s with the turbidity port, turbidity port plus one side port, and turbidity port plus two side ports opened, respectively. Load rejection studies (U.S. Army Engineer Division, North Pacific, CE, HEDB Study No. 011475, "Lost Creek Turbidity Conduit," circa June 1975) under the turbidity only operational mode, showed that without corrective measures a maximum surge of 18 feet within the tower (i.e., unlimited well height above pool El. 1,872) would occur when the powerhouse was operating at 2,500 ft^3/s. To alleviate this potential surge problem two port gates at the 1,730 tier elevation were replaced with specially designed pressure relief gates. These relief gates have twenty-seven 15- by 27-inch orifices that are closed by top-hinged panels, but which will be opened when the water surface elevation in the tower increases slightly above the pool elevation. With the two pressure relief gates installed and all flow drawn through the turbidity conduit, a surge of 2.7 feet above the pool level is expected with a load rejection at maximum pool and a surge of 3.3 feet at the pool corresponding to critical head. Any consideration for sustained operation which will place a differential pressure greater than 20 feet on the pressure relief gates is not permissible.

The intake ports are designed to operate at a maximum discharge with a minimum submergence of 5 feet above the intake roof. Operation without the required 5-foot submergence could result in fluctuation of the water surface within the wet well, unsteady flow conditions, and pulsation of flow to the turbines. The greater the number of ports open the less likely these conditions are to occur. In addition, trash is much more likely to invade the wet well. The 5-foot submergence constraint can be relaxed under special conditions where surface water temperature release cannot be achieved by lower ports. Invert elevations, roof of the intake elevations, and intake roof with a 5-foot head criteria are shown on Table 7-1.

Table 7-1. Water Temperature Control Ports Intake Elevations, Roof of the Intake Elevations, and Intake Roof with 5-Foot Head Criteria for Lost Creek Dam.

Intake Level	Invert Elevation (ft)	Intake Roof Elevation (ft)	Intake Roof Elevation with 5-Foot Head Criteria Elevation (ft)
1	1,845	1,860	1,865
2	1,790	1,805	1,810
3	1,730	1,745	1,750
4	1,640	1,655	1,660
Turbidity Conduit	1,595	13.5-foot-diameter conduit	Turbidity conduit requires sufficient head above El. 1,640 to overcome hydraulic losses. Additional information may be obtained from CENWP-EC-HD.

The floating trash structure surrounding the intake tower is capable of operation only to pool El. 1,750. Anticipated operation to a lower pool level will require removal to prevent damage to the structure.

(6) Fish Hatchery Warm Water Supply. The fish hatchery warm water supply system has a lower operating limit of El. 1,800 ft. If operation of the pool nears or is projected to go below this elevation, the hatchery personnel should be alerted. Operational practice is to close the warm water supply valve at approximately El. 1805 ft to maintain water in the supply pipe, if the reservoir is expected to fall below El. 1,800 ft.

b. Downstream Limitations. Downstream limitations are as follows:

(1) Minimum Flow Below Project. Because of fish spawning areas below the dam, minimum flow from Lost Creek Lake during flood damage reduction operations is 500 ft^3/s to avoid dewatering of redds. Minimum releases during non-flood periods vary during other times of the year, and are discussed in paragraph 7-6.

(2) Maximum Controlled Flow Below Project. Three flood control points are located downstream of Lost Creek Lake. They are Dodge Bridge (RM 138.6, flood regulation goal 20,000 ft^3/s); Raygold (RM 125.8, flood regulation 34,000 ft^3/s); and Grants Pass (RM 101.8, flood regulation goal 45,000 ft^3/s). Flood regulation is discussed in paragraph 7-4.

(3) Rate of Release Change Limitations. Rate of release change limitations are specified in paragraph 7-4(d), and are variable depending on whether they are performed in the interest of flood control or conservation purposes. When operations are being conducted for conservation purposes a maximum rate of change in flow of 1,200 ft3/s per hour will be observed for increases and decreases. Flows will be increased or decreased at a lesser rate whenever possible. Typically, flows will be decreased at a rate of 150 ft3/s every three hours, not to exceed the lesser of 750 ft3/s or a total of 20% in a 24-hour period. The Corps of Engineers has agreed to comply with these rates in the interest of fishery enhancement as long as other authorized project functions are not jeopardized.

Flood control operations will also target a maximum rate of change in flows of 1,200ft3/s per hour. However, compliance with flood reduction objectives, such as the use of special curves or observation of flood regulation goals on the Rogue River, take precedent and may result in changes to flow that exceed 1,200 ft3/s per hour. Changes to flow in excess of 1,200 ft3/s per hour require formal documentation. Flows will be increased or decreased at a lesser rate whenever possible. Typically, flows will be decreased at a rate of 150 ft3/s every three hours, not to exceed the lesser of 750 ft3/s or a total of 20% in a 24-hour period.

7-3 OVERALL PLAN FOR WATER CONTROL.

a. General. Lost Creek Lake is a multipurpose project with flood control being a primary function. Regulation of Lost Creek Lake provides effective flood regulation in the Rogue River Basin and substantial water-use or conservation benefits during the remainder of the year. The seasonal streamflow regime is such that the same reservoir storage space can be scheduled to serve both flood regulation and water conservation effectively. Flood regulation is adequately provided by reserving storage space for flood control during the late fall, winter, and early spring. Beginning in January, as the flood potential decreases, the storage space reserved for winter floods is filled gradually with a goal to be filled by 30 April.

Maximum scheduled pool elevations are defined by a water control diagram shown on Plate 7-1, and should not be exceeded except in case of a flood or when seasonal runoff forecasts clearly indicate that limited storage above the scheduled pool level is desirable. This action would be required very infrequently with current conservation demands. Action of this latter type would require deviation approval from CENWD. Guidance on the deviation process is available from CENWD-PDW-HP and NWD Regulation No. 11110-2-6 Deviation Requests for Approved Water Control Manuals. The water control diagram provides sufficient storage space to regulate all but the most infrequent floods during the November to May period.

In scheduling the regulation of Lost Creek Lake, the year is divided into three seasons as follows:

(1) Major flood season, 1 November through31 January.

(2) Conservation storing season, 1 February through30 April.

(3) Conservation release season, 1 May through31 October.

These three water management seasons are illustrated on Plate 7-1.

b. Major Flood Season (1 November through31 January). A minimum of 180,000 acre-feet of flood control space is reserved in Lost Creek Lake from 1 November through 31 January, the period of maximum flood potential. During the period 1 November through 31 December the lake is held at minimum flood control pool, El. 1,812, except when the regulation of floods requires use of the storage space. During the month of January a limited filling of the lake takes place reaching El. 1,823.2 with 315,000 acre-feet of stored water (150,000 acre-feet of flood control space) by 31 January. Immediately following each flood, the lake is evacuated to the scheduled flood control rule curve elevation as rapidly as downstream conditions and weather will permit. However, under no circumstances should any evacuation create a downstream flow greater than that which would have been experienced as a result of the preceding flood without regulation by Lost Creek Lake. Paragraph 7-4.c describes in greater detail the flood control regulation for Lost Creek Lake.

c. Conservation Storing - Season (1 February through 30 April). Storing of water for conservation purposes progresses at a rapid rate after the major flood season. Filling rates are shown on Plate 7-1. Under normal filling conditions the lake reaches full pool at El. 1,872 on 30 April. Filling may be delayed if a substantial spring snowpack exists in the basin above the lake. This would be a precautionary measure to provide adequate storage space in the lake to regulate any rapid snowmelt that might develop from rainstorm activity and snowmelt runoff. The modified rescheduled filling would in no way jeopardize achieving a full lake. In the event that the inflow is not adequate to fill the lake by 30 April, storing may be continued after that date. Excess streamflow above that necessary to provide minimum releases and other scheduled conservation requirements will be stored in order to fill the lake as much as possible.

d. Conservation Release Season (1 Mav through 31 October). Release of stored water from Lost Creek Lake during the period 1 May through 31 October is scheduled to provide optimum conservation benefits consistent with water use priorities. The volume of water stored in Lost Creek Lake, streamflow conditions during the low water season, and the conservation demands for stored water will vary from year to year. These variables require that a flexible conservation release schedule be developed each year. A preliminary operating plan based upon available stored water, forecasted streamflow, and current water demands is prepared each spring. Development of this annual Conservation Plan is described in paragraph 7-6.

7-4 FLOOD CONTROL REGULATION

a. Corps of Engineers - Role. Under authority contained in various legislative acts, the Chief of Engineers is responsible for establishing overall policy for the regulation of reservoirs for flood control. In the Portland District, water control plans and manuals for flood control projects are formulated in Engineering and Construction Division in accordance with instructions contained in Engineering Manual (EM) 1110-2-3600, dated 30 November 1987, and are submitted to Northwestern Division (CENWD) for approval. Any future changes in the reservoir regulation plan that affect the authorized functions of the reservoirs or constitutes major changes in the approved water control plan will be submitted to CENWD for approval. Additional information on the Corps role is noted in chapter 9.

b. Basic Method of Flood Regulation. One of the primary functions of Lost Creek Project is the regulation of floods. The objective is to keep the Rogue River below flood regulation goals at key downstream points as much of the time as possible. During floods which do not threaten to exceed the capacity of Lost Creek Lake, releases from the lake will be regulated towards this objective.

If a series of small floods or a large flood indicate that the capacity of Lost Creek Lake will be exceeded, a special flood control regulation schedule will be used. The special schedule prescribes a gradual increase in the lake release as soon as it is evident that the flood is too large to be completely controlled, thus avoiding an abrupt increase in outflow when lake storage is exhausted. This operation will also result in a lower maximum release than that which would occur if the lake were permitted to fill and suddenly release inflow using the normal release schedule. During the New Year's Day flood of 1997, it was necessary to use the special flood regulation schedule. Further discussion on use of the special flood regulation schedule is presented in paragraph 7-4.e.

c. Flood Control Regulation - Criteria. The basic criteria during the major flood season (1 November through 31 January) is to pass inflow through the project as long as possible without exceeding the flood regulation goals of 20,000 ft^3/s at Dodge Bridge, 34,000 ft^3/s at Raygold, or 45,000 ft^3/s at Grants Pass. The project will release discharges equal to inflow until one of the following criteria occur:

(1) It is no longer possible to continue passing inflow to Lost Creek Lake without exceeding flood regulation goals at the downstream control points. The release from Lost Creek Lake will be reduced as needed to a minimum of 500 ft^3/s before the flood regulation goals are predicted to be exceeded. This will normally be directed by CENWP-EC-HR.

(2) The inflow exceeds the outlet capacity. At that time the storing of water in the lake will occur.

(3) During minor floods, CENWP-EC-HR may direct a release schedule that minimizes dramatic increases and decreases in outflow, so long as the schedule does not compromise project flood damage reduction goals.

Once the project outflow is reduced for flood control regulation, minimum releases of 500 ft^3/s will be maintained unless one of the following criteria occurs:

(4) Downstream control stations recede to below flood regulation goals and are forecasted to continue falling.

(5) The project is directed by CENWP-EC-HR to increase outflows.

(6) The observed inflow and pool elevation indicates use of the special flood regulation schedule, Plate 7-2, is required to make maximum use of the remaining storage.

Evacuation of stored floodwater should not be initiated until streams below the project have receded to their flood regulation goals and should be scheduled not to exceed these goals. An exception to this procedure could occur when the lake is full or near full and there are indications of another flood occurring. At the direction of CENWP-EC-HR, after inflow recedes to project outflow, the procedure will be to maintain the outflow of the time until at least 9,000 acre-feet of flood control storage has been restored. This occurs at El. 1,869.4. After this evacuation has been performed, releases shall be made which are equal to the maximum amount possible without exceeding downstream flood regulation goals. Under no circumstances should any evacuation create a downstream flow greater than that which would have been experienced as a result of the preceding flood without regulation by Lost Creek Lake.

Project releases during the recession phase will be maintained to keep the downstream flows at or near the flood regulation goals. The normal maximum evacuation release of 10,000 ft^3/s will allow emptying of the flood control space in a period of 10 to 14 days. Extreme caution should be used when maintaining the normal maximum release of 10,000 ft^3/s. Downstream control points may respond quickly to subsequent storms, requiring actions at the project well before downstream flooding occurs.

d. Rate of Change in Reservoir Releases. Safety precautions preclude sudden large increases in the release from Lost Creek Lake. During and following floods, increases in the controlled release should not exceed 1,200 ft^3/s in any 1-hour period. The increase can be made in one or more adjustments, and it is cautioned that the maximum rate of increase should be used only when the situation is most critical. Table 7-2 shows the rate of change for incremental flows for both flood control and conservation regulation. The 1,200 ft^3/s maximum rate of change does not apply when using the special gate regulation curve shown on Plate 7-2 and described in paragraph 7-4.e.

Table 7-2. Rate of Change Limitations for Lost Creek Lake[1]

Discharge Range (ft^3/s)	Rate of Change per Hour	
	High Flow Periods[2] (ft^3/s)	Low Flow Periods[2] (ft^3/s)
500-1,000	300	200
1,000-3,000	600	300
3,000-10,000	1,200	600

[1]Whenever possible, it is preferable to make changes at smaller rates unless project functions are jeopardized, especially during critical fishery periods. **A rate of change, when reducing flow, of 150 ft^3/s every 3 hours with a maximum reduction of the lesser of 20% or 750 ft^3/s per day is preferable during periods other than during flood damage reduction operations.** In general, these ramp rates are most critical during the March through October time frame and less critical during the November to February time frame. Flood damage reduction operations are considered operations initiated keep the Rogue River below flood regulation goals at key downstream points as much of the time as possible and when drafting water stored in the reservoir during a flood event.
[2]Regulation for "high flow periods" is considered to be in the interest of flood damage reduction and regulation for "low flow periods" is considered to be in the interest of all other uses.
[3]Rate of increase reflects a stage increase below the dam of 0.5 feet per hour during high flow periods and 0.3 feet during low flow periods.

e. Special Flood Regulation Schedule. A special situation exists when a flood cannot be completely regulated at the dam with the available storage in the lake. The special flood regulation schedule for Lost Creek Lake is a deviation from the normal flood control regulation schedule and is shown on Plate 7-2. These special curves indicate when the normal lake release should be increased and what the revised release should be if the remaining storage in the lake is to be used effectively and an uncontrolled release avoided.

Plate 7-3, a computation of lake inflow, is provided to assist in use of the special flood regulation schedule. Releases using special curves will usually exceed the regulating outlet and powerhouse capacity, and require use of the spillway. The inflow parameter curves (Plate 7-3) are constructed so that the intersection of the current pool elevation with the current inflow indicates the outflow that will make optimum use of the remaining storage. The procedure results in a gradual increase in the outflow and a corresponding lower maximum reservoir release from that which would be experienced should no special action be taken. Experience indicates that a reduction in previously established outflow should not be affected on the basis of one check period, otherwise the outflow could fluctuate excessively. Usually two check periods will establish a definite trend. This procedure only applies to reducing the outflow, not increasing the outflow, which should comply with the special curves.

f. Normal Maximum Release. The criteria involved in the selection of an outlet capacity was that the outlets should be large enough to evacuate the entire flood control storage space in approximately a 2-week period and at the same time take full advantage of the capacity of the channel below the project. Another criterion was that the outlet capacity at Lost Creek Lake was to be large enough to discharge an inflow that would be comparable to the flood regulation goal of 45,000 ft^3/s at Grants Pass. A project discharge of 10,000 ft^3/s is the amount that would maximize the downstream channel capacity but still remain below bankfull. The outlets at Lost Creek Lake are capable of passing 10,000 ft^3/s at the minimum flood control pool elevation of 1,812, and 11,600 ft3/s at full pool El. 1,872. Normal maximum release should be limited to 10,000 ft^3/s.

g. Travel Times for Flood Control Releases to the Downstream Control Points. Past peak discharges from the Lost Creek Dam site to Dodge Bridge, Raygold, and Grants Pass show a travel time of approximately 4, 6, and 10 hours, respectively. Travel times will be used in scheduling releases from Lost Creek Lake to obtain optimum flood regulation.

h. Flood Regulation Goals of the Downstream Control Points. Areas subject to flooding are located along the 90-mile reach of Rogue River from the mouth of Big Butte Creek to Grave Creek (west of Merlin). Flood regulation goals at Dodge Bridge, Raygold, and Grants Pass are 20,000, 34,000, and 45,000 ft^3/s, respectively. The regulation of Lost Creek Lake is based on river conditions within the 90-mile reach using the three stream gaging stations as control points. Since Lost Creek Lake controls only 28 percent of the area above Grants Pass, the flood regulation goal of 45,000 ft^3/s will frequently be exceeded by runoff from the uncontrolled area.

i. National Emergency with Project Personnel Evacuation. If all personnel are ordered to evacuate from Lost Creek Project during a national emergency, the power facilities should be shut down and the outlets adjusted to discharge flows in the following manner:

(1) Release normal minimum flows plus 3,000 ft^3/s or forecasted inflows plus 3,000 ft^3/s, whichever is greater, and not to exceed 10,000 ft^3/s.

(2) If the pool is below the spillway crest (El, 1,823), the spillway gates should be fully opened before leaving the project.

This regulation will ensure evacuation of storage space in the project, reducing possible damage downstream if a breach occurs. This regulation also attempts to maintain the downstream control points within channel capacity, and protects the project from overtopping in the event of a large flood.

j. Regulation During an Impending Dam Failure. In the event of conditions developing which could lead to a potential or actual dam failure, project personnel will refer to the Lost Creek Lake Emergency Action Plan (EAP) and begin the emergency notification procedure. Evacuation rates are specified in section 11.2.3 , "Reservoir Emergency Dewatering Subplan," of the Lost Creek Lake Emergency Action Plan.

7-5 STANDING INSTRUCTIONS TO OPERATIONS PERSONNEL

It is impossible to anticipate every unusual flood, power emergency, or combination of events that will require special regulation; therefore, general instructions are provided in the following paragraphs for such contingencies. Should an emergency develop or appear imminent, the Operations Project Manager at Lost Creek Lake or a representative will promptly contact CENWP-EC-HR, report existing field conditions, and suggest a course of action. CENWP-EC-HR shall evaluate the emergency and suggested course of action and instruct the project further. In the event of a communication failure, repeated efforts will be made to contact CENWP-EC-HR or CENWD-PDW-R. Should communications to both Portland water management offices fail during a flood, but remain operative to the downstream control points below the project, the Operations Project Manager or an authorized representative will direct the regulation of Lost Creek Lake as outlined in this manual.

If all communication is lost during flooding, project personnel will operate Lost Creek Lake in the following manner:

a. Determine lake inflow. Compute lake inflow by means of the storage equation using Plate 7-3.

b. Consult special curves. Every 2 hours consult Plate 7-2 and if the curves are applicable, adjust the lake release as indicated. Enter the curve with the current pool elevation and the average inflow for the preceding 2 hours to determine the required lake release.

c. If the special curves are not applicable and communication with CENWP-EC-HR or CENWD-PDW-R is not expected to be reestablished within several hours, reduce the outflow to 500 ft^3/s at a maximum rate of 1,200 ft^3/s change per hour.

d. Repeat steps “a” and “b” every 2 hours until communication has been restored.

e. Maintain continuous hydrographs of lake inflow, elevation, and flow at downstream control points. Graphs of this type provide a useful tool for forecasting short-term conditions. Exhibit B contains graphs designed for this purpose.

During the period that special regulation curves are applicable, the lake release will be determined every 2 hours on the basis of the average inflow for the preceding 2 hours and the current lake elevation.

After the lake reaches maximum elevation, maintain that elevation by adjustment of the release so that it is equal to the lake inflow until post-flood evacuation is initiated. Post-flood evacuation will normally not be initiated until streams have receded to within their banks. An exception to this rule would be made on special occasions if communications have been restored and CENWP-EC-HR determines that forecasted runoff from an approaching storm indicates that accelerated lake evacuation should be made to provide storage space for flood control. On these special occasions the rate of evacuation may result in downstream overbank flow. Under no circumstances should any evacuation create a downstream flow greater than that which could have been experienced as a result of the preceding flood without regulation by Lost Creek Lake.

7-6 CONSERVATION REGULATION

a. Conservation Storing Regulation. Lost Creek Lake storage space is scheduled for multipurpose use. To help ensure refill of the lake, space reserved for flood control is gradually filled for conservation purposes near the end of the flood season as the storm activity decreases. This procedure is accomplished without jeopardizing the flood control effectiveness of the project. The conservation season filling schedule, regulation with abundant water supply, inadequate water supply, and potential flooding are discussed in the following paragraphs.

(1) Conservation Filling Schedule. The conservation season filling schedule for Lost Creek Lake permits conservation storage after 1 January as specified by the flood control rule curve, shown on Plate 7-1 and corresponding Table 7-3. The schedule is divided into three filling rates. During January, February, and the March-April period the filling rate is 968, 2,857, and 1,148 acre-feet per day, respectively. If this schedule is maintained, the maximum pool elevation of 1,872 will be reached on 30 April, providing 180,000 acre-feet of additional stored water for conservation use.

The flood control rule curve should not be exceeded except when regulating a flood or when seasonal runoff forecasts clearly indicate that limited storage above the scheduled pool level is desirable. This action would be required very infrequently with current conservation demands. Action of this latter type would require deviation approval from CENWD. Flood control, a principal function of Lost Creek Lake, would be jeopardized by any substantial encroachment on the storage reservation. On occasion, there could be filling at a lesser rate provided the action did not unduly jeopardize reaching full pool. The minimum rate of storing, which would provide a reasonable assurance of filling the lake, varies from year to year depending upon weather and snow conditions in the basin upstream of the lake.

Frequent monitoring of watershed conditions during the winter and spring will help determine what filling rate can be used without jeopardizing lake refill.

(2) Conservation Regulation with Abundant Water Supply. Procedures for making snowmelt runoff forecasts after 1 February have been derived for Lost Creek Lake. The forecasts are made primarily from an analysis of snow water content and precipitation data. At times when there is reasonable assurance that the seasonal snowmelt runoff will be more than adequate to fill the lake, it may be filled at a lesser rate to provide for increased flood control protection and fishery enhancement by reducing the intensity of peak flows during the period eggs and sac-fry incubate in the gravel.

(3) Conservation Regulation with Inadequate Water Supply. There will be times when the lake inflow will not be adequate to maintain the scheduled minimum release and meet the desired filling schedule. Under such circumstances minimum releases will be provided, but filling will fall behind schedule. Provision for minimum releases and prior water rights take precedence over storing for conservation uses. Any deficiency in filling may be made up at a later date if the inflow is adequate. Likewise, storing may be continued after 1 May, if necessary, provided there is a surplus of streamflow above the amount required to satisfy prior water rights and minimum flow requirements. An estimate of the runoff required to accomplish conservation filling may be obtained from Plate 7-4 which indicates the volume in acre-feet required to fill by or before 31 May, assuming minimum flow requirements are met.

If volume runoff forecasts indicate that an inadequate volume of water will be available to meet conservation release requirements, a water shortage will be declared by CENWP. This action will usually take place after 1 April since a high probability for significant runoff exists prior to this date. After 1 April the probability for significant rainfall-runoff events has decreased and filling of the lake becomes highly dependent on snowmelt and base flow conditions. Use of the Lost Creek volume runoff procedures, given as exhibit B and discussed in chapter 6, should be the primary guide for evaluating the severity of the shortage. Using these procedures CENWP may declare a shortage. Coordination with other Federal and State agencies is initiated, and a modified release schedule is developed. In this manner water shortages in the Rogue River Basin are effectively moderated as irrigation, water supply, and fishery enhancement requirements for stored water receive an equal percent reduction of their full supply.

Hypothetical seasonal regulations of Lost Creek Lake were performed over a 33-year period, 1928 to 1961. This study showed that the lake filled to maximum pool, EL. 1,872, during all but 5 of the 33 years. The years were 1929, 1930, 1931, 1934, and 1941. In those years the inflow was not sufficient to fill the lake. In the most critical year of 1931, the lake would have only filled to 71 percent of its storage capacity by the end of the storing season.

(4) Conservation Regulation and Flooding. Although the flood potential of the basin normally decreases as the spring season advances, floods can occur during the conservation storing season. Regulation of a flood during this or any other season will be in accordance with paragraph 7-4, using the normal or special regulation schedules as required.

Following a flood, excess floodwaters stored in the lake will be evacuated and the pool will be drawn down to the scheduled pool level.

b. Conservation Release Regulation. During the period 1 May to 31 October, water stored in Lost Creek Lake is released to provide optimum conservation benefits for fisheries enhancement, irrigation, municipal and domestic water supply and secondary benefits including water quality control, electric power, and public use. Releases in excess of the natural flows for conservation purposes normally start in June. By 1 November the lake is evacuated to the minimum flood control pool, El. 1,812. Seasonal conservation storage in Lost Creek Lake, between minimum flood-control pool and full pool, is 180,000 acre-feet. This seasonal storage is composed of 125,000 acre-feet of stored water for fishery enhancement; 35,000 acre-feet of stored water for irrigation; 10,000 acre-feet of stored water for municipal and domestic use; and 10,000 acre-feet that is not allocated for any single purpose. Of the 20,000 acre-feet of municipal and domestic water storage planned for the Rogue Basin, 10,000 acre-feet was originally authorized for Lost Creek Lake and the same amount for Elk Creek Lake. Carryover conservation storage water in Lost Creek Lake between minimum conservation pool and minimum flood control pool is 135,000 acre-feet. This carryover storage is used in years of water shortage when authorized minimum flows or fish or municipal and domestic or irrigation requirements cannot be provided by the seasonally stored water.

(1) Conservation Release Schedule. During the conservation release season, demand for stored water will vary from year to year depending upon the natural streamflow and the amount of stored water in the lake. Therefore, a fixed schedule for releasing stored water is not practical. Each year, a provisional conservation release schedule is formulated in cooperation with the Rogue Basin Water Management Advisory Group. The Advisory Group has representatives from the US Army Corps of Engineers, Oregon Water Resources Department, Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon State Marine Board, NOAA Fisheries, US Fish and Wildlife Service, US Forest Service, US Bureau of Land Management, and the US Bureau of Reclamation. The OWRD acts as the representative of the state of Oregon to this agreement who with the Corps exchanges letters of concurrence.

Conservation season planning begins in February. By April a more definitive operating plan is presented to the advisory group for review. After the advisory group has commented on the plan, a revised plan is presented to the public in late May for comments and public comments are then considered in adopting the final plan. The final release schedule is developed by early June. The operating plan is reviewed periodically throughout the conservation release season and is revised, if necessary, to meet changing conditions and water demands. Normally the natural streamflow provides for all conservation needs through June including prior water rights. Therefore, drafting from storage for conservation purposes is usually not significant until early July. July and August are months of greatest demand for stored water. During years with inadequate water storage when minimum flow requirements and contracted water from storage cannot be met in full, all authorized project purposes will be reduced so that each function would receive the same percentage of the incomplete storage as they would have received of the full storage.

If the conservation demands do not draft the reservoir to the elevation of 1,812 by 1 November, the excess water will be released to lower the pool for flood regulation purposes. Fisheries research indicates that conditions for Chinook are favorable when there is minimal flow augmentation between 21 September and 15 November. Therefore, drafting of the reservoir to elevation 1,812 is typically achieved by 21 September when possible.This action will contribute to fishery enhancement, an important project function. During the mid-September through October period, releases from Lost Creek Lake are generally scheduled to not exceed 1400 ft^3/s unless regulating a flood. Should project inflows exceed 1400 ft^3/s, a limited encroachment of up to 10 percent storage space (18,000 acre feet) should be considered. If a greater encroachment into flood control occurs, the excess water shall be promptly evacuated to the 10 percent encroachment level. Close coordination on how this water is released should be performed with the OWRD and Federal and State fishery agencies.

(2) Water-Use Priorities. Irrigation, fishery enhancement, and municipal and domestic use have the highest priority on 180,000 acre-feet of stored water above the minimum flood control pool elevation. Stored water released for other uses are water quality control and power operation. Lake and downstream recreation have no priority on stored water; however, as much consideration as possible will be extended without adversely affecting the authorized functions. In most instances, water released from Lost Creek Lake for a specific purpose will also benefit some conservation interests. Insofar as possible, the regulation of the lake considers the requirements of the nonconsumptive interests as well as the fishery, irrigation, and municipal and domestic water supply so that preferential treatment will not be accorded any particular interest to the exclusion of the needs of the others. The basic policy will be to provide the most beneficial overall regulation consistent with the water control plan and Federal and State water laws.

(3) Prior Water Rights. The water laws of the state of Oregon provide that all water within the State, from all sources of supply, belongs to the public. Subject to existing water rights and in accordance with the statutory provisions governing such matters, all natural flow within the State may be appropriated for beneficial use. Prior water rights granted in accordance with Oregon State law(s) will be honored to the extent of the natural inflow into Lost Creek Lake.

(4) Minimum Reservoir Releases. Minimum releases, exclusive of periods of flood regulation, use 700 ft^3/s (increased from 200 ft^3/s as described in the project authorization) as an informally agreed to regulation practice. Table 7-5 shows the adopted minimum releases for fisheries enhancement. Provisions for these flows, from the dam site to the mouth of the Rogue River, do not include water needed for irrigation, municipal and industrial water supply, and to satisfy prior water rights. Local watermasters have the responsibility to assure that these releases remain in the entire reach of the river.

The minimum observed mean monthly flow at Lost Creek Lake is about 600 ft^3/s. Releases from Lost Creek Lake, except during the filling period from 1 January to 1 May, will generally be in excess of natural flows because of conservation needs. Minimum flow requirements shall be met by use of the 125,000 acre-feet of fishery enhancement storage allocated for this purpose or by use of the carryover storage during periods of extended water shortage.

(5) Flood Occurrence During Conservation Release Season. Should a flood occur during the conservation release season, the lake will be regulated in accordance with paragraph 7-4 of this manual, and floodwater will be stored to reduce downstream flooding. Following a flood, excess water will be evacuated and the lake will be drawn down to the indicated pool elevation for that date as soon as the downstream channel capacities will permit.

Table 7-5. Minimum Release Requirements from Lost Creek[1,2].

Period	Minimum Releases – Ft^3/s
1 Feb – 30 Apr	700
1 May –15 May	1,000
16 May – 31 May	1,300
1 Jun – 10 Jun	1,500
11 Jun – 30 Jun	1,800
1 Jul – 20 Aug	2,000
21 Aug – 7 Sep	1,500
8 Sep – 31 Jan	1,000

[1]Minimum releases unless coordinated with OWRD. Actual releases during filling and conservation seasons will often differ from the minimum releases shown in this table.
[2]Minimum release in the interest of flood damage reduction is 500 cfs. This does not need to be coordinated with OWRD.

7-7 IRRIGATION

Rainfall deficiency in the valley areas of the Rogue River Basin during the growing season makes supplemental water supply a necessity for successful crop and orchard production. Lost Creek Lake has 35,000 acre-feet of seasonal conservation storage allocated for irrigation. An additional 135,000 acre-feet of carryover conservation storage is available for shared use for irrigation, fishery enhancement, and municipal and domestic purposes during water short years. The USBR handles all irrigation water sales from Federal projects and receives all payments for the U.S. Government. That agency has filed with OWRD for the multipurpose conservation storage in Lost Creek Lake. The USBR keeps CENWP informed of irrigation contracts so that water release planning can include them. The Corps of Engineers releases stored water for irrigation at the request of the USBR.

7-8 FISHERY ENHANCEMENT

The water control plan for Lost Creek Lake includes fisheries enhancement as a primary project function. The Rogue River fishery is a complex system with a variety of fish species at various stages of development. The abundance of the life stages of the salmonid population in the Rogue River over time and by river reach is shown on Plates 7-5a through 7-5c.

As a project function fishery enhancement is considered equal to irrigation and water supply, but subordinate to flood control. The most important and constant components of the water control plan for fisheries enhancement are as follows:

a. Provision of Minimum Flows. The provision of minimum flows as described in paragraph 7-6, serves to enhance the Rogue River fishery. These flows will not be reduced except during periods of declared water shortages, by request of the state of Oregon, or when hydrologic conditions indicate that other primary authorized functions will be jeopardized. The ODFW has a state of Oregon permit to use 125,000 acre-feet of water from seasonal conservation storage for fishery enhancement purposes. If this storage is insufficient the ODFW has also a joint-use permit for additional storage within the carryover conservation pool which may be released to meet minimum flow requirements.

b. Rates of Change of Reservoir Releases. Rates of change in reservoir releases are specified below Corps projects in the interest of public safety. However, with fishery enhancement being an authorized project function at Lost Creek Lake, maximum rate of change restrictions also exist to protect the fishery. The latter purpose is best accomplished by changing flows at a rate less than the maximum allowable. Typically, flows will be decreased at a rate of 150 ft^3/s every three hours, not to exceed the lesser of 750 ft^3/s or 20% in a 24-hour period during non-flood damage reduction operations. Rates of change limitations are specified in Table 7-2 and paragraph 7-4.

c. Temperature Control. A temperature release schedule is developed annually by CENWP-EC-HR in coordination with ODFWand ODEQ. Project releases will be made as close to the schedule as possible. The temperature of the waters released during the spring and fall seasons are selected so that they are about the same as the river temperatures that occurred before the construction of the dam. Water is released in the summer having a temperature of between 48° to 55°F (8.8° to 12.8°C). Ongoing studies by ODFW and ODEQ serve to provide the Corps of Engineers with the best temperature regulation schemes for anadromous fish management. During the spring of each year, CENWP personnel, ODFW biologists and ODEQ jointly develop a temperature release schedule for the coming year. The schedule is presented to the public in May and serves as a guide to all offices concerned with water temperature.

The operation of a selective withdrawal structure to achieve temperature control is a function of both the temperature profile of the stored water and its availability due to gate limitations. CENWP-EC-HR hydrologists monitor pool temperature and gate availability to reduce the probability of large sudden changes in temperatures occurring as one system of gates becomes dewatered and a new set of gates, lower in elevation, is utilized. Close monitoring results in smooth transitions to new release temperatures and benefits to the fishery downstream.

The selective withdrawal structure will not be operated outside of stated operating constraints (see paragraph 7-2) for purposes of meeting temperature goals except by instructions from CENWP-EC-H. Further discussion of temperature enhancement is included in paragraph 7-10.

d. Flow Control During the Spawning Through Incubation Period. During the mid-September through October period, Chinook salmon are spawning in the Rogue River below Lost Creek Lake. Fisheries research indicates that conditions are favorable when there is minimal flow augmentation between 21 September and 15 November. To the extent possible, reservoir releases at this time are kept to a maximum of 1,400 ft^3/s (if flood control storage requirements are satisfied) to encourage spawning at river levels which are less susceptible to dewatering later in the year. During the February through April period, a minimum release of 900 ft^3/s is preferred to minimize dewatering during project refill. If 900 ft^3/s is not possible, a minimum release of 700 ft^3/s is provided except during flooding when a minimum release of 500 ft^3/s may be performed. Through this process flow control is achieved during the most critical periods for the fishery.

7-9 PROVISION OF FUTURE WATER SUPPLY

Lost Creek Lake and Elk Creek Lake (partially constructed, no impounded water) have been designed to provide a total of 20,000 acre-feet of stored water for future municipal and industrial use. It is anticipated that water would be released into the Rogue River for withdrawal at appropriate downstream points. No special outlet is required for this purpose. Lost Creek has 10,000 acre-feet of storage allocated for municipal and industrial water supply.

7-10 WATER QUALITY CONTROL

Water quality control is an authorized project purpose and also contributes to fisheries enhancement. Water temperature control and turbidity after major rainstorms are two of the main water quality issues in the Rogue River Basin. A multilevel withdrawal structure, shown previously on Plate 2-9, is used to selectively release water of various temperatures during the conservation release season (1 May to 31 October). Information on the turbidity conduit can be found in paragraph 2-3.c.

7-11 RECREATION

Recreation contributes materially to the economy of the basin. The Rogue River Basin constitutes one of Oregon's major recreation attractions and ranks high among the Nation's vacation areas. Based upon the evaluation of the recreational resources of the project and assuming a reasonable development schedule to meet the public-use demand, the annual attendance at Lost Creek Lake will continue to increase. No storage is specifically allocated for recreation so recreation opportunities depend on the use of provided facilities and on availability of water which results from operation of the project for other purposes.

Elevation 1,830 has been found to be the lowest lake level where all lake recreational facilities are in service and provide for optimum use. Carryover conservation storage will be maintained for in-lake purposes unless minimum flow requirements or contracted water demands require its use. Additional coverage of lake recreation is presented in Design Memorandum No. 5A, "Master Plan."

In addition to lake recreation, the river supports numerous recreation opportunities including fishing, rafting and jetboat excursions. Rogue River sport fishery and rafting opportunities are nationally known.

7-12 WILDLIFE ENHANCEMENT

No storage has been specifically allocated for wildlife enhancement. However, habitat areas adjacent to the lake and downstream on the Rogue River shall be considered as much as possible after the primary project functions have been satisfied.

7-13 HYDROELECTRIC POWER

The Lost Creek Project power plant operates as a base load plant. In the interest of fishery protection, recreation, and safety, the project outflow is not fluctuated to meet hourly fluctuations in power demands. No exclusive storage is reserved at Lost Creek Lake for power use. Releases are determined by requirements of flood control, irrigation, water supply, and fisheries enhancement. Large fluctuations in discharge as a result of power generation will not be performed if detrimental to fishery enhancement. Daily stage fluctuations due to power generation will be only that which is acceptable from the standpoint of ensuring fishery enhancement, determined by CENWP-EC-HR, CENWP fish biologists, and responsible state and federal agencies. This is in accordance with the Rogue River Projects authorizing document, House Document 566, paragraph 56(a) and (i).

The power installation at Lost Creek Dam consists of two Francis-type 24,500 kilowatt power units operating with heads between 317 and 193 feet. The average power head is 275 feet based upon studies for the period 1928 to 1961. Conservation purpose releases are normally available for power generation. Nearly all flows below 2,500 ft^3/s released from the project will be through the power facilities. Flows above 2,500 $ft^{3/}s$ will be jointly released through the turbines and regulating outlet.

A communication network has been established between the Lost Creek Project powerhouse, CENWP-EC-HR, and BPA. Power outages, generation scheduling, and emergency outage information are transmitted to agencies involved using the prescribed procedure in Table 7-7.

a. Generation Scheduling. CENWP-EC-HR does not typically coordinate scheduling with BPA. CENWP-EC-HR transmits the flow schedule by CBT to the Lost Creek Project powerhouse and BPA. BPA will inform a Pacific Power scheduler. Changes (nonemergency) in the projected generation schedule initiated by the Lost Creek Project powerhouse are coordinated with a BPA dispatcher.

b. Outage Schedules. Planned outages are provided to the BPA outage coordinator two years in advance. These planned outages are discussed during a weekly regional conference call with BPA and the Corps. A BPA scheduler will clear the outage through their outage dispatcher and the Pacific Power outage dispatcher. The planned outage schedule is periodically shared with CENWP-EC-HR.

During an emergency outage the project is to take whatever action is necessary to protect personnel and project equipment. As soon as possible the project is to notify the BPA dispatcher and the CENWP-EC-HR regulator on duty.

7-14 NAVIGATION

During the summer and early fall, natural low flows are usually inadequate for navigation. Release of stored water from Lost Creek Lake increases the summer and fall flows of the Rogue River and improves shallow draft boat navigation in the Middle and Lower Rogue River. The contribution of Lost Creek Lake outflow to navigation is greatest during July and August. If possible, major flow reductions should be scheduled well in advance.

7-15 DEVIATION FROM NORMAL REGULATION

The District Engineer is occasionally requested to deviate from normal regulation of the reservoir. Deviation requests usually fall into one of three categories: emergencies, unplanned minor deviations, or planned deviations. Each is discussed as follows:

a. Emergencies. Some emergencies that can be expected are drowning and other accidents, and failure of operation facilities. Necessary action under emergency conditions is taken immediately unless such action would create equal to worse conditions. Actions under emergency conditions shall utilize the following priority:

(1) Protection of human life.

(2) Protection of personal property.

(3) Execution of the water control plan.

Normally, use of the water control plan will serve to protect human life and property. However, isolated incidents have occurred whereby the project manager or engineer has been required to deviate from the plan without prior notification to the regulating office. In the interest of providing rapid response to the protection of life and property, the project manager shall follow priorities paragraph 7-15.a(l), (2), and (3) and make immediate contact with CENWP-EC-HR for further guidance. A written confirmation showing the deviation and conditions will be furnished to CENWP-EC-HR.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulation of the lake. Construction accounts for a major portion of the incidents and includes utility stream crossing, bridge work, and major construction contracts. Changes in releases are sometimes necessary for maintenance and inspection. Requests for changes of release rates are generally for a few hours to a few days. Each request is analyzed on its own merit. Consideration is given to upstream watershed conditions, potential flood threat, lake storage, and possible alternative measures. In the interest of maintaining good public relations the requests are complied with, providing there are no adverse effects on the overall regulation of the project, for the authorized purposes. Approval for these minor deviations will normally be obtained from CENWP-EC-HR by telephone. If the request is outside authorized operating limits, approval will be obtained from CENWD. If requested or appropriate, a written confirmation showing the deviation and conditions will be furnished to CENWP-EC-HR. Unplanned minor deviations should be coordinated by CENWP-EC-HR with State and local authorities and interested individuals.

c. Planned Deviations. Planned deviations from the water control plan include actions for which some benefit may be gained if undertaken, and for which time is available to provide an analysis of the trade-offs involved to form the basis for a decision. Examples that have been discussed include reducing the outflow below normal minimum release, and temporarily exceeding the scheduled elevation of the Water Control Diagram. The analysis and decision making needed should involve a multi-disciplinary approach that includes structural, hydraulic, environmental, and operations personnel as required. The decisions will be approached on a collaborative basis with both the District and Division offices involved. Each condition should be analyzed on its merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable affects on other authorized and useful purposes will be communicated to CENWP-EC-HR along with recommendations for review and approval. Approval from CENWD-PDW is required if the request is for operation outside of authorized limits. In addition, the planned deviations should be coordinated by CENWP-EC-HR with State and local authorities and interested individuals.

7-16 RATE OF RELEASE CHANGE

Rates of change in reservoir releases are specified below Corps projects in the interest of public safety. However, with fishery enhancement being an authorized project function at Lost Creek Lake, maximum rate of change restrictions also exist to protect the fishery.

Safety precautions preclude sudden large changes in the release from Lost Creek Lake. During and following floods, increases in the controlled release should not exceed 1,200 ft^3/s in any 1-hour period. The increase can be made in one or more adjustments, and it is cautioned that the maximum rate of increase should be used only when the situation is most critical. Table 7-2 shows the rate of change for incremental flows for both flood control and conservation regulation. The 1,200 ft^3/s maximum rate of change does not apply when using the special gate regulation curve shown on Plate 7-2 and described in paragraph 7-4.e.

Protecting the fishery is best accomplished by changing flows at a rate less than the maximum allowable. Typically, flows will be decreased at a rate of 150 ft^3/s every three hours, not to exceed the lesser of 750 ft^3/s or 20% in a 24-hour period. Rates of change limitations are specified in Table 7-2 and paragraph 7-4.

SECTION 8

EFFECT OF WATER CONTROL PLAN

8-1 GENERAL

Lost Creek Lake provides drainage control for 674 square miles or almost 28 percent of the Rogue River watershed above Grants Pass. The storage of floodwaters by Lost Creek Lake provides valuable benefits to Rogue River communities downstream of the project. Irrigation water stored by the project can provide a reliable water supply for about 18,890 acres of dry land in the Rogue River Valley, and about 6,380 acres of irrigated lands needing a supplemental supply. The multilevel withdrawal structure of the dam is operated to regulate downstream water temperatures and generally improve the water quality of the Rogue River. Aquatic habitat is enhanced by this modification of temperature and flow. Construction of a large, intensively developed recreation facility at the project has also enhanced lake-oriented recreation opportunities in Jackson County.

The effect of the water control plan on each of the project purposes is discussed in the following paragraphs. Economic benefits for flood control have been updated to 2012 price levels. Economic benefits for the remaining project functions are expressed in terms of current use.

8-2 FLOOD CONTROL

During a flood, water is stored in the lake and gradually released over a period of time into the natural channel of the river. The project is operated to maintain downstream flow within the riverbanks to the maximum extent possible. Whenever flow in the Rogue River is expected to exceed flood regulation goals, lake releases are reduced. However, complete regulation of flow on the Rogue River is not always possible. Less than one-third of the watershed above Grants Pass is above the dam site, and significant tributaries enter the river below the project. The lake is capable, however, of reducing the 10 and 20-year flood flows by about 20 percent, and the 50 and 100-year flood flows by 22 and 17 percent, respectively, at Grants Pass, Oregon, 57 miles downstream of Lost Creek Lake.

Benefits from flood damage reduction include reduction of damage, increased land use, and improved drainage in agricultural areas. As a result of flood control efforts, interruption of industrial services is lessened including costs associated with residential and commercial repair. Flood control benefits have been updated to 2012 dollars with a weighted price index which reflects typical costs associated with flood damage repair. Average annual flood control benefits are estimated to be $23,002,640 based on a 2012 price level and 100-year project life.

a. Probable Maximum Flood. The Corps of Engineers policy regarding the design of major storage projects, such as Lost Creek Lake, is that they be designed so that overtopping of the dam will not occur. Such projects are designed to pass without exceeding maximum pool, the largest flood that the basin area above the dam could theoretically produce. Historical and observed floods are not indicative of such an occurrence; therefore, a theoretical flood event is derived using the most severe combination of critical hydrologic and meteorological events. This storm results in the probable maximum flood (PMF) for the basin above Lost Creek Lake. This flood, sometimes called the spillway design flood, is the basis for establishing the spillway capacity.

In deriving the PMF, several maximum flood-producing elements and conditions have to be determined and arranged in a sequence that will simulate the most critical flood runoff. These meteorological and hydrological elements are: probable maximum precipitation for the critical storm period; maximum basin snow cover; maximum temperature and rainfall sequence during the design storm; minimum surface losses; and a hydrograph that will reflect the runoff from a probable maximum storm.

The probable maximum storm derived for Lost Creek Lake site is shown on plate 8-1. The peak discharge of the flood is 169,000 ft^3/s, or 251 ft^3/s per square mile, which is 2.6 times the peak of the standard project flood and 3.0 times the peak of the December 1964 flood (57,500 ft^3/s), the largest flood of record at the dam site. The total volume of the PMF, including base flow, is 817,000 acre-feet which equals 22.7 inches over the area tributary to the dam site. The characteristics of the PMF are similar to those of observed major floods in that it is flashy and of relatively short duration.

The PMF was routed through Lost Creek Lake to determine the design of the spillway and maximum resulting pool elevations. Routings were done for three separate pool elevations at the start of the flood: full pool El. 1,872; spillway crest El. 1,823.5; and minimum flood control pool El. 1,812. With the pool full at the start of the flood, there was no reduction in the flood levels since Lost Creek Lake has no surcharge storage; therefore, the peak outflow was 169,000 ft3/s. A routing with the pool at the spillway crest, likewise, showed no reduction in the peak inflow. The 145,000 acre-feet of storage above the spillway crest, which represents 80 percent of maximum flood control reservation, was filled before the peak occurred. With the pool at minimum flood control level there is 180,000 acre-feet of storage space available for flood regulation. Through the use of this space and special gate regulation schedules, the PMF peak was reduced slightly from l69000 to 160,800 ft^3/s. On the basis of the results of the routings, the spillway is designed for 158,000 ft^3/s which is 169,000 ft^3/s minus the capacity of the outlets at full pool elevation. The 158,000 ft^3/s discharge provides for passage of the spillway flood without any reduction in peak discharge. Plate 8-2 illustrates the El. 1,812 routings made for Lost Creek Lake.

b. Standard Project Flood. The standard project flood for Lost Creek Lake was derived in accordance and in compliance with instructions contained in Office of the Chief of Engineers, Circular Letter No. 4262, dated 20 November 1946; and Civil Engineer Bulletin No. 52-8, EM 1110-2-1411, dated 26 March 1952, reprinted March 1965. This flood would result from maximum hydrologic conditions that might reasonably be expected over the basin, and represents a standard for comparing and judging the adequacy of a project to regulate floods at the project site. Such a flood would be exceeded only on rare occasions. Development of the standard project flood for the Lost Creek Project was based upon a series of theoretical circumstances representing the most severe flood-producing sequence of meteorological and hydrological events considered reasonably representative of the basin. Because observed streamflow records were too short to properly evaluate the flood potential of the upper Rogue River Basin, steps used in deriving the standard project flood were as follows:

(1) Antecedent Flood. The November 1953 flood was selected as the high water to develop a synthetic analysis of the standard project flood. The November 1953 high water discharge of 20,700 ft^3/s has a probability of recurrence of once every 8 years, and could reasonably precede a second storm of standard flood proportions. A double-crested flood is not an uncommon occurrence in the Rogue River Basin.

(2) Standard Project Flood. The theoretical portion of the standard project flood was derived by applying a 6-hour unit hydrograph to the water excesses of the standard project storm. To this synthetic flood hydrograph a base flow of 3,000 ft^3/s was added. The synthetic flood had a peak of 64,500 ft^3/s or 95.5 ft^3/s per square mile. This peak discharge is 1.17 times the December 1964 flood, the largest on record. Its recurrence, based upon the flood frequency studies made for the dam site, would be on the average of once in 250 years.

To complete the standard project flood analysis the high water of November 1953 was combined with the theoretical portion of the flood. Such a sequence of flows is reasonable and represents the critical flow pattern used to regulate a storage reservoir because of the large flood volume. The volume of the standard project flood, including base flow, is 480,200 acre-feet or 13.4 inches of runoff over the basin. The duration of the standard project flood series is 13 days. Plate 8-3 illustrates the standard project flood hydrograph and the standard project storm.

(3) Regulation of Standard Project Flood. The standard project flood was routed through Lost Creek Lake with the lake level at minimum pool for the start of the flood. Through the use of special flood regulation curves it was possible to reduce the outflow to 45,900 ft^3/s, approximately 71 percent of the peak inflow. The peak outflow occurred 34 hours after the flood crested. Plate 8-4 shows the results of the flood routing. These results indicated that Lost Creek Lake has the capability of reducing the peak of a standard project flood at Grants Pass by 33,000 ft^3/s.

c. Examples of Past Flood Regulation. Two large floods have been analyzed which occurred on the Rogue River prior to the construction of Lost Creek Lake. These were the floods of December 21 through 23, 1955, and December 21 through 26, 1964. The synthetic regulation of these floods is shown on plate 8-5. Important elements of the examples shown for both floods include the following:

(1) Reduction to minimum project outflow as soon as the first of three downstream control points (Dodge Bridge, Raygold, and Grants Pass) indicate its flood regulation goal would be exceeded. Note that the minimum outflow shown on plate 8-5 is 200 ft^3/s which is 300 ft^3/s lower than the current minimum project outflow of 500 ft^3/s.

(2) Storage of floodwaters by the project during the 1955 flood until downstream control points have receded to below flood regulation goals, after which the normal evacuation rate of 10,000 ft^3/s was released.

(3) Storage of floodwaters by the project during the 1964 flood until the special flood regulation schedule indicated that the flood could not be completely regulated and increased releases were necessary. These releases were performed and resulted in an effective use of the remaining storage in the lake.

Future flood regulation should use these floods as examples. Actual regulation will depend on the flood characteristics, available storage, and streamflow forecasts.

d. Flood Frequencies as Regulated by Lost Creek Lake. Lost Creek Lake has a significant effect on reducing downstream flooding. The greatest effect occurs immediately below the project. Flood frequency curves were shown on plates 4-13 through 4-16 for the Lost Creek Dam site and downstream control points on the Rogue River. Table 4-8 previously compares regulated and unregulated discharges at Lost Creek Lake for selected recurrence intervals. These resources can be used to determine the effect that Lost Creek lake storage has on downstream flooding.

8-3 IRRIGATION

By releasing stored water into the Rogue River during the summer, the project provides reliable flows for irrigation use. The USBR estimates that reservoir storage in Lost Creek Lake and the proposed Elk Creek Lake will provide irrigation water to 18,890 acres of dry land and supplemental flow for 6,380 acres of irrigated land in the Rogue Valley. These lands, situated near the river or near canals that divert flow from the river, are privately developed. As of 2012, 8,805 acre-feet of stored water had been contracted for irrigation use, about 25 percent of the 35,000 acre-feet of available storage.

8-4 FISHERY ENHANCEMENT

Economic benefits of the project pertaining to fisheries consist primarily of benefits to downstream fisheries resources. Fishery agencies state that an increase in downstream flows improves habitat for anadromous and resident fish if adequate temperature control is achieved. This improvement occurs because the multilevel withdrawal structure allows water to be withdrawn from four levels in the lake and mixed to regulate the temperature of released water for miles downstream of the dam. Flows for temperature enhancement are regulated to release water from the project at the target release temperatures shown in table 7-6 or whenever practicable. Although flows gradually warm following downstream release, the water in the river reach between the lake and Grants Pass is cool enough to provide an enhanced aquatic habitat in the river. Available storage is limited, however, and optimum water temperatures do not occur in all years.

Lost Creek Lake provides both positive and negative impacts on the $31 million (1983 figure) Rogue River fishery. The project has increased spring chinook salmon survival by increasing water flows in the summer and decreasing water temperature in the downstream river. Another benefit is that the growth rate of juvenile chinook salmon has increased because forage material from the lake is being discharged downstream into the river system. Also, the reduction of peak flood flows following storm events increases juvenile fish survival by preventing the nests in the spawning beds from being scoured out by high flows.

Possible impacts include the early emergence of young fish out of their spawning beds caused by the faster embryonic development with warmer water temperatures. The temperature of water released from Lost Creek Lake during the fall is warmer than what naturally existed in that reach of the Rogue River. The warmer water stimulates faster fish egg development that, in turn, causes early emergence because their food source is not yet available. An additional possible negative impact is the isolation of spawning beds from the river flow after the reservoir has been evacuated to its minimum flood control pool in the fall. This impact is minimized by maintaining a minimum flow in the conservation filling season of 700 ft^3/s except during periods of flooding when minimum flow is reduced to 500 ft^3/s.

In summary, benefits for fishery enhancement are based on an increased downstream fishery due to reductions in stream temperature, increased streamflow during the summer and fall, increased recreational opportunities, and a newly provided reservoir fishery.

8-5 WATER SUPPLY

Lost Creek and Elk Creek Lakes were designed and are operated to provide 20,000 acre-feet of water for municipal and domestic use. Stored water will be released for downstream withdrawal by contracted water users. The amount of water released for this purpose is determined annually by CENWP-EC-HR. As of 2012 approximately 3,850 acre feet of water for domestic and/or municipal use have been contracted from storage. The effect of the Lost Creek Lake water control plan on water supply is to ensure that 20,000 acre-feet (the combined Lost Creek and Elk Lake allocation) of municipal and domestic water will remain available for future use.

8-6 WATER QUALITY CONTROL

Lost Creek Lake enhances water quality by both reducing summer streamflow temperature and increasing summer streamflow in the Rogue River. Benefits attributed to the improved water quality include increased recreational use of the Rogue River and adjacent public lands below the project.

8-7 RECREATION

Use of the recreational resources of the project and its facilities, especially by local residents, is high. Based on Lost Creek Lake scenic attractions, accessibility, sport fishery, climate, and pool operation, an annual recreational use of in excess of 1,000,000 visitor days is expected by the year 2000. Current use is approximately 500,000 visitor days (1988).

8-8 WILDLIFE ENHANCEMENT

Wildlife enhancement benefits accrue from wildlife habitat areas at the project and from provision of water for wildlife habitat areas downstream of the project. The effect of the water control plan on wildlife enhancement is negligible.

8-9 HYDROELECTRIC POWER

A power installation is provided at Lost Creek Lake. The plant is operated without a reregulating reservoir, and with a daily load factor of approximately 100 percent. No exclusive storage is reserved for power. During most of the year generation is contingent on releases made for other purposes. Operating within these constraints the plant is currently producing 303,000 megawatt hours of generation worth an estimated $6,000,000 (1988 dollars).

8-10 NAVIGATION

Use of the Rogue River for commercial navigation does not exist. Recreational navigation, however, is a thriving activity. Low flows during the summer and early fall months, which were often depleted by pumping for irrigation, were usually inadequate for navigation by any craft larger than a drift boat. At present, release of stored water from Lost Creek Lake significantly increases the summer and fall low flows of the Rogue River, allowing a larger and greater variety of craft to use the river. The contribution of Lost Creek Lake to navigation is greatest during July and August, the period of highest minimum reservoir releases.

8-11 DROUGHT CONTINGENCY PLANS

In the Rogue River Basin water is used for irrigation, municipal and domestic water supply, fishing and fishery enhancement, lake and river recreation, power generation, and a host of other associated activities. During periods of below-average runoff the supply of water is reduced causing impacts to a wide variety of users. Storage of water at Lost Creek Lake helps to minimize these impacts by increasing summer and fall stream flow. By releasing stored water into the Rogue River during the conservation season, the project provides flows during times of drought. Even with the release of stored water, dry conditions may persist in downstream tributaries, resulting in low flows on the Rogue River and significant socioeconomic damages.

The goal of the U.S. Army Corps of Engineers water storage projects during droughts is to proactively respond so that drought-related damages can be minimized. Using the information discussed in chapter 4, chapter 6 and the Drought Contingency Plan, CENWP may declare a shortage. Coordination with other Federal and State agencies is initiated, and a modified release schedule is developed. In this manner water shortages in the Rogue River Basin are effectively moderated as irrigation, water supply, and fishery enhancement requirements for stored water receive an equal percent reduction of their full supply.

8-12 FLOOD EMERGENCY ACTION PLANS

Normally, the use of the water control plan will serve to protect human life and property; however, isolated incidents may occur whereby it is necessary to deviate from the plan. The Emergency Action Plans (no longer called Flood Emergency Action Plans) describe necessary actions to be taken under emergency conditions, unless such actions would create equal to worse conditions. Actions taken under emergency conditions utilize the following priority: protection of human life, protection of personal property, and execution of the water control plan.

Emergency Action Plans are developed and maintained by the Dam Safety Section, CENWP-EC-HC. In the event of conditions developing, which could lead to a potential or actual dam failure, refer to the Lost Creek Emergency Action Plan (EAP) and begin the emergency notification procedure.

8-13 FREQUENCIES

a. Inflow Probability. The summary hydrograph showing the inflow exceedence probability is shown on Plate 4-11. Plate 4-11 is a summary hydrograph for the Rogue River at Lost Creek Lake, period of record 1929 through 2011, which includes minimum daily discharges, maximum daily discharges, and exceedence probabilities.

b. Pool Elevation. Daily reservoir elevations for Lost Creek Lake are shown on Plates 8-6a through 8-6d. These plots do not include data prior to water year 1978 when the initial filling of the reservoir occurred followed by a drought year. Risk Rule Curves, developed for the period of record 1929-1997, are shown on Plates 8-7 through 8-11. These probability curves reflect the maximum pool level at the beginning of a storm that will not cause the reservoir to reach maximum pool.

c. Key Control Points. A cumulative frequency curve for Lost Creek Lake, based on maximum annual discharges is shown on Plate 4-13. Cumulative frequency curves for maximum annual discharges for key downstream control points are found on Plates 4-14 through 4-16.

8-14 OTHER STUDIES

CENWP provides floodplain management services to local officials and residents along the Rogue River. The technical services primarily involve interpretation of available floodplain data. The data consists of water surface profiles and flooded-area mapping for the Rogue River that were developed by the USGS and are utilized by the Federal Emergency Management Agency (FEMA) in rate map preparation. These floodplain data have been updated to reflect operation of Lost Creek Lake for flood control purposes.

Both Jackson and Josephine Counties are in the "regular phase" of the flood insurance program, as administered by FEMA. Residents along the Rogue River floodplain are currently eligible to purchase flood insurance at actuarial rates for their dwellings. The counties, however, must adopt and enforce floodplain regulations that regulate future development in the floodplain. Minimum standards for the floodplain regulations were established by FEMA.

8-15 USE CONFLICTS

The several interrelated project purposes, together with multilevel withdrawal capability, have made the task of water management a complex one. Irrigation advocates, recreationists, fishermen, mail boat operators, river rafters, and fishery interests are some of the groups with possible conflicting needs. When requests are made, CENWP-EC-HR must assess the alternatives and make a decision that will provide the most benefit to the general public consistent with project authorization. A discussion about conflicting needs follows.

a. Irrigation Versus Fishery Needs. A possible conflict exists between these needs if a "declaration of water shortage conditions" is necessary. This occurs when the total water available from conservation storage is less than that amount required to satisfy the total downstream demands such as irrigation and fisheries needs. Should this unlikely event occur, a shortage would be declared and water released for authorized purposes would be reduced by equal percentages.

b. Fishing Versus Fishery Needs. Successful fishing may require low streamflows so that fish will hold up in pools. However, optimum benefits for fisheries are provided by higher streamflows. Plates 7-6a through 7-6c previously showed the diverse salmonoid population found year-round throughout the downstream reaches of the Rogue River, many species of which are dependent upon minimum flow requirements. These minimum flow requirements are often higher than what would be ideal for fishing .

c. Fishing Versus Navigation Needs. Shallow draft navigation on the Lower Rogue River requires sustained minimum project releases from both Applegate and Lost Creek Lakes. While fishing interests may benefit from lower flows, reductions in lake releases from Applegate and Lost Creek Lakes usually have a negative effect on downstream navigation on the Rogue River.

d. Lake Recreation Versus Downstream Recreation/Fishery. Lake recreationalists who use Lost Creek Lake, marina, and campsites have an interest in maintaining as high a pool level as is possible from 1 May through the Labor Day weekend. Downstream interests, however, require water to be released from the lake such that drawdown usually begins by early July. These releases serve several needs. They enhance the downstream fishery, provide additional water for the drift boats and mail boats, and evacuate enough water from the lake so that by the time spring chinook begin to spawn, usually in September, excess water will not have to be released. This allows spawning to take place on gravels which will not be subject to dewatering later in the year. As a result, lake levels are usually lowered to El. 1,830 or less by Labor Day weekend.

e. Outflow Fluctuations. During certain periods of the year the fishery is especially sensitive to flow change and may be adversely affected by operations which are within the normal operating criteria. For this reason flow changes are usually made at one-half of the allowable rate of change. A second concern is dewatering of fish spawning areas. This dewatering may occur if sustained high releases are made during a critical period for fish spawning, followed by lower flow releases. This situation is to be avoided if at all possible.

f. Regulation for Flood Control. During periods of high runoff, Lost Creek Lake stores excess water which is subsequently released after downstream flows have receded to within their banks. Releasing this water, however, may have a negative effect on downstream river users who previously were only inconvenienced a brief time during flooding, but are now affected by prolonged releases for as long as 2 weeks. River fisherman, drift boaters, guides, and the fishery agencies have expressed concern over this situation.

g. Power Generation Versus Fishery. Downstream flow fluctuations may occur on the Rogue River as a result of scheduling releases in the interest of power generation. Reservoir releases may change from 1,200 to 2,400 ft^3/s to allow generation of full load on one unit to full load on two units. Although these fluctuations are within the authorized maximum rates of change, they may result in substantial and negative impacts to the fishery downstream. For this reason releases should be scheduled with respect to the primary project functions, which are flood control, irrigation, water supply, and fishery enhancement. Releases for power operation will only utilize flows released specifically for the previous purposes. This is in accordance with the Rogue River Projects Authorizing Document, House Document 566, paragraph 56(a).

SECTION 9

WATER CONTROL MANAGEMENT

9-1 RESPONSIBILITIES AND ORGANIZATION

Under authority contained in various legislative acts, the Office of the Chief of Engineers is responsible for establishing overall policies for the regulation of all Corps of Engineers reservoirs. Oversight of these policies is delegated to CENWD. In the Portland District, reservoir regulation plans and schedules are formulated in Engineering and Construction Division in accordance with policies set forth in ER 1110-2-2400, dated 8 October 1972, and instructions contained in EM 1110-2-3600, dated 30 November 1987. As outlined in ER 1110-2-240, these plans and schedules are then submitted to CENWD for approval. Any future changes in reservoir regulation plans that affect the authorized functions or constitute a major change in the approved regulation plan must be submitted to CENWD for approval.

a. Corps of Engineers. The functional organizations for the regulation of Lost Creek Lake are shown on Plate 9-1. The plate shows responsible project offices and agencies through which instructions are transmitted both for administration and water management of the project. Coordination and liaison are maintained with the NWS and the USGS for the purpose of obtaining basic meteorological and hydrological data essential to the regulation of Lost Creek Lake. Responsibilities and organization of Corps of Engineers offices are described in the following paragraphs.

(1) Northwestern Division. Planning and Engineering Division. CENWD-PDW-R (RCC) is responsible for overseeing the water management activities of CENWP-EC-HR. Both offices are familiar with Portland District projects and their operations. During major flood events the combined resources of CENWP-EC-HR and the RCC shall be utilized to the fullest extent possible. In the event that communication becomes disrupted between the project office and either CENWP-EC-HR or the RCC, or qualified personnel are not available during a flood or water management emergency, the office with communications and personnel shall temporarily assume reservoir regulation responsibilities. When communication and/or staffing have been restored to CENWP-EC-HR, the reservoir regulation responsibility shall be assumed by that office. Through this arrangement the ability of the Corps of Engineers to react to critical water management situations with qualified staff is greatly enhanced.

(2) Portland District. Engineering and Construction Division. Regulation of Lost Creek Lake and other multipurpose reservoirs in the Rogue River Basin is the responsibility of CENWP with the primary responsibility delegated to CENWP-EC-HR. Within CENWP-EC-HR are personnel directly assigned to reservoir regulation. The operations project manager at Lost Creek Lake is periodically furnished with the names of CENWP personnel authorized to issue reservoir regulation instructions for the project. This list is revised as changes in personnel assigned to reservoir regulation are made. All significant reservoir regulation instructions issued by CENWP-EC-HR are confirmed by message on the CBT. During the flood season CENWP-EC-HR personnel will be on duty (as needed) during weekends and holidays to instruct Lost Creek Lake as necessary.

Duties of CENWP-EC personnel that are assigned to water management activities related to regulation of Rogue River flood control projects are as follows:

(a) Issue flood control and conservation release instructions to the project, schedule and coordinate power generation, and provide instructions during water management emergencies.

(b) Prepare, distribute, and revise water control manuals as necessary which incorporate professional water management principles and the concept of system regulation.

(c) Maintain a continuing program of study to improve lake regulation techniques for more effective operation for authorized project purposes.

(d) Monitor the operation of the Rogue River Projects. Maintain records and display charts of all hydrologic data pertinent to the operation of those projects. Issue daily bulletins of pertinent operational data.

(e) Maintain a water quality monitoring program consistent with overall project needs.

(f) Provide applicable portions of special flood reports, survey reports, definite project reports, and design memorandums.

(g) Maintain the hydrometeorlogical stations used for the regulation of the Rogue River Projects.

(h) Describe major reservoir regulation changes to the public through local press and Corps bulletins.

(i) Prepare an annual summary of water management actions taken at the project. A report titled "Reservoir Regulation of Lost Creek Lake," was prepared annually by CENWP-EC-HR since 1985. This report provided a concise summary of the water management actions taken during the calendar year. The report was completed as soon as possible following the year of interest and is distributed to all concerned offices. The first page of the report, "Reservoir Regulation of Lost Creek - 1986" is included in this manual as Exhibit C. In recent years, rather than prepare the report shown in Exhibit C, the annual summary of operations has been presented to project staff and members the interagency group at an After Action Review meeting held in November.

(3) Operations Division. Physical operation and maintenance of multipurpose projects in the Portland District are the responsibility of the Operations Division under the direct supervision of the operations project manager. The manager, in turn, is responsible to the Chief, Operations Division. The operations project manager is also responsible for carrying out reservoir regulation instructions received from CENWP-EC-HR through powerhouse operators. The operators are the direct recipients of instructions from CENWP-EC-HR. Corps personnel will utilize the Corps Water Management Website and Teacup Diagram to provide interested citizens up-to-date discharge and lake elevation information.

b. Other Federal Agencies.

(1) National Weather Service. Arrangements have been made for the Corps of Engineers to cooperate with the River Forecast Center of the NWS in Portland, Oregon, in forecasting floods in the Rogue River Basin. The NWS has the responsibility of furnishing the public with flood warning services whereas the Corps of Engineers is involved in flood regulation. Therefore, there is a clear need for an interchange of information so that both agencies can carry out their responsibilities effectively. This has resulted in a joint venture between the agencies with a maximum of cooperation. Stage forecasts are provided to the public by the NWS (see paragraph 5-5).

(2) Bonneville Power Administration. BPA is responsible for marketing power generated at Lost Creek Dam through their regional power system. Use of PP&L transmission lines has been coordinated between involved parties.

(3) U.S. Geological Survey. Coordination and liaison are maintained with the USGS at all times for the purpose of obtaining basic hydrologic data essential to the regulation of Lost Creek Lake. The USGS is responsible for the maintenance and operation of the majority of the stations used in the regulation of Lost Creek Lake.

(4) U.S. Bureau of Reclamation. The USBR is responsible for the sale of stored water from Federal projects for irrigation, and receives all payments for the United States Government. The USBR has filed with the OWRD director for the multipurpose conservation storage available at Lost Creek Lake. The USBR keeps CENWP informed of irrigation needs so that both day-to-day and long-range reservoir releases reflect irrigator's requirements. The Corps of Engineers will release stored water for irrigation at the request of the USBR only if a valid contract is in force. This is also coordinated with the OWRD.

(5) Natural Resources Conservation Service. The NRCS is responsible for the collection and distribution of snow survey information. During the January through May period the NRCS issues monthly water supply forecasts. These forecasts as well as other information are used by CENWP-EC-HR to assist in water management.

(6) U.S. Fish and Wildlife Service. The USFWS is one of two agencies responsible for representing the Federal interests in fish and wildlife management. The USFWS is represented at all key reservoir regulation meetings which affect fisheries or wildlife.

(7) NOAA Fisheries. NOAA Fisheries is jointly responsible with the USFWS for Federal fish management interests and is represented at all key reservoir regulation meetings which affect fisheries.

c. State and County Agencies.

(1) Oregon Water Resources Department. The administration of the water laws of the state of Oregon is vested in the Water Resources Director of the OWRD, who issues permits for the use of water and is generally recognized as an authority on all matters concerning judicial decisions and appropriation of water rights. The OWRD, through their respective county watermasters, take actions as necessary to ensure that stored water

releases are consistent with existing irrigation, fisheries, and municipal water contracts. The Corps of Engineers considers the OWRD to represent the state of Oregon and through that role provides the state of Oregon water policy and management. Other state agencies are, therefore, represented through the OWRD. All requests for changes from the normal reservoir regulation schedule from any Oregon State water resource-related agency must come through the OWRD.

(2) Oregon Department of Fish and Wildlife. The ODFW is the state of Oregon fish and wildlife management agency. The ODFW provides comments pertaining to water management through the OWRD. Liaison is maintained with the ODFW concerning fisheries concerns and the operation of the Cole M. Rivers Fish Hatchery.

(3) Jackson and Josephine Counties. The two primary counties in the middle and upper Rogue River Basin are Jackson and Josephine Counties. The primary responsibility of these counties is to staff and partially fund the OWRD Watermasters Offices.

d. Local Groups. Because of public interest in the Rogue River Basin, many chartered organizations and unofficial groups contact the Corps of Engineers for coordination regarding operation of Lost Creek Lake. These groups include the Rogue River Basin Flood Control and Water Resources Association, Medford Water Forum, Rogue River Guides, Rogue River Mail Boats, and Rogue River Fly Fishers. Each individual or group is encouraged to contact the Corps to express their opinions pertaining to water management.

9-2 INTERAGENCY COORDINATION

The Corps of Engineers coordinates with other Federal, State, local agencies, and local groups concerning the Lost Creek Lake water control plan, flood fighting, and special regulation events. CENWP-EC-HR has the primary responsibility for water management coordination. Principal agencies which CENWP-EC-HR coordinates with are identified in paragraph 9-1.

9-3 INTERAGENCY AGREEMENTS

The Corps of Engineers has three major existing interagency agreements concerning Lost Creek Lake. On June 12, 1978, the Oregon State Department of Transportation, Highway Department, leased Stewart State Park for public park and recreation purposes for 25 years (copy on file). The Corps of Engineers also entered into a contract on July 14, 1978, with the Oregon State Board of Forestry to provide fire protection for project lands during the fire season (copy on file). This agreement was necessary because the Corps of Engineers retained ownership and management of project acquisitioned lands. A contract was agreed upon by the Corps of Engineers and the ODFW on August 23, 1972, that describes the agreed-upon format for the operation and maintenance of Cole M. Rivers Fish Hatchery located at Lost Creek Lake (copy on file). Numerous other agreements related to Lost Creek Lake exist, but are beyond the scope of this manual.

9-4 COMMISSIONS, RIVER AUTHORITIES, COMPACTS, AND COMMITTEES

Only one official committee exists which is responsible in an advisory capacity for water management of Lost Creek Lake. This committee is the Rogue River Water Management Group (RRWMG) which consists of the Corps, OWRD, ODFW, ODEQ, NMFS, USFWS, USBR, and USFS. The RRWMG meets during the spring and summer to cooperatively plan water release schedules for Lost Creek and Applegate Lakes. During periods of unusual water conditions the RRWMG may advise the Corps on preferred water management strategies. Although the RRWMG is limited to an advisory role, their recommendations and exchange of information with the Corps significantly add to cooperative water management in the Rogue River Basin.

9-5 REPORTS

Several reports pertaining to Lost Creek Lake are prepared by project personnel. These reports keep the many interested parties informed on project activities and provide a permanent record of such activities. In general, these reports are made on standard forms and follow a prescribed distribution. Some are for project use only; others are prescribed by regulations and require greater distribution. This manual is primarily concerned with reports pertaining to reservoir regulation that have an off-the-project distribution. The standard forms pertinent to this manual are listed in Table 9-1.

The report "Reservoir Regulation of Lost Creek Lake” has been replaced by the annual After Action Review. It is prepared by CENWP-EC-HR at the end of each calendar year and is described in paragraph 9-1.

An annual water quality report is also prepared by CENWP-EC-HR for Portland District projects. It is distributed to interested Corps offices. Other organizations that receive the annual water quality report include the USFWS, NMFS, EPA, ODFW, and the Oregon Department of Environmental Quality (DEQ).

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA FOR LOST CREEK PROJECT

GENERAL INFORMATION

Other names for project	Not applicable.
Location	1) Basin: Rogue River. 2) Stream: Rogue River. 3) River Mile: 158.4 4) County and State: Jackson, Oregon. 5) Latitude 42°40′ Longitude 122°46′. 6) SE 1/4, Section 26, T.33.S, R.1.E. Willamette Mer.
Type of project	Dam and lake.
Objectives of regulation	1) Lost Creek Lake is an authorized multiple-purpose project. Primary purposes of the project are flood control, irrigation, fish enhancement, and water supply. 2) Secondary purposes include wildlife enhancement, water quality control, power generation, and recreation.
Project owner	U.S. Army Corps of Engineers.
Operating agency	The project is physically operated by the U.S. Army Corps of Engineers, Portland District. In all cases, the project is manned 24 hours a day, 7 days per week.
Regulating agency	The Corps of Engineers.
Water rights	1) The water laws of Oregon provide that all water within the State, from all sources of supply, belongs to the public. Hence the USBR has filed with the State Engineer for the multiple-purpose conservation storage in Lost Creek Lake. 2) Prior water rights granted in accordance with Oregon law are honored to the extent of natural inflow into Lost Creek Lake, and are based on prior appropriation doctrine or "first in time, first in right."
Project cost	$135,900,000 (1977 dollars).

GENERAL INFORMATION (Continued)

Closure date	18 February 1977.
Special project feature	The multilevel withdrawal structure is a specially built tower with the capability to withdraw water from any of four different levels to regulate discharges for water temperatures and other water quality considerations. A fifth and lowest level of withdrawal is available through use of a low level turbidity conduit.

LOST CREEK LAKE

Real estate taking line for fee title	300 feet horizontally from maximum conservation pool El. 1,872. A line approximately 100 feet horizontally from the maximum pool was used in the upper forks of the lake where it lies in a deep gorge.
Real estate taking line for easement	No easements.
Range of clearing	Upper elevation 1,875. Lower elevation 1,550.
Reservoir length at top conservation pool	8.5 miles.
Shoreline length at top conservation pool	28 miles.
Safety aspects, possibly requiring warning	Safety precautions preclude sudden large increases in the release from Lost Creek Project, especially during summer recreational season. During and following floods, increases in the controlled release should not exceed 1,200 ft^3/s in any 1-hour period. The increase can be made in one or more adjustments, and it is cautioned that the maximum rate of increase should be used only when the situation is most critical. Rate of increases and decreases for incremental flows for both the flood season and the conservation season are tabulated as follows:

SUPPLEMENTARY PERTINENT DATA

LOST CREEK LAKE (Continued)

RATE OF CHANGE IN LOST CREEK LAKE RELEASES

Discharge Range (ft^3/s)	Rate of Change per Hour High Flow Periods* (ft^3/s)	Low Flow Periods* (ft^3/s)
500 - 1,000	300	200
1,000 - 3,000	600	300
3,000 -10,000	1,200	600

[3]Regulation for "High Flow Floods" is considered to be in the interest of flood control, and regulation for "Low Flow Periods" is considered to be in the interest of all other uses. Whenever possible it is preferable to make changes at one-half of these rates unless project functions are jeopardized, especially during critical fishery periods.

The rate of change reflects a stage differential below the dam of 0.5 foot per hour during high flow periods and 0.3 foot per hour during low flow periods.

Emergency drawdown

1) Emergency drawdown or emergency dewatering of the project is a dam safety issue and is discussed in the Flood Emergency Plans for Lost Creek Lake, Section 3. The release limitations are described in paragraph 7.4.

2) Two hydraulic slide gates (regulating outlets) 6.5 by 12.5 feet are used to draw down Lost Creek during an emergency. The outlet tunnel invert elevation is 1,640 feet.

3) Minimum time required to empty all storage at the project is 14 days, depending on inflow and without use of the spillway.

4) The regulating outlets will evacuate all active and inactive storage at the project and, hence, pumping or siphoning are not required.

SUPPLEMENTARY PERTINENT DATA

LOST CREEK LAKE (Continued)

MINIMUM FLOW REQUIREMENTS

Period	Minimum Releases - Ft^3/s
1 Feb - 30 Apr	700
1 May - 15 May	1,000
16 May - 31 May	1,300
1 Jun - 10 Jun	1,500
11 Jun - 30 Jun	1,800
1 Jul - 20 Aug	2,000
21 Aug - 7 Sep	1,500
8 Sep - 31 Jan	1,000

A minimum release of 500 ft^3/s will be used during flood control operations.

PRINCIPAL ELEVATIONS, PROJECT USE, INCREMENTAL AND CUMULATIVE STORAGE, AND WATER SURFACE AREA

FEATURES	ELEVATION (Feet, NGVD)	PROJECT USE	INCREMENTAL STORAGE (Acre-Feet)	CUMULATIVE STORAGE (Acre-Feet)	WATER SURFACE AREA (Acres)
Top of Dam	1,882			500,000	3,580
Top of Spillway Gates (Closed)	1,874	Wind - Wave Freeboard	10,000	475,000	3,450
Maximum and Full Pool	1,872	Seasonal Conservation Storage	180,000	465,000	3,430
Minimum Flood Control Pool (Also Top of Carryover Conservation Pool)	1,812	Carryover Conservation Storage	135,000	285,000	2,600
Minimum Conservation Pool (Also Top of Inactive Pool)	1,751	In-lake Use	129,000	150,000	1,800
Dead Storage (Top)	1,640		21,000	21,000	N/A
Low Point in Lake	1,550	Dead Storage		0	0

SUPPLEMENTARY PERTINENT DATA

HYDROLOGY

Drainage area 674 square miles.

Design Flood Data

Item	Standard Project Flood	Probable Maximum Flood*
1. Maximum water surface elevation, NGVD	1,872 feet	1,872 feet
2. Peak inflow	64,500 ft^3/s	169,000 ft^3/s
3. Total storm runoff	480,000 acre-feet	817,700 acre-feet
4. Flood volume stored	180,000 acre-feet	180,000 acre-feet
5. Maximum outflow	45,900 ft^3/s	169,000 ft^3/s
6. Duration of flood	6 days	6 days
7. Seasonal distinction	Winter storm conditions	Winter storm conditions
8. Distribution of precipitation/storm type	Rainfall - 75 percent Snowmelt - 25 percent	Rainfall - 82 percent Snowmelt - 18 percent

Climate	The Rogue River Basin is characterized by mild, wet winters and hot, dry summers.
One inch runoff equal	35,950 acre-feet.
Storm types	Orographic and frontal activities - Pacific Ocean origin.
Flood season	November through March.
Low flow season	July and August.
Hydrology Data	Period of Record, Water Years 1929-1990.
Minimum daily flow and date of occurrence	535 ft^3/s on 18 August 1977. Note: extremely cold conditions on the Rogue River in December of 1990 reduced inflow to less than 400 ft^3/s for a 24-hour period.
Minimum monthly flow and date	620 ft^3/s in August 1931.
Minimum annual flow and year	980 ft^3/s in 1931.
Average annual flow	1,920 ft^3/s.

*At Lost Creek Lake, the spillway design flood is equal to the probable maximum flood.

SUPPLEMENTARY PERTINENT DATA

HYDROLOGY (Continued)

Maximum annual flow and year	2,940 ft^3/s in 1956.
Maximum monthly flow and year	7,770 ft^3/s in December 1964.
Maximum daily flow and date	36,930 ft^3/s on 23 December 1964.
Maximum instantaneous flow and date	55,000 ft^3/s on 22 December 1964.
Maximum flood volume and date	350,000 acre-feet 8-day volume between 21 December 1964 and 28 December 1964.

Name and Location of Key Streamflow Stations

1) Rogue River below Prospect, OR (1913 to 1930, 1968 to Present) at RM 169.4.
2) South Fork Rogue River South of Prospect, OR (1966 to Present) at RM 2.4.
3) Lost Creek Lake near McLeod, OR (1977 to Present) at RM 157.2.
4) Rogue River at McLeod, OR (1973 to Present) at RM 155.6.
5) Big Butte Creek near McLeod, OR (1945 to 1957, 1967 to Present) at RM 0.64.
6) Rogue River near McLeod, OR (1965 to Present) at RM 154.0.
7) Rogue River at Dodge Bridge near Eagle Point, OR (1938 to Present) at RM 138.6.
8) Rogue River at Raygold Near Central Point, OR (1905 to Present) at RM 125.8.
9) Rogue River at Grants Pass, OR (1938 to Present) at RM 101.8.
10) Rogue River near Agness, OR (1960 to Present) at RM 29.7.

Type of hydrometeorological data recorded at dam site

Hardwired to the project are:

1) Readings for pool and tailwater elevations and lake temperature profiles.
2) The USGS gage height readings at Rogue River below Prospect, OR; Big Butte Creek near McLeod, OR; and Rogue River near McLeod, OR.
3) Manually read at the project are: air temperature and precipitation.

SUPPLEMENTARY PERTINENT DATA

HYDROLOGY (Continued)

Number of precipitation stations used in hydrologic forecasting	Prospect 25W, Crater Lake National Park Headquarters and Lost Creek Dam are the only climatological stations in or near the area tributary to Lost Creek Lake. These stations provide data to the Corps and NWS for forecasting purposes.
Number of snow courses	Eleven high-level snow courses are within or near the basin tributary to Lost Creek Lake. The normal date of maximum snowpack is 1 April.
Number of sediment ranges	A total of 22 sediment ranges have been established in the lake area. Two sediment ranges were established downstream of Lost Creek Lake.

EMBANKMENTS, DIKES, LEVEES, OR FLOOD BARRIERS

An erodible dike was constructed at the terminus of the spillway to prevent fish movement into the excavated stilling basin. This dike is designed to be washed away when the spillway is put into use.

SPILLWAY

Location	Spillway is on the left abutment of the dam.
Type	Concrete gravity, gated, ogee section.
Crest elevation	1,823 feet, NGVD.
Net overflow length	135 feet.
Number and size of gates	Three - 45 feet by 51 feet.
Type of gates	Tainter.
Top of gate elevation	1,874.0 feet, NGVD (in closed position).
Induced surcharge	None.
Design head	48.5 feet.
Maximum discharge capacity	158,000 ft^3/s.

SPILLWAY (Continued)

Bridge deck elevation	1,877 feet, NGVD.
Type energy dissipator	Unlined rock spillway stilling basin.
Time required to open/ close all gates	45 to 60 minutes during normal working hours, or 2 hours during non-duty hours (due to travel).
Type emergency closure and time required	Manual closure with hand crank, a 45- to 60- minute time frame during duty hours; 2 hours during non-duty hours (due to travel).

OUTLET FACILITIES

Location	Multilevel withdrawal tower is located on the right abutment to serve as upstream control for the regulating outlet, power intake, and water temperature control ports and turbidity conduit.
Purpose	Flood control, irrigation, and water quality control (i.e., low flow augmentation).
Type outlet	Multilevel withdrawal structure with wet well and dry well, 271 feet high, freestanding concrete tower. Regulating outlet is a lined tunnel.
Size of outlet	12 feet 6-inch-diameter, 943-foot-long concrete tunnel (1.5 percent slope).
Type of service gates	Hydraulic pressure slide.
Number and size of gates	Two regulating gates 6 feet 6 inches by 12 feet 6 inches. Two emergency gates 6 feet 6 inches by 12 feet 6 inches.
Entrance invert elevation	1,640 feet, NGVD.

OUTLET FACILITIES Continued

Outlet Channel: Size and Type	The outlet channel has four parts: 1) A 943-foot concrete tunnel, 12 feet 6-inch-diameter, on a 1.5 percent slope. 2) A 65-foot-transition from the tunnel to a 20-foot-wide rectangular open channel chute. 3) A 393-foot-long and 20-foot-wide rectangular open channel chute to the flip bucket (slope varies). 4) A 30-degree 50-foot-radius flip bucket expanding from 20 feet to 36 feet wide at the lip.
Minimum time required to open/close service gates	1) Regulating outlet gates: 15 minutes. 2) Water temperature control ports: 1 minute.
Time emergency closure as time required	1) Same as above. 2) No emergency closure gates for water temperature.
Type energy dissipator	Flip bucket.
Water Temperature Control Ports - Type	Hoisted full open - full closed multilevel gates.
Port invert elevations	1,640, 1,730, 1,790, and 1,845 feet, NGVD; low level outlet is at 1,595 feet, NGVD.
Intake ports numbers and size:	Three 8 by 15 feet at each level.
Design discharge for Minimum Flood Control (1,812 feet, NGVD)	9,860 ft^3/s.
Full Pool (1,872 feet, NGVD)	11,460 ft^3/s.

SUPPLEMENTARY PERTINENT DATA

HYDROELECTRIC POWER FACILITIES

Location	The penstock and powerhouse are located in the right dam abutment.
Type	Base load.
Installed capacity	49,000 kW.
Number, type, and capacity of units	Two Francis type turbines rated at 24,500 kW each.
Power on-line date	6 July 1977.
Provision for future	None.
Load factor	100 percent.
Penstock	One 15-foot-diameter conduit branching into two 10-foot 6-inch-diameter conduits.
Turbine discharge (two units)	2,760 ft^3/s at critical head for generator overload; 2,640 ft^3/s at critical head (251 feet) for 100 percent generator rating.
Design head	275 feet (net) (turbine design).
Maximum gross head for power	321 feet.
Average net head	279 feet (gross).
Minimum flow required for generation	700 ft^3/s.
Drawdown	None.
Minimum head	197 feet (gross), 193 feet (net).
Critical drawdown	DNA.
Minimum peaking capacity	DNA.
Dependable capacity	27,600 kW.
Average annual energy	303,096,000 kW-hr.

SUPPLEMENTARY PERTINENT DATA

HYDROELECTRIC POWER FACILITIES (Continued)

Annual firm energy (40 percent load factor)		22,100 kW.
Specific hydroelectric power storage or pondage		None.
Commingled, joint use, or seasonal storage		Generation from flows between 750 ft^3/s and 2,400 ft^3/s.
Critical tailwater		Minimum 1,548.4 feet at 700 ft^3/s.
Type of emergency closure and time required	1)	Wicket gates: less than 1 minute.
	2)	Butterfly valve: 5 minutes.
Penstock unwatering		Bulkhead placement: 4 hours.

CONTROL POINTS/RIVER REACHES

Location	1)	Rogue River at Dodge Bridge near Eagle Point, OR, RM 138.6, DA = 1,215 mi^2.
	2)	Rogue River at Raygold near Central Point, OR, RM 125.8, DA = 2,053 mi^2.
	3)	Rogue River at Grants Pass, OR., RM 101.8, DA = 2,459 mi^2.
Purpose of control		The control points are used to regulate floods (for downstream river conditions), to meet irrigation water obligations and fisheries enhancement.
Channel/floodway description		The Rogue River Channel from the dam site downstream to its mouth is well defined. The bed stability of the stream is good, although high stream velocities can cause streambank erosion.
Uncontrolled drainage		Lost Creek Lake controls only 28 percent of the area drainage area above Grants Pass, Oregon. The channel capacity at Grants Pass (45,000 ft^3/s) will frequently be exceeded by runoff from the uncontrolled area.

SUPPLEMENTARY PERTINENT DATA

CONTROL POINTS/RIVER REACHES (Continued)

Target flow rates for flood control (not to exceed)	1) Rogue River at Dodge Bridge: 20,000 ft^3/s. 2) Rogue River at Raygold: 34,000 ft^3/s. 3) Rogue River at Grants Pass: 45,000 ft^3/s.
Time of water travel	The average travel time for the normal maximum release (10,000 ft^3/s) from Lost Creek Lake to Dodge Bridge, Raygold, and Grants Pass is approximately 4, 6, and 10 hours, respectively. For lower flows (i.e. 2,000 ft^3/s) the travel time is approximately doubled (8, 12, and 20 hours, respectively).

RELATED CONTROL STRUCTURES

Name	1) Savage Rapids Dam - a diversion structure on the Rogue River with fish passage facilities and power generation. 2) Gold Hill Dam - a diversion and generation facility on the Rogue River not presently operating. 3) Gold Ray Dam - a diversion structure on the Rogue River with fish passage facilities and power generation not presently operating. 4) Emigrant Dam and Lake - a USBR water storage project on Emigrant Creek with 20,000 acre-feet of seasonally available flood control storage space.
Location	1) Savage Rapids Dam is located just upstream of Grants Pass, Oregon, at RM 107.7 on the Rogue River. 2) Gold Hill Dam is located at Gold Hill, Oregon, at RM 120.5. 3) Gold Ray Dam is located downstream of the confluence of Bear Creek and the Rogue River at RM 125.5.

RELATED CONTROL STRUCTURES (Continued)

4) Emigrant Dam is located 20 miles southeast of Medford, Oregon, 32 miles above the mouth of Bear Creek.

Purpose

1) The purpose of Savage Rapids Dam is to store and divert water into the Grants Pass irrigation canals and generate power to operate transporting devices on the canals.

2) Gold Ray and Gold Hill Dams are not operating at present so their purpose is not defined.

3) Emigrant Dam and Lake is a water storage project which provides benefits for flood control, irrigation, water supply, recreation, and fish and wildlife.

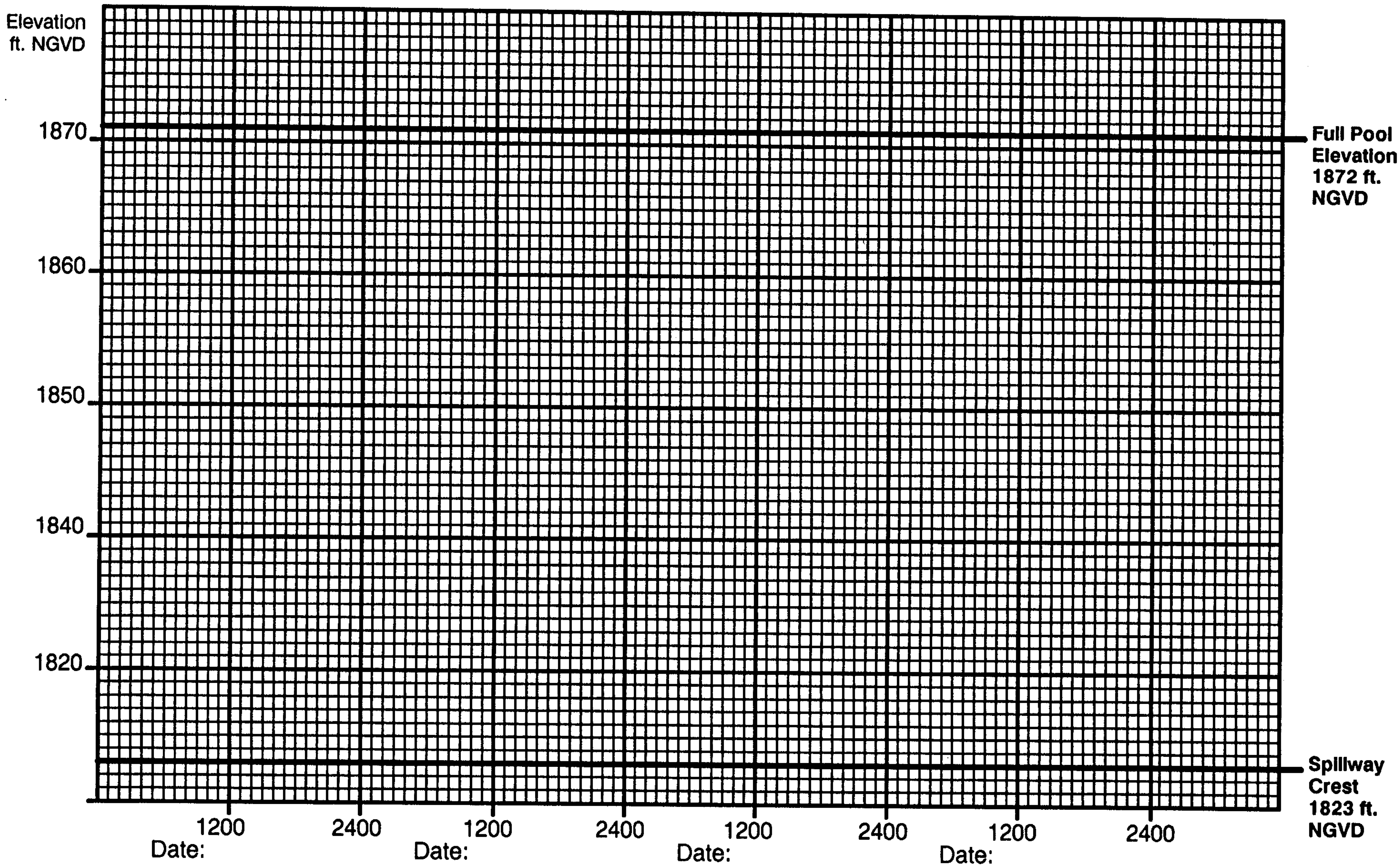
Owner/Operator

1) Savage Rapids Dam is owned and operated by the Grants Pass Irrigation District.

2) Gold Hill Dam is owned by the City of Gold Hill but is not being operated at present.

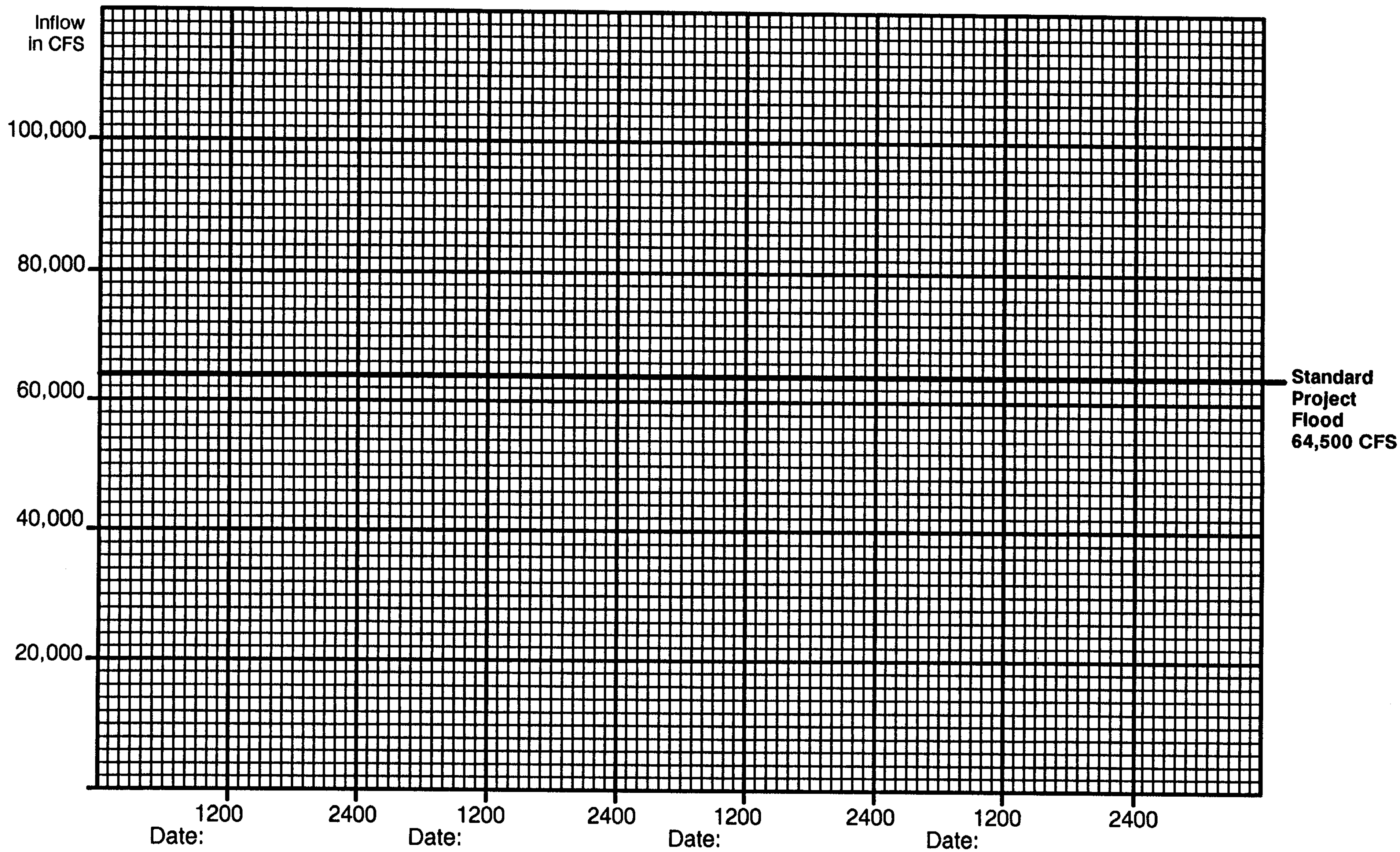
3) Gold Ray Dam is owned by Jackson County, but is not being operated at present.

4) Emigrant Dam is owned by the USBR and is operated by the Talent Irrigation District.



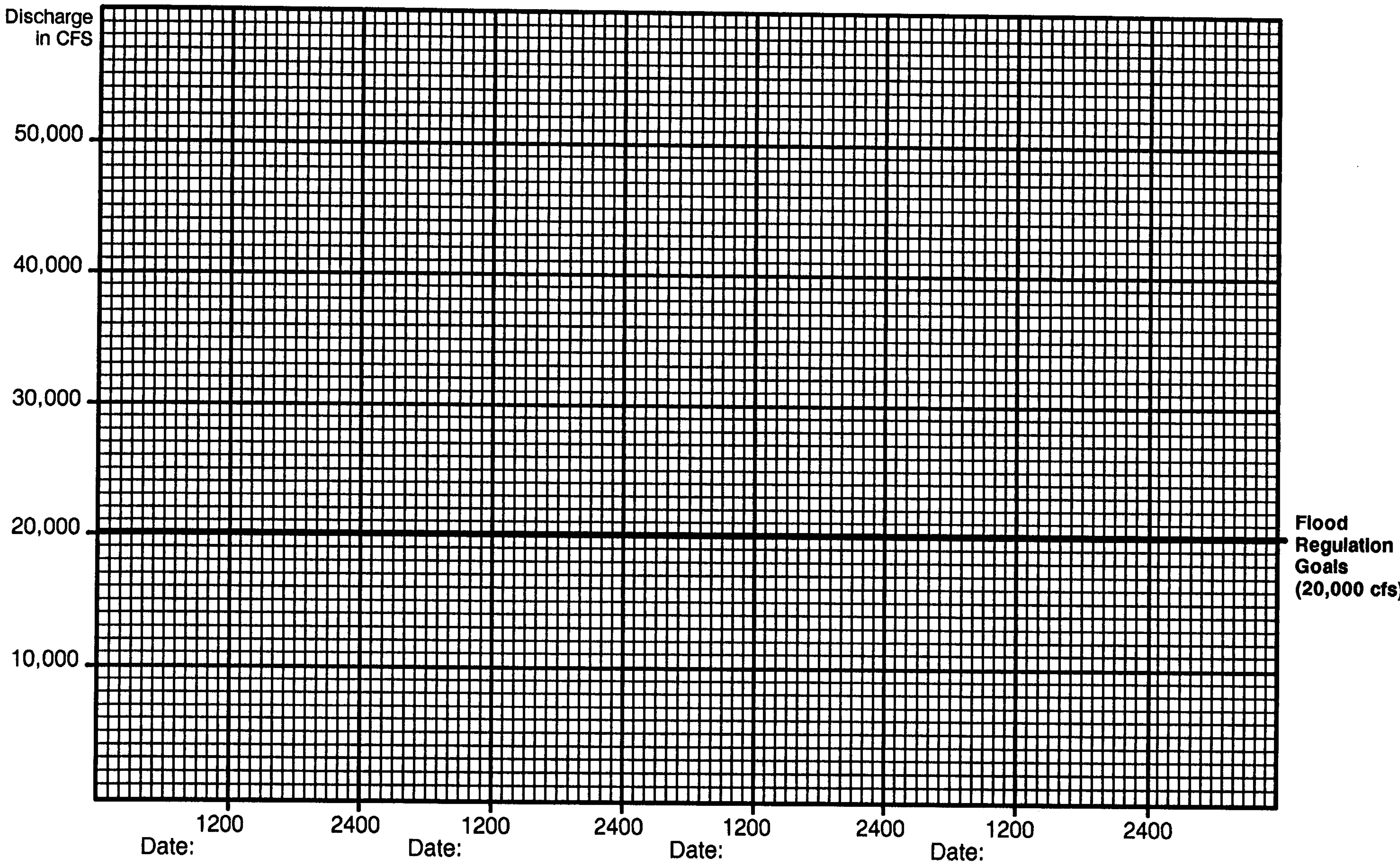
Lost Creek Lake Elevation Hydrograph
Lost Creek Lake Water Control Manual

Exhibit B1



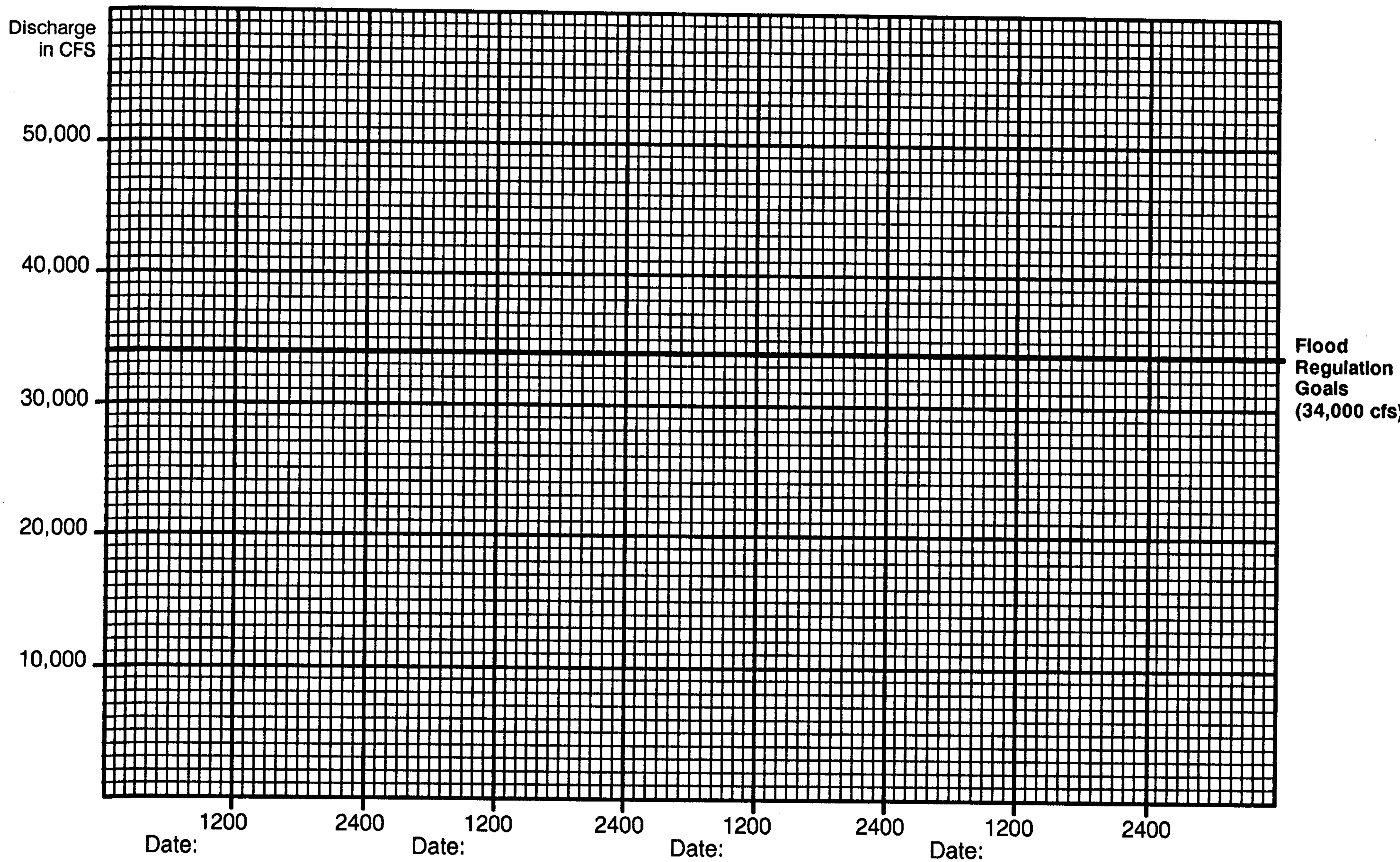
Lost Creek Lake Inflow Hydrograph
Lost Creek Lake Water Control Manual

Exhibit B2



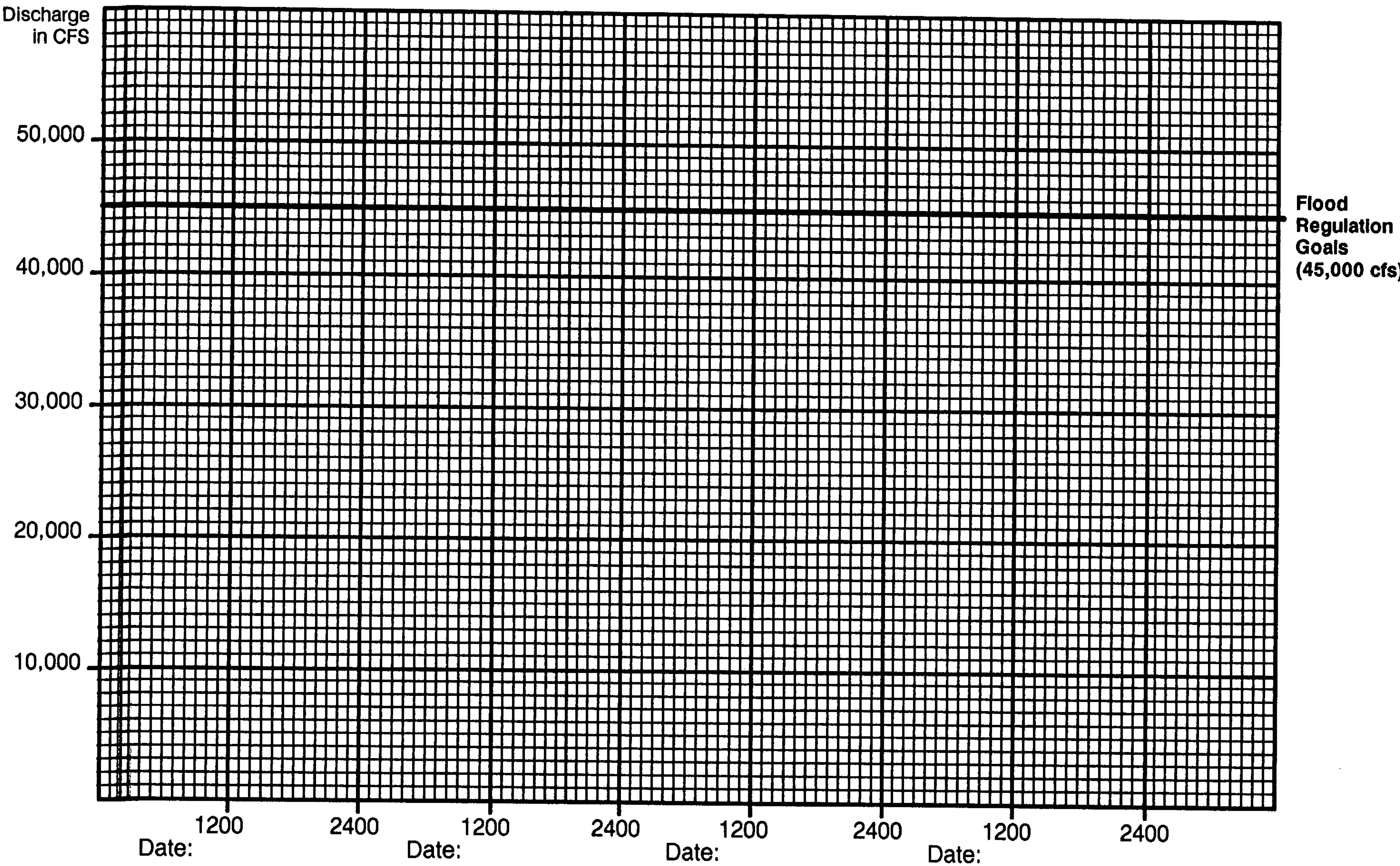
Flood Regulation Goal of Rouge River at Dodge Bridge, Oregon

Exhibit B3



Flood Regulation Goal of Rouge River at Raygold, Oregon

Exhibit B4



Flood Regulation Goal of Rouge River at Grants Pass, Oregon

Exhibit B5

Exhibit C

REPORT ON RESERVOIR REGULATION OF LOST CREEK LAKE - 1986

DATE: 12 JAN 87

The following is a brief summary of reservoir regulation actions performed by the Portland District, Corps of Engineers at Lost Creek Lake during the 1986 calendar year. Specific water control actions and their purpose are stated in order of occurrence, and plots of reservoir elevation, inflow/outflow, and observed and requested release temperatures are included. Additional information on specific actions may be obtained by contacting the Reservoir Regulation and Water Quality Section, Hydraulics and Hydrology Branch at 221-6468 or 221-6469.

01 Jan	Action: Project reduces outflow to minimum of 1000 cfs. Purpose: Filling season begins.
13 Jan	Action: Refill analysis for 1986 completed by HH-R. Purpose: The refill analysis is a procedure used annually to develop monthly flow estimates for integration into the Annual Operating Plan.
18-20 Feb	Action: Highest inflows to project occur; releases up to 9600 cfs. Purpose: Regulate flooding; regain flood control storage.
21 Feb	Action: HH-R holds Preliminary Rogue River Basin Water Regulation Meeting. Purpose: Plans for operation of Lost Creek Lake (and Applegate Lake) presented for early review by OWRD, ODFW, NMFS, USFWS.
18-19 Mar	Action: Project reduces outflow from 3000 cfs to 1200 cfs. Purpose: Regulating outlet inspection; high February releases caused some waterstop/seal leakage; flows were reduced incrementally as coordinated with ODFW.
26 Mar - 11 Apr	Action: Project outflow reduced to 1200 cfs. Purpose: Gravel bar removal immediately below project required lower flows; coordinated with ODFW.
09 Apr	Action: Meeting with OWRD, ODFW, NMFS, USFWS re: Rogue River Annual Operating Plan. Purpose: Receive agency comments on Preliminary Plan; ODFW requests of 1200 cfs maximum October release.
15 Apr	Action: HH-R sends modified Annual Operating Plans to OWRD, ODFW, NMFS, USFWS. Purpose: Final approval by OWRD of modified Plan.
01 May	Action: Project fills to elevation 1871; begins passing inflow. Purpose: Lake is at maximum desired elevation, one-foot below full pool; retains 3500 acre-feet for freshet runoff protection.
01 May	Action: Public meeting in Grants Pass, OR. Purpose: Present to public Annual Operating Plans for Rogue River Projects.

20 May — Action: Request from ODFW to HH-R to evaluate three temperature schemes for 1986 conservation regulation at Lost Creek Lake.
Purpose: Provide technical support and analysis of proposed scheme; HH-R recommended scheme to evacuate warm water (55 degrees) during summer thereby conserving cool water supply for fall release.

30 Jun - 10 Sep — Action: Project drafts lake down to elevation 1820.
Purpose: Provide minimum flows; carry out Plan of Operation; prepare lake for stable releases of 1200 cfs from 15 Sep - 1 Nov without significant encroachment into flood control.

12 Aug — Action: HH-R and ODFW coordinate modified temperature schedule.
Purpose: Provide smooth transition to optimum temperature releases during fall spawning period; temperature agreed to were $55^{\circ}F$ through 8 Sep; reduction to as-cold-as-possible by 15 Sep; hold as long as possible.

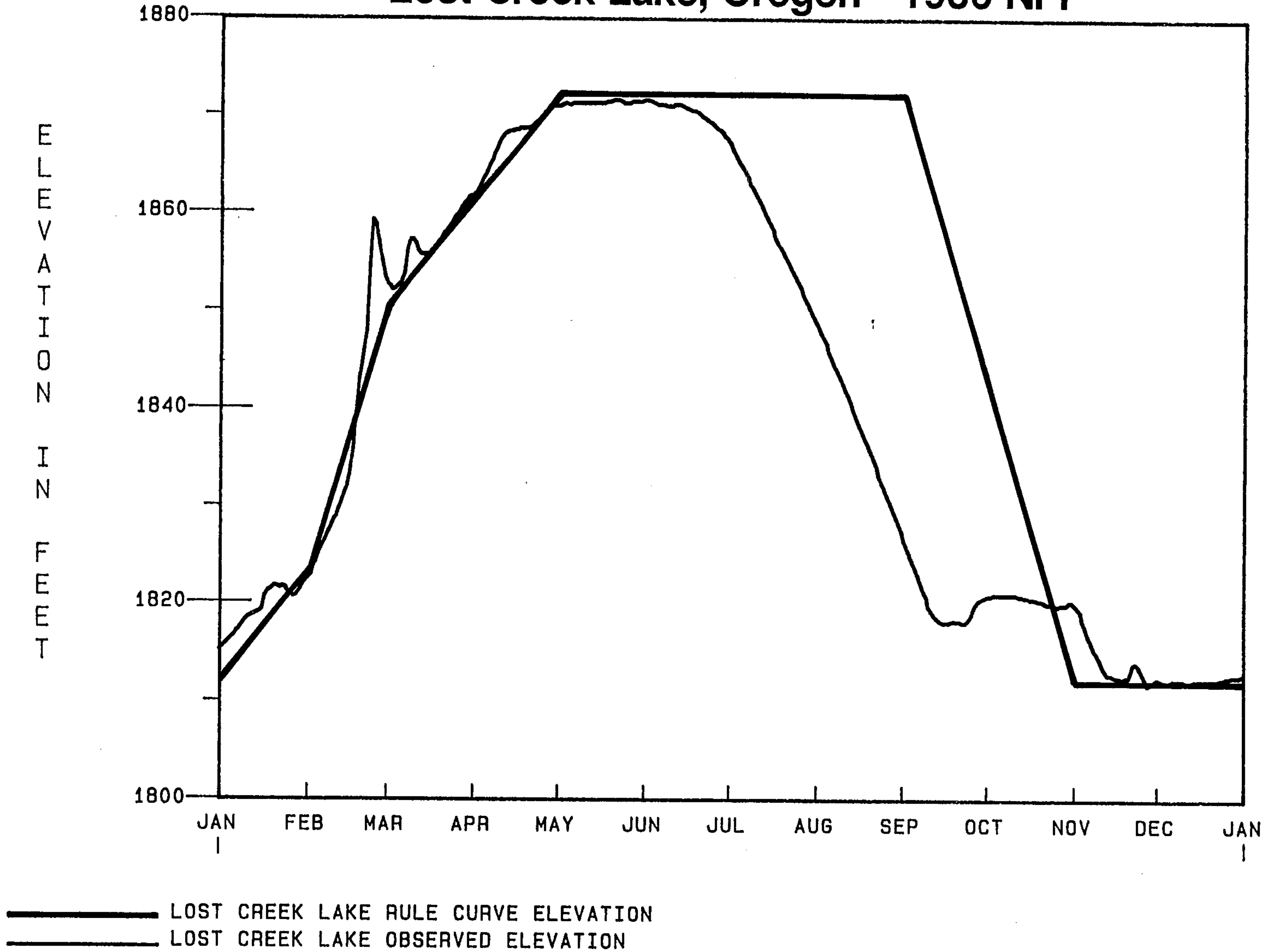
16 Sep - 01 Nov — Action: Project releases 1200 cfs; temperatures as-cold-as-. possible.
Purpose: Implementation of 1 May Annual Operating Plan.

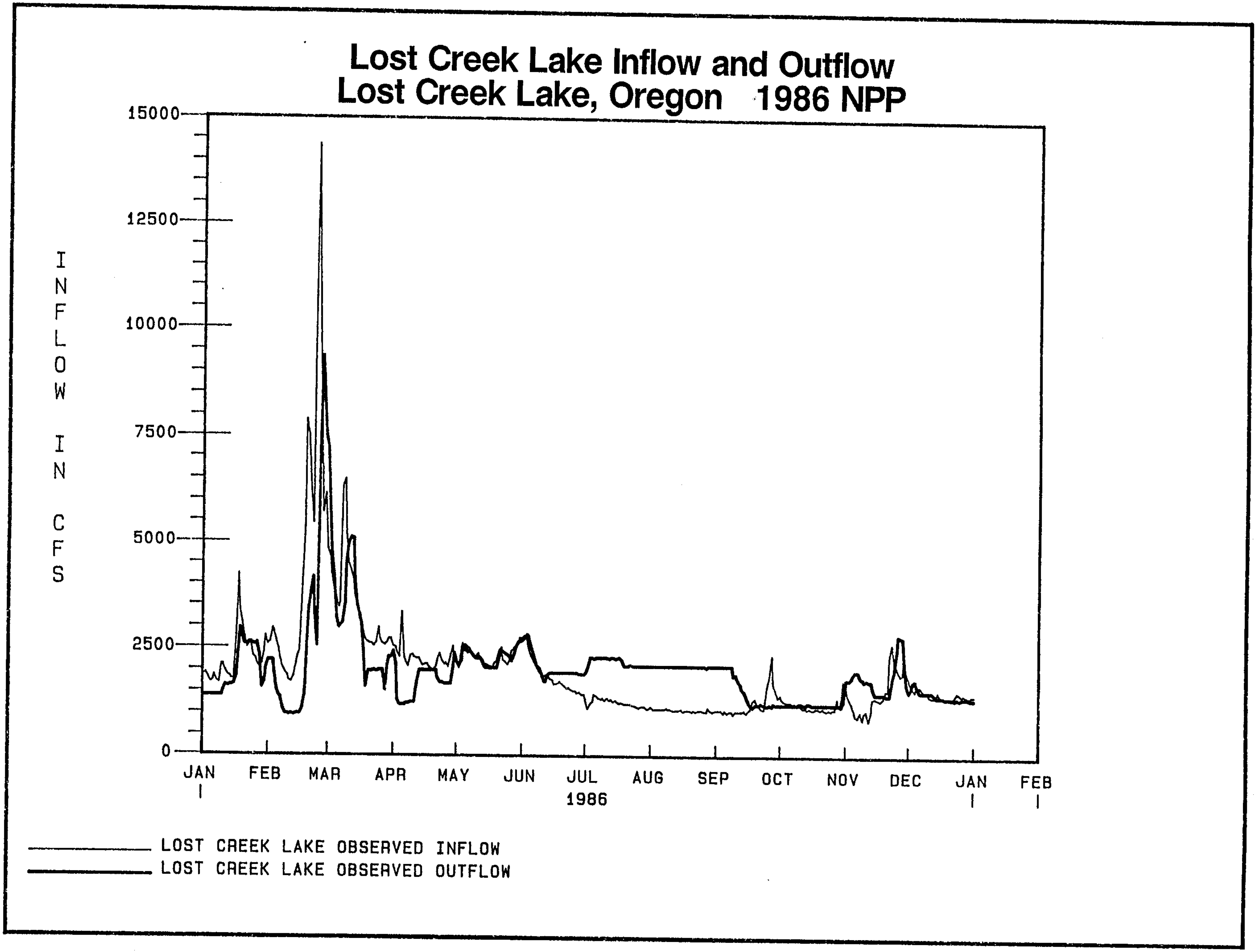
Oct 28 - 19 Nov — Action: HH-R provided to NPP/RCC 1-15 Nov release schedule.
Purpose: Storm activity with increased runoff caused additional encroachment into flood control; releases scheduled to evacuate 21,000 acre-feet to return to minimum flood control by 15 Nov.

30 Oct — Action: HH-R authorizes use of project regulating outlet for temperature control.
Purpose: Coldest water only available at RO depth; reduction of $3^{\circ}F$ ($46^{\circ}F$ to $43^{\circ}F$ achieved through use of RO.

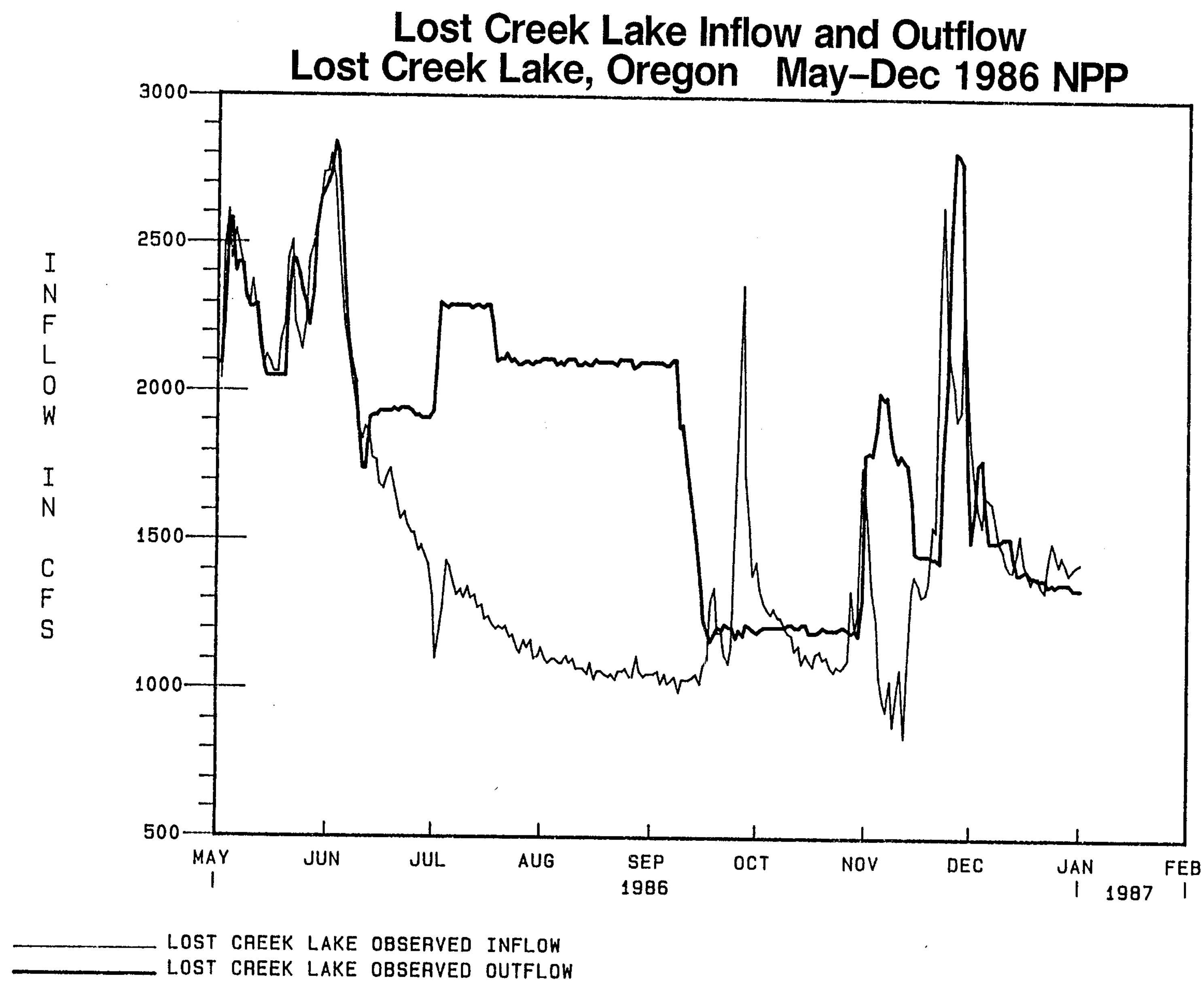
19 Nov - — Action: Project passing inflow at elevation 1812.
Purpose: provision of 285,000 acre-feet of storage for flood control purposes.

Lost Creek Lake Pool Elevation
Lost Creek Lake, Oregon 1986 NPP





Lost Creek Lake Inflow and Outflow
Lost Creek Lake, Oregon 1986 NPP
INFLOW IN CFS
15000
12500
10000
7500
5000
2500
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
1986
LOST CREEK LAKE OBSERVED INFLOW
LOST CREEK LAKE OBSERVED OUTFLOW


Lost Creek Lake Inflow and Outflow
Lost Creek Lake, Oregon May–Dec 1986 NPP
INFLOW IN CFS
3000
2500
2000
1500
1000
500
MAY
JUN
JUL
AUG
SEP
1986
OCT
NOV
DEC
JAN
1987
FEB
LOST CREEK LAKE OBSERVED INFLOW
LOST CREEK LAKE OBSERVED OUTFLOW

Requested and Observed Release Temperatures
Lost Creek Lake, Oregon 1986 NPP

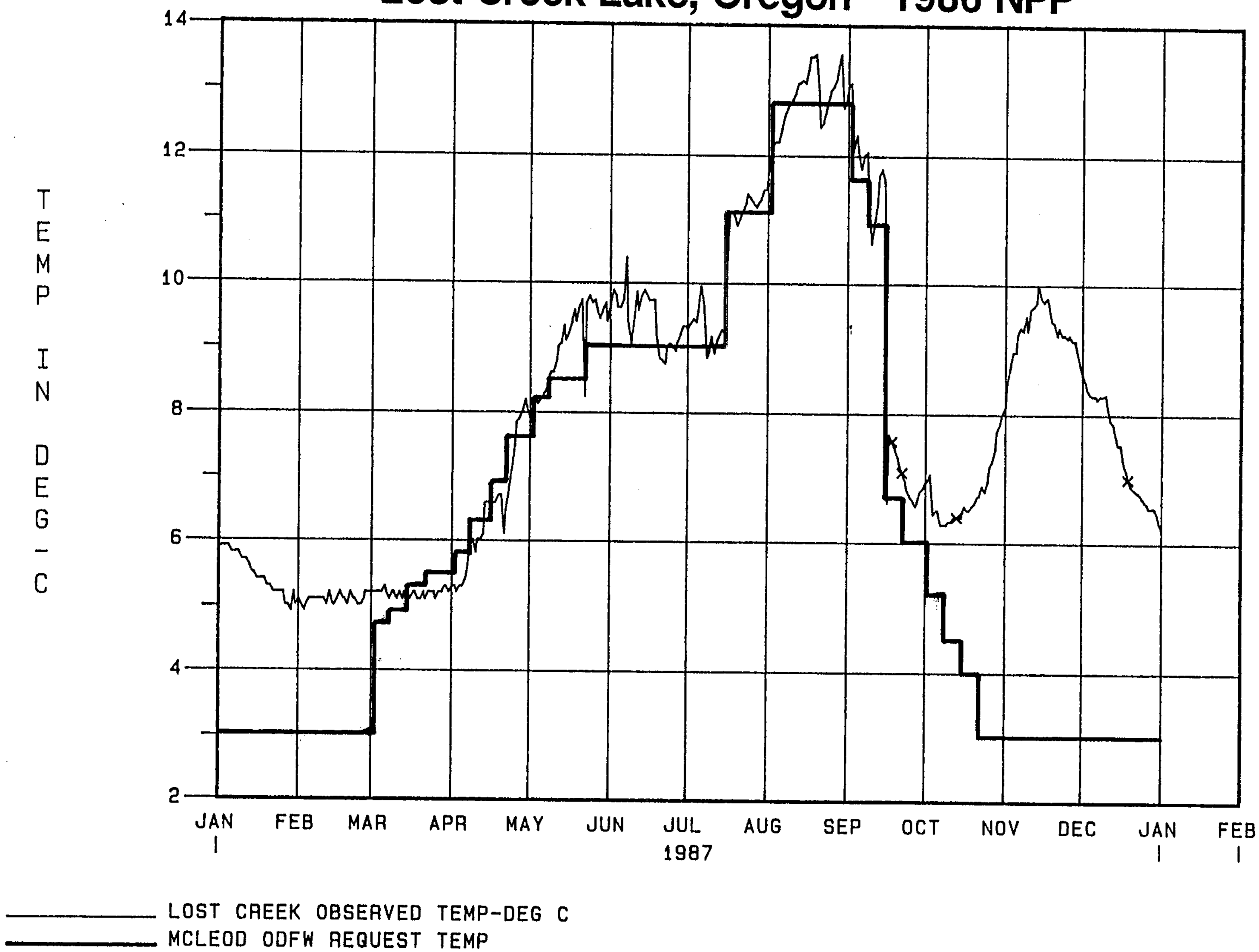


Exhibit D

DROUGHT CONTINGENCY PLAN

FOR

ROGUE RIVER BASIN PROJECT

U.S. Army Corps of Engineers
Portland District
Reservoir Regulation and Water Quality Section

September 1992

Exhibit D - Drought Contingency Plan

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Exhibit D - **Drought Contingency Plan**

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Exhibit D - Drought Contingency Plan

1. INTRODUCTION

Drought contingency plans for the Corps of Engineers reservoirs in the Rogue River Basin meet the requirements of ER 1110-2-1941, Development of Drought Contingency Plans. This appendix meets the need to have adequate plans for use in Corps Water Control Manuals during drought situations. This Drought Contingency Plan is an internal appendix to each Water Control Manual for the Corps dams in the Rogue River Basin.

This Drought Contingency Plan is a comprehensive evaluation of the Corps reservoir system to meet the water resources related drought needs in the Rogue River Basin, and to define each projects role addressing surface water storage aspects of a drought.

2. AUTHORITIES

The following list of authorities are pertinent to the preparation of drought contingency plans and actions:

ER 1110-2-1941, Drought Contingency Plans, dated 15 September 1981. This regulation provides policy and guidance for the preparation of drought contingency plans as part of the Corps of Engineers over-all water management activities.

Section 216, Public Law 91-611 (84 Stat 1830), Rivers and Harbors Act of 1970. This act authorizes the Secretary of the Army to review the operation of existing Corps projects and recommend to Congress modification of their structure or operation to improve the environment.

ETL 1110-2-251, Preparation of Water Control Manuals, dated 14 March 1980. This document provides the guidance for preparing water control manuals for individual water resource projects to include drought contingency plans.

ER 1110-2-240, Water Control Management, dated 8 October 1982. This regulation describes the policies and procedures to be followed in water management activities, including special regulations to be conducted during droughts. It also sets the responsibility and approval authority in development of water control plans.

PL 84-99. Emergency Supplies for Clean Drinking Water as amended by PL 95-91. This law provides the authority under which the Chief of Engineers may, under certain conditions, construct wells and transport water to farmers, ranchers, and political subdivision within areas determined to be drought distressed.

ER 500-1-1, Emergency Employment of Army and Other Resources, Natural Disaster Procedures, dated 11 March 1991. This ER identifies the mission, authorities, responsibilities, and chain of command of the Corps in provision of disaster assistance. Specifically it establishes guidance in the application of PL 84-89 and PL 95-91 and sets reporting and assistance request procedures.

EM 1110-2-3600, Management of Water Control Systems, 30 November 1987. This regulation requires that the drought management plan be incorporated into the project water control manuals and master water control manuals. It also provides guidance in formulating strategies for project regulation during droughts.

Section 6, Flood Control Act of 1944, provides the authority for the Secretary of the Army to make contracts with states, municipalities, private concerns, or individuals at such prices and on such terms as he may deem reasonable for domestic and industrial uses for surface water that may be available at any reservoir under the control of the Department of the Army.

EC 1105-2-181, Municipal and Industrial Water Supply Storage. An Army General Counsel opinion of 13 March 1986, states that Section 6 of the 1944 Flood Control Act empowers the

Secretary of the Army to make reasonable reallocations between different project purposes. Thus, water stored for purposes no longer necessary, or a better use in certain cases, can be considered surplus.

ER 405-1-12, Real Estate Handbook, dated 20 November 1985. Provides guidance for issuing an appropriate real estate instrument for water withdrawal users who will be installing water lines or other facilities or equipment.

3. DROUGHTS

Neither our global society, nor our nation, have agreed upon a precise definition of a drought. The major problem associated with objectively defining a drought is the diverse ways that a drought is defined by various fields of study.

Worldwide, farmers and agriculturists measure or identify a drought as a function of a specific crop under cultivation. In Bali, any period of 6 days or more without rain is considered a drought. In Libya, droughts are identified only after 2 years without rain. Other perspectives include the definition of a drought as a function of the impact on institutional and human activity, and on their response during a drought.

In the science of hydrology, a drought event is identified in terms of both precipitation and streamflow deficiencies. Hence, a working definition requires consideration of both rainfall and runoff. Geophysicists include climatology, meteorology, hydrology, limnology, and oil physics. A water resources engineer analyses droughts as a problem of supply and demand. Therefore, water managers generally view droughts as a shortage in streamflow runoff and reduced water storage.

A. Definition of Drought

Drought was defined by the National Research Council, Water Science and Technology Board, in a 1985 colloquium as the period of time when streamflows, reservoir storages, and shallow ground-water levels are abnormally low as a result of climatically-induced lack of moisture.

> "...water levels are abnormally low as a result of climatically-induced lack of moisture."

A key to understanding the impacts of a drought is to evaluate the specific components of the hydrologic cycle. From an evaluation using the hydrologic cycle perspective, precipitation can be considered the carrier of the drought signal, while hydrologic processes such as runoff, soil moisture, streamflow, and groundwater can be viewed as the indicators revealing the drought presence. Climate, then, describes the long-term behavior of this signal. However, the beginning and end of a drought are difficult to identify because of the variability of precipitation.

The current technical literature reveals that the causes of droughts are complex, and poorly understood. The strongest drought signals usually occur when large amounts of precipitation are expected but do not occur. The major droughts that have occurred in the United States were characterized by abnormally long periods without rain. The severe droughts of the 1890s, 1910s, 1930s, and 1950s were events without rain for the spring and summer seasons; normally the wettest seasons in the Great Plains states. More recently, the north-central United States experienced severe lack of precipitation during the April - July period of 1988. The drought of 1988 was the worst drought in the Midwest since 1936.

A period without rain is not the only climatological factor that produces precipitation deficits. Droughts can be associated with seasonal periods where low intensity precipitation occurs. A few studies show that it is not unusual for dry years to have as many days with rain as wet years. Iowa data shows approximately the same number of days with rain during the drought July 1976 as compared to the normal July of 1977.

According to Hydrologic Engineering Center Research Document No. 33, A Preliminary Assessment of Corps of Engineers Reservoirs, Their Purposes and Susceptibility to Drought (1990), the duration, magnitude, severity, frequency, and areal extent have been identified as five common characteristics of drought. Improving Corps of Engineers response to a drought can be accomplished, firstly, by defining drought for the regional area in which the reservoirs are located, and secondly, by describing the five common characteristics of a drought. In Oregon, a surface water supply index (SWSI) is the technical tool used to assess a drought and to measure the anticipated water supply in the state of Oregon.

It is important to recognize that any declaration of drought in Oregon is a political act performed by the Governor on a county-by-county or on a state-wide basis. The Governors technical advisory group is the Oregon Drought Council. The Corps of Engineers does not make a declaration of drought conditions associated with its reservoirs in the Rogue River Basin. However, according to the authorizing document for the Rogue Basin Project, the Corps can declare water shortages. The Portland District has made it a policy to follow any state action. Any Corps emergency management assistance related to a drought can only occur after the State programs have been exhausted and the Assistant Secretary of the Army has made a declaration of drought.

B. Historic Northwest Droughts

Tree-ring studies performed in Oregon, Washington, and Northern California resulted in a general picture of droughts and wet periods dating as far back as about 1670. A University of Washington 1985 doctoral thesis indicates that droughts are slightly more common than wet periods. Droughts are variable in length; one of the longest droughts lasted from 1865 to 1892. There were six major droughts in Western Oregon and Washington during the past 300-year period, or approximately one every 50 years. East of the Cascade Mountain Range, the average occurrence of droughts was one every 37 years.

The research showed variation from year to year. The wettest years were 1702, 1810, and 1863. The driest years were 1854 and 1889. Extremes of dry or wet years do not necessarily occur during prolonged periods of dry or wet sequences. The dry years of 1854 and 1889 came during what was otherwise a wet period in the southern portion of the region. Wet years and dry years can follow each other. Extreme annual fluctuations in rainfall are normal. Climatic variation and fluctuation is considered normal; long-term stability is not considered normal.

C. El Niño and La Niña

There is a type of meteorological phenomenon called the El Niño Southern Oscillation that is related to the occurrence of drought conditions. Effects in the Pacific Northwest can include warmer-than-usual winters, dry spring seasons, and shrinking mountain snowpack conditions. However, the El Niño effects in a specific region of the country can be different with each event. Climate fluctuations in the South Pacific Ocean cause global weather changes (Figure 1). Extensive and prolonged warming of the eastern Pacific Ocean near South America causes air pressure and ocean current reversals to occur at two to seven year intervals. There have been 116 events since 1525. The earliest occurrence of El Niño was recorded on one of Francisco Pizarro's ships in the South Pacific. Only nine of the 116 events have been categorized as very strong. On the average, El Niños occur once in every four years. The strongest El Niño Southern Oscillation of this century occurred in 1982-83, causing an estimated $ 8.65 billion in global devastation ranging from floods to droughts. The previous one, in 1976-77, caused a significant drought in the Western United States.

Under normal conditions, the oceanic atmospheric conditions exhibit a high pressure system near South America and a low pressure system near Australia and Indonesia. This causes the winds to blow from the east near South America to the west towards Australia and Indonesia as the Trade Winds. A reversal of air pressure and, concomitantly, of ocean currents occurs during an El Niño event. South American fishermen first coined the name El Niño (Spanish for the male child) when the Peruvian and Ecuadorian coast exhibited unusually warm water in late December, near the date of a major Christian holiday. Surface waters can warm up to 10 degrees above normal. The change of atmospheric patterns and the change in current patterns in the southern Pacific Ocean influences weather patterns and ocean current patterns in North America. Winters tend to be drier in the Pacific Northwest and wetter and cooler in the Southwest United States. Effects during the spring and summer in the Pacific Northwest are variable and inconsistent. The 1982-83 El Niño effects in Oregon and Idaho produced cold, wet conditions. The reason for such changes are due to to the upper air flow patterns being more meridional during El Niño years. If the Pacific Northwest is under the ridge position,the dry, warm weather persists. If the pattern shifts slightly, the area can be in the trough position which brings cool, moist weather.

According to Nicholas Graham (Science, 24, 1992), El Niño got stuck part way on for 10 straight years following the El Niño of 1976-77. The National Center for Atmospheric Research (Science, 255, 1992) has shown that the atmospheric circulation went out of balance after 1976, and stayed that way until the late 1980s.

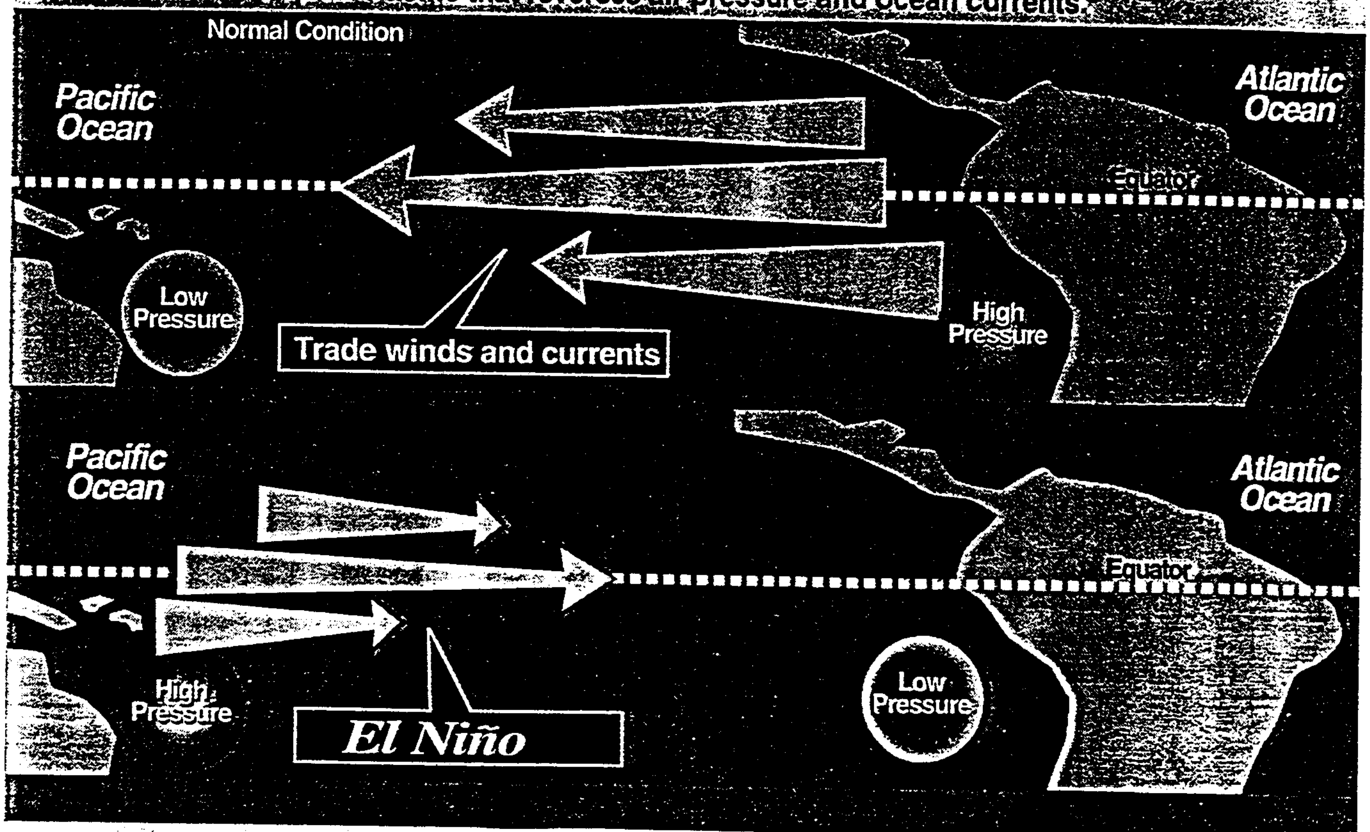
Other climatological conditions that have some impact on potential hydrometeorological conditions in the Pacific Northwest have been termed La Niña (Spanish for the female child). The La Niña phenomenon causes weather changes throughout North America. La Niña effects in the Pacific Northwest are variable. However, La Niña causes droughts in other parts of the country.

La Niña conditions in the Pacific Northwest are are often, but not always, characterized by cold air temperatures starting in November and December, high snowpack conditions in the mountains and low elevation snowfall in the valleys, and reduced snowmelt in the mountains until late spring.

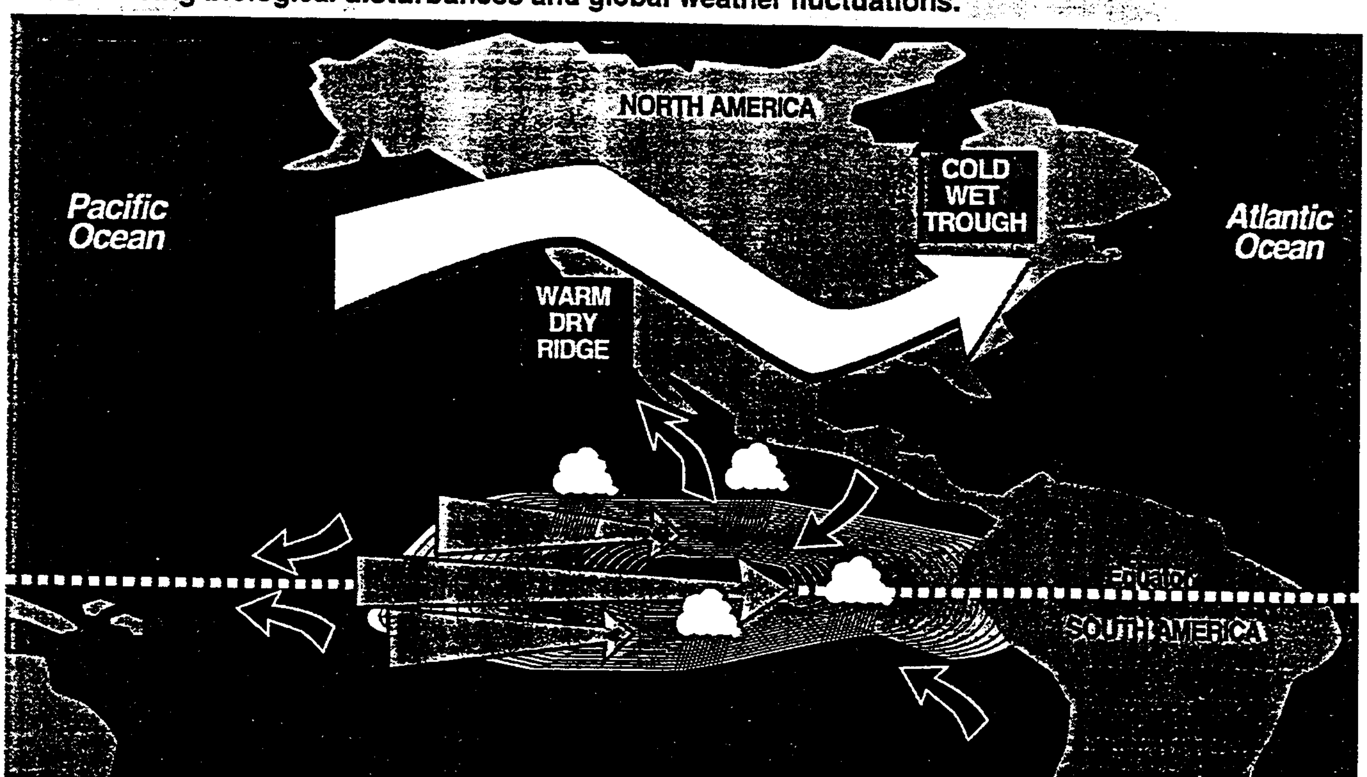
FIGURE 1

El Niño: Southern Oscillation

1 El Niño is a climate fluctuation phenomenon caused by extensive and prolonged warming of the eastern tropical Pacific that reverses air pressure and ocean currents.



2 As El Niño approaches South America, surface waters can warm up 10 degrees above normal, causing biological disturbances and global weather fluctuations.



3 El Niño affects storm tracks that influence weather in North America by shifting the Jet Stream northward. El Niño may bring higher temperatures to the Northwest.

Rearranged atmospheric high pressure systems in the eastern Pacific and over the continental North America cause the phenomenon called La Niña (Figure 2). The cause for the shift in pressure systems is yet unknown. The shift in locations causes the birthplace of storms and unstable weather called the Inter-Tropical Convergence Zone, and its accompanying warm waters, to shift to a more northerly location off the Mexican coast. This movement brings cold waters to the equatorial Pacific Ocean. A low pressure trough is formed off the California portion of the North American coastline, and it pushes the Jet Stream northward.

D. Hydrometeorological Conditions in the Rogue River Basin

The hydrometeorologic conditions of the Rogue River Basin are considered somewhat different from the Columbia River Basin conditions.

(1) Climatic Conditions

The Rogue River Basin experiences a wide range of climatic conditions but is generally characterized as a maritime climate. Warm, subtropical airmasses from the equatorial Pacific Ocean flow north and northeastward to meet cold air masses from the polar regions. The resulting unstable air masses move eastward across the Northern Pacific in frontal systems. During the winter, the frontal systems move across northern California and Oregon. During the summer, the subtropical Pacific air moves further north before interacting with the polar airmasses, resulting in drier conditions in much of the Pacific Northwest. As a result, about 80 percent of the annual precipitation in the Rogue Basin occurs between October and March. Most winter precipitation occurs as rain in the lower elevations of the Rogue Valley and as snow in the mountains. The greatest annual precipitation in the Rogue Basin, as much as 120 inches, falls on the western slopes of the Coast Range. Parts of the central basin receive less than 20 inches per year. Most precipitation in the mountains falls as snow. Water content of the snowpack usually is at a maximum in March and April, with most of the runoff generally occurring during April and May.

Water from natural sources is in short supply throughout Oregon from July through September. This condition has been described as Oregon's seasonal drought.

"...from July through September. ...Oregon's seasonal drought."

(2) Rainfall Forecasts

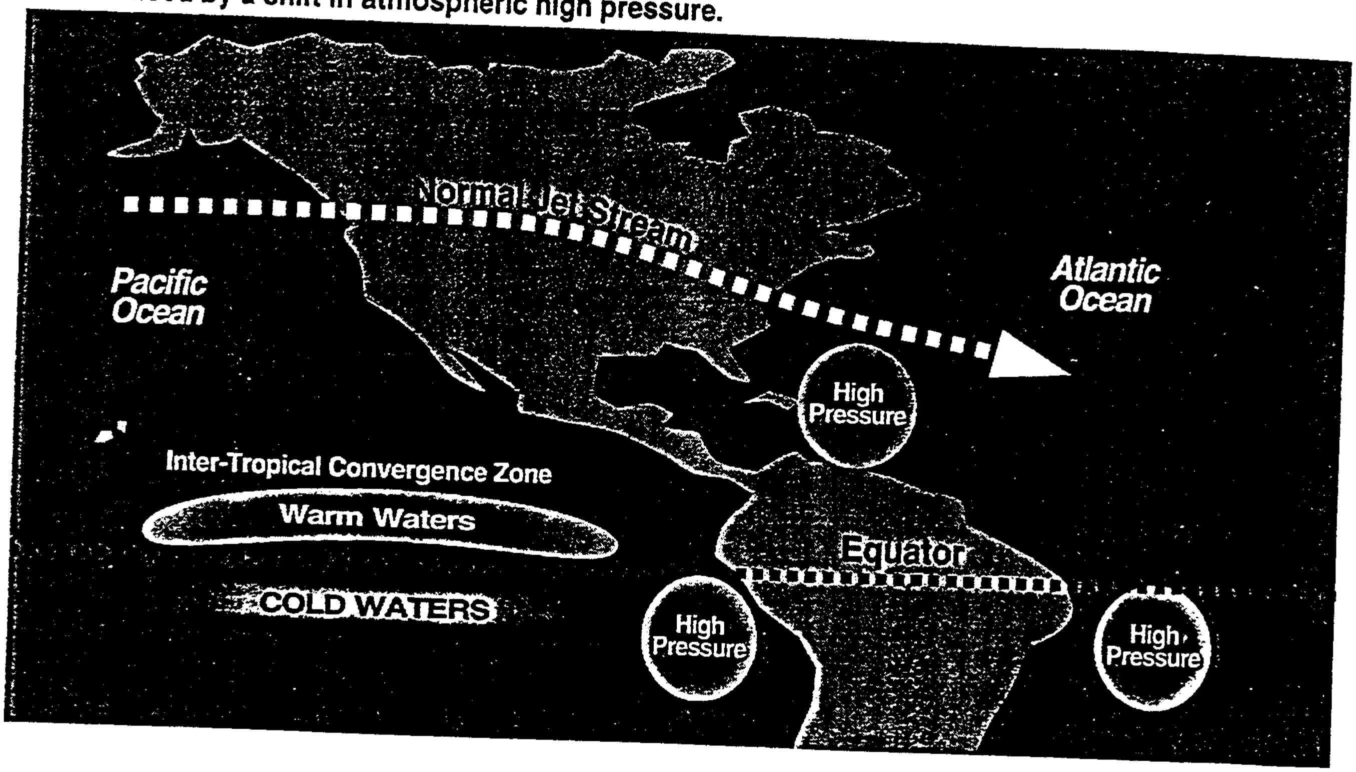
The National Weather Service (NWS) has been providing water managers of the Pacific Northwest with means to evaluate the current climatic conditions based on computations and comparison with averages. An air temperature-precipitation (T-P) index of the major tributaries of the Columbia River Basin has been used since 1948. No index stations are located in the Rogue River Basin and use of this index has generally been superseded by the use of another NWS index; the Division Average Index.

The NWS Division Average Index contains more precipitation stations than the T-P Index. Monthly precipitation data is measured in hundredths of inches and reported as accumulations from April 1 (Figure 3). Included is the departure from the 30-year average (1961-1990), and the

FIGURE 2

La Niña Shift

1 La Niña is a climate fluctuation phenomenon caused by a shift in atmospheric high pressure.



2 As La Niña shifts high pressure in the Pacific, the Jet Stream is also moved northward. A low pressure trough is created off the California coast. The warm waters of the Inter-Tropical Convergence Zone are pushed northward towards southern California and cold waters move northward toward Central America. La Niña can cause increased snow in the mountains in the Pacific Northwest and/or drought conditions in the portions of the Pacific Northwest that have continental climate (eastern Oregon and Washington).

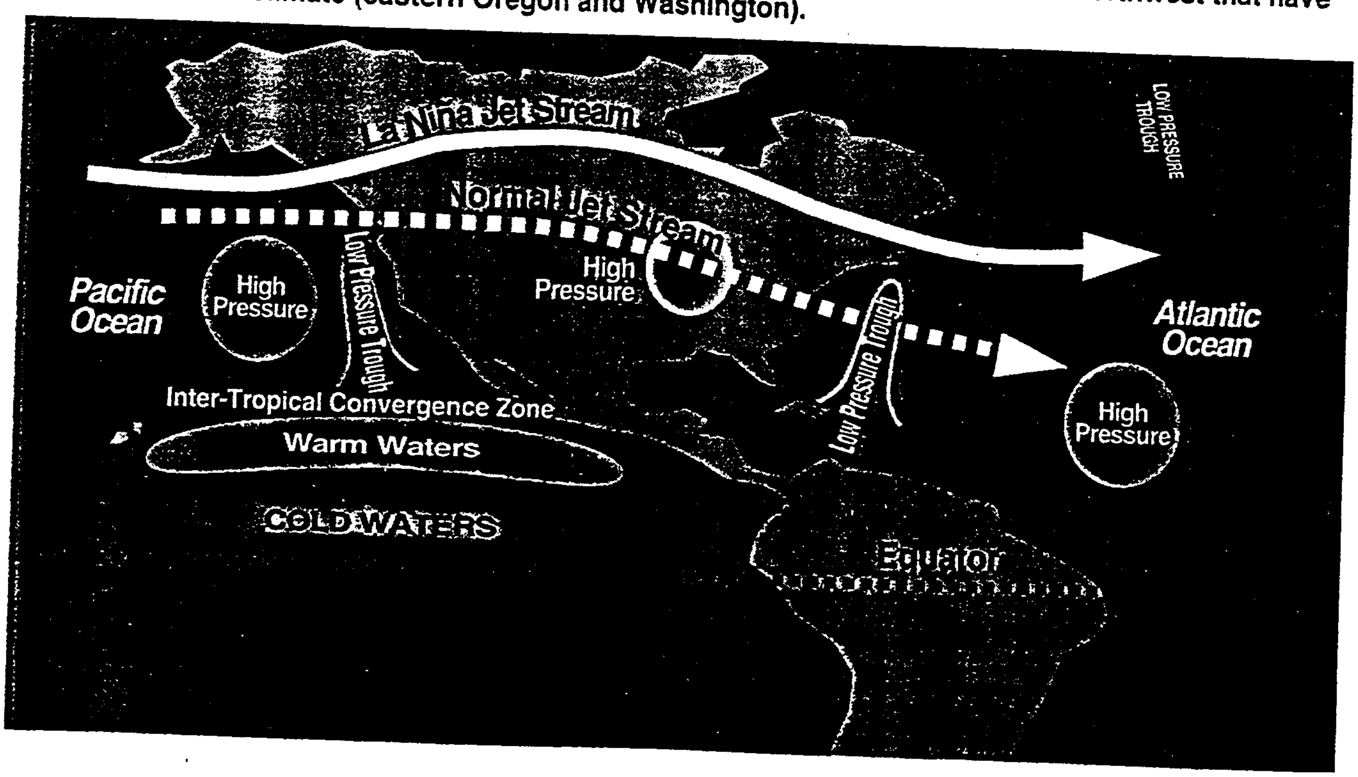


FIGURE 3 - Division Average Precipitation Indices

NORTHWEST RIVER FORECAST CENTER, PORTLAND, OREGON
MONTHLY SUMMARY OF PRECIPITATION FOR THE COLUMBIA BASIN
COLUMBIA BASIN DIVISION AVERAGES OF SEASONAL PRECIPITATION

DIVISION	..APR TO DAY 30...			...OCT - APR...		
	OBSD	DEP	PCT AV	OBSD	DEP	PCT AV
COLUMBIA ABOVE COULEE	2.05	0.45	128.	13.25	-2.87	82.
SNAKE RV AB ICE HARBOR	1.52	0.09	106.	8.77	-3.07	74.
COLUMBIA AB THE DALLES	1.93	0.33	120.	12.86	-3.07	81.
COLUMBIA AB CASTLEGAR	2.36	0.48	125.	20.18	-1.31	94.
KOOTENAI	2.28	0.68	143.	13.78	-1.95	88.
CLARK FORK	1.72	0.48	139.	8.67	-2.05	81.
FLATHEAD	1.79	0.22	114.	11.10	-2.91	79.
PEND OREILLE--SPOKANE	2.23	0.15	107.	17.30	-4.21	80.
NORTHEAST WASHINGTON	1.86	0.55	142.	10.01	-1.76	85.
OKANOGAN	0.83	-0.16	84.	7.37	-2.22	77.
EAST SLOPES WASH CASC.	2.66	0.56	127.	28.08	-4.81	85.
CENTRAL WASHINGTON	1.33	0.70	211.	6.23	-0.15	98.
UPPER SNAKE	1.66	0.05	103.	9.16	-3.72	71.
SNAKE RIVER PLAIN	0.70	-0.33	68.	4.13	-2.94	58.
OWYHEE--MALHEUR	0.59	-0.32	65.	5.43	-2.17	71.
SALMON/ BOISE/ PAYETTE	1.55	0.04	102.	9.97	-4.62	68.
BURNT/ GRANDE RONDE	1.43	0.26	116.	8.36	-2.62	76.
CLEARWATER	3.58	0.99	138.	17.92	-3.04	85.
SOUTHEAST WASHINGTON	1.81	0.32	121.	10.07	-3.42	75.
UPPER JOHN DAY	1.07	-0.10	91.	7.19	-3.04	70.
UMATILLA LWR JOHN DAY	2.25	0.84	159.	10.37	-1.40	88.
UPR DESCHUTES CROOKED	1.80	0.94	210.	8.41	-2.78	75.
HOOD/ LOWER DESCHUTES	3.74	1.79	192.	21.35	-2.55	89.
NW SLOPE WASH CASCADES	7.75	1.54	125.	61.83	-8.88	87.
SW WA CASCADES/COWLITZ	7.18	2.21	144.	49.33	-8.60	85.
WILLAMETTE VALLEY	7.85	3.56	183.	41.50	-8.03	84.
ROGUE--UMPQUA	**3.66**	**1.24**	**151.**	**20.35**	**-10.47**	**66.**
KLAMATH BASIN	1.39	0.38	137.	8.20	-6.38	56.
LAKE COUNTY GOOSE LAKE	0.71	-0.28	72.	5.27	-3.55	60.
HARNEY--MALHEUR BASIN	0.63	-0.20	76.	5.03	-2.76	65.

DIVISION VALUES ARE COMPUTED BY UTILIZING UN-WEIGHTED PRECIPITATION AMOUNTS FROM KEY STATIONS IN EACH AREA. FOR FURTHER INFORMATION CONTACT: NWRFC (503) 326-2914

percent of average.

The U.S. Soil Conservation Service has developed a Columbia River Basin-wide index for snow water equivalence (Figure 4). A single combined index has been established for the Umpqua-Rogue River Basins. Water content and precipitation are reported in inches and as percent of average. The reference period to determine the average condition is 1961-1985 data.

FIGURE 4 - Snow-Precipitation Indices

United States Department of Agriculture	Soil Conservation Service	West National Technical Center Water Supply Forecasting Staff Portland, OregoN

S N O W - P R E C I P I T A T I O N   U P D A T E

Based on Mountain Data from SCS SNOTEL Sites
As of THURSDAY: DECEMBER 12, 1991

BASIN Data Site Name	SNOW WATER EQUIVALENT % of average	PRECIPITATION % of average
COLUMBIA RIVER BASIN REPORT		
KOOTENAI RIVER IN MONTANA	105*	103
FLATHEAD RIVER BASIN	122*	125*
CLARK FORK ABOVE MISSOULA	127	128
BITTERROOT	153*	141*
PRIEST, COEUR D'ALENE, ST. JOE, SPOKANE, PALOUSE, PEND OREILLE	117*	103*
COLUMBIA ABOVE METHOW	101	69
CHELAN, ENTIAT, WENATCHEE	134	101
YAKIMA, AHTANUM	107*	104*
SNAKE ABOVE PALISADES	126	110
HENRYS FORK, TETON, WILLOW, BLACKFOOT, PORTNEUF	124*	97*
BIG WOOD, LITTLE WOOD, BIG LAST, LITTLE LOST	123	120
RAFT, GOOSE, SALMON FALLS, BRUNEAU	134	115
WEISER, PAYETTE, BOISE	104	104
OWYHEE MALHEUR	72*	102
GRAND RONDE, POWDER, BURNT, IMNAHA	125	111
CLEARWATER AND SALMON	137*	119*
UMATILLA, WALLA WALLA, WILLOW	102	134
DESCHUTES, CROOKED, JOHN DAY	75	117
LOWER COLUMBIA, HOOD RIVER	43	113
WILLAMETTE	77*	116*
LEWIS, COWLITZ	91	98
WHITE, GREEN, CEDAR, SKYKOMISH, SNOQUALMI, BAKER, SKAGIT	118*	114*
ROGUE, UMPQUA	**46**	**104**
KLAMATH	78	91
LAKE COUNTY, GOOSE LAKE	68*	74*
HARNEY AND SILVIES	81	110

Provisional data, subject to revision.

* = Snowpack and/or Precipitation summaries may contain erroneous data and not be a valid measure of conditions.

Water Content and Precipitation readings are reported in inches.

Reference period for average conditions is 1961-85.

These indices are reported and discussed at monthly Columbia Basin interagency water management meetings.

(3) Rogue River Basin Hydrology

The Rogue River Basin is a 5,080 square mile coastal watershed and is located almost entirely within the state of Oregon. Two multiple purpose Corps dams in the watershed control about 18 percent of the entire drainage area. The average flow of the Rogue River at Agness (river mile 29.3, drainage 3939 square miles) is 5885 cfs. This is over a period of record between 1961 and 1991. Agness is the most downstream gage on the Rogue River. The average flow at Grants Pass over a longer period of 1929-1991, is 3295 cfs or 2.39 million acre-feet per year (flows during 1929-1940 are estimates). The Grants Pass gage is located at river mile 103, drainage area of 2459 square miles. Figure 5 graphically depicts the trends in runoff at the Grants Pass gage from 1929 through 1991.

Approximately 84 miles of the lower Rogue River, between Grants Pass and the confluence with Lobster Creek, designated as either a recreational, scenic, or wild river. There is intense interest in flow related issues in these areas. The minimum daily discharge at Grants Pass over the period of record was 606 cfs on 10 September 1968. This flow occurred before either of the Corps dams were completed and operational, although only Lost Creek Lake is upstream of Grants Pass.

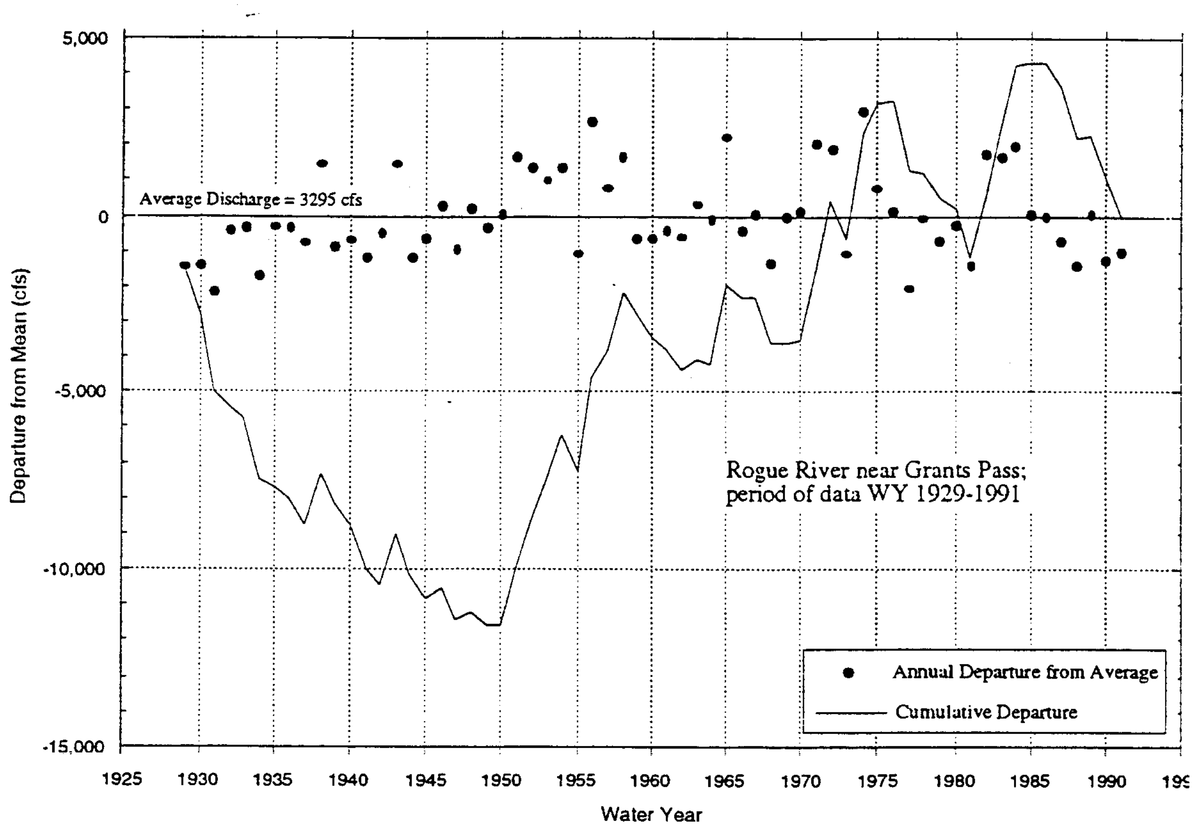
The hydrology of the Rogue River Basin is not conducive to long-range forecasting of basin runoff. A major portion of the runoff during the months of February and March occurs as a direct result of rainfall. It is not quantitatively predictable for any period beyond 24 to 48 hours. In an average year, approximately 70 percent of the runoff during the April through June period is produced from the water content in the basin snowpack accumulated as of 1 April. The SCS does make a season runoff forecast for the period of May through September. It is developed using a numerical forecasting model and is based on the 1 April snowpack. This forecast is used as a guide to the initial summer water management plan.

(4) Streamflow Forecasts

Operational streamflow forecasts in the Columbia River Basin are coordinated efforts through agreement between the National Weather Service, Corps of Engineers, and the Bonneville Power Administration. The interagency agreement is termed the Columbia River Forecasting Service. Operational forecasting is performed using the Streamflow Synthesis and Reservoir Regulation Model (SSARR). It is a numeric model of the hydrology of the Columbia River Basin system. The model is comprised of a generalized watershed model, and a streamflow and reservoir regulation model. The model is intended to be used for floods and does not currently provide forecasts for low flow periods. Should its veracity be confirmed it could be modified for low-flows estimates.

The Soil Conservation Service (SCS), in cooperation with the National Weather Service, provides seasonal water supply forecasts for over 6000 points in the western United States. Seasonal water supply forecasts are generated from January through June for most areas. Most

FIGURE 5 - Rogue River at Grants Pass Flow Variation



water supply forecasts are produced using regression techniques. Melting snow and rain are the components that most directly relate to seasonal streamflow volume. Variables typically used in developing the forecast at each location include snow water equivalent, precipitation, and antecedent streamflow. Each month, five forecasts are issued for each forecast point and each forecast period. The forecasts include: the most probable (50 percent chance of exceeding) forecast, and the 10, 30 70, and 90 percent chance of exceeding forecasts. New regression procedures rely on information known at the time that each forecast is made. This technique requires the use of a different equation for each forecast month.

The Soil Conservation Service forecasts for 15 locations in the Rogue River Basin. These include locations on Rogue River, South Fork Rogue River, Big and Little Butte Creeks, Illinois River, the inflow to both Lost Creek Lake and Applegate Lake, and on several other tributaries throughout the basin.

(5) Recent Droughts

Five significant hydrologic drought periods have occurred in Oregon since the 1920s: 1928-41, 1959-64, 1976-81, 1987-88, and 1990-92. The drought period of 1928-41 was generally considered a statewide drought, except for the northern Oregon coast. The U.S. Geological Survey has calculated that it had an average recurrence interval of greater than 25 years. Eastern Oregon had reduced streamflow conditions from 1959 to 1964. This drought had an average recurrence interval 10 to greater than 25 years. Western Oregon had drought conditions from 1976 to 1981. The U.S. Geological Survey has calculated that it also had a 10 to greater than 25 year recurrence interval. The drought year of 1977 was the most severe one-year occurrence during this drought period, and the impacts were statewide. U. S. Geological Survey records also show that streamflows were in a deficit condition west of the Cascades again as early as 1984, and exhibited a statewide deficit in 1987-88. The 1987-88 drought was calculated to have a 5 to 20 year recurrence interval. The current drought period, 1990-92, is quite pronounced and may be the most acute drought since the 1930's.

Seasonal hydrologic droughts are consider to occur every year in Oregon. Reservoir storage is necessary in most parts of the state to augment summer flows during these seasonal droughts. More severe one-year drought episodes occur as a result of the El Niño Southern Oscillations. The potential occurrence of multiple drought years is unclear.

E. Water Year 1977

Five common characteristics of a drought can be used to determine Corps of Engineers response to drought conditions (as discussed in 3.A. Droughts). For water year 1977, the following characteristics of duration, areal extent, frequency, severity and magnitude can be examined.

(1) Duration

The general perception of severe drought conditions in Oregon are generally compared to one specific drought year, 1977. However, according to runoff records, the U.S. Geological Survey considers water year 1977 as the most significant drought year of a multiple-year drought event lasting from 1976 through 1981. The severest portion of that drought began in September 1976, and continued through the July 1977. Significant rains occurred in August and September 1977 to end the severest portion of the drought period.

(2) Areal Extent

The entire Pacific Northwest experienced overall water shortages to varying degrees.

(3) Magnitude

The May 1977 surface water supply index (SWSI, described in 4.C. Drought Forecasts) for the the entire state of Oregon ranged from -2.1 to -3.5. The Rogue River Basin experienced -3.1.

(4) Frequency

The U. S. Geological Survey reported that the 1977 drought had a 10 to 25 year recurrence interval.

(5) Severity

Water year 1977 was, to date, the driest year throughout the Columbia River Basin and the Pacific Northwest since weather had been recorded. The winter of 1976-1977 was the driest winter on record. Portland experienced a record low December 1976 rainfall of 1.38 inches. The air temperature and precipitation indices indicated that there were eight months with below normal precipitation and seven months with above normal air temperatures for the period between September 1976 and August 1977. A high pressure frontal system formed off the Pacific coast in September 1976 and remained until the late summer of 1977. However, Salem, Oregon recorded the second coldest May of record. July air temperatures were cooler than normal. August had persistently hot and dry conditions for the initial 20 days, but the remainder of the month was cold and wet.

Annual mean streamflow in the Pacific Northwest during 1977 was generally less than ever experienced since recording streamflow data began in the late nineteenth century. Average daily discharge at Grants Pass for the year was 1297 cfs, 38% of average. Total runoff amounted to only 0.92 million AF. Average flow at Agness was just 1583 cfs. Inflow to Lost Creek Lake, which was just completed and began filling in January 1977 was the third lowest of record. Until 1992, this was the only year in which the lake did not fill. Average flow for the year at the Applegate Lake site, the dam was not closed until 1980, was 80 cfs. This is only 20% of the period of record average of 414 cfs. Applegate Dam was not yet completed during 1977.

Precipitation over the Rogue-Umpqua Basin, of 20.4", was only 57% of the 30-year average.

The drought had a varied effect on agriculture throughout the state, depending on the location and the type of product. Eastern Oregon was the hardest hit. Eastern Oregon crop losses were estimated to be as high as $70 million because crop yields were 50 to 75 percent of normal. In other areas, the threat of drought caused a shift to alternate drought-resistant crops. Many farmers who irrigated their crops using water from storage reservoirs were not abnormally affected by the drought. Irrigators that depended on direct stream diversions had poor supplies. In Jackson County, approximately 25,000 acres had inadequate water supplies. There was a 40 percent reduction in crop production with the principal effects occurring on dryland pasture hay.

Livestock growers in Eastern Oregon were also adversely affected. There were reductions in the number of stock water ponds and water holes. Some springs went dry early in the season. Losses of herds in eastern Oregon were offset by increases in the western portion of the state.

F. Water Year 1992

Although water year 1992 is not complete, some generalizations of the five characteristics of a drought can be made. Because the drought does not appear to be ended, and could last indefinitely, duration and frequency are not yet determined and, therefore, can only be partially commented upon. Areal extent, magnitude, and severity also will be given cursory treatment.

(1) Duration

(5) Severity

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(1) Duration

Like the 1977 drought, the 1992 drought has, to date, been the worst year of a multiple year drought period. In the Rogue River Basin, the drought period of below average precipitation and runoff is considered to have started in 1987. The U.S. Geological Survey has indicated that they consider 1987-1988 as a distinct drought period with a 5 to 20 year recurrence interval. Like the 1976-1981 drought period that is generally referred to as the 1977 drought, this current drought period has also been referred to by its worst year, 1992.

(2) Areal Extent

Like the 1977 drought, most of the Pacific Northwest is being affected to varying degrees by the 1992 drought. Virtually all of Oregon has been affected to some extent. The areal extent of the 1992 drought has also been variable within the state of Oregon. Governor Barbara Roberts expanded the declaration of drought emergency from 18 eastern and southern Oregon counties to a statewide drought emergency on 4 September 1992. The statewide declaration allows the state agencies to coordinate drought mitigation efforts and gives the Water Resources Department the authority to issue emergency water rights.

(3) Magnitude

The surface water supply index (SWSI, described in 4.C. Drought Assessment) for the 14 Oregon river basins in Oregon range from -1.1 to -3.1 during July 1992. As with many of the 14 basins, the Rogue River Basin SWSI index of -2.9 is near that experienced in 1977.

(4) Frequency

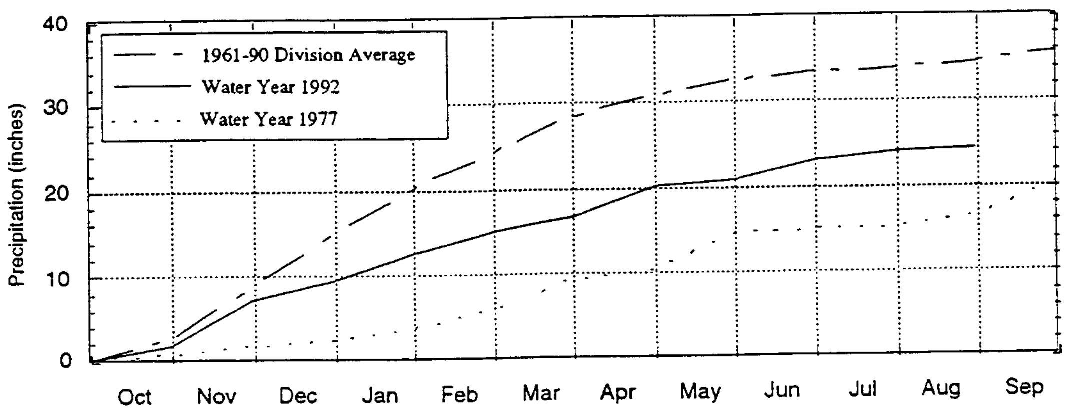
No frequency has yet been assigned this hydrologic period, however it will probably approach that of water year 1977, at 10 to 25 years.

(5) Severity

According to the National Weather Service, the El Niño of 1991 - 1992 was classified as a moderate to strong Southern Oscillation event. This event was the first El Niño that was predicted using computer models by a forecasting team at Columbia University Lamont-Doherty Geological Observatory, Scripps Institution of Oceanography, and Florida State University. The El Niño may have been altered by the 1991 eruption of Mount Pinatubo in the Philippines by producing a dust veil that cut down the solar radiation reaching the south Pacific Ocean.

Water Year 1992 was a dry water year throughout the Columbia River Basin and the Pacific Northwest. Figure 6 shows that the precipitation for the Rogue River Basin will be probably end up being about 70 percent of "normal" (1961-90).

FIGURE 6 - Precipitation for Rogue-Umpqua Basins



The April 1, 1992 snow water equivalences were 20 to 50 percent in the Southern Cascades. Oregon had the driest May on record. The May air temperatures were also the hottest Oregon has ever recorded. The final SCS water supply forecast, in June 1992, for this year indicated that the Rogue River at Lost Creek Lake would only receive 33% percent of normal runoff and that Applegate Lake would received only 23% of average.

4. STATE OF OREGON DROUGHT MANAGEMENT

All water rights in Oregon are managed by the State of Oregon. Prior to 1909, water rights were based on both the common law doctrine and the riparian doctrine. Subsequent to 1909, the common law doctrine was virtually abolished by the Oregon Water Code. The appropriation doctrine holds that a water right is limited to the quantity of water which is beneficially used, without waste. In 1935, an Oregon Revised Statute (ORS 537.10) concerning public ownership of water was established. The statute stated that All water within the state from all sources belongs to the public. During times of low streamflows, the appropriator with the oldest date of priority can demand water specified in their water right permit obtained from the Oregon Water Resources Department, regardless of the needs of other users. The date of priority, determined by the date of application for the permit, determines the seniority of the appropriators right. The more senior the water right, the longer water is available during periods of low streamflow.

A Water Resources Commission was created to establish water policies for the Water Resources Department. The state agency systematically evaluated the availability of water in each river basin. Through this process, the state allocated some of the unappropriated water to public use. The commission did these allocations by setting minimum streamflow levels. Minimum streamflows were administrative rules adopted starting in 1955. They were often set at the lowest levels which would support key fish species identified by the Department of Fish and Wildlife, or set at the lowest levels that did not violate Department of Environmental Quality water quality standards. They were not considered water rights, and they could be changed by the commission. Initially, minimum flows were established at locations where gaging stations existed. For these reasons, low streamflows limited the availability of fish habitat and recreational opportunity in many parts of the state.

A. Instream Water Rights

An instream water right law was enacted in Oregon via Senate Bill 140 during 1987. Oregon is one of 15 states, as of 1988, that have developed laws to establish and protect instream flows. The Oregon legislation recognized that public uses are beneficial uses, as defined by the appropriation doctrine. The act allowed the Departments of Fish and Wildlife, Environmental Quality, and the Parks and Recreation Division to request instream water rights from the commission. The law gives instream water rights the same status as other water rights, except that municipal uses may have priority over these rights. Unlike minimum streamflows, the commission cannot waive the instream right in favor of later water rights during the periods of low streamflow. Instream water rights have a priority date, and are regulated in the same way as other water rights. An instream water right cannot affect a use of water with a senior priority date. On the Applegate River, the instream water rights priority dates are from 1982. Water rights dates on the Rogue, however, are in need of clarification at this point.

Instream water rights do not guarantee that a specified quantity of water will be maintained in a stream or is available for use. When the water level in a stream is below the instream water right level, holders of junior water rights are required to stop using the water. A holder of a water right to the natural flow of the stream has no right to stored water in a reservoir without an additional storage permit.

B. Drought Management

The Oregon Water Resources Departments conservation efforts date back to the 1976-77 drought. A Drought Council to address drought issues was created. After the drought ended, the group was disbanded. In 1985, the Water Resources Commission directed the Department to report on other states conservation programs. Concomitantly, the Oregon Water Resources Department formed a volunteer work group to assist them in addressing water conservation and drought planning in 1985. Representatives from the Portland Water Bureau, U.S. Geological Survey, U.S. Soil Conservation Service, Oregon State University, Oregon Trout, and other private interests and citizens formed the Water Conservation/Drought Planning Work Group.

As a result of the low runoff in 1987, the Strategic Water Management Group was formed to represent the Governor of Oregon in natural resources issues. The group consists of the directors of all State agencies that are involved in natural resource management. They are responsible for drought management in the state. Their drought management plan was annexed to the Oregon Emergency Management Plan. The plan outlines potential actions for water districts, cities, counties, state agencies, and the Federal government to take during droughts. Also in 1987, the Oregon Water Resources Department organized a subcommittee of the Strategic Water Management Group (SWMG) called the Oregon Drought Council to monitor drought conditions around the state and to prepare a state drought response plan.

The Council (Table 1) consists of members from state agencies involved in drought forecasting, assessment, response, and recovery. The goal of the council is to reduce or mitigate the effects of any impending drought through coordinated Federal, State, Local, and voluntary effort. When drought conditions exist, the council submits weekly reports to the Governor. Then the Governor considers declaration of a drought on a county-by-county basis, or as a state-wide declaration, if appropriate. The Corps of Engineers representative on the Drought Council is a staff member from the Portland District Operations Division Emergency Management Branch. During drought conditions, representatives from the North Pacific Division Reservoir Control Center and/or the Portland District Planning and Engineering Divisions Hydraulics and Hydrology Branch will also attend, if necessary.

The Oregon Drought Council created the Water Availability Committee to monitor and evaluate current meteorological and hydrologic conditions, and to estimate future severity of low rainfall or runoff conditions. The Committee is headed by the Oregon Water Resources Department and includes The Oregon Department of Forestry, the State Climatologist, the U.S. Soil Conservation Service Snow Survey Section, the National Weather Service, the NWS River Forecast Center, and the U.S. Geological Survey as members. The Water Availability Committee meets monthly throughout the twelve months of the year. Potential drought conditions are reported to the Corps of Engineers by the Water Resources Department and the NWS River Forecast Center.

The Oregon legislature passed Senate Bill 152 in 1989 granting the Water Resources Commission emergency powers to manage waters of the state during a drought.

Table 1 - Oregon Drought Council

Chair:	Oregon Emergency Management
State Members:	Department of Agriculture Department of Economic Development Department of Energy Department of Environmental Quality Extension Service (Higher Education) Department of Fish and Wildlife Department of Forestry Department of Human Resources-Health Division Military Department Public Utility Commission Water Resources Department State Climatologist
Federal Members:	Farmers Home Administration U.S. Department of Agriculture Bureau of Land Management U.S. Army Corps of Engineers Bonneville Power Administration U.S. Forest Service U.S. Soil Conservation Service National Weather Service National Weather Service-River Forecast Center U.S. Geological Survey Bureau of Reclamation
Associations:	League of Oregon Cities American Water Works Association Oregon Association of Water Utilities

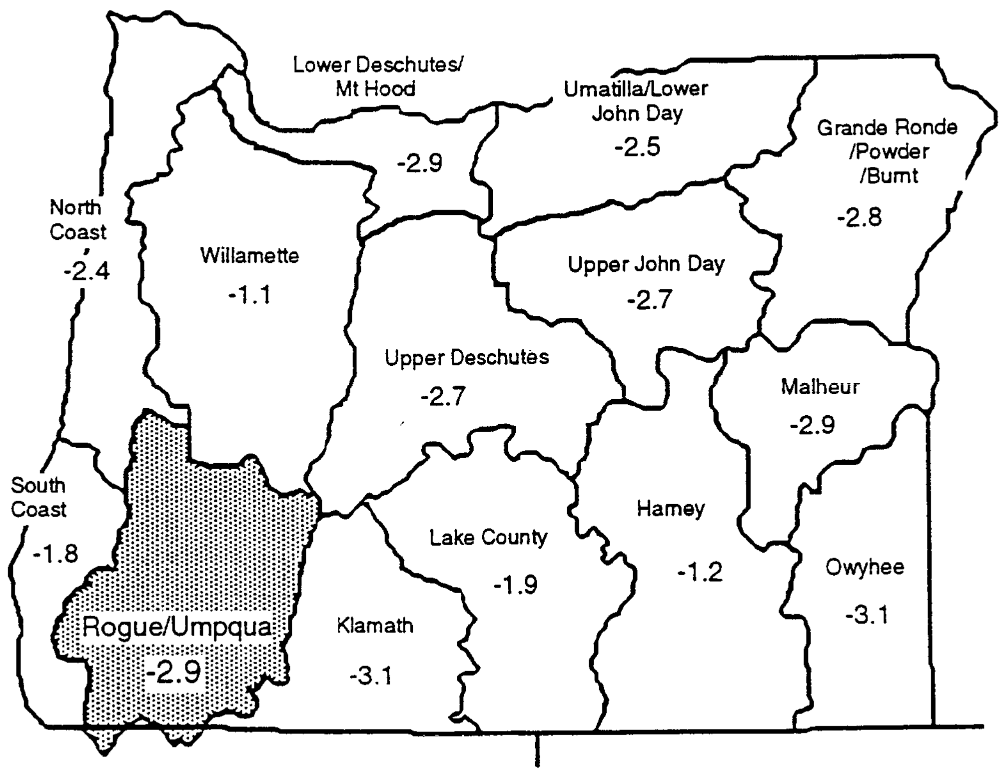
C. Drought Forecasts

The State of Oregon uses a drought assessment system called the surface water supply index (SWSI), which was developed by the U.S. Soil Conservation Service (SCS). The index is similar to what was developed by the SCS in Colorado during the early 1980s, with some important enhancements. The SWSI is calculated using mountain snowpack, precipitation, reservoir storage, and streamflow data to predict the anticipated water availability for the upcoming year. The SWSI scale measures anticipated water supply by drainage basin, ranging from a +4.1 representing extremely wet conditions to -4.1, representing extreme drought.

The enhancements include using different equations for different months, using all available data all of the time, using an objective method to determine coefficients, and using a 5-month running average to smooth the effects between months.

The SWSI Index is used for 14 river basins within Oregon to evaluate state-wide drought conditions. The basin indices for July 1992 is shown in Figure 7. The computed values are generally comparable to those for May of 1977. The May 1977 value for the Rogue/Umpqua basin was -3.1 or slightly drier than 1992.

Figure 7 - Surface Water Supply Index (SWSI) for 1 July 1992.



The Surface Water Supply Index (SWSI) is an index of current water conditions throughout the state. This index utilizes snow, precipitation, reservoir, and streamflow data for key stations in each basin. However, not every basin has all four data types. The lowest SWSI value is -4.1, which indicates extreme drought conditions. The highest SWSI value +4.1, which indicates very wet conditions. The mid-point at 0.0 represents a "normal" water supply.

The use of the Palmer Index to determine moisture conditions in the Pacific Northwest has been limited. Western water managers have felt that the Palmer Index does not effectively represent mountainous western regions where a significant portion of the water supplies are derived from snowmelt and where large reservoirs may have several years of stored water available for irrigation and other beneficial uses.

5. CORPS OF ENGINEERS WATER MANAGEMENT

The U.S. Army Corps of Engineers operates 2 of the five or six significant dams in the Rogue River Basin. The two dams operate for multi-purposes including; flood control, fishery enhancement, hydropower, etc.

A. Available Storage

The Corps reservoirs in the Rogue River Basin can store up to approximately 519,000 acre-feet of usable water. This represents about 12 percent of the average annual runoff of the Rogue River at Agness. A total of 35,000 acre-feet in Lost Creek Lake and 26,000 acre-feet in Applegate Lake have been authorized for irrigation use. There are only 3310 acre-feet of water actually contracted, as of March 1992. The Bureau implements and manages the sale of irrigation water for the Federal government. A contract holder with the Bureau must also obtain an Oregon Water Resources Department permit to withdraw water from an Oregon stream.

The storage of water in the Corps reservoirs of the Rogue River Basin is based on seasonal regulation schedules established according to the individual flood control rule curves for each dam.

B. Water Management Seasons

Three seasons are associated with reservoir regulation activities. The major flood season extends from early- to mid-November through January. Starting in February and a small amount in January, the conservation storing season lasts until the end of April. During this period, the reservoirs are normally filled to their maximum conservation pool level. Some of the natural inflow to the reservoir is passed through the dams to meet minimum releases required by the authorizing document. The adopted Federal minimum flows for the preservation of fish life are shown in Table 2.

Federal minimum release flows are not related to the state instream flow. If the reservoirs do not achieve their appropriate pool levels, the storage period is extended as long as there is sufficient water entering the reservoir. The conservation release season lasts from 1 May through 1 or 15 November. Water is released for all consumptive and nonconsumptive, non-flood control purposes during this period. Releases from each dam is composed of the volume of water that is equivalent to a combination of natural flows entering the reservoir and some component of stored water.

Water releases that are above the Federal minimum flows are usually made after Labor Day, up through the end of the conservation release season of each dam.

The Corps is reluctant to store water above the flood control rule curves during the conservation storing season of February through April, even though there appears to be a seasonal drought occurring. There does not appear to be any strong correlation between a seasonal drought with below average natural streamflows and the occurrence of a spring flood.

TABLE 2 - Minimum Instream Flows

Applegate River

Month	Dates		...Applegate River Gage Location... Copper (cfs)	Applegate (cfs)	Wilderville (cfs)
October	01	31	130	240	360
November	01	30	100	240	360
December	01	31	100	240	360
January	01	31	100	200	300
February	01	29	100	200	300
March	01	31	170	265	340
April	01	30	170	265	340
May	01	31	170	265	360
June	01	30	200	265	360
July	01	31	230	230	120
August	01	31	200	200	120
September	01	15	200	200	120
"	16	30	130	200	120

Rogue River

Month	Dates		Lost Creek Lake Release (cfs)
October	01	31	1,000
November	01	30	1,000
December	01	31	1,000
January	01	31	1,000
February	01	29	700
March	01	31	700
April	01	30	700
May	01	15	1,000
"	16	31	1,300
June	01	10	1,500
"	11	30	1,800
July	01	31	2,000
August	01	20	2,000
"	21	31	1,500
September	01	07	1,500
"	08	30	1,000

It is the Corps goal to fill the 2 storage projects on an annual basis to meet the streamflow goals on the Rogue and Applegate Rivers.

C. Recent State Actions

Recent court action (the Diack decision) has affected acceptable instream flows for designated State wild and scenic rivers[1]. In response to this decision the State has set standards of accept-

TABLE 3 - Proposed flow requirements for the Rogue River State Scenic Waterway (Applegate River to Lobster Creek) measured at the Agness gage, USGS #14372300 [Source: Bureau of Reclamation, May 1992]

Month	Minimum flow[1]	Maximum flow	Average flow[2]	Flow for fishery[3]	Recreation flow	Recommended scenic waterway flow
January	3,104	13,340	6,933	1,600	3,500	3,500
February	3,071	30,282	8,598	1,600	3,500	3,500
March	2,207	17,750	7,572	1,600/3,200	3,500	3,500
April	2,455	15,086	5,609	3,200	3,500	3,500
May	2,577	8,158	4,315	3,000	2,000	3,000
June	2,140	5,363	3,250	2,700	2,000	2,700
July	1,829	3,446	2,383	1,800	2,000	2,000
August	1,858	3,370	2,321	1,800/2,400	2,000	2,000/2,400
September	1,630	3,187	2,249	2,400/1,500	2,000/1,600	2,400/1,600
October	1,421	3,497	2,281	1,300	1,600	1,600
November	1,386	16,652	4,857	1,600	1,600/3,500	1,600/3,500

[1] Minimum and maximum flows are the lowest and highest mean monthly flows measured for the period of record 1981-1990.

[2] Average flow is the 50 percent exceedence (median) mean monthly flow value as estimated by ODWR for period of record 1981-1990.

[3] Flows for fish and wildlife are recommended through analysis of research done by McPherson and Satterthwaite (ODFW).

able instream flows for the lower Rogue River as shown in Table 3. These flowrates are measured at the Rogue River near Agness gage.

D. Technical Analyses

To develop a comprehensive water management plan and to adequately estimate and assess the effects of the plan on lake and instream water use operational goals are established and defined and analysis techniques are developed. The possibility or desirability of meeting operational goals is determined following an analysis of current basin conditions, a review of circumstances leading to current status, a relative ranking of use priorities, and a forecast of effects of various management alternatives.

[1] Progress Report, Fish Passage Improvement, Savage Rapids Dam, Josephine County Water Management Improvement Study, Rogue River Basin, Oregon; USDI, Bureau of Reclamation, Boise, Idaho, May 1992

(1) Base Conditions

Basic data such as historic flow and precipitation data are collected, organized, and maintained as an ongoing water management task. The basin should be described by a series of statistical analyses of river flow, precipitation, water demands, etc. Annual, monthly, seasonal, or other durations are used to represent various periods of interest. For example, statistics pertaining to the runoff during the conservation filling period is developed to use as a guide to the possibility of filling a reservoir. Ranking flows and developing discharge or precipitation-frequency curves allows easy comparison of hydrologic information periods or locations. Other information or operational constraints should be rigorously identified and reviewed; elevations of boat ramps and docks, flow requirements for boating, irrigation, fishery, etc. A list of general effects which would result from abnormally high or low water availability should be made. Specific values should then be applied where available or estimated where not readily apparent. The description of effects should be coordinated among interested local, state, and federal agencies, and other public or private individuals or groups on a periodic basis, the frequency of which depending on the severity of the drought situation.

Reliable realtime streamflow, precipitation, and reservoir data is required. These may be obtained through many different methods and redundancy of access methods is essential.

The technical analyses should result in a description of the nature of the climatology and typical and expected hydrologic conditions for the basin. These are the base from which water management plans and decisions are made and modified.

(2) Analysis Tools

Published data is generally available from the USGS or the NWS and from Corps project records for the Rogue Basin. These data are analyzed by several statistical applications for personal computers.

Reservoir regulation analysis tools are in a preliminary state of development. The important factor considered when implementing the analysis development is that a series of alternatives will often need to be compared. To provide timely responses to "what-if" alternatives, the analysis tools used for the Rogue Basin include both the HEC program HEC-5, Simulation of Flood Control and Conservation Systems and a personal computer spreadsheet application.

(3) Water Management Decisions during Drought Conditions

a. Current Conditions

Current hydrometeorological conditions and trends are established to form a starting point for future estimates of basin conditions.

b. Forecasts

Runoff forecasts are the most important, and perversely, the most tenuous of the information used in water management. Weather forecasts are quantitatively imprecise over a mid- to long-term period so estimates of future runoff is best made using current conditions; snowpack, soil moisture, streamflow, general weather pattern forecasts, etc. and comparing these with historic information. During a period with little precipitation, forecasts of runoff may be made by reviewing base flow conditions in streams and using statistical computations for extrapolating flow recession. These analyses should be based on current streamflow trends and compared to historical data to validate the estimates. Even with the best of data, the forecasted streamflows have some error associated with them. Therefore, the estimate should be based on a range of conditions and provide water managers with a range of possible future streamflows.

E. Interagency Coordination Meeting

The Corps of Engineers has been holding Federal and state agency coordination meeting for the Rogue River system since 1977. Corps proposed water release schedules are presented for discussion. A basic water release plan is developed for the June through October period using information about existing reservoir storage conditions, forecasted snowmelt runoff volumes, unregulated flow conditions, and conditions of the hydropower market. Operational constraints envisioned for project maintenance needs, competing project purposes, and downstream physical, environmental, and social needs are discussed.

6. CORPS OF ENGINEERS DROUGHT MANAGEMENT

Corps of Engineers drought management activities are performed as part of the regular reservoir regulation management process. The drought related water management work is integrated within the overall Corps water management responsibilities and associated activities.

A. Drought Forecasting

The Corps of Engineers relies on the Oregon Drought Council (see Section 4 B), and it's Water Availability Committee, to characterize the potential for drought conditions in the Rogue River Basin. The Surface Water Supply Index (SWSI) is the most used technical tool used to evaluate water conditions throughout the State of Oregon (see Section 4 C).

B. Management Issues in Drought Forecasting

Numerous issues arise during a period of low water. These include in-lake recreation, in-lake fishery, physical operating constraints on the dam structure and outlet works, downstream recreation, downstream fishery, irrigation, along with other minor concerns.

(1) Irrigation

There is, potentially, one major financial problem related to economic damages resulting from inaccurate drought forecasting. A $20 million lawsuit against the Federal government was filed against the U.S. Bureau of Reclamation in 1977. Erroneous forecast and calculation errors for the Yakima River Basin during the drought of 1976-77 caused the farmers of the area to adjust their farming practices that resulted in the loss of profits from crop sales, and caused added expenditures such as well drilling. The courts have not determined, as of August 1992, whether the Federal government is liable for these erroneous forecasts. This issue raises the question as to whether the public sector or the private sector should assume the liability for the declaration of a drought.

(2) Fisheries

One of the primary purposes of Rogue Basin Corps Projects is fisheries enhancement. The coordination of releases from Corps Projects is a major component in the development of a water management plan. This is especially true during periods of limited water supply. Various runs of anadromous fish and resident fish all vie for temporal distribution of stored water. Coordination with OWRD and ODFW becomes an ongoing process which will result in best use of the limited water supply.

Water in Corps reservoirs is used both as a quantity and temperature enhancement for downstream flows. Under low flow conditions, the problem of limited stored water becomes exacerbated by the fact that downstream water temperature control is severely limited by the shrinking availability of stored water at appropriate temperature.

(3) Recreation

Although recreation is not a primary purpose of the Corps Rogue River Project, the effects on recreation due to changes in operation brought about because of low-flow conditions can be significant. Types of recreation affected by flow regulation by Corps dams include but are not limited to; in-lake boating and swimming, downstream drift boat fishing, downstream jet-boating, rafting, and fishing.

In-lake problems include drafting the pool below usable levels for boat ramps and docks, exposing (or almost exposing) submerged islands or rocks, decreasing surface area which could lead to increased congestion, and drafting below usable levels for swimming beaches, parks, etc.

Downstream recreational needs often conflict for river water under the best of conditions. High flows desirable for fisheries may make certain instream activities more dangerous. Low streamflows can create congestion problems when motorized equipment completes with swimmers, rafters, and drifters for a narrow stream corridor. The inability of storage projects to completely alleviate the low flow conditions during a drought is reasons for a carefully throughout release schedule to minimize the adverse affects.

(4) Reservoir Refilling

Another consideration is the possibility of refilling the reservoir in time for the next conservation use season. Careful review of the amount of runoff required during the winter and spring to refill the projects is made. The risk of not refilling is subjective but may be used with other factors to fix a minimum pool level acceptable during drought operations.

C. Drought Management Action Plan

At the start of each calendar year, the Reservoir Regulation Section of the Portland District begins an evaluation of the potential runoff of the system to fill the conservation storage space available at the Corps dams in Rogue River Basin. Using various indices and water supply forecasts, the rainfall and streamflow conditions in the Rogue River Basin are monitored and evaluated on a continual basis.

Four drought action plan levels have been established to guide progressively intensifying reservoir regulation water management actions in the event of a drought. These levels present an outline of actions necessary to effectively manage the Willamette Basins surface water resources stored, and potentially stored in the Corps reservoirs, during the time of water shortage. The actions broadly relate to the level of drought severity.

The following four action level plans described below give water resources managers a basic framework to carry out a drought response.

ACTION LEVEL

LEVEL 1 This action level is designated the drought advisory phase. Level 1 is reached when the rainfall and runoff forecasts show that the Corps' Rogue reservoir system will not fill to their maximum conservation pool levels. Normal operational procedures are followed by staff regulators. Status reports are provided to the first and second level management. North Pacific Division Reservoir Control Center staff will initiate a dialogue with Portland District Reservoir Regulation and Water Quality Section staff about the potential for a drought.

LEVEL 2 This action level is designated the drought watch phase. Level 1 activities are expanded. Extra management emphasis is placed on rainfall and runoff indices. Verbal discussions are initiated with the Oregon Department of Water Resources Regional Manager for the Rogue River Basin concerning the need to drop below the Federal minimum flow requirements for fish life to fill the reservoir system (Table 2). Verbal coordination with Federal and State fisheries agencies occurs.

LEVEL 3 This action level is designated the drought warning phase. Level 1 and 2 activities are expanded. Engineering and Planning, and Operations Division-level briefing are provided to Corps management. Senior management level staff are kept informed of the drought situation. Interagency meetings with the Oregon Water Resources Department, Department of Fish and Wildlife, Department of Environmental Quality, Marine Board, and Parks and Recreation Department are scheduled to discuss the inability of filling the system to the maximum conservation pool levels by June 1.

LEVEL 4 This action level is designated the drought distress phase. Level 1, 2, and 3 activities are continued. Drought distress occurs when the summer releases cannot meet 1000 cfs releases from Lost Creek Lake or 100 cfs releases from Applegate Lake. Additionally, another indicator of the drought distress phase is the need to use water to meet drought-modified target flows by exhausting the carryover storage at either lake by the end of December. At the beginning of the drought distress phase, a District Drought Management Committee is activated. The committee coordinates requests and actions related to the drought to assure that various elements of the Corps are responding to the drought issues in a coordinated effort. Water management staff provided briefings and participate in Drought Council and Drought Advisory Committee meetings.

D. District Drought Management Committee

The District Drought Management Committee for the Rogue River Basin projects consists of Portland District (NPP) representatives. Representatives will include the Chief of the Hydraulics and Hydrology Branch, the chief of the Reservoir Regulation and Water Quality Section, the chief of the Hydrologic, Coastal, and River Engineering Section, the Project Manager of the Rogue Valley Projects, a representative from the Regulatory and Environmental Resource Branch, and a representative from the Public Affairs Office. The chair of the committee will be the chief of the Hydraulics and Hydrology Branch.

The purpose of the Corps Drought Management Committee will be to coordinate procedures and communicate actions that will be required by the drought management action plan.

E. Water Year 1992 Drought Management

Water year 1992 runoff was among the lowest since record have been kept in the Rogue River Basin. It is the lowest year since the 2 Corps dams were constructed. It has provided in realtime a model to develop and fine-tune the Corps' drought management actions.

(1) Coordination and Issues

The major issues this year revolved around inlake and instream recreation, fishery flow enhancement, and how low to draw Applegate and Lost Creek Lakes. The driving force for setting releases from the projects was for based on fishery needs as recommended by OWRD and ODFW. The problems were emphasized because neither lake filled during the spring 1992 filling season. This was the first year that Lost Creek Lake had not filled. The Rogue Basin water management plan was set in two phases this year, rather than one, following consultation among various state and federal agencies. The extreme low flows and uncertainty of summer runoff made it prudent to fix releases from the projects first through 10 August, then through the remainder of the conservation use season, 31 October. The two phase approach allowed a formal review of water management plans with updating of flow information later in the summer.

The release schedules were essentially those requested by OWRD and ODFW. These releases were based on using the limited water available to minimize fall chinook mortality. However, flow patterns which are good for fish are not necessarily those which are optimum for drifting and jet boating. These recreation groups worked around releases and planned their businesses accordingly. In the lakes, recreation opportunities were curtailed much earlier in the year than normal due to falling lake levels. Lake levels were falling about two months ahead of normal. The marina at Lost Creek Lake was "out-of-water" and generally unusable in mid-August 1992.

(2) Analyses

The phase one water management plan was based on the spring SCS and Corps runoff forecasts for May through September. These runoff forecasts permitted analyses of various release proposals and the effects on recreation, fishery, and future water supply. Phase two used updated Corps runoff forecasts. The new runoff forecasts were estimated using a regression analysis of observed inflows to Lost Creek Lake. It was assumed that the streamflow recession would be gradual and follow the trend exhibited by observed daily lake inflows. A new analysis of reservoir operation using HEC-5 was performed with several outflow proposals through the next filling period, May 1993. This type of analysis allowed both lakes' level and streamflow to be characterized. Estimates were made of the lowest level the lakes would reach and what type of runoff would then be required to refill each lake next year; i.e. percent of average runoff. Rankings and statistical estimates provided a qualitative "risk" assessment of the water management plan. Further refinement of the techniques in future years will enhance the decision making process.

(3) Actions

Based on runoff forecasts, several release plans were developed for the Rogue Basin projects. The plans were regularly reviewed during the conservation use season and were modified through when conditions warranted.

Lost Creek Lake releases were modified both temporally and in quantity to best meet the most important priorities during the year. Due to the already depressed situation and the possible long-term ill-effects, fishery enhancement was given top priority for manipulation of flow releases. Lost Creek Lake will have, on average, doubled natural flows at the project during the period May through September.

In June, Applegate Lake releases were set through November. This plan was subsequently altered, in September, due to lower than anticipated inflows, and the desire to maintain a minimal quantity of water in the lake in case of low winter flows.

7. WATER SUPPLY CONTRACTS

Each spring, when reservoirs in the Rogue River Basin at their highest pool level, the conservation storage volume is determined. This calculation determines the full impact of any drought on the system. Plans for the conservation release season are made in consultation with other Federal and State agencies, as described in Section 4 B.

When stored water is in excess of meeting the authorized project purposes it can be identified as surplus water and becomes available for contracts. The two Corps reservoirs in the Rogue River Basin can store up to approximately 519,000 acre-feet of usable storage. Under extreme emergency conditions, inactive and dead storage may be released with the assistance of a temporary pumping plant. There are only 3310 acre-feet of water under long-term contract, as of March 1992; 1148 acre-feet in Lost Creek Lake and 2162 acre-feet in Applegate Lake. Without any reallocation process, the remaining water can become available for emergency use as described in Section 6 of the 1944 Flood Control Act (Public Law 78-534). Determination of the availability of stored water is done in consultation with the USBR. The price of the available water is adjusted annually based on actual costs associated with constructing and maintaining the reservoir.

The withdrawal of water from streams, lakes, and the withdrawal of water released from reservoir storage is regulated by the Oregon Water Resources Department (OWRD) under the Appropriation Law. An applicant must first file for water with OWRD. Any withdrawal permit for stored water will be issued subject to a contract or agreement with the owner/operator of the facility (such as the Corps of Engineers).

For temporary drought relief and for purposes other than crop irrigation, Corp Project Managers are authorized to sign contracts for drought relief where water can be taken directly from the reservoir (ER 1105-2-100). There are two types of contract forms. Exhibit 1 shows the short, one page, form that can be used for quantities less than 50 acre-feet, but for not less than $25. The longer form (Exhibit 2), for quantities of 100 acre-feet or greater are subject to approval by higher authority. Water taken from the streams below Corps projects will require the use of the five-page contract form. Authority to sign these contracts is reserved to the appropriate higher authority.

Contracts forwarded to higher authority must be accompanied by a brief letter report assessing the impacts of the surplus water contract. To expedite this process, a quantity of drought contingency storage is being apportioned in advance, separate from the surplus storage.

Information needed to fill out the contract forms such as, availability of storage and the current price of storage, are available from CENPP-PE-HR and updated annually.

8. PUBLIC INFORMATION

The reservoir regulation staff works with the Public Affairs staff to provide the news media and the general public with water resources information related to Corps projects in the Rogue River Basin, using a positive approach to deal with drought distress situations. Annual public information meetings are held every May in locations such as Eugene, Sweet Home, Stayton, and Salem. The purpose of the meetings are to inform people about the water release strategies being considered by the interagency group described in Section 5 E. After receiving public comment, a summer water release strategy is finalized by the Corps of Engineers. A news release describing the water release plan is distributed to the media.

A. Toll-Free Telephone Information

A toll-free (800) telephone number is installed by the Public Affairs Office of the Portland District. Weekly recorded messages are updated with current information concerning Corps reservoirs that have good recreation, and with information concerning reservoirs whose boat ramps have limited service, or are out of service. The telephone message is updated weekly by the Public Affairs staff. The toll-free number is publicized by television, radio, and newspaper service announcements (Exhibit 3).

B. Public Service Announcements (PSA)

A public service announcement is prepared by the Public Affairs Office for Level 3 Drought Warnings and Level 4 Drought Distress condition (Exhibit 4). The PSA is mailed to television stations in Portland, Eugene, and Salem. The PSA contains information about the toll-free telephone number.

C. News Releases

Monthly, or bimonthly, or more frequently if required, news releases containing updated water resources facts concerning the drought, as they related to Corps reservoir conditions, are prepared and distributed (Exhibit 5). News releases are produced cooperatively by the reservoir regulation staff and the Public Affairs staff. The Public Affairs staff are responsible for distributing the news releases.

D. Flyers

Flyers are produced by the Public Affairs Office (Exhibit 6) for posting at the Corps projects, local Chambers of Commerce, and State and other Visitor Information Centers.

E. Interviews

The Public Affairs staff and the reservoir regulation staff provide telephone, radio and television interviews to the news media concerning reservoir conditions, and related streamflows conditions, as needed.

EXHIBITS

Exhibit 1	Water Contract Short Form
Exhibit 2	Water Contract Long Form
Exhibit 3	Public Service Announcement
Exhibit 4	Drought Distress Public Service Announcement
Exhibit 5	News Release - General Reservoir Condition
Exhibit 6	Public Affairs Office Flyers

EXHIBIT 1

WATER WITHDRAWAL PERMIT
__________ LAKE

Pursuant to the authority contained in Section 6 of the Flood Control Act of 1944 and in recognition of the declaration of emergency in the State of __________, as declared by the Governor, this permit grants permission to __________ to withdraw water subject to the following conditions:

a. Payment of __________ 1/ for the withdrawal of up to __________ 2/ gallons of water during __________ 3/. User will report the amount of each withdrawal to the Project Office.

b. Right-of-entry and permission to withdraw water is granted only at the location(s) designated by the Corps of Engineers.

c. Should facilities, such as roads, etc. be damaged by the User as a result of emergency uses, the User may be assessed and billed a follow up charge to help in the cost of necessary repairs.

d. Your copy of this permit must be displayed during water withdrawal.

f. The User certifies that water withdrawn from the project is for domestic and/or industrial purposes and will not be used for crop irrigation purposes.

g. The User agrees to comply with appropriate State laws concerning water rights and uses and will obtain permits as are required.

h. The User shall hold and save the Government, including its officer, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the withdrawal of water from the Project by the User, or as a result of the operation or maintenance of any facilities or appurtenances owned and operated by the User.

User's Name __________
(Print)
Address __________
Telephone __________
User's Signature __________

Government Approval __________
(Project Manager)

Today's Date __________

1/ The dollar value of the storage utilized as determined by the pricing policy, or $25., whichever is larger. The $25. represents the minimum cost for storage that will be marketed.

2/ The number of gallons that the storage utilized yields on an annual basis. The minimum amount being the yield represanted by a cost of $25.

3/ Explain the time period allowed for the withdrawal as well as other time related specifications for the withdrawal, such as a maximum rate over any given time period. The period shall not exceed one year.

EXHIBIT 2

SURPLUS WATER CONTRACT
BETWEEN THE UNITED STATES OF AMERICA
AND
____
FOR
SURPLUS OF WATER FROM ______________________

THIS CONTRACT, entered into this ______ day of __________, 19__, by and between the UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and __________ __________, (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, pursuant to *Public Law _______, ________ the Congress, ______ Session, approved __________________ 19__, the Government has constructed and is operating ______________, (hereinafter called the "Project"); and,

WHEREAS, Section 6 of the Flood Control Act of 1944 (Public Law 78-534), as amended, provides that the Secretary of the Army is authorized to make contracts with states, municipalities, private concerns, or individuals, at such prices and on such terms as he may deem reasonable, for domestic and industrial uses for surplus water that may be available at any reservoir under his control provided that no contracts for such water shall adversely affect the existing lawful uses of such water; and,

WHEREAS, the User desires to contract with the Government for the privilege of withdrawing surplus water from the Project;

NOW, THEREFORE, the parties do mutually agree as follows:

ARTICLE 1 - Water Supply and Withdrawals.

a. The Government will reserve ______ acre feet of storage space in the Project in order to meet the water demands of the User. From this storage space the User shall have the privileges of withdrawing water at a rate not to exceed __________ during the term of this contract as specified in Article 6 hereof.

b. The User shall have the right to construct, operate and maintain installations and facilities, or to contract with third parties therefor, for the purpose of withdrawing water from the Project, subject to the approval of the Contracting Officer as to design and location of such installation and facilities. All costs associated with such installations and facilities or any modifications thereof or any future construction in connection therewith, shall be without expense to the Government.

*Use correct authorization citation (e.g., WRDA of 19__, Public Law __-____).

c. The Government reserves the right [to maintain at all times minimum downstream releases through the gates or spillway of the dam to meet established water requirements] [to maintain at all times a minimum downstream release of ______ cubic feet per second through the gates or spillway of the dam.] [to lower the water in the Project to elevation ________ feet National Geodetic Vertical Datum during such periods of time as are deemed necessary, in its sole discretion, for flood control purposes.] [to control and use any future water supply storage and/or any water supply storage not under contract in accordance with authorized Project purposes.] The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

d. The User recognizes that this contract provides storage space for raw water only. The Government makes no representation with respect to the quality or availability of water and assumes no responsibility therefor, or for treatment of the water. The water level of the Project will be maintained at elevations which the Government deems will best serve the authorized purposes of the Project, and this contract shall not be construed as giving the User any rights to have the water level maintained at any elevation. The User further recognizes that it is acquiring no permanent right to the use of storage in the Project.

ARTICLE 2 - Metering. For the purpose of maintaining an accurate record of the water withdrawn from the Project, the User agrees to furnish and install, or cause to be installed, meters or measuring devices satisfactory to the Contracting Officer, without cost to the Government. As required, the User agrees to furnish to the Contracting Officer advance estimates of need and records of the quantity of water actually withdrawn. Such devices shall be available for inspection by Government representatives at all reasonable times.

ARTICLE 3 - Federal and State Laws.

a. The User shall utilize the water withdrawn from the Project in a manner consistent with Federal, State, and local laws.

b. The User furnishes, as part of the contract, an assurance (Exhibit __) that the User will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 252; 42 U.S.C. 2000d, et seq) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

c. Any discharges of water or pollutants into a navigable stream or tributary thereof resulting from the User's facilities and operations undertaken under this contract shall be performed only in accordance with applicable Federal, State and local laws and regulations.

ARTICLE 4 - Regulation of the Use of Water. The regulation of the use of and water rights needed for the water withdrawn or released from the storage space shall be the sole responsibility of the User and under the sole authority of the User in accord with Federal, State, and local laws and shall not be considered a part of this contract. The Government shall not be responsible for the use of water by the User, nor will it become a party to any controversies involving the water use, except as such controversies may affect the operations of the Project.

ARTICLE 5 - Consideration and Payment. (To be determined by the pricing policy as described in paragraph 4-32b of this regulation. Derivation of costs and storage volumes need to be provided in an exhibit similar to that used in storage contracts.)

(a) In consideration of the right to withdraw _____ acre-feet per calendar year for [not to exceed five (5) years] from the Project for municipal and industrial water supply purposes, the User shall pay the Government $_____ [per year, the first of] which shall be due and payable within thirty (30) days of the effective date of the contract as set forth in Article 6 herein. [Future payments thereafter will be due and payable on [the anniversary date the first payment is due.][(day and month) each following year, beginning in (year).]]

(b) The repayment amount shown in Article 5(a) is based upon joint use and specific water supply construction costs updated to October 19___ price levels using appropriate indices and the Fiscal Year 19____ water supply interest rate of ______________ percent as computed by the Secretary of the Treasury in accordance with Section 932 of the Water Resources Development Act of 1986 (Public Law 99-662).

(c) If the User shall fail to make any payment under this contract within thirty (30) days of the date due, interest thereon shall accrue at the rate as determined by the Department of Treasury's Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management") and shall compound annually from the date due until paid. This provision shall not be construed as waiving any other rights the Government may have in the event of default by the User, including but not limited to the right to terminate this contract for default.

ARTICLE 6 - Duration of Contract. This contract shall become effective as of the date of the approval by the [Secretary of the Army or his duly authorized representative] [Contracting Officer], and shall continue in full force and effect under the conditions set forth herein, for a period of not to exceed 5 years from the said date of approval. Upon expiration, this contract may be extended by mutual agreement for additional periods of not to exceed 5 years each. All such contract extensions shall be subject to recalculation of reimbursement.

ARTICLE 7 - Termination of Contract.

a. Either party may terminate this contract and the privilege of withdrawing water upon [period] written notice. In the event of termination under this paragraph, the Government will make pro rata refund for any balance of the contract term for which payment has been made and the User will pay all charges which have accrued through the date of the termination.

b. The Government may terminate this contract and the privilege of withdrawing water upon ninety (90) days written notice, if the User shall default in performance of any obligation of this contract. Upon such a termination, User shall continue to be liable to the Government for any monies owned and for any costs incurred by the Government as a result of the default.

c. In the event of any termination pursuant to this Article or Article 6, User shall, upon request of the Contracting Officer, promptly remove, at User's own expense, any facilities constructed on Project land for water withdrawal and restore premises around the removed facilities to a condition satisfactory to the Contracting Officer.

<u>ARTICLE 8 - Rights-of-Way</u>. Occupancy and use of Project lands shall be in accordance with any permits, rights-of-way, or easements granted to the User by the Government.

<u>ARTICLE 9 - Release of Claims</u>. The User shall hold and save the Government, including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the withdrawal or release of water from the Project made or ordered by the User, or as a result of the construction, operation or maintenance of any facilities or appurtenances owned and operated by the User except for damages due to the fault or negligence of the Government or its contractors.

<u>ARTICLE 10 - Transfer or Assignment</u>. The User shall not transfer or assign this contract nor any rights acquired thereunder, nor suballot said water or storage space or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army or his duly authorized representative provided that, unless contrary to public interest this restriction shall not be construed to apply to any water which may be withdrawn or obtained from the water supply storage space by the User and furnished to any third party or parties or to the rates charged therefor.

<u>ARTICLE 11 - Officials Not to Benefit</u>. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

<u>ARTICLE 12 - Covenant Against Contingent Fees</u>. The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this contract without liability, or in its discretion, to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13 - Environmental Quality. During any construction, operation, and maintenance by the User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of water and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 14 - Approval of Contract. This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this contract as of the day and year first above written.

APPROVED: THE UNITED STATES OF AMERICA

__________________________ By ______________________
1/ (Contracting Officer)

[Insert name of User]

DATE:__________ By ______________________
[Title]

1/ Fill-in Title of appropriate approving Government official if other than the District Commander.

(Necessary approvals and countersignatures required by State and local law with respect to execution on behalf of the User must be ascertained by the Contracting Officer and his Counsel and added to the signature block.)

EXHIBIT 3

Grants Pass, OR
(Josephine Co.)
Daily Courier
(Cir. D. 17,580)

APR 23 1992

Allen's P. C. B Est. 1888

Word out on reservoirs

The word is 'trickle'

By Jeff Duewel
of the Daily Courier

Water outflows from Lost Creek and Applegate Reservoirs will be at record lows this summer because of extreme drought.

Officials from the U.S. Army Corps of Engineers, State Water Resource Department and Oregon Department of Fish and Wildlife set outflows Tuesday in Salem. The plans will be up for public comment at 7:30 p.m. May 11 at the Grants Pass City Council chambers, 101 N.W. A St.

"I'm sure these are near the lowest outflows we've ever had," said Dick Cassidy, chief of reservoir regulation and water quality section for the Corps of Engineers in Portland. "We're still looking for it to be quite dry in the basin through the fall."

Cassidy said that snowpack in the Rogue basin is 50 percent of what it was in the drought year of 1977, and inflows into Lost Creek will likely be only about 60 percent of normal from April through July. Inflows into Applegate are projected at 34 percent for the same period.

As a result, the Corps will be storing water a month past the normal filling date of May 1; and even then, the reservoirs will not be full.

Cassidy said the schedule could change following the May 1 snow survey results and if more precipitation than normal falls. A year ago heavy rains in April and May drastically changed summer flows.

Cassidy said Lost Creek Lake will probably end up 20 feet below full pool this year, the first time it hasn't filled. Applegate will likely fall 30 feet short of full pool, which would be at least the fifth time the reservoir has not filled.

The tentative outflow schedule from Lost Creek is:

- **May 1-15** — 1,000 cubic feet per second.
- **May 16-31** — 1,650 cfs.
- **June 1-July 15** — 1,760-1,800 cfs.
- **July 15-Aug. 10** — 1,350 cfs.
- **Aug. 11-Sept. 10** — 1,850 cfs.

EXHIBIT 4

DEPARTMENT OF THE ARMY
PORTLAND DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2946
PORTLAND, OREGON 97208-2946

U.S. Army Corps of Engineers
BONNEVILLE LOCK & DAM
in Celebration of our
50
Fiftieth Year

July 9, 1987

Public Affairs Office
(CENPPPA)

Dear News Director:

Drought conditions may mean inconvenience to people looking for water based recreation this summer. To assist individuals, we have set up an 800 number with a recorded message to provide current information on Corps' reservoirs with good recreation, and areas with limited or no access. We are asking for your assistance in letting your viewers know about this number.

As the Pacific Northwest's dry conditions continue, forecasts show the possibility of near-record low water levels throughout the state.

Latest runoff forecasts for the Willamette basin indicate that only three of the eleven Corps' reservoirs will fill this year. A water shortage has been declared at Applegate Lake near Medford and water levels in the Columbia River have dropped to levels normally not seen until late August.

While U. S. Army Corps of Engineers' reservoirs supply water for irrigation, water supply, hydropower, fisheries and water quality needs, experts predict recreation interests will be hardest hit.

Will you please show the enclosed public service announcement during July and August particularly on Thursdays and Fridays when your viewers are making their weekend plans. We will update the 800 number recording weekly while the drought lasts.

Sincerely,

ALENE J. JACQUES
Public Affairs Officer

Enclosure

JACQUES/PA
BRIMHALL/PA
6005

EXHIBIT 5

News Release

US Army Corps of Engineers
Portland District

Release No.
PA 92-48
For Release:
August 12, 1992

Contact:
Heidi Y. Brown
Phone:
(503) 326-6005

LOW WATER LEVELS AT LOST CREEK LAKE

Portland, Ore.--Low water levels at Lost Creek Lake may cause boating hazards and inconveniences, the Portland District, U.S. Army Corps of Engineers, announced today.

Earlier this month, federal and state agencies agreed on a remainder-of-the-season water release plan for Lost Creek Lake in Southern Oregon.

August 13, water releases from Lost Creek Lake will be increased to 2,200 cubic feet per second (cfs) from the current 1,000 cfs, and held at that amount until Aug. 31. River users should be aware of possible water level changes during this time.

Because of the increased releases, Lost Creek Lake's pool elevation is expected to drop to 1,812 feet, or minimum operating pool, by Aug. 15 or 16. The Stewart State Park boat ramp becomes unusable somewhere between elevation 1,810 feet and 1,812 feet, depending on the boat and trailer size.

Boaters may use the Takelma day-use boat ramp on the north shore, which should remain open throughout the recreation season.

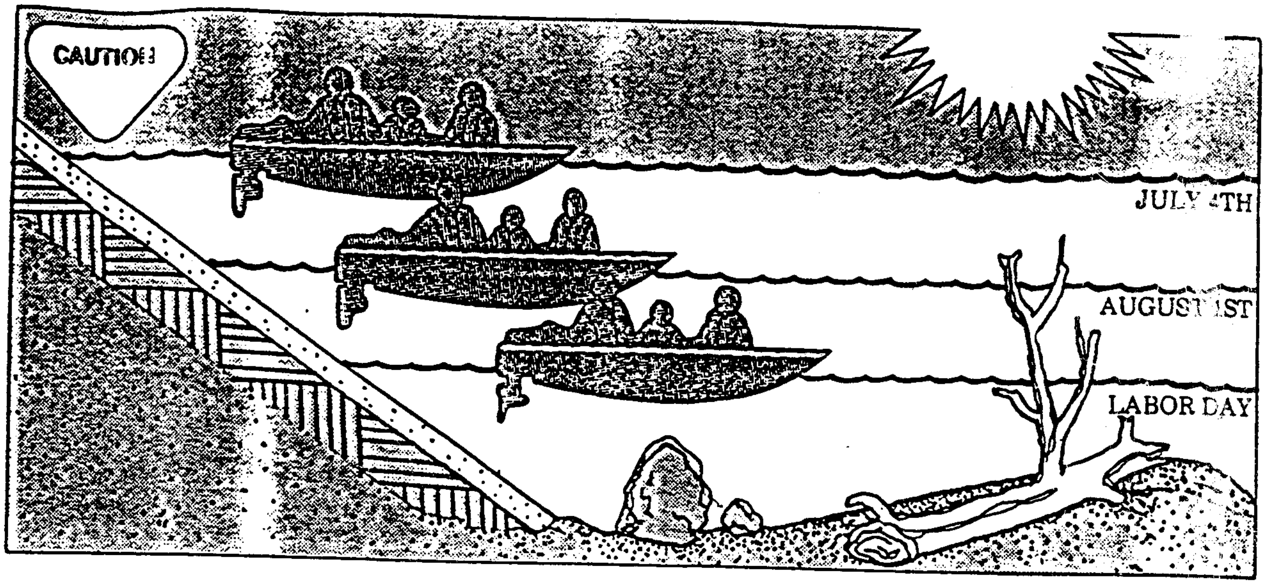
Boaters and water skiers are reminded to be alert near shorelines where stumps and other hazards may exist. Also, they are reminded to watch for buoys and for unmarked hazards that low water levels may reveal.

Boaters can call 1-800-472-2434 to reach a recorded message with information on Lost Creek Lake levels and water releases. They also may call the project office at (503) 878-2255.

Also, interested recreationists can call 1-800-892-8601 to reach a recorded message providing current recreation information about Corps of Engineers lakes through out the Willamette Valley and in the Rogue Basin.

EXHIBIT 6

Summer 1987



Drought conditions may mean inconvenience to people looking for water based recreation this summer, while U. S. Army Corps of Engineers' reservoirs supply water to the Willamette Valley for irrigation, water supply, hydropower, fisheries, and water quality needs.

Most reservoirs will have some boat ramps in service throughout the summer, however there may be limited water recreation because of low water levels, exposed banks, and reduced access.

Boaters should watch for submerged stumps and shallow shorelines and decrease their speed especially in the upper reservoir areas. Waterskiiers need to use extra caution. Some river areas downstream of the dams may be shallow.

Conditions will be continuously reevaluated and may change depending on this summer's weather and streamflow conditions.

For information about the Corps of Engineers recreation area you want to visit, call:

1-800-521-0848

Table 1-1. Conversion from English Units to SI Units.

Length Conversion

English Unit		SI Unit
1 inch	=	2.54 cm
1 foot	=	0.3048 m
1 mile	=	1.6093 km

Area Conversion

1 $inch^2$	=	6.452 cm^2
1 $foot^2$	=	0.0929 m^2
1 acre (43,560 ft^2)	=	4,047 m^2
1 square mile (640 acres)	=	2,589,998 m^2 259 Hectares

Volume Conversion

1 $inch^3$	=	16.39 cm^3
1 $foot^3$	=	0.02832 m^3
1 acre-foot (43,560 ft^3)	=	1,233.5 m^3

Flow Conversion

1 ft^3/second (ft^3/s)	=	0.0283 m^3/second 28.317 liters/second

Miscellaneous Conversions

1 ft^3/day (ft^3/d)	=	1.9835 acre-feet/day
°F	=	(°F-32)/1.8 = °C

Table 1-2. Lost Creek Project Design Memorandums.

No.	Subject	Submission Date
1.	Site Selection	Jun 65
2.	Hydrology and Meteorology	Feb 66
3.	Hydropower Capacity	May 66
4.	General Design (Includes Foundation and Material Appendix)	Jun 66
	Supplement No. 1 - Development of North Shore Area	Apr 74
	Supplement No. 2 - Needle Rock Slide	Dec 74
	Supplement No. 3 - Needle Rock Slide	Oct 75
5A.	Preliminary Master Plan	Sep 66
6.	Relocations of Roads and State Park	Aug 66
	Supplement No. 1 - Right Bank Bypass Road	Mar 67
	Supplement No. 2 - Peyton Bridge	Dec 67
	Supplement No. 3 - McLeod Bridge	Feb 68
	Supplement No. 4 - Oregon State Route No. 62	Jul 71
	Supplement No. 5 - Right Bank Road Upper Section	Aug 73
	Supplement No. 6 - Right Bank Road Lower Section	Oct 74
7.	Real Estate	Sep 66
8.	Fish Facilities	Jul 67
	Supplement No. 1 - Spawn Building	Dec 67
9.	Spillway and Outlet Works	May 68
10.	Clearing and Stump Removal	Dec 67
11.	Embankment Design	Jun 68
12.	Powerplant	Feb 70
	Preliminary Design Report	
13.	Powerhouse - Structural	May 71
14.	Powerhouse - Architectural	Apr 71
15.	Powerhouse - Mechanical	Jul 71
16.	Service Building	Jun 72
17.	Concrete Aggregate Investigations	Mar 70
	Supplement No. 1	May 73
18.	Relocation of Power and Telephone Lines	Aug 71
19.	Reservoir Regulation	Sep 71
20.	Relocation of Isolated Burial Sites	Oct 72
21.	Geology and Foundations	Oct 72
22.	Master Plan	Jun 74
23.	Inspection and Evaluation	Aug 74
-	Embankment Criteria and Performance Report	Jun 81
-	Foundation Report	Dec 81
24.	Earthquake and Fault Study	Mar 82

Table 2–3. Capacity Table for Lost Creek Lake

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1550.0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
1551.0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	1	1	1
1552.0	1	1	1	1	1	1	1	1	2	2
	1	1	1	1	1	1	1	2	2	2
1553.0	2	2	2	3	3	3	3	4	4	4
	2	2	2	2	2	3	3	3	3	3
1554.0	4	5	5	6	6	6	7	7	8	8
	3	4	4	4	4	4	4	5	5	5
1555.0	9	9	10	10	11	12	12	13	14	14
	5	5	6	6	6	6	7	7	7	7
1556.0	15	16	17	18	18	19	20	21	22	23
	8	8	8	8	9	9	9	9	10	10
1557.0	24	25	26	27	28	30	31	32	33	35
	10	11	11	11	11	12	12	12	13	13
1558.0	36	37	39	40	41	43	45	46	48	49
	13	14	14	14	15	15	16	16	16	17
1559.0	51	53	55	56	58	60	62	64	66	68
	17	17	18	18	19	19	19	20	20	21
1560.0	70	72	74	76	79	81	83	85	88	90
	21	21	21	22	22	22	22	23	23	23
1561.0	92	95	97	99	102	104	107	109	112	114
	23	24	24	24	24	25	25	25	25	26
1562.0	117	119	122	125	127	130	133	135	138	141
	26	26	26	27	27	27	27	28	28	28
1563.0	144	147	150	153	155	158	161	164	168	171
	28	29	29	29	30	30	30	30	31	31
1564.0	174	177	180	183	186	190	193	196	200	203
	31	31	32	32	32	33	33	33	33	34

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1565.0	206	210	213	217	220	224	227	231	234	238
	34	34	35	35	35	36	36	36	36	37

1566.0	242	246	249	253	257	261	265	269	272	276
	37	37	38	38	38	39	39	39	40	40
1567.0	280	284	289	293	297	301	305	309	314	318
	40	40	41	41	41	42	42	42	43	43
1568.0	322	327	331	335	340	344	349	353	358	363
	43	44	44	44	45	45	45	46	46	46
1569.0	367	372	377	381	386	391	396	401	406	411
	47	47	47	48	48	48	49	49	50	50
1570.0	416	421	426	431	436	441	446	452	457	462
	50	51	51	51	52	52	52	53	53	53
1571.0	468	473	479	484	490	495	501	506	512	518
	54	54	55	55	55	56	56	56	57	57
1572.0	523	529	535	541	547	553	559	565	571	577
	58	58	58	59	59	59	60	60	61	61
1573.0	583	589	595	602	608	614	620	627	633	640
	61	62	62	63	63	63	64	64	65	65
1574.0	646	653	659	666	673	680	686	693	700	707
	65	66	66	67	67	67	68	68	69	69
1575.0	714	721	728	735	742	749	756	764	771	778
	70	70	70	71	71	72	72	73	73	73
1576.0	785	793	800	808	815	823	831	838	846	854
	74	74	75	75	76	76	76	77	77	78
1577.0	861	869	877	885	893	901	909	917	925	934
	78	79	79	79	80	80	81	81	82	82
1578.0	942	950	958	967	975	984	992	1001	1009	1018
	83	83	84	84	84	85	85	86	86	87
1579.0	1027	1035	1044	1053	1062	1071	1080	1089	1098	1107
	87	88	88	89	89	90	90	91	91	92

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1580.0	1116	1126	1135	1144	1154	1163	1172	1182	1191	1201
	92	92	93	93	94	94	95	95	96	96
1581.0	1211	1220	1230	1240	1250	1260	1270	1280	1290	1300
	97	97	98	98	99	99	100	100	101	101
1582.0	1310	1320	1330	1340	1351	1361	1372	1382	1393	1403
	101	102	102	103	103	104	104	105	105	106
1583.0	1414	1424	1435	1446	1457	1468	1478	1489	1500	1512
	106	107	107	108	108	109	109	110	110	111

1584.0	1523	1534	1545	1556	1568	1579	1590	1602	1613	1625
	111	112	112	113	114	114	115	115	116	116
1585.0	1637	1648	1660	1672	1684	1696	1708	1720	1732	1744
	117	117	118	118	119	119	120	120	121	121
1586.0	1756	1768	1780	1793	1805	1818	1830	1843	1855	1868
	122	122	123	124	124	125	125	126	126	127
1587.0	1881	1893	1906	1919	1932	1945	1958	1971	1984	1997
	127	128	128	129	129	130	131	131	132	132
1588.0	2011	2024	2037	2051	2064	2078	2091	2105	2119	2132
	133	133	134	134	135	136	136	137	137	138
1589.0	2146	2160	2174	2188	2202	2216	2230	2244	2259	2273
	138	139	140	140	141	141	142	142	143	144
1590.0	2287	2302	2316	2331	2346	2360	2375	2390	2405	2420
	144	145	145	146	146	147	148	148	149	149
1591.0	2435	2450	2465	2480	2495	2510	2526	2541	2556	2572
	150	151	151	152	152	153	154	154	155	155
1592.0	2588	2603	2619	2635	2650	2666	2682	2698	2714	2730
	156	157	157	158	158	159	160	160	161	161
1593.0	2747	2763	2779	2795	2812	2828	2845	2862	2878	2895
	162	163	163	164	165	165	166	166	167	168
1594.0	2912	2929	2946	2963	2980	2997	3014	3031	3048	3066
	168	169	170	170	171	171	172	173	173	174

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1595.0	3083	3101	3118	3136	3154	3171	3189	3207	3225	3243
	175	175	176	177	177	178	178	179	180	180
1596.0	3261	3279	3297	3316	3334	3352	3371	3389	3408	3427
	181	182	182	183	184	184	185	186	186	187
1597.0	3445	3464	3483	3502	3521	3540	3559	3578	3598	3617
	188	188	189	190	190	191	192	192	193	194
1598.0	3636	3656	3675	3695	3715	3734	3754	3774	3794	3814
	194	195	196	196	197	198	198	199	200	200
1599.0	3834	3854	3874	3895	3915	3935	3956	3976	3997	4018
	201	202	202	203	204	205	205	206	207	207
1600.0	4039	4059	4080	4101	4123	4144	4165	4187	4208	4230
	208	209	210	211	212	213	214	215	216	217
1601.0	4251	4273	4295	4317	4339	4361	4384	4406	4429	4451
	218	219	220	221	222	223	224	225	226	227

1602.0	4474	4497	4520	4543	4566	4589	4612	4636	4659	4683
	228	229	230	231	232	233	234	235	236	237
1603.0	4707	4730	4754	4778	4802	4827	4851	4875	4900	4925
	238	239	240	241	242	243	244	245	246	247
1604.0	4949	4974	4999	5024	5049	5075	5100	5126	5151	5177
	248	249	250	251	252	253	254	255	256	257
1605.0	5203	5228	5254	5281	5307	5333	5360	5386	5413	5440
	259	260	261	262	263	264	265	266	267	268
1606.0	5466	5493	5521	5548	5575	5602	5630	5658	5685	5713
	269	270	271	273	274	275	276	277	278	279
1607.0	5741	5769	5797	5826	5854	5883	5911	5940	5969	5998
	280	281	282	284	285	286	287	288	289	290
1608.0	6027	6056	6086	6115	6145	6174	6204	6234	6264	6294
	291	293	294	295	296	297	298	299	301	302
1609.0	6324	6355	6385	6416	6446	6477	6508	6539	6570	6601
	303	304	305	306	308	309	310	311	312	313

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1610.0	6633	6664	6696	6728	6760	6792	6824	6856	6888	6921
	315	316	317	318	319	320	322	323	324	325
1611.0	6953	6986	7019	7052	7085	7118	7151	7185	7218	7252
	326	328	329	330	331	332	334	335	336	337
1612.0	7286	7320	7354	7388	7422	7456	7491	7526	7560	7595
	338	340	341	342	343	345	346	347	348	350
1613.0	7630	7665	7701	7736	7772	7807	7843	7879	7915	7951
	351	352	353	354	356	357	358	360	361	362
1614.0	7987	8024	8060	8097	8134	8170	8208	8245	8282	8319
	363	365	366	367	368	370	371	372	373	375
1615.0	8357	8395	8432	8470	8508	8547	8585	8623	8662	8701
	376	377	379	380	381	382	384	385	386	388
1616.0	8739	8778	8818	8857	8896	8936	8975	9015	9055	9095
	389	390	392	393	394	396	397	398	399	401
1617.0	9135	9175	9216	9256	9297	9338	9379	9420	9461	9502
	402	403	405	406	407	409	410	412	413	414
1618.0	9544	9585	9627	9669	9711	9753	9796	9838	9881	9923
	416	417	418	420	421	422	424	425	426	428
1619.0	9966	10009	10052	10095	10139	10182	10226	10270	10314	10358
	429	431	432	433	435	436	437	439	440	442

1620.0	10402	10447	10491	10535	10580	10625	10669	10714	10759	10804
	443	444	445	445	446	447	448	449	450	450
1621.0	10849	10894	10940	10985	11030	11076	11121	11167	11213	11259
	451	452	453	454	454	455	456	457	458	459
1622.0	11304	11350	11397	11443	11489	11535	11582	11628	11675	11721
	459	460	461	462	463	463	464	465	466	467
1623.0	11768	11815	11862	11909	11956	12003	12050	12097	12145	12192
	468	468	469	470	471	472	473	474	474	475
1624.0	12240	12287	12335	12383	12431	12479	12527	12575	12623	12672
	476	477	478	479	479	480	481	482	483	484

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1625.0	12720	12769	12817	12866	12915	12963	13012	13061	13110	13160
	484	485	486	487	488	489	490	490	491	492
1626.0	13209	13258	13308	13357	13407	13456	13506	13556	13606	13656
	493	494	495	496	496	497	498	499	500	501
1627.0	13706	13756	13807	13857	13907	13958	14009	14059	14110	14161
	502	502	503	504	505	506	507	508	508	509
1628.0	14212	14263	14314	14365	14417	14468	14520	14571	14623	14675
	510	511	512	513	514	515	515	516	517	518
1629.0	14727	14779	14831	14883	14935	14987	15040	15092	15145	15197
	519	520	521	522	522	523	524	525	526	527
1630.0	15250	15303	15356	15409	15462	15515	15568	15622	15675	15729
	528	529	530	530	531	532	533	534	535	536
1631.0	15782	15836	15890	15944	15998	16052	16106	16160	16214	16269
	537	538	538	539	540	541	542	543	544	545
1632.0	16323	16378	16433	16487	16542	16597	16652	16708	16763	16818
	546	547	547	548	549	550	551	552	553	554
1633.0	16873	16929	16985	17040	17096	17152	17208	17264	17320	17376
	555	556	556	557	558	559	560	561	562	563
1634.0	17433	17489	17546	17602	17659	17716	17773	17830	17887	17944
	564	565	566	567	567	568	569	570	571	572
1635.0	18001	18058	18116	18173	18231	18289	18347	18404	18462	18521
	573	574	575	576	577	578	579	579	580	581
1636.0	18579	18637	18695	18754	18812	18871	18930	18989	19047	19106
	582	583	584	585	586	587	588	589	590	591
1637.0	19165	19225	19284	19343	19403	19462	19522	19582	19642	19702
	592	592	593	594	595	596	597	598	599	600

1638.0	19762	19822	19882	19942	20003	20063	20124	20185	20246	20307
	601	602	603	604	605	606	607	608	609	609
1639.0	20367	20429	20490	20551	20612	20674	20735	20797	20859	20921
	610	611	612	613	614	615	616	617	618	619

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1640.0	20983	21045	21107	21169	21231	21294	21356	21419	21481	21544
	620	621	622	623	623	624	625	626	627	628
1641.0	21607	21670	21733	21796	21859	21922	21986	22049	22113	22176
	629	629	630	631	632	633	634	635	636	636
1642.0	22240	22304	22368	22432	22496	22560	22624	22688	22753	22817
	637	638	639	640	641	642	643	643	644	645
1643.0	22882	22946	23011	23076	23141	23206	23271	23336	23401	23467
	646	647	648	649	650	650	651	652	653	654
1644.0	23532	23598	23663	23729	23795	23861	23927	23993	24059	24125
	655	656	657	658	658	659	660	661	662	663
1645.0	24191	24258	24325	24391	24458	24524	24591	24658	24725	24793
	664	665	666	666	667	668	669	670	671	672
1646.0	24860	24927	24995	25062	25130	25197	25265	25333	25401	25469
	673	674	674	675	676	677	678	679	680	681
1647.0	25537	25605	25673	25742	25810	25879	25948	26016	26085	26154
	682	683	683	684	685	686	687	688	689	690
1648.0	26223	26292	26361	26431	26500	26570	26639	26709	26779	26848
	691	692	693	693	694	695	696	697	698	699
1649.0	26918	26988	27059	27129	27199	27269	27340	27411	27481	27552
	700	701	702	703	704	704	705	706	707	708
1650.0	27623	27694	27765	27836	27907	27978	28050	28121	28193	28265
	709	710	711	712	713	714	715	715	716	717
1651.0	28336	28408	28480	28552	28625	28697	28769	28842	28914	28987
	718	719	720	721	722	723	724	725	726	727
1652.0	29059	29132	29205	29278	29351	29424	29498	29571	29644	29718
	728	728	729	730	731	732	733	734	735	736
1653.0	29791	29865	29939	30013	30087	30161	30235	30310	30384	30459
	737	738	739	740	741	742	743	743	744	745
1654.0	30533	30608	30683	30757	30832	30907	30983	31058	31133	31209
	746	747	748	749	750	751	752	753	754	755

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1655.0	31284	31360	31436	31511	31587	31663	31739	31816	31892	31968
	756	757	758	759	760	761	761	762	763	764
1656.0	32045	32121	32198	32275	32352	32428	32506	32583	32660	32737
	765	766	767	768	769	770	771	772	773	774
1657.0	32815	32892	32970	33048	33125	33203	33281	33360	33438	33516
	775	776	777	778	779	780	781	782	783	784
1658.0	33594	33673	33752	33830	33909	33988	34067	34146	34225	34304
	785	785	786	787	788	789	790	791	792	793
1659.0	34384	34463	34543	34622	34702	34782	34862	34942	35022	35103
	794	795	796	797	798	799	800	801	802	803
1660.0	35183	35263	35344	35425	35505	35586	35667	35748	35829	35910
	804	805	806	806	807	808	809	809	810	811
1661.0	35991	36072	36153	36235	36316	36398	36479	36561	36643	36724
	812	812	813	814	815	815	816	817	818	819
1662.0	36806	36888	36970	37052	37135	37217	37299	37382	37464	37547
	819	820	821	822	822	823	824	825	826	826
1663.0	37629	37712	37795	37878	37961	38044	38127	38211	38294	38377
	827	828	829	829	830	831	832	833	833	834
1664.0	38460	38544	38628	38711	38795	38879	38963	39047	39131	39215
	835	836	836	837	838	839	840	840	841	842
1665.0	39299	39384	39468	39552	39637	39721	39806	39891	39976	40061
	843	843	844	845	846	847	847	848	849	850
1666.0	40146	40231	40316	40401	40487	40572	40658	40743	40829	40914
	850	851	852	853	854	854	855	856	857	858
1667.0	41000	41086	41172	41258	41344	41430	41517	41603	41689	41776
	858	859	860	861	862	862	863	864	865	865
1668.0	41862	41949	42036	42123	42210	42297	42384	42471	42558	42645
	866	867	868	869	869	870	871	872	873	873
1669.0	42733	42820	42908	42995	43083	43171	43259	43347	43435	43523
	874	875	876	877	877	878	879	880	881	881

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1670.0	43611	43699	43788	43876	43964	44053	44142	44231	44319	44408
	882	883	884	885	885	886	887	888	889	889
1671.0	44497	44586	44675	44765	44854	44943	45033	45122	45212	45302
	890	891	892	893	893	894	895	896	897	897
1672.0	45391	45481	45571	45661	45751	45841	45932	46022	46113	46203
	898	899	900	901	901	902	903	904	905	906
1673.0	46294	46384	46475	46566	46657	46748	46839	46930	47021	47113
	906	907	908	909	910	910	911	912	913	914
1674.0	47204	47296	47387	47479	47571	47662	47754	47846	47938	48030
	914	915	916	917	918	919	919	920	921	922
1675.0	48123	48215	48307	48400	48492	48585	48678	48771	48863	48956
	923	923	924	925	926	927	928	928	929	930
1676.0	49049	49142	49236	49329	49422	49516	49609	49703	49797	49890
	931	932	932	933	934	935	936	937	937	938
1677.0	49984	50078	50172	50266	50361	50455	50549	50644	50738	50833
	939	940	941	942	942	943	944	945	946	947
1678.0	50927	51022	51117	51212	51307	51402	51497	51593	51688	51784
	947	948	949	950	951	951	952	953	954	955
1679.0	51879	51975	52070	52166	52262	52358	52454	52550	52646	52743
	956	956	957	958	959	960	961	961	962	963
1680.0	52839	52935	53032	53128	53225	53322	53419	53516	53613	53711
	964	965	966	967	968	969	970	971	972	973
1681.0	53808	53905	54003	54100	54198	54296	54394	54492	54590	54689
	974	975	976	977	978	979	980	981	982	983
1682.0	54787	54885	54984	55083	55181	55280	55379	55478	55577	55677
	984	985	986	987	988	989	990	991	992	993
1683.0	55776	55876	55975	56075	56175	56274	56374	56475	56575	56675
	994	995	996	997	998	999	1000	1001	1002	1003
1684.0	56775	56876	56976	57077	57178	57279	57380	57481	57582	57683
	1004	1005	1006	1007	1008	1009	1010	1011	1013	1014

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1685.0	57785	57886	57988	58090	58191	58293	58395	58498	58600	58702
	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024
1686.0	58804	58907	59010	59112	59215	59318	59421	59524	59628	59731
	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034
1687.0	59834	59938	60042	60145	60249	60353	60457	60562	60666	60770
	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044
1688.0	60875	60979	61084	61189	61294	61399	61504	61609	61714	61820
	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055
1689.0	61925	62031	62137	62243	62349	62455	62561	62667	62773	62880
	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065
1690.0	62987	63093	63200	63307	63414	63521	63628	63736	63843	63951
	1066	1067	1069	1070	1071	1072	1073	1074	1075	1076
1691.0	64058	64166	64274	64382	64490	64598	64706	64815	64923	65032
	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086
1692.0	65140	65249	65358	65467	65576	65685	65795	65904	66014	66124
	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097
1693.0	66233	66343	66453	66563	66674	66784	66894	67005	67115	67226
	1098	1099	1100	1101	1102	1103	1105	1106	1107	1108
1694.0	67337	67448	67559	67670	67781	67892	68004	68116	68227	68339
	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118
1695.0	68451	68563	68675	68787	68900	69012	69125	69237	69350	69463
	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129
1696.0	69576	69689	69802	69915	70029	70142	70256	70370	70484	70598
	1130	1131	1133	1134	1135	1136	1137	1138	1139	1140
1697.0	70712	70826	70940	71054	71169	71284	71398	71513	71628	71743
	1141	1142	1143	1144	1146	1147	1148	1149	1150	1151
1698.0	71858	71974	72089	72204	72320	72436	72552	72668	72783	72900
	1152	1153	1154	1155	1156	1158	1159	1160	1161	1162
1699.0	73016	73132	73249	73365	73482	73599	73716	73833	73950	74067
	1163	1164	1165	1166	1167	1168	1170	1171	1172	1173

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1700.0	74184	74302	74420	74537	74655	74773	74891	75009	75127	75246
	1174	1175	1176	1177	1179	1180	1181	1182	1183	1184

1701.0	75364	75483	75602	75720	75839	75958	76078	76197	76316	76436
	1186	1187	1188	1189	1190	1191	1193	1194	1195	1196
1702.0	76556	76675	76795	76915	77036	77156	77276	77397	77517	77638
	1197	1198	1200	1201	1202	1203	1204	1205	1207	1208
1703.0	77759	77880	78001	78122	78243	78365	78486	78608	78730	78852
	1209	1210	1211	1213	1214	1215	1216	1217	1218	1220
1704.0	78974	79096	79218	79340	79463	79585	79708	79831	79954	80077
	1221	1222	1223	1224	1225	1227	1228	1229	1230	1231

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1705.0	80200	80324	80447	80571	80694	80818	80942	81066	81190	81315
	1233	1234	1235	1236	1237	1239	1240	1241	1242	1243
1706.0	81439	81563	81688	81813	81938	82063	82188	82313	82438	82564
	1244	1246	1247	1248	1249	1250	1252	1253	1254	1255
1707.0	82689	82815	82941	83067	83193	83319	83445	83572	83698	83825
	1256	1258	1259	1260	1261	1262	1264	1265	1266	1267
1708.0	83952	84079	84206	84333	84460	84587	84715	84843	84970	85098
	1268	1270	1271	1272	1273	1274	1276	1277	1278	1279
1709.0	85226	85354	85483	85611	85740	85868	85997	86126	86255	86384
	1281	1282	1283	1284	1285	1287	1288	1289	1290	1291

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1710.0	86513	86642	86772	86901	87031	87161	87291	87421	87551	87681
	1293	1294	1295	1296	1298	1299	1300	1301	1302	1304
1711.0	87811	87942	88073	88204	88335	88465	88597	88728	88859	88991
	1305	1306	1307	1308	1310	1311	1312	1313	1315	1316
1712.0	89122	89254	89386	89518	89650	89782	89915	90048	90180	90313
	1317	1318	1320	1321	1322	1323	1324	1326	1327	1328
1713.0	90446	90579	90712	90845	90979	91112	91246	91379	91513	91647
	1329	1331	1332	1333	1334	1336	1337	1338	1339	1340
1714.0	91781	91916	92050	92184	92319	92454	92589	92724	92859	92994
	1342	1343	1344	1345	1347	1348	1349	1350	1352	1353

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LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1715.0	93129	93265	93400	93536	93672	93808	93944	94080	94216	94353
	1354	1355	1357	1358	1359	1360	1362	1363	1364	1365
1716.0	94489	94626	94763	94900	95037	95174	95312	95449	95587	95725
	1367	1368	1369	1370	1372	1373	1374	1375	1377	1378
1717.0	95862	96000	96139	96277	96415	96553	96692	96831	96970	97109
	1379	1380	1382	1383	1384	1385	1387	1388	1389	1390
1718.0	97248	97387	97526	97666	97805	97945	98085	98225	98365	98505
	1392	1393	1394	1395	1397	1398	1399	1401	1402	1403

1719.0	98646	98786	98927	99068	99209	99349	99491	99632	99773	99915
	1404	1406	1407	1408	1409	1411	1412	1413	1414	1416

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1720.0	100056	100198	100340	100482	100624	100766	100909	101052	101194	101337
	1417	1418	1419	1421	1422	1423	1424	1426	1427	1428
1721.0	101479	101623	101766	101909	102052	102196	102339	102483	102627	102771
	1429	1430	1432	1433	1434	1435	1437	1438	1439	1440
1722.0	102915	103059	103204	103348	103493	103637	103782	103927	104072	104217
	1442	1443	1444	1445	1446	1448	1449	1450	1451	1453
1723.0	104363	104508	104654	104799	104945	105091	105237	105384	105530	105676
	1454	1455	1456	1458	1459	1460	1461	1463	1464	1465
1724.0	105823	105970	106117	106263	106410	106557	106705	106852	107000	107148
	1466	1468	1469	1470	1471	1473	1474	1475	1476	1478

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1725.0	107295	107443	107592	107740	107888	108036	108185	108334	108482	108631
	1479	1480	1481	1483	1484	1485	1486	1488	1489	1490
1726.0	108780	108930	109079	109228	109378	109527	109677	109828	109977	110128
	1491	1493	1494	1495	1496	1498	1499	1500	1501	1503
1727.0	110278	110428	110579	110730	110881	111031	111183	111334	111485	111637
	1504	1505	1506	1508	1509	1510	1511	1513	1514	1515
1728.0	111788	111940	112092	112244	112396	112548	112700	112853	113005	113158
	1516	1518	1519	1520	1522	1523	1524	1525	1527	1528
1729.0	113311	113464	113617	113770	113924	114077	114231	114385	114538	114692
	1529	1530	1532	1533	1534	1535	1537	1538	1539	1541

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LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1730.0	114846	115001	115155	115309	115464	115619	115774	115929	116084	116239
	1542	1543	1544	1546	1547	1548	1550	1551	1552	1553
1731.0	116395	116550	116706	116862	117018	117173	117330	117486	117642	117799
	1555	1556	1557	1558	1560	1561	1562	1564	1565	1566
1732.0	117956	118113	118270	118426	118584	118741	118899	119056	119214	119372
	1567	1569	1570	1571	1573	1574	1575	1576	1578	1579
1733.0	119529	119688	119846	120004	120163	120321	120480	120639	120798	120957
	1580	1582	1583	1584	1586	1587	1588	1589	1591	1592
1734.0	121116	121276	121436	121595	121755	121915	122075	122235	122395	122556
	1593	1595	1596	1597	1598	1600	1601	1602	1604	1605

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1735.0	122716	122877	123038	123199	123360	123521	123682	123844	124005	124167
	1606	1608	1609	1610	1611	1613	1614	1615	1617	1618
1736.0	124329	124491	124653	124815	124978	125140	125303	125466	125629	125792
	1619	1621	1622	1623	1625	1626	1627	1628	1630	1631

1737.0	125955	126118	126282	126445	126609	126773	126937	127101	127265	127429
	1632	1634	1635	1636	1638	1639	1640	1642	1643	1644
1738.0	127594	127758	127923	128088	128253	128418	128584	128749	128914	129080
	1646	1647	1648	1650	1651	1652	1653	1655	1656	1657
1739.0	129246	129412	129578	129744	129911	130077	130244	130411	130577	130744
	1659	1660	1661	1663	1664	1665	1667	1668	1669	1671
1740.0	130911	131079	131246	131414	131581	131749	131917	132085	132253	132421
	1672	1673	1674	1675	1677	1678	1679	1680	1681	1682
1741.0	132589	132758	132927	133095	133264	133432	133602	133771	133940	134109
	1684	1685	1686	1687	1688	1689	1690	1692	1693	1694
1742.0	134279	134448	134618	134788	134958	135128	135298	135468	135638	135809
	1695	1696	1697	1699	1700	1701	1702	1703	1704	1706
1743.0	135979	136150	136321	136492	136663	136834	137006	137177	137349	137520
	1707	1708	1709	1710	1711	1713	1714	1715	1716	1717
1744.0	137692	137864	138036	138208	138381	138553	138725	138898	139070	139244
	1718	1720	1721	1722	1723	1724	1725	1727	1728	1729

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1745.0	139416	139589	139763	139936	140109	140283	140456	140630	140804	140978
	1730	1731	1732	1734	1735	1736	1737	1738	1739	1741
1746.0	141152	141326	141501	141675	141850	142024	142199	142375	142549	142725
	1742	1743	1744	1745	1746	1748	1749	1750	1751	1752
1747.0	142900	143075	143251	143426	143602	143778	143954	144130	144306	144483
	1754	1755	1756	1757	1758	1759	1761	1762	1763	1764
1748.0	144659	144836	145013	145189	145367	145543	145721	145898	146075	146253
	1765	1767	1768	1769	1770	1771	1772	1774	1775	1776
1749.0	146430	146608	146786	146964	147143	147321	147499	147678	147856	148035
	1777	1778	1780	1781	1782	1783	1784	1786	1787	1788
1750.0	148214	148393	148572	148751	148930	149110	149289	149469	149649	149829
	1789	1790	1791	1793	1794	1795	1796	1797	1799	1800
1751.0	150009	150189	150369	150550	150730	150911	151092	151273	151453	151635
	1801	1802	1803	1805	1806	1807	1808	1809	1811	1812
1752.0	151816	151997	152179	152360	152542	152724	152906	153088	153270	153453
	1813	1814	1815	1817	1818	1819	1820	1822	1823	1824
1753.0	153635	153818	154000	154183	154366	154549	154732	154916	155099	155283
	1825	1826	1828	1829	1830	1831	1832	1834	1835	1836
1754.0	155466	155650	155834	156018	156202	156386	156571	156755	156940	157125
	1837	1839	1840	1841	1842	1843	1845	1846	1847	1848

1755.0	157309	157495	157680	157865	158050	158236	158422	158607	158793	158979
	1849	1851	1852	1853	1854	1856	1857	1858	1859	1860
1756.0	159165	159351	159538	159724	159911	160097	160284	160472	160658	160846
	1862	1863	1864	1865	1867	1868	1869	1870	1872	1873
1757.0	161033	161220	161408	161596	161784	161971	162160	162348	162536	162725
	1874	1875	1876	1878	1879	1880	1881	1883	1884	1885
1758.0	162913	163102	163291	163480	163669	163858	164047	164237	164426	164616
	1886	1888	1889	1890	1891	1892	1894	1895	1896	1897
1759.0	164805	164996	165186	165376	165566	165756	165947	166138	166328	166519
	1899	1900	1901	1902	1904	1905	1906	1907	1909	1910

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1760.0	166710	166902	167093	167285	167476	167668	167860	168052	168244	168436
	1911	1912	1914	1915	1917	1918	1920	1921	1922	1924
1761.0	168629	168821	169014	169207	169400	169593	169787	169980	170174	170367
	1925	1927	1928	1930	1931	1932	1934	1935	1937	1938
1762.0	170561	170755	170950	171144	171338	171533	171728	171923	172117	172313
	1940	1941	1943	1944	1945	1947	1948	1950	1951	1953
1763.0	172508	172704	172899	173095	173291	173487	173683	173880	174076	174273
	1954	1955	1957	1958	1960	1961	1963	1964	1966	1967
1764.0	174469	174666	174864	175060	175258	175455	175653	175851	176049	176247
	1968	1970	1971	1973	1974	1976	1977	1979	1980	1982
1765.0	176445	176643	176842	177041	177240	177438	177638	177837	178036	178236
	1983	1984	1986	1987	1989	1990	1992	1993	1995	1996
1766.0	178435	178635	178835	179035	179236	179436	179637	179837	180038	180239
	1998	1999	2000	2002	2003	2005	2006	2008	2009	2011
1767.0	180440	180642	180843	181044	181246	181448	181650	181853	182055	182257
	2012	2014	2015	2017	2018	2020	2021	2022	2024	2025
1768.0	182460	182663	182866	183068	183272	183475	183679	183882	184086	184290
	2027	2028	2030	2031	2033	2034	2036	2037	2039	2040
1769.0	184494	184698	184903	185107	185312	185516	185722	185927	186132	186337
	2042	2043	2045	2046	2047	2049	2050	2052	2053	2055
1770.0	186543	186749	186955	187160	187367	187573	187779	187986	188193	188400
	2056	2058	2059	2061	2062	2064	2065	2067	2068	2070
1771.0	188606	188814	189021	189229	189436	189644	189852	190060	190268	190477
	2071	2073	2074	2076	2077	2079	2080	2082	2083	2085
1772.0	190685	190894	191103	191312	191521	191730	191940	192149	192359	192569
	2086	2088	2089	2091	2092	2094	2095	2096	2098	2099

1773.0	192779	192989	193199	193410	193620	193831	194042	194253	194464	194676
	2101	2102	2104	2105	2107	2108	2110	2111	2113	2114
1774.0	194887	195099	195311	195523	195735	195947	196160	196372	196585	196798
	2116	2117	2119	2120	2122	2123	2125	2126	2128	2129

LOST CREEK LAKE - CAPACITY TABLE

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1775.0	197011	197224	197437	197651	197864	198078	198292	198506	198720	198935
	2131	2133	2134	2136	2137	2139	2140	2142	2143	2145
1776.0	199149	199364	199579	199794	200009	200224	200440	200655	200871	201087
	2146	2148	2149	2151	2152	2154	2155	2157	2158	2160
1777.0	201303	201519	201736	201952	202169	202385	202602	202820	203037	203254
	2161	2163	2164	2166	2167	2169	2170	2172	2173	2175
1778.0	203472	203689	203908	204125	204344	204562	204780	204999	205218	205437
	2176	2178	2179	2181	2183	2184	2186	2187	2189	2190
1779.0	205656	205875	206095	206314	206534	206753	206974	207194	207414	207635
	2192	2193	2195	2196	2198	2199	2201	2202	2204	2205
1780.0	207855	208076	208297	208518	208739	208960	209182	209404	209625	209847
	2207	2208	2210	2211	2212	2213	2215	2216	2217	2218
1781.0	210068	210291	210513	210735	210958	211180	211403	211626	211848	212072
	2220	2221	2222	2223	2225	2226	2227	2229	2230	2231
1782.0	212294	212518	212742	212965	213189	213412	213636	213861	214085	214309
	2232	2234	2235	2236	2237	2239	2240	2241	2243	2244
1783.0	214533	214758	214983	215207	215432	215657	215883	216108	216333	216559
	2245	2246	2248	2249	2250	2251	2253	2254	2255	2257
1784.0	216785	217011	217237	217463	217689	217915	218142	218369	218595	218822
	2258	2259	2260	2262	2263	2264	2266	2267	2268	2269
1785.0	219049	219276	219504	219731	219959	220186	220414	220642	220870	221098
	2271	2272	2273	2274	2276	2277	2278	2280	2281	2282
1786.0	221326	221555	221783	222012	222241	222469	222699	222928	223157	223387
	2283	2285	2286	2287	2289	2290	2291	2292	2294	2295
1787.0	223616	223846	224076	224306	224536	224766	224996	225227	225457	225688
	2296	2298	2299	2300	2302	2303	2304	2305	2307	2308
1788.0	225919	226150	226381	226612	226844	227075	227307	227539	227770	228002
	2309	2311	2312	2313	2314	2316	2317	2318	2320	2321
1789.0	228234	228467	228699	228932	229165	229397	229630	229863	230096	230330
	2322	2324	2325	2326	2327	2329	2330	2331	2333	2334

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ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1790.0	230563	230797	231031	231264	231499	231732	231967	232201	232435	232670
	2335	2336	2338	2339	2340	2342	2343	2344	2346	2347
1791.0	232905	233140	233375	233610	233845	234080	234316	234552	234788	235024
	2348	2350	2351	2352	2353	2355	2356	2357	2359	2360
1792.0	235259	235496	235733	235968	236205	236442	236679	236916	237153	237390
	2361	2363	2364	2365	2366	2368	2369	2370	2372	2373
1793.0	237627	237865	238103	238340	238578	238816	239054	239293	239531	239770
	2374	2376	2377	2378	2380	2381	2382	2384	2385	2386
1794.0	240008	240247	240486	240725	240965	241204	241443	241683	241922	242163
	2387	2389	2390	2391	2393	2394	2395	2397	2398	2399
1795.0	242402	242643	242883	243123	243364	243604	243845	244086	244327	244569
	2401	2402	2403	2405	2406	2407	2409	2410	2411	2413
1796.0	244810	245051	245293	245534	245776	246018	246260	246503	246745	246988
	2414	2415	2416	2418	2419	2420	2422	2423	2424	2426
1797.0	247230	247473	247716	247959	248202	248445	248689	248933	249176	249420
	2427	2428	2430	2431	2432	2434	2435	2436	2438	2439
1798.0	249664	249908	250152	250397	250641	250886	251130	251376	251620	251866
	2440	2442	2443	2444	2446	2447	2448	2450	2451	2452
1799.0	252111	252356	252602	252848	253094	253339	253586	253832	254078	254325
	2454	2455	2456	2458	2459	2460	2462	2463	2464	2466
1800.0	254571	254818	255065	255312	255560	255806	256054	256301	256549	256797
	2467	2468	2469	2470	2472	2473	2474	2475	2476	2477
1801.0	257044	257292	257540	257788	258037	258284	258533	258782	259030	259279
	2478	2479	2481	2482	2483	2484	2485	2486	2487	2488
1802.0	259528	259777	260026	260275	260525	260774	261024	261274	261523	261773
	2490	2491	2492	2493	2494	2495	2496	2498	2499	2500
1803.0	262023	262274	262524	262774	263025	263275	263526	263777	264028	264279
	2501	2502	2503	2504	2505	2507	2508	2509	2510	2511
1804.0	264530	264781	265033	265284	265536	265787	266040	266291	266543	266796
	2512	2513	2515	2516	2517	2518	2519	2520	2521	2522

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ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1805.0	267048	267301	267553	267805	268058	268311	268564	268817	269070	269324
	2524	2525	2526	2527	2528	2529	2530	2532	2533	2534
1806.0	269577	269831	270085	270338	270592	270846	271100	271355	271609	271864
	2535	2536	2537	2538	2540	2541	2542	2543	2544	2545
1807.0	272118	272373	272628	272882	273138	273392	273648	273903	274159	274415
	2546	2548	2549	2550	2551	2552	2553	2554	2556	2557
1808.0	274670	274926	275182	275438	275694	275950	276207	276464	276720	276977
	2558	2559	2560	2561	2563	2564	2565	2566	2567	2568
1809.0	277234	277491	277748	278005	278263	278520	278778	279036	279293	279551
	2569	2571	2572	2573	2574	2575	2576	2577	2579	2580
1810.0	279809	280067	280326	280584	280842	281101	281360	281619	281877	282137
	2581	2582	2583	2584	2586	2587	2588	2589	2590	2591
1811.0	282396	282655	282915	283174	283434	283693	283953	284213	284473	284734
	2592	2594	2595	2596	2597	2598	2599	2601	2602	2603
1812.0	284994	285255	285515	285776	286037	286297	286559	286820	287081	287343
	2604	2605	2606	2607	2609	2610	2611	2612	2613	2614
1813.0	287604	287866	288127	288389	288651	288913	289175	289438	289700	289963
	2616	2617	2618	2619	2620	2621	2622	2624	2625	2626
1814.0	290225	290488	290751	291014	291277	291540	291804	292067	292331	292594
	2627	2628	2629	2631	2632	2633	2634	2635	2636	2638
1815.0	292858	293122	293386	293650	293915	294179	294443	294708	294973	295238
	2639	2640	2641	2642	2643	2644	2646	2647	2648	2649
1816.0	295502	295768	296033	296298	296564	296829	297095	297361	297626	297893
	2650	2651	2653	2654	2655	2656	2657	2658	2660	2661
1817.0	298158	298425	298692	298958	299225	299491	299758	300025	300292	300559
	2662	2663	2664	2665	2667	2668	2669	2670	2671	2672
1818.0	300826	301094	301362	301629	301897	302165	302433	302701	302969	303238
	2674	2675	2676	2677	2678	2679	2681	2682	2683	2684
1819.0	303506	303774	304043	304312	304581	304850	305119	305389	305658	305928
	2685	2686	2688	2689	2690	2691	2692	2693	2695	2696

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ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1820.0	306197	306468	306738	307007	307278	307548	307818	308089	308360	308631
	2697	2698	2700	2701	2702	2703	2705	2706	2707	2709
1821.0	308901	309172	309444	309715	309986	310258	310530	310802	311073	311346
	2710	2711	2713	2714	2715	2716	2718	2719	2720	2722
1822.0	311618	311890	312163	312435	312708	312981	313254	313527	313800	314074
	2723	2724	2726	2727	2728	2729	2731	2732	2733	2735
1823.0	314347	314622	314896	315169	315444	315717	315992	316267	316541	316816
	2736	2737	2739	2740	2741	2742	2744	2745	2746	2748
1824.0	317090	317365	317641	317915	318191	318466	318742	319018	319294	319570
	2749	2750	2752	2753	2754	2755	2757	2758	2759	2761
1825.0	319846	320122	320399	320675	320952	321228	321506	321783	322060	322337
	2762	2763	2765	2766	2767	2769	2770	2771	2772	2774
1826.0	322614	322892	323170	323447	323726	324003	324282	324561	324839	325117
	2775	2776	2778	2779	2780	2782	2783	2784	2786	2787
1827.0	325396	325675	325954	326233	326513	326791	327071	327351	327631	327911
	2788	2789	2791	2792	2793	2795	2796	2797	2799	2800
1828.0	328191	328471	328752	329032	329313	329593	329874	330155	330436	330717
	2801	2803	2804	2805	2807	2808	2809	2810	2812	2813
1829.0	330998	331280	331562	331843	332126	332407	332690	332972	333254	333537
	2814	2816	2817	2818	2820	2821	2822	2824	2825	2826
1830.0	333819	334102	334386	334668	334952	335235	335519	335802	336086	336370
	2828	2829	2830	2832	2833	2834	2835	2837	2838	2839
1831.0	336654	336938	337223	337506	337791	338075	338361	338646	338931	339216
	2841	2842	2843	2845	2846	2847	2849	2850	2851	2853
1832.0	339501	339787	340073	340358	340644	340929	341216	341503	341789	342075
	2854	2855	2857	2858	2859	2861	2862	2863	2865	2866
1833.0	342362	342649	342936	343222	343510	343797	344085	344372	344660	344948
	2867	2869	2870	2871	2873	2874	2875	2877	2878	2879
1834.0	345235	345524	345813	346100	346389	346677	346967	347256	347544	347834
	2881	2882	2883	2885	2886	2887	2889	2890	2891	2893

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ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
1835.0	348123	348412	348702	348992	349282	349571	349862	350152	350442	350733
	2894	2895	2897	2898	2899	2901	2902	2903	2905	2906
1836.0	351023	351314	351606	351896	352188	352479	352770	353062	353354	353646
	2907	2909	2910	2911	2913	2914	2915	2917	2918	2919
1837.0	353937	354229	354522	354814	355107	355399	355692	355986	356278	356572
	2921	2922	2923	2925	2926	2927	2929	2930	2931	2933
1838.0	356865	357158	357452	357745	358040	358333	358628	358922	359216	359511
	2934	2935	2937	2938	2939	2941	2942	2943	2945	2946
1839.0	359805	360100	360396	360690	360986	361281	361577	361872	362168	362464
	2948	2949	2950	2952	2953	2954	2956	2957	2958	2960
1840.0	362760	363057	363354	363650	363947	364243	364540	364837	365134	365432
	2961	2962	2964	2965	2967	2968	2970	2971	2972	2974
1841.0	365729	366027	366325	366622	366921	367218	367517	367816	368114	368413
	2975	2977	2978	2980	2981	2983	2984	2985	2987	2988
1842.0	368712	369011	369310	369609	369909	370208	370508	370809	371108	371409
	2990	2991	2993	2994	2996	2997	2998	3000	3001	3003
1843.0	371708	372009	372310	372610	372912	373212	373514	373816	374117	374419
	3004	3006	3007	3009	3010	3011	3013	3014	3016	3017
1844.0	374720	375022	375324	375626	375929	376231	376534	376837	377140	377443
	3019	3020	3022	3023	3024	3026	3027	3029	3030	3032
1845.0	377746	378050	378353	378657	378961	379264	379569	379873	380177	380482
	3033	3035	3036	3038	3039	3040	3042	3043	3045	3046
1846.0	380786	381092	381397	381701	382007	382312	382618	382924	383229	383536
	3048	3049	3051	3052	3054	3055	3056	3058	3059	3061
1847.0	383841	384148	384455	384761	385068	385374	385682	385989	386296	386604
	3062	3064	3065	3067	3068	3070	3071	3073	3074	3075
1848.0	386911	387219	387527	387835	388143	388451	388760	389069	389377	389687
	3077	3078	3080	3081	3083	3084	3086	3087	3089	3090
1849.0	389995	390305	390614	390923	391233	391543	391853	392164	392473	392784
	3092	3093	3095	3096	3097	3099	3100	3102	3103	3105

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1850.0	393094	393405	393716	394027	394338	394649	394961	395273	395584	395896
	3106	3108	3109	3111	3112	3114	3115	3117	3118	3120
1851.0	396208	396520	396833	397145	397458	397770	398083	398397	398709	399023
	3121	3122	3124	3125	3127	3128	3130	3131	3133	3134
1852.0	399336	399650	399964	400277	400592	400906	401220	401535	401849	402165
	3136	3137	3139	3140	3142	3143	3145	3146	3148	3149
1853.0	402479	402795	403110	403425	403741	404056	404373	404689	405005	405321
	3151	3152	3153	3155	3156	3158	3159	3161	3162	3164
1854.0	405637	405954	406271	406587	406905	407222	407539	407857	408174	408493
	3165	3167	3168	3170	3171	3173	3174	3176	3177	3179
1855.0	408810	409128	409447	409765	410084	410402	410721	411040	411359	411679
	3180	3182	3183	3185	3186	3188	3189	3191	3192	3194
1856.0	411998	412318	412637	412957	413277	413597	413918	414238	414559	414880
	3195	3197	3198	3200	3201	3203	3204	3206	3207	3209
1857.0	415200	415522	415843	416164	416486	416807	417129	417451	417773	418096
	3210	3212	3213	3214	3216	3217	3219	3220	3222	3223
1858.0	418418	418741	419063	419386	419709	420032	420356	420679	421002	421327
	3225	3226	3228	3229	3231	3232	3234	3235	3237	3238
1859.0	421650	421975	422299	422623	422948	423272	423597	423922	424247	424573
	3240	3241	3243	3244	3246	3247	3249	3250	3252	3253
1860.0	424898	425224	425550	425875	426202	426527	426854	427181	427507	427834
	3255	3256	3258	3259	3261	3262	3264	3265	3267	3268
1861.0	428160	428487	428815	429142	429470	429797	430125	430453	430781	431109
	3269	3271	3272	3274	3275	3277	3278	3280	3281	3282
1862.0	431437	431766	432095	432423	432752	433081	433410	433740	434069	434399
	3284	3285	3287	3288	3290	3291	3293	3294	3295	3297
1863.0	434728	435058	435389	435718	436049	436379	436710	437041	437371	437703
	3298	3300	3301	3303	3304	3306	3307	3308	3310	3311
1864.0	438034	438365	438697	439028	439360	439692	440024	440357	440689	441021
	3313	3314	3316	3317	3319	3320	3322	3323	3324	3326

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1865.0	441354	441687	442020	442353	442686	443019	443353	443687	444020	444355
	3327	3329	3330	3332	3333	3335	3336	3338	3339	3340
1866.0	444688	445023	445358	445692	446027	446361	446696	447032	447367	447702
	3342	3343	3345	3346	3348	3349	3351	3352	3354	3355
1867.0	448038	448374	448710	449045	449382	449718	450054	450392	450728	451065
	3357	3358	3359	3361	3362	3364	3365	3367	3368	3370
1868.0	451401	451739	452077	452413	452751	453089	453427	453766	454103	454442
	3371	3373	3374	3376	3377	3378	3380	3381	3383	3384
1869.0	454780	455119	455458	455796	456136	456475	456814	457154	457493	457833
	3386	3387	3389	3390	3392	3393	3395	3396	3398	3399
1870.0	458173	458513	458854	459194	459535	459875	460216	460558	460898	461240
	3401	3402	3403	3405	3406	3408	3409	3411	3412	3414
1871.0	461581	461923	462265	462606	462948	463290	463633	463976	464318	464661
	3415	3417	3418	3420	3421	3423	3424	3426	3427	3429
1872.0	465003	465347	465691	466034	466377	466720	467065	467409	467752	468097
	3430	3431	3433	3434	3436	3437	3438	3440	3441	3443
1873.0	468441	468786	469130	469475	469820	470164	470510	470855	471201	471546
	3444	3445	3447	3448	3449	3451	3452	3454	3455	3456
1874.0	471892	472238	472584	472930	473276	473622	473969	474316	474663	475010
	3458	3459	3461	3462	3463	3465	3466	3468	3469	3470
1875.0	475356	475704	476052	476399	476747	477094	477442	477791	478139	478487
	3472	3473	3475	3476	3477	3479	3480	3482	3483	3484
1876.0	478835	479184	479533	479882	480231	480580	480930	481279	481629	481978
	3486	3487	3489	3490	3491	3493	3494	3496	3497	3498
1877.0	482328	482679	483029	483379	483729	484080	484431	484782	485132	485484
	3500	3501	3503	3504	3505	3507	3508	3510	3511	3512
1878.0	485835	486187	486538	486890	487242	487593	487946	488299	488651	489003
	3514	3515	3517	3518	3519	3521	3522	3524	3525	3526
1879.0	489356	489709	490062	490415	490768	491121	491475	491829	492183	492537
	3528	3529	3531	3532	3534	3535	3536	3538	3539	3541

TABLE 4 - 1

Climatological Summary

Prospect 2 SW, Oregon

Station: 356907, Elevation 2,480 feet

Period of Record: 1931 - 2005

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°F)														
Monthly Averages	**Maximum (°F)**	46.2	51.2	55.6	62	69.8	77.1	86.6	86.5	81	68.3	53	46.1	65.3
	Minimum (°F)	27.7	29.2	30.8	33.5	38.6	43.6	47.5	46.2	41.7	36.3	32	29	36.3
	Mean (°F)	37	40.2	43.2	47.8	54.2	60.3	67	66.4	61.3	52.3	42.5	37.5	50.8
Daily Extremes	**High (°F)**	70	76	86	89	102	103	106	110	106	98	82	71	110
	Year of High	1961	1977	2003	1947	1983	1961	1987	1981	1955	1980	1949	1985	1981
	Low (°F)	-12	-2	5	18	22	28	30	30	22	12	2	-8	-12
	Year of Low	1937	1950	1971	1963	1968	1962	1955	1960	1950	1949	1955	1972	1937
Monthly Extremes	**Highest Mean (°F)**	44.2	46.7	51	53.9	61	65.9	72	72.3	66.5	60.2	48	42.8	53.9
	Year of Highest Mean	2003	1991	2004	1934	1992	1986	2003	1967	1991	1988	1999	1958	1992
	Lowest Mean (°F)	23.8	32.8	38.2	40.8	46.8	54	60.4	60.8	55	47.2	35.9	31.1	48
	Year of Lowest Mean	1937	1933	1952	1967	1933	1953	1993	1957	1986	1949	1994	1972	1955
Precipitation (Inches)														
Precip	**Mean (inches)**	6.38	4.64	4.44	3.07	2.53	1.39	0.44	0.64	1.19	3.47	6.31	7.11	41.6
	Maximum (inches)	13.47	12.3	10.23	7.01	6.01	5.3	3.54	5.99	7.17	13.44	16.69	23.68	66.55
	Year of Maximum	1936	1986	1938	1937	1953	1937	1987	1976	1986	1950	1973	1964	1996
	Minimum (inches)	0.67	0.9	0.52	0.58	0.09	0	0	0	0	0	0.15	0.69	25.55
	Year of Minimum	1985	1988	1965	1939	1982	1951	1949	1931	1932	1936	1936	1976	1985
	One Day Max (inches)	3.41	2.46	3.23	2.32	1.92	1.85	1.5	1.5	2.38	3.84	4.31	4.39	4.39
	Year of Maximum	1951	1938	1972	1937	1944	1937	1987	1953	1977	1950	1998	1964	1964
Snowfall	**Mean (inches)**	16.5	9.5	7.1	2.2	0.1	0	0	0	0	0.3	3.3	10.6	49.6
	Maximum (inches)	87.5	63.7	34.3	23	3	0	0	0	2	10.9	22.5	47.8	157.8
	Year of Maximum	1950	1949	1951	1967	1964	1931	1931	1931	1971	1935	1931	1971	1971

Station History

3 miles north of Prospect, 1908, 1912

2 SW at Cal-Ore Power Plant 1912 to date

April 2012

TABLE 4 - 2

Climatological Summary

Medford WSO, Oregon

Station: 355429, Elevation 1,298 feet

Period of Record: 1928 - 2005

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°F)														
Monthly Averages	**Maximum (^{o}F)**	45.9	53.3	58.6	64.9	72.9	80.7	90.1	89.5	83	69.3	53.3	45.3	67.2
	Minimum (^{o}F)	30.6	32.5	35.2	38.5	44	50	55.1	54.3	47.9	40.2	34.5	31.8	41.2
	Mean (^{o}F)	38.2	42.9	46.9	51.7	58.4	65.4	72.6	71.9	65.4	54.8	43.9	38.5	54.2
Daily Extremes	**High (^{o}F)**	71	79	86	93	103	111	115	114	110	99	80	72	115
	Year of High	1961	1992	1930	1987	1986	1992	1946	1981	1988	1980	1929	1962	1946
	Low (^{o}F)	-3	6	16	21	28	31	38	39	29	18	10	-6	-6
	Year of Low	1930	1950	1956	1936	1954	1952	1962	1962	1950	1971	1978	1972	1972
Monthly Extremes	**Highest Mean (^{o}F)**	45.1	48.3	55	57.8	66.3	70.4	77.4	77.9	71	61.9	49.8	43.8	57.6
	Year of Highest Mean	1995	1992	1934	1934	1992	1987	2003	1967	1963	1988	1999	1950	1992
	Lowest Mean (^{o}F)	26.9	37.3	42.5	45.1	51.8	59.6	64.8	67.2	59.1	49.5	38.1	31.5	51.3
	Year of Lowest Mean	1937	1956	1952	1975	1933	1953	1993	1954	1978	1946	1985	1972	1948
Precipitation (Inches)														
Precip	**Mean (inches)**	2.89	2.05	1.76	1.23	1.25	0.79	0.24	0.35	0.67	1.57	2.86	3.44	19.11
	Maximum (inches)	6.67	5.67	5.54	3.59	4.58	3.49	1.63	2.83	4.22	9.16	8.62	12.72	31.41
	Year of Maximum	1936	1983	1957	2000	1945	1931	1966	1976	1977	1950	1942	1964	1996
	Minimum (inches)	0.19	0.2	0.29	0.16	0	0	0	0	0	0	0.01	0.36	10.42
	Year of Minimum	1984	1988	1969	1949	1982	1935	1928	1928	1929	1936	1936	1976	1959
	One Day Max (inches)	2.32	1.87	1.57	0.98	1.67	1.61	1.07	1.15	2.8	2.61	2.88	3.3	3.3
	Year of Maximum	1958	1959	1940	1980	1956	1932	1966	1999	1977	1950	1953	1962	1962
Snowfall	**Mean (inches)**	3	1.1	0.7	0.2	0	0	0	0	0	0	0.4	1.4	6.9
	Maximum (inches)	22.6	11.6	8.1	4.2	0.1	0	0	0	0	1.3	11.4	12.2	24.1
	Year of Maximum	1930	1956	1956	1953	1988	1928	1928	1928	1928	1956	1955	1972	1930

Station History

1911-1924 Main and Grape Streets (Cooperative)

1926-1927 Barber Field (Fairgrounds)

1927-1929 Man and Grape Streets

1929-pres. Medford Jackson County Airport

April 2012

TABLE 4 - 3

Climatological Summary - Selected Stations in the Rogue River Basin

	Prospect 2SW	Crater Lake NP HQ	Butte Falls 1SE	Medford WSO	Grants Pass	Sexton Summit WSO
Selected Stations						
Elevation	2,480	6,470	2,500	1,298	920	3,840
Period of Record	1931 - 2005	1931 - 2005	1950 - 1986	1928 - 2005	1928 - 2005	1948 - 2005
Precipitation						
Normal Annual (inches)	41.60	66.33	36.49	19.11	30.90	35.95
Maximum Annual (inches)	66.55	100.81	51.95	31.41	55.64	59.68
Year of Maximum Annual	1996	1950	1983	1996	1996	1998
Minimum Annual (inches)	25.55	42.08	22.79	10.42	15.35	14.84
Year of Minimum Annual	1985	1976	1959	1959	1976	1985
Average Number of Days >= 0.01 inch	129	140	119	101	113	125
Average Number of Days >= 1.00 inch	8	17	7	2	6	7
Maximum 24-Hour Recorded (inches)	4.39	7.13	3.98	3.30	5.27	5.25
Month and Year of Maximum 24 Hour	Dec-64	Dec-64	Dec-64	Feb-62	Oct-50	Jan-74
Snowfall						
Normal Seasonal (inches)	49.60	523.50	26.00	6.90	3.80	98.90
Maximum Seasonal (inches)	157.80	885.70	77.20	24.10	27.50	223.20
Year of Greatest 1 day Snowfall	1971	1951	1971	1930	1930	1971
Temperature (°F)						
Normal Annual	50.8	38.2		54.2	54.6	48.0
Absolute Maximum	110.0	90.0		115.0	114.0	97.0
Absolute Minimum	-12.0	-21.0		-6.0	-1.0	-4.0
January Mean	37.0	25.7		38.2	39.8	35.9
July Mean	67.0	55.1		72.6	71.0	63.6
Difference (July - January)	30.0	29.4		34.4	31.2	27.7

NOTES

Butte Falls 1 SE temperature data not available.

April 2012

TABLE 4-4. Snow Survey Summary for Rogue River Basin Snowcourses

	Annie Springs	Four Mile Lake	Cold Springs Camp	Seven Mile	Fish Lake	Big Red Mountain	Bigelow Camp
Period of Record	1929 - 2009	1933 - 2009	1959 - 2009	1959 - 2009	1933 - 2009	1936 - 2009	1981 - 2009
Elevation (feet)	6,010	5,970	5,940	5,700	4,660	6,050	5,130
January 1st Data							
Average SWE Depth (inches)	17.0	14.3	13.1	13.4	6.2	11.6	5.8
Highest Water Equivalent (inches)	39.3	30.9	27.8	25.0	14.8	22.6	16.7
Year of Highest	1952	1949	1984	1984	1949	1985	2003
Lowest Water Equiv (inches)	1.6	0.0[1]	0.0	0.8	0.0[1]	0.1	0.0[1]
Year of Lowest	1991, 1959	1959	1990	1990	1959	1990	1996
February 1st Data							
Average SWE Depth (inches)	26.0	21.3	21.3	20.1	9.3	16.7	9.4
Highest Water Equivalent (inches)	54.6	39.7	38.5	34.3	19.8	38.2	23.9
Year of Highest	1952	1969	1972	1982	1969	1952	2008
Lowest Water Equiv (inches)	3.9	7.6	1.2	3.5	1.5	3.4	0.0[1]
Year of Lowest	1977	1959	1977	1977	1959	1977	1991
March 1st Data							
Average SWE Depth (inches)	33.5	27.1	27.0	26.7	11.1	22.5	12.7
Highest Water Equivalent (inches)	70.5	52.3	46.5	42.1	26.1	46.5	32.7
Year of Highest	1952	1949	1999	2004	1956	1956	1999
Lowest Water Equiv (inches)	8.3	6.4	5.0	9.2	0.0[1]	4.8	0.0[1]
Year of Lowest	1977	1981	1977	1981	1991	1977	1992
April 1st Data							
Average SWE Depth (inches)	42.8	30.7	28.2	30.5	8.4	28.4	11.6
Highest Water Equivalent (inches)	76.5	62.9	53.8	51.3	28.6	58.1	38.6
Year of Highest	1952	1956	1999	1983	1956	1983	1999
Lowest Water Equiv (inches)	13.7	3.1	0.0[1]	5.9	0.0[1]	7.8	0.0[1]
Year of Lowest	1977	1992	1992	1992	2001	1963	2001
May 1st Data							
Average SWE Depth (inches)	39.7	23.5	21.3	22.6	1.4	26.4	6.5
Highest Water Equivalent (inches)	77.6	44.6	46.2	46.6	17.4	62.5	34.9
Year of Highest	1974	1984	1999	1984	2008	1983	83.1
Lowest Water Equiv (inches)	3.5	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]
Year of Lowest	1977	2002	1994	1990	2007	1992	2009

[1]Multiple years of zero snow water equivalent measurements.

TABLE 4-5. Evaporation and Related Data for Medford, Oregon, and Lost Creek Lake

Item	Period of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Medford Experimental Station														
Average Wind Speed (mph)[1,2]	1933-1980	0.7	0.8	0.9	0.9	0.7	0.7	0.7	0.5	0.4	0.3	0.4	0.6	0.6
Mean Air Temperature (°F)	1933-1980	37.5	42.2	45.6	50.6	57.2	63.7	70.0	68.7	63.2	52.9	43.4	38.3	52.8
Class A Pan Evaporation (in)[3]	1933-2003	0.53	1.02	2.26	3.56	5.29	6.54	8.24	6.78	4.05	1.81	0.76	0.44	41.28
Lost Creek Lake														
Pan Coefficients[4]	N/A	1.1	0.9	0.7	0.6	0.6	0.6	0.6	0.6	0.8	1.2	1.3	1.2	N/A
Evaporation (in)	N/A	0.67	1.00	1.59	2.27	3.35	4.12	5.24	4.34	3.61	2.35	2.21	0.56	31.27
Evaporation (acre-feet)[5]	N/A	148	243	424	634	958	1169	1452	1161	902	529	479	121	8220

[1]Wind speed 6 inches above evaporation pan.

[2]No record of evaporation and wind speed October through March 1938-42 and 1970-80.

[3]Updated data available for the Medford Experimental Station on the Western Regional Climate Center website: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html.

[4]Pan coefficients are based on "Lake Heffner Study."

[5]Based on average scheduled pool elevations at Lost Creek Lake.

Table 5-1. Hydrometeorological Stations Used for Regulation of Lost Creek Lake.

STREAM AND WATER QUALITY GAGING STATIONS		AUTOMATED INTERROGATION		MANUAL INTERROGATION (OBSERVED PARAMETERS)
NUMBER	STATION	NETWORK	PRIMARY PARAMETER	
14330000	Rogue River below Prospect	Hardwired into Lost Creek Lake Powerhouse	GH/Q	
14334700	South Fork Rogue River south of Prospect			GH/Q
14335075	Rogue River at McLeod			WT
14337500	Big Butte Creek near McLeod	Module C with memomark to Lost Creek Lake Powerhouse	GH/Q	
14337600	Rogue River near McLeod	Module C with memomark to Lost Creek Lake Powerhouse	GH/Q	
14338000	Elk Creek Near Trail	Hardwired into Lost Creek Lake Powerhouse		
14339000	Rogue River at Dodge Bridge near Eagle Point	1. GOES 2. NWS Telemetry	GH/Q GH/Q	
14359000	Rogue River at Raygold near Central Point	1. GOES 2. NWS Telemetry	GH/Q GH/Q	
14361500	Rogue River at Grants Pass	GOES	GH/Q	
14372300	Rogue River near Agness	NWS Telemetry	GH/Q	
LOST CREEK LAKE PROJECT				
14335040	Lost Creek Lake near McLeod	Hardwired into Lost Creek Lake	FB, WT IN, TW	
PRECIPITATION STATIONS				
	Lost Creek Lake			Daily PP
	Prospect 2 SW			Daily PP
	Crater Lake NP HQ	NWS AFOS	PP	
	Butte Falls 1 SE	NWS AFOS	PP	
	Medford WSO	NWS AFOS	PP, AT	
	Grants Pass	NWS AFOS	PP, AT	
	Sexton Summit WSO	NWS AFOS	PP, AT	
SNOW COURSES				
	Diamond Lake SNOTEL	SCS SNOTEL	SWC, PP, AT	Bimonthly SWC, PP
	Billie Creek SNOTEL	SCS SNOTEL	SWC, PP, AT	Bimonthly SWC, PP
	Fish Lake SNOTEL	SCS SNOTEL	SWC, PP, AT	Bimonthly SWC, PP
	Seven Mile Marsh SNOTEL	SCS SNOTEL	SWC, PP, AT	Bimonthly SWC, PP
	Four Mile Lake SNOTEL	SCS SNOTEL	SWC, PP, AT	Bimonthly SWC, PP
	Cold Springs Camp SNOTEL	SCS SNOTEL	SWC, PP, AT	Bimonthly SWC, PP

GH/Q = Gage Height/Discharge
WT = Water Temperature
SWC = Snow Water content
FB = Forebay elevation
TW = Tailwater elevation
IN = Inflow
Cond = Conductivity
PP = Precipitation
AT = Air temperature

Table 5-3. Discharge Rating Table – Rogue River near McLeod, Oregon

CROHMS RATING TABLE STATION MCLO   DATE DEC 18,1985

GHT	DISCH	DIFF	GHT	DISCH	DIFF
1.00	700.	60.	4.00	4000.	173.
1.10	760.	60.	4.10	4173.	176.
1.20	820.	60.	4.20	4349.	180.
1.30	880.	60.	4.30	4529.	185.
1.40	940.	60.	4.40	4714.	188.
1.50	1000.	80.	4.50	4902.	192.
1.60	1080.	83.	4.60	5094.	196.
1.70	1163.	86.	4.70	5290.	200.
1.80	1249.	89.	4.80	5490.	204.
1.90	1338.	92.	4.90	5694.	208.
2.00	1430.	89.	5.00	5902.	212.
2.10	1519.	92.	5.10	6114.	215.
2.20	1611.	94.	5.20	6329.	220.
2.30	1705.	96.	5.30	6549.	224.
2.40	1801.	99.	5.40	6773.	228.
2.50	1900.	113.	5.50	7001.	232.
2.60	2013.	117.	5.60	7233.	235.
2.70	2130.	120.	5.70	7468.	240.
2.80	2250.	123.	5.80	7708.	244.
2.90	2373.	127.	5.90	7952.	248.
3.00	2500.	133.	6.00	8200.	251.
3.10	2633.	136.	6.10	8451.	256.
3.20	2769.	140.	6.20	8707.	259.
3.30	2909.	144.	6.30	8966.	264.
3.40	3053.	147.	6.40	9230.	267.
3.50	3200.	152.	6.50	9497.	272.
3.60	3352.	157.	6.60	9769.	275.
3.70	3509.	160.	6.70	10044.	280.
3.80	3669.	163.	6.80	10324.	284.
3.90	3832.	168.	6.90	10608.	288.

CROHMS RATING TABLE STATION MCLO   DATE DEC 18,1985

GHT	DISCH	DIFF	GHT	DISCH	DIFF
7.00	10896.	291.	10.00	21000.	363.
7.10	11187.	297.	10.10	21363.	366.
7.20	11484.	300.	10.20	21729.	368.
7.30	11784.	304.	10.30	22097.	372.
7.40	12088.	308.	10.40	22469.	375.
7.50	12396.	313.	10.50	22844.	377.
7.60	12709.	316.	10.60	23221.	381.
7.70	13025.	321.	10.70	23602.	383.
7.80	13346.	325.	10.80	23985.	386.
7.90	13671.	329.	10.90	24371.	389.
8.00	14000.	316.	11.00	24760.	392.
8.10	14316.	320.	11.10	25152.	395.
8.20	14636.	323.	11.20	25547.	398.
8.30	14959.	327.	11.30	25945.	401.
8.40	15286.	330.	11.40	26346.	404.
8.50	15616.	334.	11.50	26750.	406.
8.60	15950.	338.	11.60	27156.	410.
8.70	16288.	341.	11.70	27566.	412.
8.80	16629.	344.	11.80	27978.	415.
8.90	16973.	348.	11.90	28393.	418.
9.00	17321.	352.	12.00	28811.	421.
9.10	17673.	356.	12.10	29232.	424.
9.20	18029.	358.	12.20	29656.	427.
9.30	18387.	363.	12.30	30083.	430.
9.40	18750.	366.	12.40	30513.	432.
9.50	19116.	370.	12.50	30945.	435.
9.60	19486.	373.	12.60	31380.	439.
9.70	19859.	377.	12.70	31819.	441.
9.80	20236.	380.	12.80	32260.	444.
9.90	20616.	384.	12.90	32704.	447.

CROHMS RATING TABLE STATION MCLO DATE DEC 18,1985

GHT	DISCH	DIFF	GHT	DISCH	DIFF
13.00	33151.	449.	16.00	47876.	535.
13.10	33600.	453.	16.10	48411.	537.
13.20	34053.	455.	16.20	48948.	540.
13.30	34508.	459.	16.30	49488.	543.
13.40	34967.	461.	16.40	50031.	546.
13.50	35428.	464.	16.50	50577.	548.
13.60	35892.	466.	16.60	51125.	552.
13.70	36358.	470.	16.70	51677.	554.
13.80	36828.	473.	16.80	52231.	557.
13.90	37301.	475.	16.90	52788.	559.
14.00	37776.	478.	17.00	53347.	563.
14.10	38254.	481.	17.10	53910.	565.
14.20	38735.	484.	17.20	54475.	568.
14.30	39219.	487.	17.30	55043.	571.
14.40	39706.	489.	17.40	55614.	573.
14.50	40195.	492.	17.50	56187.	577.
14.60	40687.	496.	17.60	56764.	579.
14.70	41183.	498.	17.70	57343.	582.
14.80	41681.	500.	17.80	57925.	584.
14.90	42181.	504.	17.90	58509.	588.
15.00	42685.	506.	18.00	59097.	590.
15.10	43191.	510.	18.10	59687.	593.
15.20	43701.	512.	18.20	60280.	596.
15.30	44213.	515.	18.30	60876.	598.
15.40	44728.	517.	18.40	61474.	601.
15.50	45245.	521.	18.50	62075.	604.
15.60	45766.	523.	18.60	62679.	607.
15.70	46289.	526.	18.70	63286.	610.
15.80	46815.	529.	18.80	63896.	612.
15.90	47344.	532.	18.90	64508.	615.

CROHMS RATING TABLE STATION MCLO   DATE DEC 18,1985

GHT	DISCH	DIFF	GHT	DISCH	DIFF
19.00	65123.	618.	0.0	0.	0.
19.10	65741.	620.	0.0	0.	0.
19.20	66361.	624.	0.0	0.	0.
19.30	66985.	626.	0.0	0.	0.
19.40	67611.	628.	0.0	0.	0.
19.50	68239.	632.	0.0	0.	0.
19.60	68871.	634.	0.0	0.	0.
19.70	69505.	637.	0.0	0.	0.
19.80	70142.	640.	0.0	0.	0.
19.90	70782.	643.	0.0	0.	0.
20.00	71425.	645.	0.0	0.	0.
20.10	72070.	648.	0.0	0.	0.
20.20	72718.	650.	0.0	0.	0.
20.30	73368.	654.	0.0	0.	0.
20.40	74022.	656.	0.0	0.	0.
20.50	74678.	659.	0.0	0.	0.
20.60	75337.	662.	0.0	0.	0.
20.70	75999.	664.	0.0	0.	0.
20.80	76663.	667.	0.0	0.	0.
20.90	77330.	670.	0.0	0.	0.
21.00	78000.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.

Table 5-4. Discharge Rating Table - Big Butte near McLeod, Oregon

CROHMS RATING TABLE STATION MLBO DATE SEP 15,1986

GHT	DISCH	DIFF	GHT	DISCH	DIFF
3.10	34.	14.	6.10	1472.	73.
3.20	48.	16.	6.20	1545.	75.
3.30	64.	18.	6.30	1620.	62.
3.40	82.	22.	6.40	1682.	62.
3.50	104.	24.	6.50	1744.	64.
3.60	128.	26.	6.60	1808.	64.
3.70	154.	26.	6.70	1872.	65.
3.80	180.	33.	6.80	1937.	66.
3.90	213.	37.	6.90	2003.	67.
4.00	250.	40.	7.00	2070.	67.
4.10	290.	45.	7.10	2137.	69.
4.20	335.	43.	7.20	2206.	69.
4.30	378.	47.	7.30	2275.	69.
4.40	425.	51.	7.40	2344.	71.
4.50	476.	54.	7.50	2415.	71.
4.60	530.	63.	7.60	2486.	73.
4.70	593.	67.	7.70	2559.	73.
4.80	660.	54.	7.80	2632.	73.
4.90	714.	57.	7.90	2705.	75.
5.00	771.	59.	8.00	2780.	83.
5.10	830.	57.	8.10	2863.	85.
5.20	887.	59.	8.20	2948.	85.
5.30	946.	61.	8.30	3033.	87.
5.40	1007.	63.	8.40	3120.	88.
5.50	1070.	62.	8.50	3208.	89.
5.60	1132.	65.	8.60	3297.	89.
5.70	1197.	66.	8.70	3386.	91.
5.80	1263.	67.	8.80	3477.	92.
5.90	1330.	70.	8.90	3569.	93.
6.00	1400.	72.	9.00	3662.	94.

CROHMS RATING TABLE STATION MLBO DATE SEP 15,1986

GHT	DISCH	DIFF	GHT	DISCH	DIFF
9.10	3756.	96.	12.10	6769.	119.
9.20	3852.	96.	12.20	6888.	121.
9.30	3948.	97.	12.30	7009.	121.
9.40	4045.	98.	12.40	7130.	122.
9.50	4143.	99.	12.50	7252.	123.
9.60	4242.	101.	12.60	7375.	125.
9.70	4343.	101.	12.70	7500.	125.
9.80	4444.	103.	12.80	7625.	126.
9.90	4547.	103.	12.90	7751.	126.
10.00	4650.	94.	13.00	7877.	128.
10.10	4744.	94.	13.10	8005.	129.
10.20	4838.	95.	13.20	8134.	129.
10.30	4933.	95.	13.30	8263.	131.
10.40	5028.	97.	13.40	8394.	131.
10.50	5125.	97.	13.50	8525.	132.
10.60	5222.	97.	13.60	8657.	133.
10.70	5319.	99.	13.70	8790.	134.
10.80	5418.	99.	13.80	8924.	135.
10.90	5517.	99.	13.90	9059.	136.
11.00	5616.	101.	14.00	9195.	136.
11.10	5717.	101.	14.10	9331.	138.
11.20	5818.	102.	14.20	9469.	138.
11.30	5920.	102.	14.30	9607.	139.
11.40	6022.	103.	14.40	9746.	140.
11.50	6125.	104.	14.50	9886.	141.
11.60	6229.	104.	14.60	10027.	142.
11.70	6333.	105.	14.70	10169.	143.
11.80	6438.	106.	14.80	10312.	144.
11.90	6544.	106.	14.90	10456.	144.
12.00	6650.	119.	15.00	10600.	155.

CROHMS RATING TABLE STATION MLBO   DATE SEP 15,1986

GHT	DISCH	DIFF	GHT	DISCH	DIFF
15.10	10755.	155.	18.10	15880.	187.
15.20	10910.	157.	18.20	16067.	188.
15.30	11067.	158.	18.30	16255.	189.
15.40	11225.	159.	18.40	16444.	190.
15.50	11384.	160.	18.50	16634.	191.
15.60	11544.	161.	18.60	16825.	193.
15.70	11705.	162.	18.70	17018.	193.
15.80	11867.	163.	18.80	17211.	194.
15.90	12030.	164.	18.90	17405.	195.
16.00	12194.	165.	19.00	17600.	0.
16.10	12359.	166.	0.0	0.	0.
16.20	12525.	167.	0.0	0.	0.
16.30	12692.	169.	0.0	0.	0.
16.40	12861.	169.	0.0	0.	0.
16.50	13030.	170.	0.0	0.	0.
16.60	13200.	172.	0.0	0.	0.
16.70	13372.	172.	0.0	0.	0.
16.80	13544.	174.	0.0	0.	0.
16.90	13718.	174.	0.0	0.	0.
17.00	13892.	176.	0.0	0.	0.
17.10	14068.	176.	0.0	0.	0.
17.20	14244.	178.	0.0	0.	0.
17.30	14422.	179.	0.0	0.	0.
17.40	14601.	179.	0.0	0.	0.
17.50	14780.	181.	0.0	0.	0.
17.60	14961.	182.	0.0	0.	0.
17.70	15143.	183.	0.0	0.	0.
17.80	15326.	184.	0.0	0.	0.
17.90	15510.	185.	0.0	0.	0.
18.00	15695.	185.	0.0	0.	0.

Table 5-5. Discharge Rating Table - Rogue River at Dodge Bridge near Eagle Point, Oregon

CROHMS RATING TABLE STATION EGLO DATE MAR 10,1987

GHT	DISCH	DIFF	GHT	DISCH	DIFF
1.50	850.	80.	4.50	5343.	217.
1.60	930.	90.	4.60	5560.	219.
1.70	1020.	100.	4.70	5779.	221.
1.80	1120.	100.	4.80	6000.	224.
1.90	1220.	100.	4.90	6224.	226.
2.00	1320.	100.	5.00	6450.	250.
2.10	1420.	100.	5.10	6700.	254.
2.20	1520.	120.	5.20	6954.	257.
2.30	1640.	120.	5.30	7211.	260.
2.40	1760.	120.	5.40	7471.	264.
2.50	1880.	138.	5.50	7735.	267.
2.60	2018.	140.	5.60	8002.	270.
2.70	2158.	140.	5.70	8272.	273.
2.80	2298.	140.	5.80	8545.	276.
2.90	2438.	142.	5.90	8821.	279.
3.00	2580.	157.	6.00	9100.	307.
3.10	2737.	158.	6.10	9407.	312.
3.20	2895.	161.	6.20	9719.	315.
3.30	3056.	161.	6.30	10034.	320.
3.40	3217.	163.	6.40	10354.	323.
3.50	3380.	180.	6.50	10677.	328.
3.60	3560.	182.	6.60	11005.	332.
3.70	3742.	184.	6.70	11337.	335.
3.80	3926.	186.	6.80	11672.	340.
3.90	4112.	188.	6.90	12012.	343.
4.00	4300.	203.	7.00	12355.	347.
4.10	4503.	206.	7.10	12702.	351.
4.20	4709.	209.	7.20	13053.	355.
4.30	4918.	212.	7.30	13408.	359.
4.40	5130.	213.	7.40	13767.	363.

CROHMS RATING TABLE STATION EGLO DATE MAR 10,1987

GHT	DISCH	DIFF	GHT	DISCH	DIFF
7.50	14130.	366.	0.0	0.	0.
7.60	14496.	371.	0.0	0.	0.
7.70	14867.	374.	0.0	0.	0.
7.80	15241.	377.	0.0	0.	0.
7.90	15618.	382.	0.0	0.	0.
8.00	16000.	416.	0.0	0.	0.
8.10	16416.	420.	0.0	0.	0.
8.20	16836.	425.	0.0	0.	0.
8.30	17261.	430.	0.0	0.	0.
8.40	17691.	434.	0.0	0.	0.
8.50	18125.	439.	0.0	0.	0.
8.60	18564.	444.	0.0	0.	0.
8.70	19008.	449.	0.0	0.	0.
8.80	19457.	453.	0.0	0.	0.
8.90	19910.	458.	0.0	0.	0.
9.00	20368.	462.	0.0	0.	0.
9.10	20830.	467.	0.0	0.	0.
9.20	21297.	472.	0.0	0.	0.
9.30	21769.	476.	0.0	0.	0.
9.40	22245.	481.	0.0	0.	0.
9.50	22726.	486.	0.0	0.	0.
9.60	23212.	490.	0.0	0.	0.
9.70	23702.	495.	0.0	0.	0.
9.80	24197.	499.	0.0	0.	0.
9.90	24696.	504.	0.0	0.	0.
10.00	25200.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.

Table 5-6. Discharge Rating Table - Rogue River at Raygold near Central Point, Oregon

CROHMS RATING TABLE STATION RYGO DATE FEB 11,1982

GHT	DISCH	DIFF	GHT	DISCH	DIFF
0.10	500.	58.	3.10	3767.	171.
0.20	558.	62.	3.20	3938.	176.
0.30	620.	59.	3.30	4114.	179.
0.40	679.	61.	3.40	4293.	183.
0.50	740.	71.	3.50	4476.	187.
0.60	811.	74.	3.60	4663.	191.
0.70	885.	78.	3.70	4854.	195.
0.80	963.	82.	3.80	5049.	199.
0.90	1045.	85.	3.90	5248.	203.
1.00	1130.	87.	4.00	5451.	207.
1.10	1217.	91.	4.10	5658.	210.
1.20	1308.	94.	4.20	5868.	215.
1.30	1402.	98.	4.30	6083.	219.
1.40	1500.	101.	4.40	6302.	223.
1.50	1601.	105.	4.50	6525.	227.
1.60	1706.	108.	4.60	6752.	230.
1.70	1814.	111.	4.70	6982.	235.
1.80	1925.	115.	4.80	7217.	239.
1.90	2040.	118.	4.90	7456.	250.
2.00	2158.	121.	5.00	7706.	256.
2.10	2279.	125.	5.10	7962.	260.
2.20	2404.	129.	5.20	8222.	266.
2.30	2533.	132.	5.30	8488.	271.
2.40	2665.	135.	5.40	8759.	276.
2.50	2800.	151.	5.50	9035.	281.
2.60	2951.	156.	5.60	9316.	286.
2.70	3107.	160.	5.70	9602.	292.
2.80	3267.	164.	5.80	9894.	296.
2.90	3431.	169.	5.90	10190.	302.
3.00	3600.	167.	6.00	10492.	307.

CROHMS RATING TABLE STATION RYGO DATE FEB 11,1982

GHT	DISCH	DIFF	GHT	DISCH	DIFF
6.10	10799.	312.	9.10	21991.	425.
6.20	11111.	317.	9.20	22416.	429.
6.30	11428.	322.	9.30	22845.	434.
6.40	11750.	327.	9.40	23279.	437.
6.50	12077.	332.	9.50	23716.	443.
6.60	12409.	338.	9.60	24159.	446.
6.70	12747.	342.	9.70	24605.	451.
6.80	13089.	348.	9.80	25056.	455.
6.90	13437.	353.	9.90	25511.	460.
7.00	13790.	358.	10.00	25971.	464.
7.10	14148.	363.	10.10	26435.	468.
7.20	14511.	368.	10.20	26903.	472.
7.30	14879.	374.	10.30	27375.	477.
7.40	15253.	378.	10.40	27852.	481.
7.50	15631.	384.	10.50	28333.	485.
7.60	16015.	388.	10.60	28818.	490.
7.70	16403.	394.	10.70	29308.	494.
7.80	16797.	399.	10.80	29802.	498.
7.90	17196.	404.	10.90	30300.	503.
8.00	17600.	378.	11.00	30803.	507.
8.10	17978.	381.	11.10	31310.	511.
8.20	18359.	387.	11.20	31821.	516.
8.30	18746.	390.	11.30	32337.	520.
8.40	19136.	395.	11.40	32857.	524.
8.50	19531.	399.	11.50	33381.	528.
8.60	19930.	404.	11.60	33909.	533.
8.70	20334.	407.	11.70	34442.	537.
8.80	20741.	412.	11.80	34979.	542.
8.90	21153.	417.	11.90	35521.	545.
9.00	21570.	421.	12.00	36066.	550.

CROHMS RATING TABLE STATION RYGO   DATE FEB 11,1982

GHT	DISCH	DIFF	GHT	DISCH	DIFF
12.10	36616.	555.	15.10	55178.	691.
12.20	37171.	558.	15.20	55869.	695.
12.30	37729.	563.	15.30	56564.	700.
12.40	38292.	568.	15.40	57264.	705.
12.50	38860.	571.	15.50	57969.	709.
12.60	39431.	574.	15.60	58678.	714.
12.70	40005.	578.	15.70	59392.	719.
12.80	40583.	583.	15.80	60111.	724.
12.90	41166.	588.	15.90	60835.	728.
13.00	41754.	593.	16.00	61563.	732.
13.10	42347.	597.	16.10	62295.	738.
13.20	42944.	602.	16.20	63033.	742.
13.30	43546.	606.	16.30	63775.	747.
13.40	44152.	611.	16.40	64522.	751.
13.50	44763.	616.	16.50	65273.	757.
13.60	45379.	621.	16.60	66030.	760.
13.70	46000.	625.	16.70	66790.	766.
13.80	46625.	630.	16.80	67556.	770.
13.90	47255.	634.	16.90	68326.	775.
14.00	47889.	639.	17.00	69101.	780.
14.10	48528.	644.	17.10	69881.	784.
14.20	49172.	649.	17.20	70665.	789.
14.30	49821.	653.	17.30	71454.	794.
14.40	50474.	658.	17.40	72248.	798.
14.50	51132.	663.	17.50	73046.	803.
14.60	51795.	667.	17.60	73849.	807.
14.70	52462.	672.	17.70	74656.	813.
14.80	53134.	677.	17.80	75469.	817.
14.90	53811.	681.	17.90	76286.	821.
15.00	54492.	686.	18.00	77107.	827.

CROHMS RATING TABLE STATION RYGO   DATE FEB 11,1982

GHT	DISCH	DIFF	GHT	DISCH	DIFF
18.10	77934.	831.	21.10	104900.	971.
18.20	78765.	836.	21.20	105871.	977.
18.30	79601.	840.	21.30	106848.	980.
18.40	80441.	845.	21.40	107828.	986.
18.50	81286.	850.	21.50	108814.	990.
18.60	82136.	854.	21.60	109804.	995.
18.70	82990.	859.	21.70	110799.	999.
18.80	83849.	864.	21.80	111798.	1004.
18.90	84713.	869.	21.90	112802.	1009.
19.00	85582.	873.	22.00	113811.	1013.
19.10	86455.	878.	22.10	114824.	1019.
19.20	87333.	882.	22.20	115843.	1023.
19.30	88215.	887.	22.30	116866.	1027.
19.40	89102.	892.	22.40	117893.	1032.
19.50	89994.	897.	22.50	118925.	1037.
19.60	90891.	901.	22.60	119962.	1042.
19.70	91792.	906.	22.70	121004.	1046.
19.80	92698.	910.	22.80	122050.	1051.
19.90	93608.	916.	22.90	123101.	1055.
20.00	94524.	919.	23.00	124156.	1061.
20.10	95443.	925.	23.10	125217.	1065.
20.20	96368.	929.	23.20	126282.	1069.
20.30	97297.	934.	23.30	127351.	1075.
20.40	98231.	939.	23.40	128426.	1079.
20.50	99170.	943.	23.50	129505.	1083.
20.60	100113.	948.	23.60	130588.	1089.
20.70	101061.	953.	23.70	131677.	1093.
20.80	102014.	957.	23.80	132770.	1097.
20.90	102971.	962.	23.90	133867.	1103.
21.00	103933.	967.	24.00	134970.	1107.

CROHMS RATING TABLE STATION RYGO   DATE FEB 11,1982

GHT	DISCH	DIFF	GHT	DISCH	DIFF
24.10	136077.	1112.	0.0	0.	0.
24.20	137189.	1116.	0.0	0.	0.
24.30	138305.	1121.	0.0	0.	0.
24.40	139426.	1126.	0.0	0.	0.
24.50	140552.	1130.	0.0	0.	0.
24.60	141682.	1135.	0.0	0.	0.
24.70	142817.	1140.	0.0	0.	0.
24.80	143957.	1145.	0.0	0.	0.
24.90	145102.	1149.	0.0	0.	0.
25.00	146251.	1154.	0.0	0.	0.
25.10	147405.	1158.	0.0	0.	0.
25.20	148563.	1163.	0.0	0.	0.
25.30	149726.	1168.	0.0	0.	0.
25.40	150894.	1173.	0.0	0.	0.
25.50	152067.	1177.	0.0	0.	0.
25.60	153244.	1182.	0.0	0.	0.
25.70	154426.	1187.	0.0	0.	0.
25.80	155613.	1191.	0.0	0.	0.
25.90	156804.	1196.	0.0	0.	0.
26.00	158000.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.

Table 5-7. Discharge Rating Table – Rogue River at Grants Pass, Oregon

CROHMS RATING TABLE STATION GRAO DATE MAR 23,1989

GHT	DISCH	DIFF	GHT	DISCH	DIFF
1.60	1080.	110.	4.60	5920.	220.
1.70	1190.	110.	4.70	6140.	220.
1.80	1300.	120.	4.80	6360.	220.
1.90	1420.	130.	4.90	6580.	220.
2.00	1550.	130.	5.00	6800.	220.
2.10	1680.	130.	5.10	7020.	230.
2.20	1810.	140.	5.20	7250.	240.
2.30	1950.	140.	5.30	7490.	240.
2.40	2090.	140.	5.40	7730.	250.
2.50	2230.	140.	5.50	7980.	250.
2.60	2370.	140.	5.60	8230.	250.
2.70	2510.	140.	5.70	8480.	250.
2.80	2650.	150.	5.80	8730.	250.
2.90	2800.	150.	5.90	8980.	250.
3.00	2950.	160.	6.00	9230.	250.
3.10	3110.	170.	6.10	9480.	260.
3.20	3280.	180.	6.20	9740.	260.
3.30	3460.	180.	6.30	10000.	270.
3.40	3640.	180.	6.40	10270.	280.
3.50	3820.	180.	6.50	10550.	280.
3.60	4000.	180.	6.60	10830.	280.
3.70	4180.	180.	6.70	11110.	280.
3.80	4360.	180.	6.80	11390.	280.
3.90	4540.	180.	6.90	11670.	280.
4.00	4720.	180.	7.00	11950.	290.
4.10	4900.	200.	7.10	12240.	300.
4.20	5100.	200.	7.20	12540.	300.
4.30	5300.	200.	7.30	12840.	300.
4.40	5500.	200.	7.40	13140.	310.
4.50	5700.	220.	7.50	13450.	310.

CROHMS RATING TABLE STATION GRAO   DATE MAR 23,1989

GHT	DISCH	DIFF	GHT	DISCH	DIFF
7.60	13760.	310.	10.60	24000.	350.
7.70	14070.	310.	10.70	24350.	350.
7.80	14380.	310.	10.80	24700.	350.
7.90	14690.	310.	10.90	25050.	350.
8.00	15000.	320.	11.00	25400.	360.
8.10	15320.	330.	11.10	25760.	360.
8.20	15650.	330.	11.20	26120.	370.
8.30	15980.	340.	11.30	26490.	370.
8.40	16320.	340.	11.40	26860.	380.
8.50	16660.	340.	11.50	27240.	380.
8.60	17000.	350.	11.60	27620.	390.
8.70	17350.	350.	11.70	28010.	390.
8.80	17700.	350.	11.80	28400.	400.
8.90	18050.	350.	11.90	28800.	450.
9.00	18400.	350.	12.00	29250.	450.
9.10	18750.	350.	12.10	29700.	500.
9.20	19100.	350.	12.20	30200.	500.
9.30	19450.	350.	12.30	30700.	500.
9.40	19800.	350.	12.40	31200.	500.
9.50	20150.	350.	12.50	31700.	500.
9.60	20500.	350.	12.60	32200.	500.
9.70	20850.	350.	12.70	32700.	500.
9.80	21200.	350.	12.80	33200.	500.
9.90	21550.	350.	12.90	33700.	500.
10.00	21900.	350.	13.00	34200.	500.
10.10	22250.	350.	13.10	34700.	500.
10.20	22600.	350.	13.20	35200.	500.
10.30	22950.	350.	13.30	35700.	500.
10.40	23300.	350.	13.40	36200.	500.
10.50	23650.	350.	13.50	36700.	500.

CROHMS RATING TABLE STATION GRAO DATE MAR 23,1989

GHT	DISCH	DIFF	GHT	DISCH	DIFF
13.60	37200.	500.	0.0	0.	0.
13.70	37700.	500.	0.0	0.	0.
13.80	38200.	500.	0.0	0.	0.
13.90	38700.	500.	0.0	0.	0.
14.00	39200.	500.	0.0	0.	0.
14.10	39700.	500.	0.0	0.	0.
14.20	40200.	500.	0.0	0.	0.
14.30	40700.	500.	0.0	0.	0.
14.40	41200.	500.	0.0	0.	0.
14.50	41700.	500.	0.0	0.	0.
14.60	42200.	500.	0.0	0.	0.
14.70	42700.	500.	0.0	0.	0.
14.80	43200.	500.	0.0	0.	0.
14.90	43700.	500.	0.0	0.	0.
15.00	44200.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	0.
0.0	0.	0.	0.0	0.	

Note: Stages greater than 15.0 feet at Grants Pass do not have a verified USGS discharge rating.

Table 7-3. Seasonal Filling Schedule for Lost Creek Lake.

UNITS: Elevation is in feet, NGVD.
Storage is in acre-feet.

Date	January		February		March		April	
	Elevation	Storage	Elevation	Storage	Elevation	Storage	Elevation	Storage
(Dec 31)	1,812.00	285,000						
1	1,812.37	285,968	1,824.28	317,857	1,850.98	396,148	1,862.09	431,721
2	1,812.74	286,935	1,825.31	320,714	1,851.35	397,295	1,862.44	432,869
3	1,813.11	287,903	1,826.35	323,571	1,851.71	398,443	1,862.78	434,016
4	1,813.48	288,871	1,827.37	326,429	1,852.08	399,590	1,863.13	435,164
5	1,813.85	289,839	1,828.39	329,286	1,852.45	400,738	1,863.48	435,311
6	1,814.22	290,806	1,829.41	332,143	1,852.81	401,885	1,863.83	437,459
7	1,814.59	291,774	1,830.42	335,000	1,853.18	403,033	1,864.17	438,607
8	1,814.96	292,742	1,831.42	337,857	1,853.54	404,180	1,864.52	439,754
9	1,815.32	293,710	1,832.42	340,714	1,853.90	405,328	1,864.87	440,902
10	1,815.69	294,677	1,833.42	343,571	1,854.26	406,475	1,865.21	442,049
11	1,816.05	295,645	1,834.61	346,429	1,854.63	407,623	1,865.55	443,197
12	1,816.42	296,613	1,835.40	349,296	1,854.99	408,770	1,865.90	444,344
13	1,816.78	297,581	1,836.39	352,143	1,855.35	409,918	1,866.24	445,492
14	1,817.15	298,548	1,837.36	355,000	1,855.74	411,066	1,866.58	446,639
15	1,817.51	299,516	1,838.34	357,857	1,856.07	412,213	1,866.93	447,787
16	1,817.87	300,484	1,839.31	360,714	1,856.43	413,361	1,867.27	448,934
17	1,818.23	301,452	1,840.27	363,571	1,856.79	414,508	1,867.61	450,082
18	1,818.59	302,419	1,841.23	366,429	1,857.14	415,656	1,867.95	451,229
19	1,818.96	303,387	1,842.19	369,286	1,857.50	416,803	1,868.29	452,377
20	1,819.32	304,355	1,843.14	372,143	1,857.86	417,951	1,868.63	453,525
21	1,819.67	305,323	1,844.09	375,000	1,858.21	419,098	1,868.97	454,672
22	1,820.03	306,290	1,845.05	377,857	1,858.57	420,246	1,869.31	455,820
23	1,820.39	307,258	1,845.98	380,714	1,858.92	421,393	1,869.65	456,967
24	1,820.75	308,226	1,846.91	383,571	1,859.28	422,541	1,869.99	458,115
25	1,821.11	309,194	1,847.84	386,428	1,859.63	423,687	1,870.32	459,262
26	1,821.46	310,161	1848.77	389,286	1,859.98	424,836	1,870.66	460,410
27	1,821.82	311,129	1,849.69	392,143	1,860.33	425,984	1,871.00	461,557
28	1,822.17	312,097	1,850.61	395,000	1,860.69	427,131	1,871.33	462,705
29	1,822.53	313,064			1,861.04	428,279	1,871.67	463,852
30	1,822.88	314,032			1,861.39	429,426	1,872.00	465,000
31	1,823.24	315,000			1,861.74	430,573		
Filling Rate	968 af/day		2,857 af/day		1,148 af/day		1,148 af/day	

NOTES:
1. Pool elevation and corresponding acre-feet applicable to the 24 hours observation.
2. In leap year, the reservoir will be 1 day ahead above schedule after 28 February.
3. Full pool is El. 1,872.

Table 7-4. Seasonal Evacuation Schedule for Lost Creek Lake.

UNITS: Elevation is in feet, NGVD.
Storage is in acre-feet.

Date	September		October	
	Elevation	Storage	Elevation	Storage
(Aug 31)	1,872.00	465,000		
1	1,871.24	462,040	1,843.60	373,519
2	1,870.27	459,090	1,842.62	370,568
3	1,869.40	456,139	1,841.63	367,617
4	1,868.52	453,188	1,840.65	364,666
5	1,867.66	450,237	1,839.67	361,716
6	1,866.78	447,287	1,838.65	358,765
7	1,865.90	444,366	1,837.75	355,814
8	1,865.01	441,385	1,836.63	352,864
9	1,864.12	438,435	1,835.62	349,913
10	1,863.23	435,484	1,834.60	346,962
11	1,862.34	432,533	1,833.57	344,011
12	1,861.43	429,581	1,832.55	341,061
13	1,860.53	426,632	1,831.52	338,110
14	1,859.63	423,681	1,830.53	335,159
15	1,858.72	420,730	1,829.43	332,209
16	1,857.80	417,779	1,828.36	329,258
17	1,856.87	414,829	1,827.34	326,307
18	1,855.96	411,878	1,826.27	323,356
19	1,855.04	408,927	1,825.20	320,406
20	1,854.11	405,977	1,824.13	317,455
21	1,853.17	403,026	1,823.06	314,504
22	1,852.24	400,075	1,821.98	311,553
23	1,851.29	397,124	1,820.90	308,603
24	1,850.35	394,174	1,819.80	305,652
25	1,849.40	391,223	1,818.70	302,701
26	1,848.44	388,272	1,817.60	299,751
27	1,847.48	385,322	1,816.50	296,800
28	1,846.52	382,371	1,815.38	293,849
29	1,845.55	379,420	1,814.24	290,898
30	1,844.58	376,469	1,813.13	287,948
31			1,812.00	285,000
Draft Rate	2,951 af/day		2,951 af/day	

NOTES: 1. Pool elevation and corresponding acre-feet applicable to the 24 hours observation.
2. Full pool is El. 1,872.

Table 7-6. Target Release Temperatures for Lost Creek Dam, 1987.

DATE	TEMPERATURE (°)		DATE	TEMPERATURE (°)	
	C	F		C	F
01 Jan	3.0	37.4	01 Jul	9.0	48.2
08 Jan	3.0	37.4	08 Jul	9.0	48.2
15 Jan	3.0	37.4	15 Jul	11.1	52.0
22 Jan	3.0	37.4	22 Jul	11.1	52.0
01 Feb	3.0	37.4	01 Aug	12.8	55.0
08 Feb	3.0	37.4	08 Aug	12.8	55.0
15 Feb	3.0	37.4	15 Aug	12.8	55.0
22 Feb	3.0	37.4	22 Aug	12.8	55.0
01 Mar	4.7	40.5	01 Sep	11.6	52.9
08 Mar	4.9	40.9	08 Sep	10.8	51.4
15 Mar	5.3	41.5	15 Sep	6.7	44.1
22 Mar	5.5	41.9	22 Sep	6.0	42.8
01 Apr	5.8	42.4	01 Oct	5.2	41.3
08 Apr	6.3	43.3	08 Oct	4.5	40.1
15 Apr	6.9	44.4	15 Oct	4.0	39.3
22 Apr	7.6	45.7	22 Oct	3.0	37.4
01 May	8.2	46.8	01 Nov	3.0	37.4
08 May	8.5	47.3	08 Nov	3.0	37.4
15 May	8.5	47.3	15 Nov	3.0	37.4
22 May	9.0	48.2	22 Nov	3.0	37.4
01 Jun	9.0	48.2	01 Dec	3.0	37.4
08 Jun	9.0	48.2	08 Dec	3.0	37.4
15 Jun	9.0	48.2	15 Dec	3.0	37.4
22 Jun	9.0	48.2	22 Dec	3.0	37.4
			31 Dec	3.0	37.4

Table 7-7. Power Generation Scheduling Procedures for Lost Creek Project.

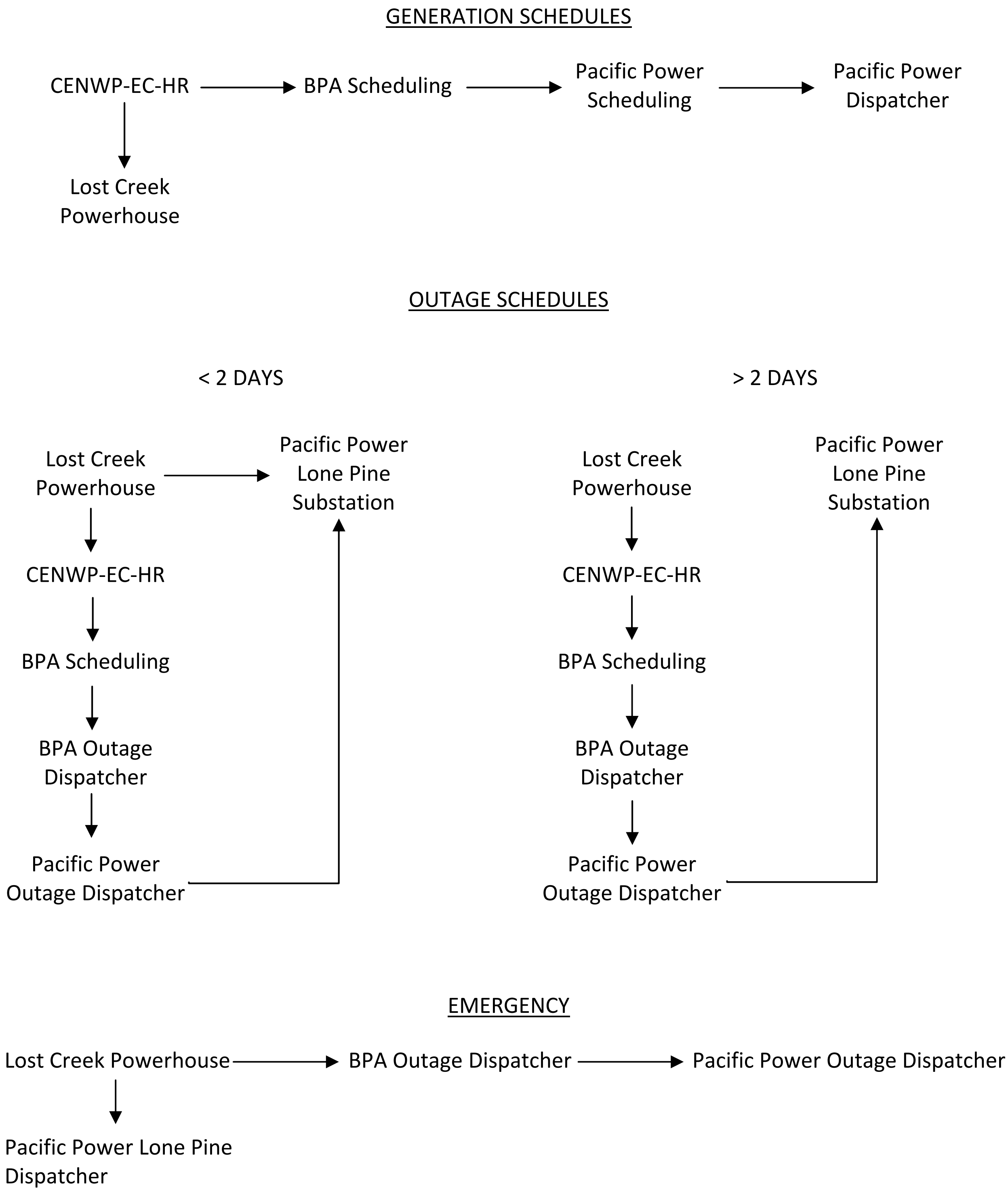
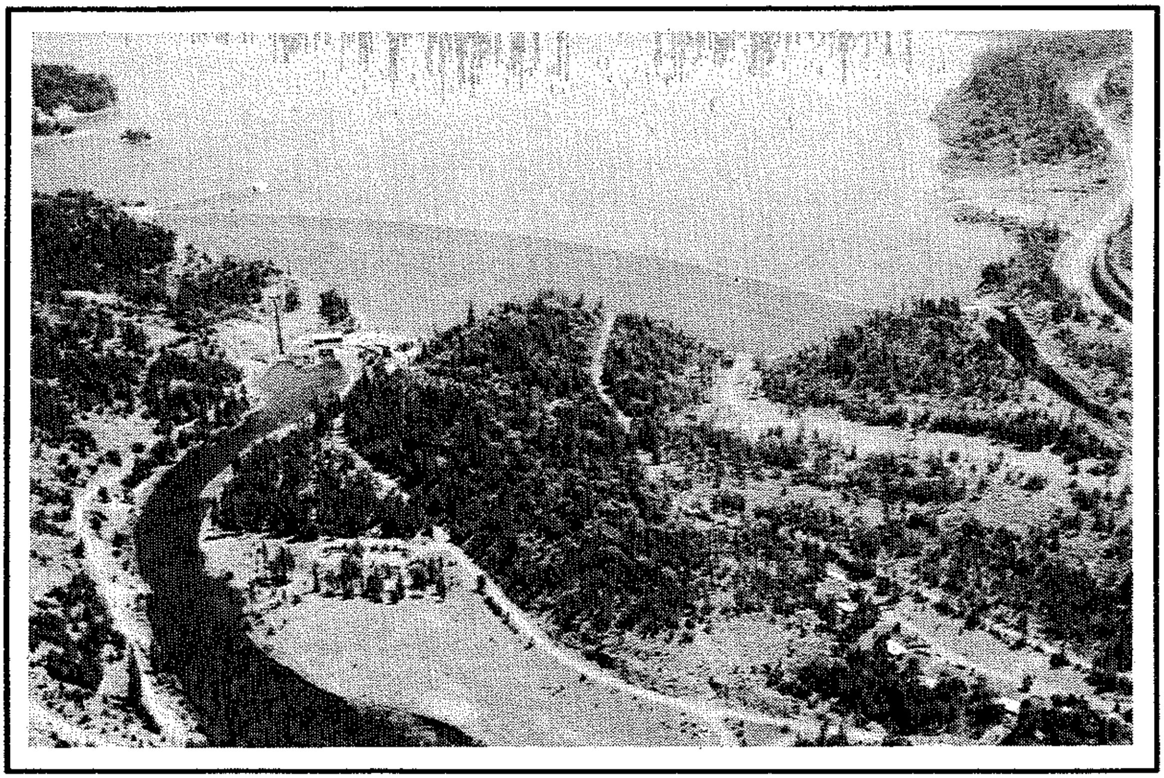
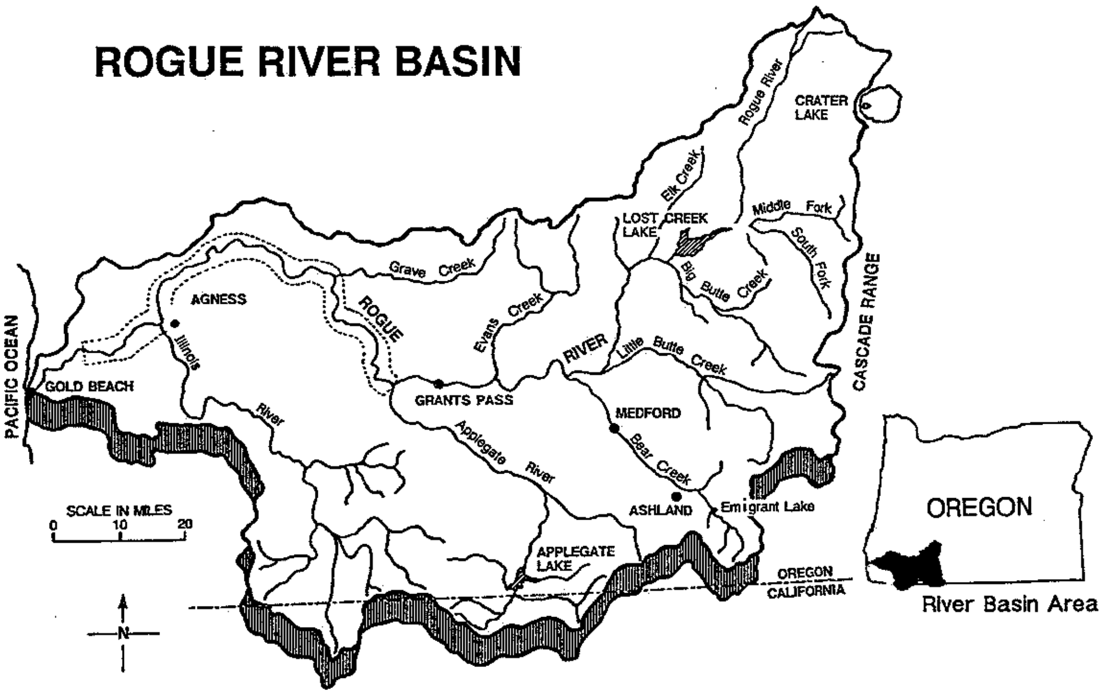


Table 9-1. Forms for Reports Used in the Water Management of Lost Creek Lake.

Form Number	Description and Disposition
NPP 34A September 1976	Lost Creek Project Daily Hydro-Meteorological and Power Data (Initiated at Lost Creek Dam)
Copies	3
Routing	1 – Engineering Division 1 – Operations Division 1 – File at Lost Creek Dam
Frequency	Daily
Distribution will be made by Lost Creek Project.	
NPP 315	Monthly Reservoir Regulation, Lost Creek Project (Initiated by CENPP)
Copies	10
Routing	1 – Office, Chief of Engineers 1 – Northwestern Division 1 – Operations Division, CENWP 1 – Hydraulics/Hydrology Branch, CENWP 1 – Lost Creek Dam 5 – Outside Agencies
Distribution will be made by Reservoir Regulation and Water Quality Section, Portland District.	
FPC No. 4 (FPC-1001)	Monthly Power Plant Report (Initiated at CWNWP)
Copies	3
Routing	1 – FERC 1 – Northwestern Division 1 – Portland District Finance and Accounting
Frequency	Monthly
Distribution will be made b Northwestern Division.	
FPC No. 1 (FPC-1002)	Annual Report of DOA-COE to FPC (Initiated by CENWP)
Copies	5
Routing	1 – Office, Chief of Engineers 1 – Northwestern Division 1 – FERC 1 – Bonneville Power Administration 1 – Portland District Finance and Accounting
Frequency	Annual
Distribution will be made by Finance and Accounting, Portland District.	

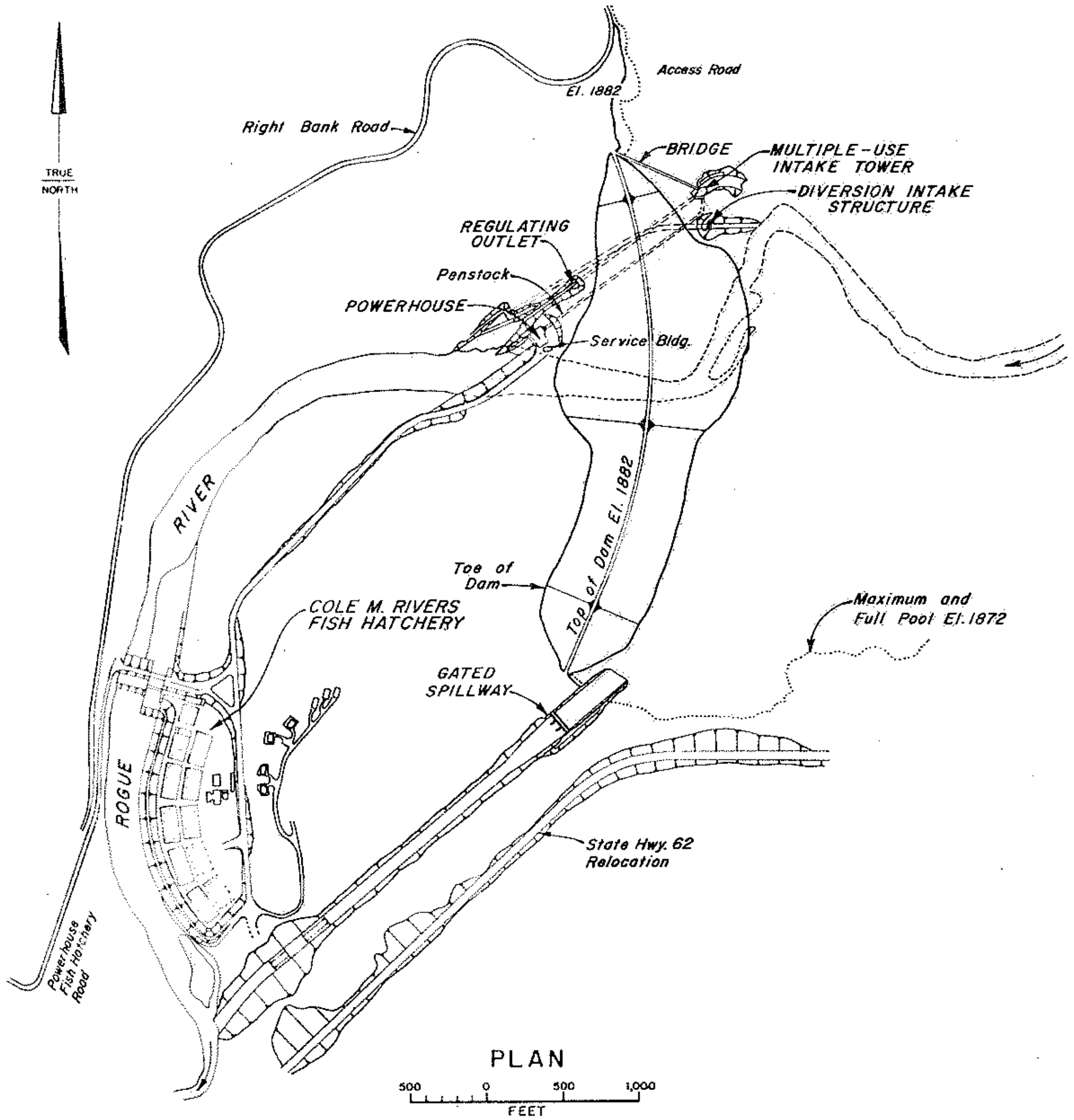


Lost Creek Lake and Upper Watershed

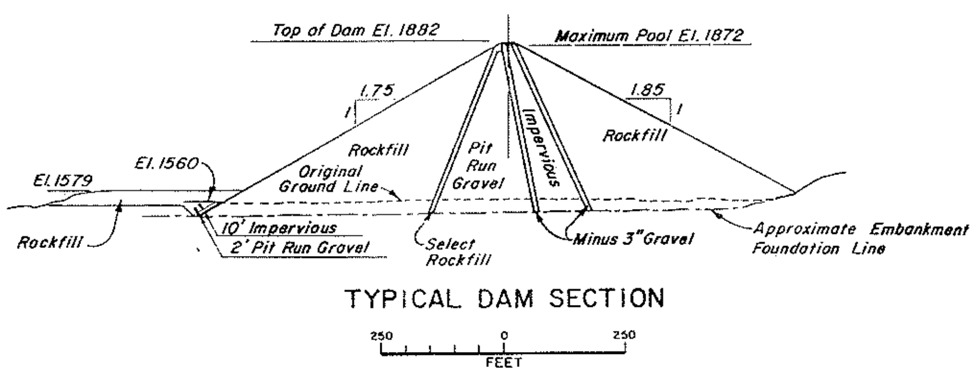


Map of Rogue River Basin

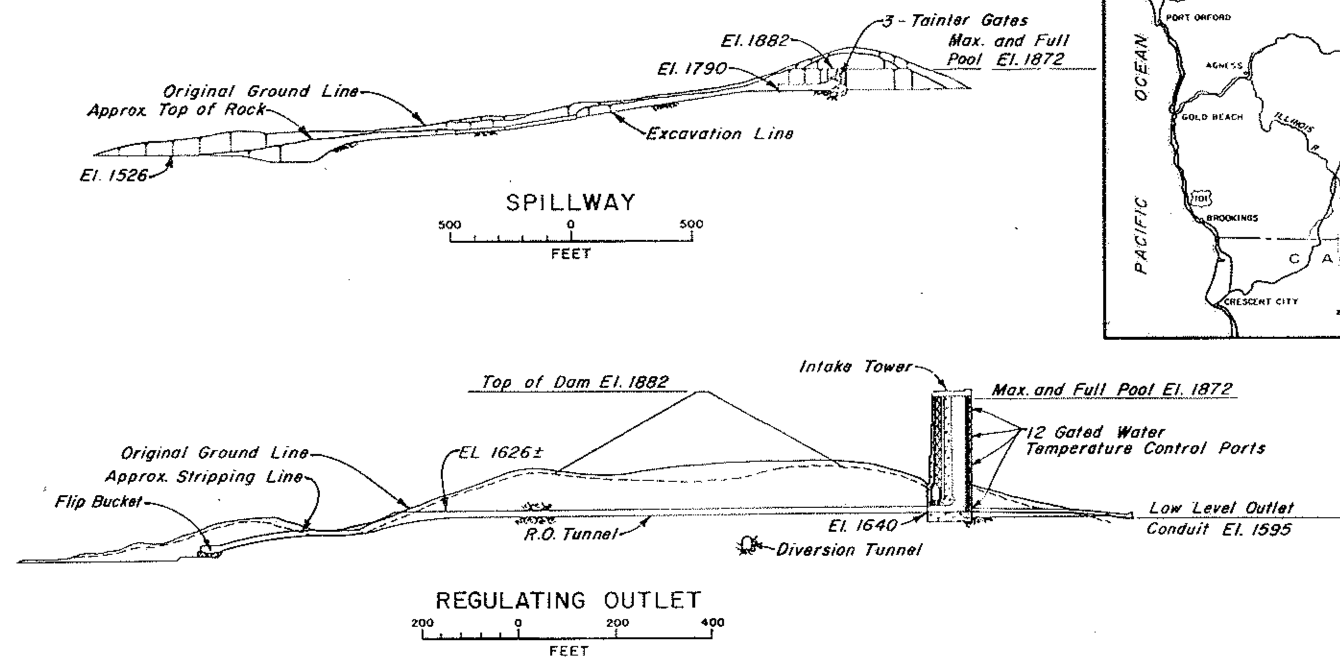
Plate 2-1



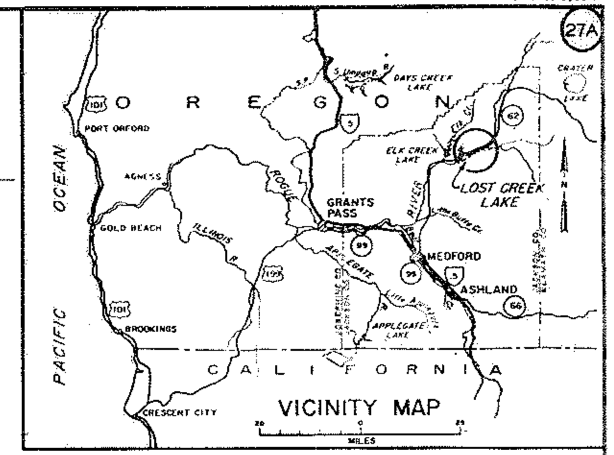
PLAN

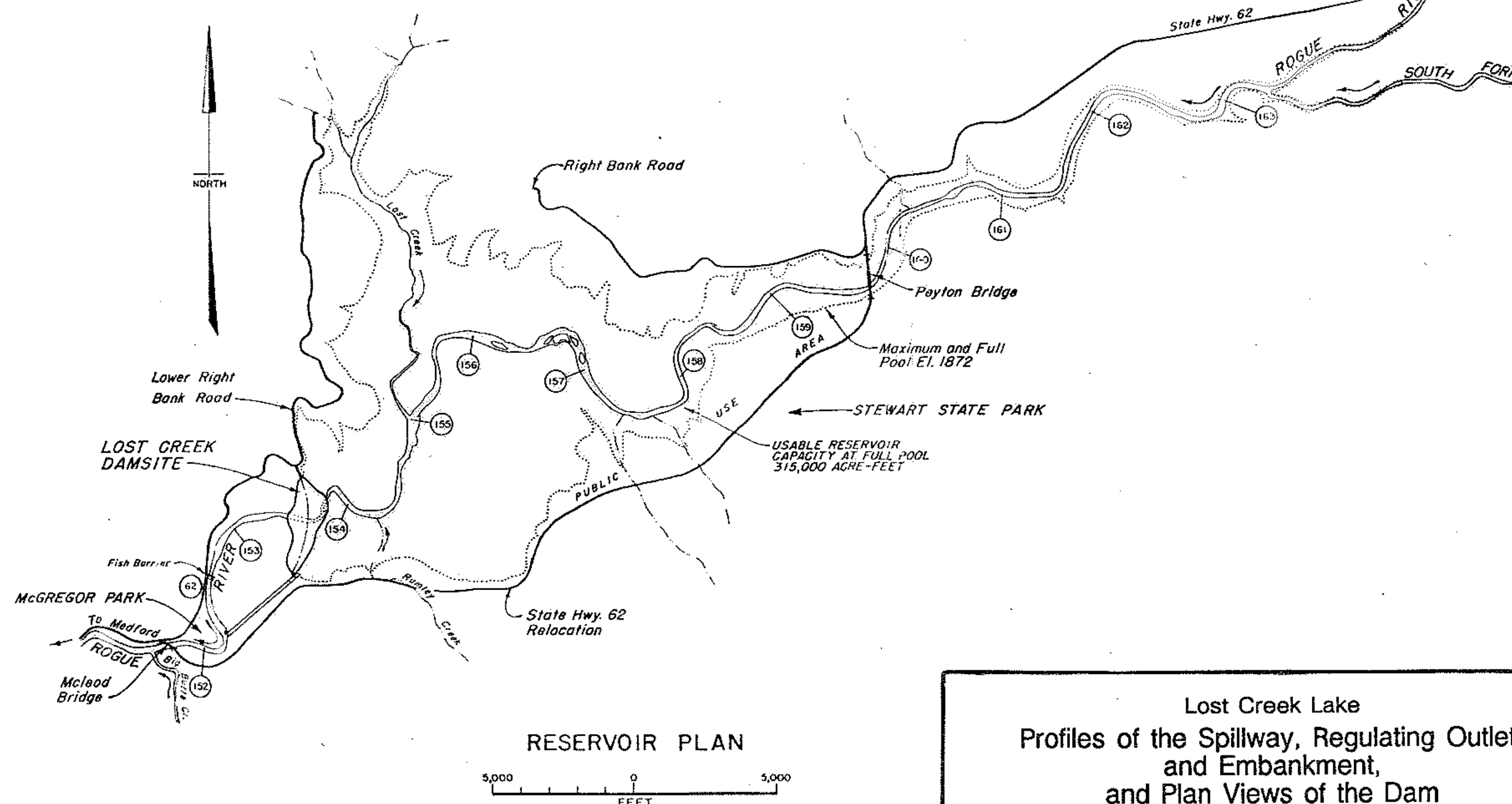


TYPICAL DAM SECTION



SECTIONS





RESERVOIR PLAN

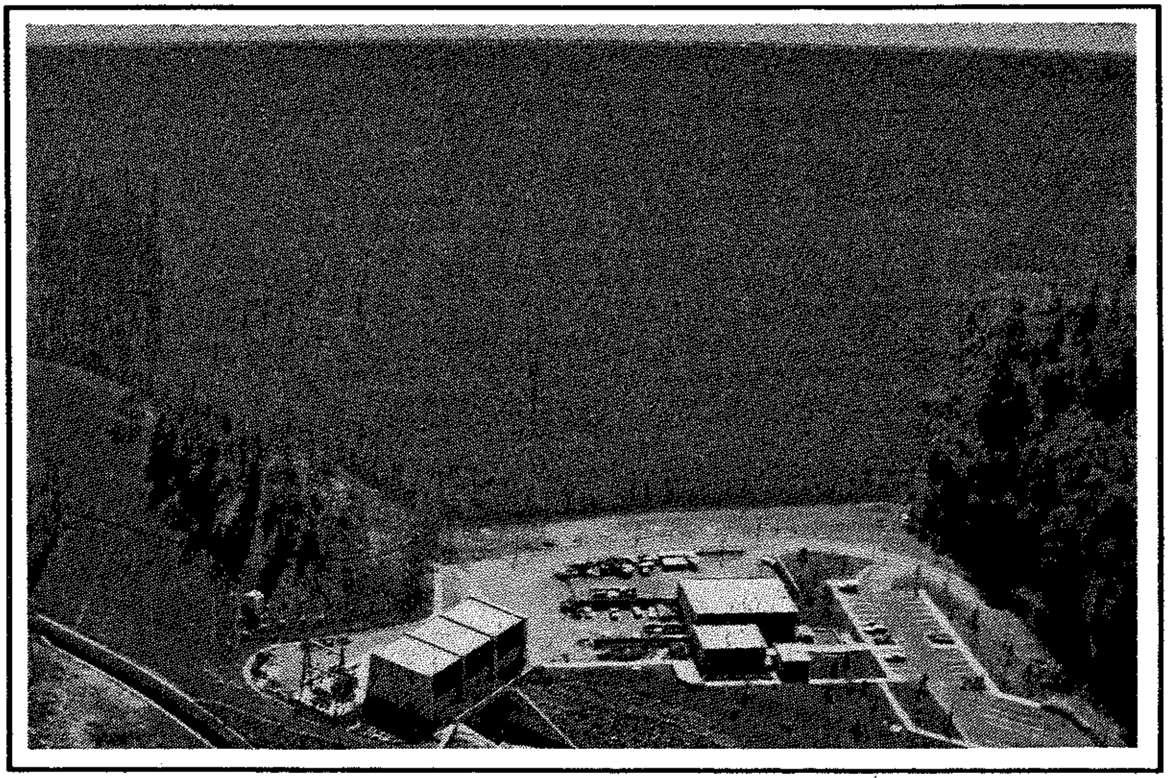
Lost Creek Lake

Profiles of the Spillway, Regulating Outlet, and Embankment, and Plan Views of the Dam

U.S. Army Engineers District, Portland

NPP

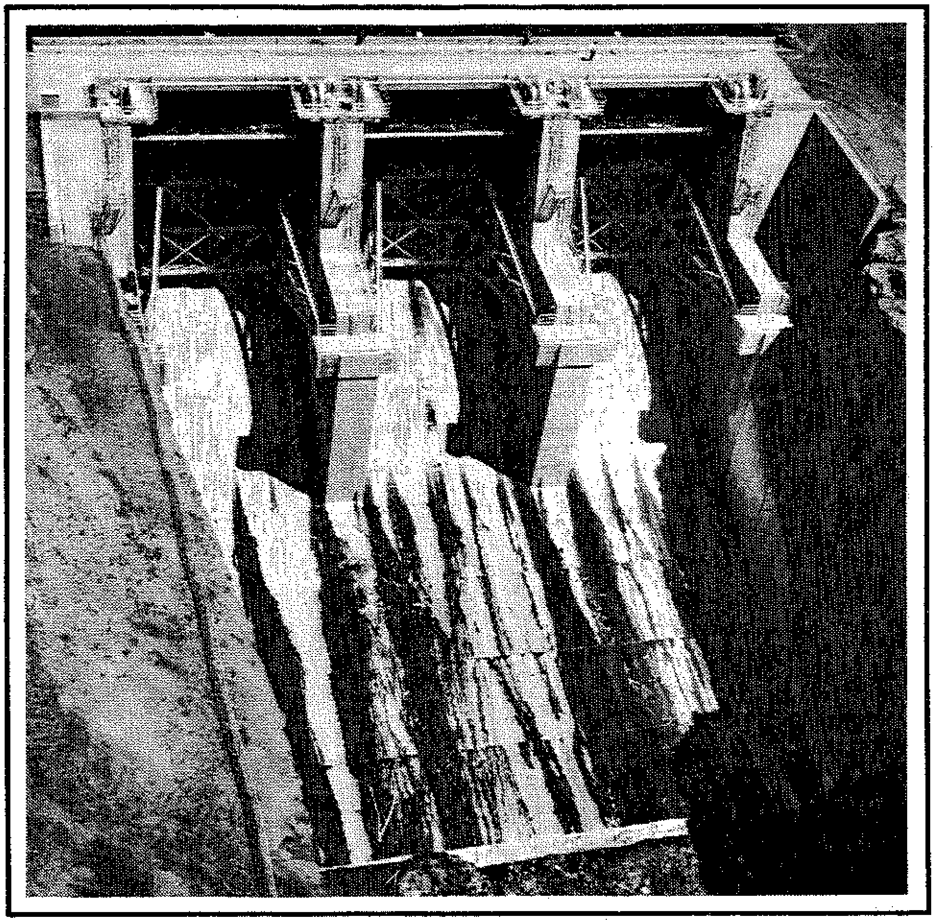
Plate 2-2



Embankment at Lost Creek Lake

Lost Creek Lake
Embankment Photograph
U.S. Army Engineers District,
Portland
NPP

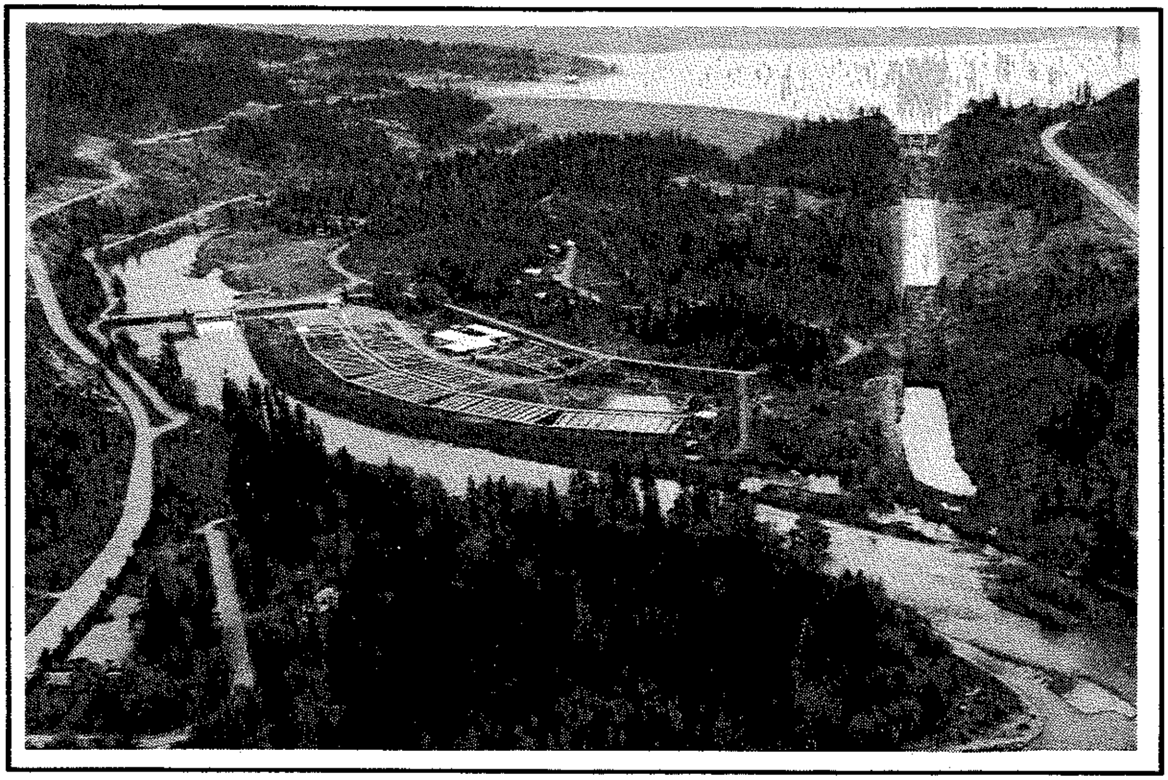
Plate 2-3



Spillway at Lost Creek Lake

Lost Creek Lake
Spillway Photograph
U.S. Army Engineers District,
Portland
NPP

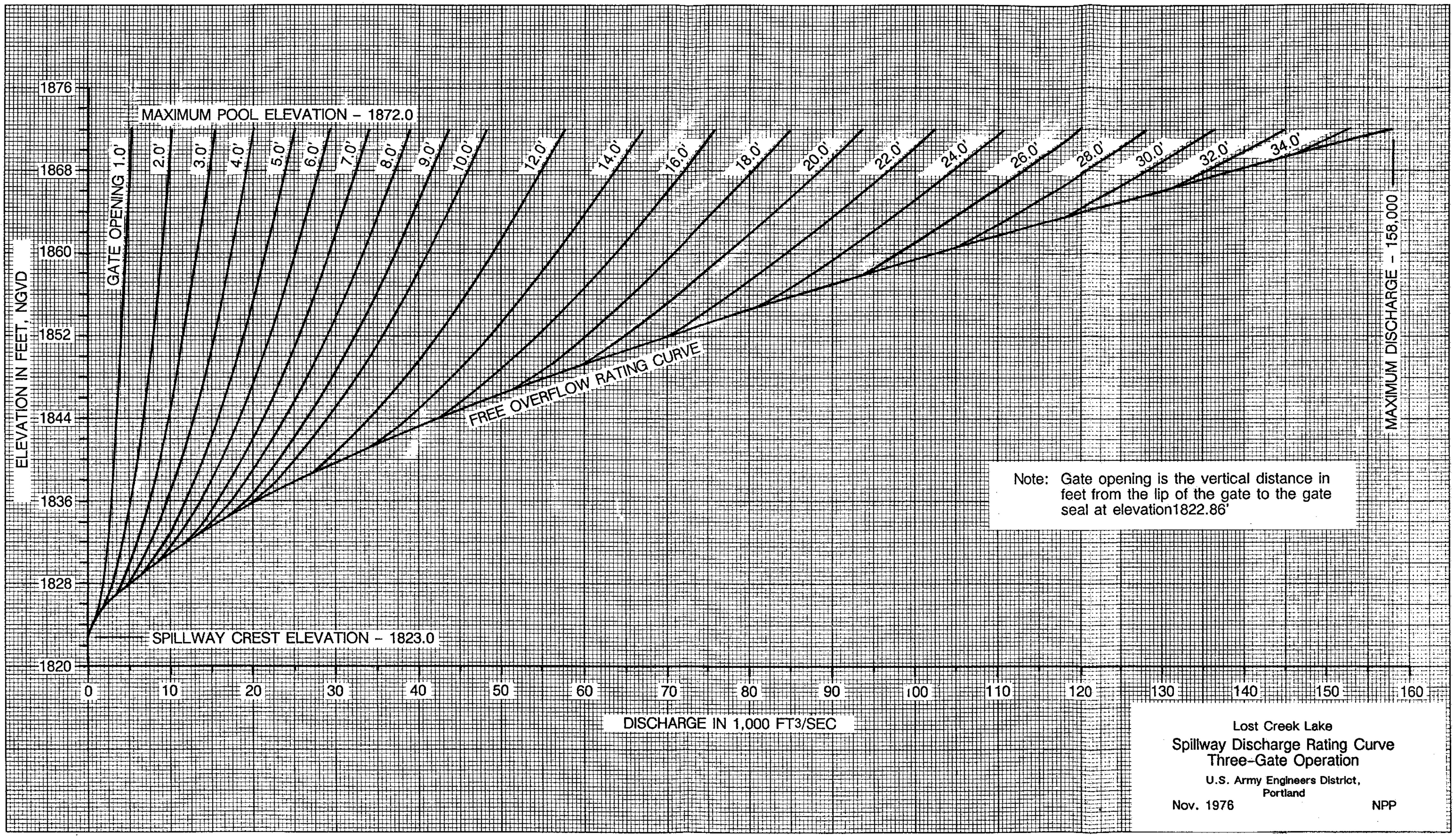
Plate 2–4



Spillway Gates, Chute and Stilling Basin at Lost Creek Lake

Lost Creek Lake
Spillway Chute Photograph
U.S. Army Engineers District,
Portland
NPP

Plate 2-5



MAXIMUM POOL ELEVATION - 1872.0
GATE OPENING 1.0'
2.0'
3.0'
4.0'
5.0'
6.0'
7.0'
8.0'
9.0'
10.0'
12.0'
14.0'
16.0'
18.0'
20.0'
22.0'
24.0'
26.0'
28.0'
30.0'
32.0'
34.0'
FREE OVERFLOW RATING CURVE
MAXIMUM DISCHARGE - 158,000
SPILLWAY CREST ELEVATION - 1823.0
ELEVATION IN FEET, NGVD
1876
1868
1860
1852
1844
1836
1828
1820
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
DISCHARGE IN 1,000 FT3/SEC
Note: Gate opening is the vertical distance in feet from the lip of the gate to the gate seal at elevation1822.86'
Lost Creek Lake
Spillway Discharge Rating Curve
Three-Gate Operation
U.S. Army Engineers District, Portland
Nov. 1976
NPP

Plate 2-6

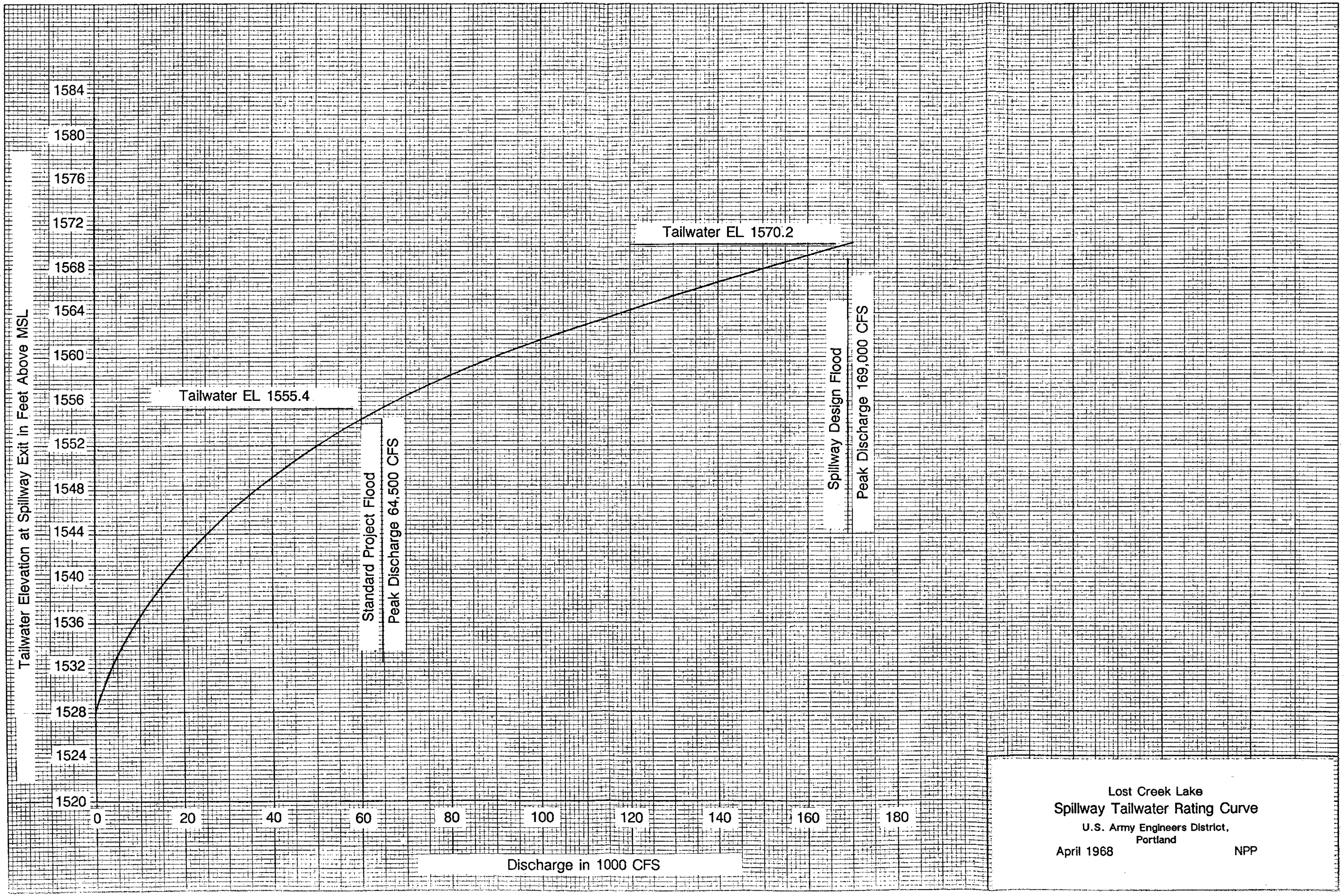
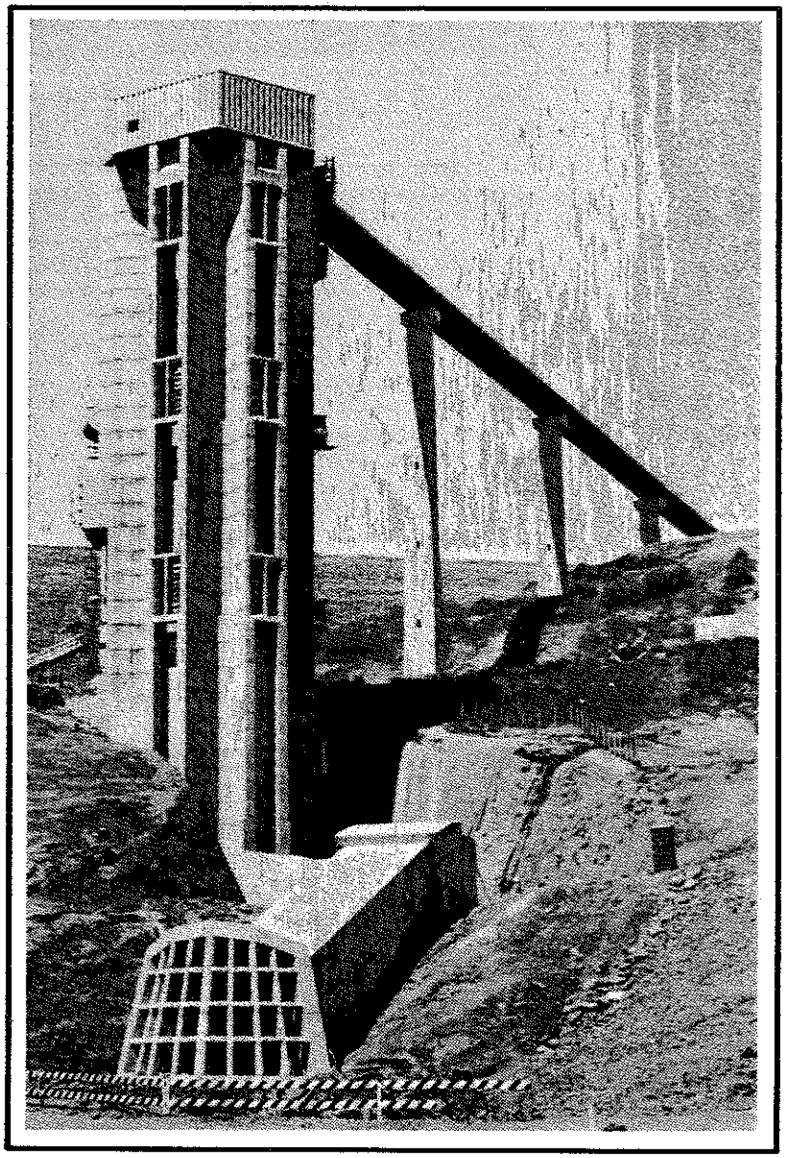

Tailwater Elevation at Spillway Exit in Feet Above MSL
1584
1580
1576
1572
1568
1564
1560
1556
1552
1548
1544
1540
1536
1532
1528
1524
1520
0
20
40
60
80
100
120
140
160
180
Discharge in 1000 CFS
Tailwater EL 1555.4
Standard Project Flood
Peak Discharge 64,500 CFS
Tailwater EL 1570.2
Spillway Design Flood
Peak Discharge 169,000 CFS
Lost Creek Lake
Spillway Tailwater Rating Curve
U.S. Army Engineers District, Portland
April 1968
NPP

Plate 2-7



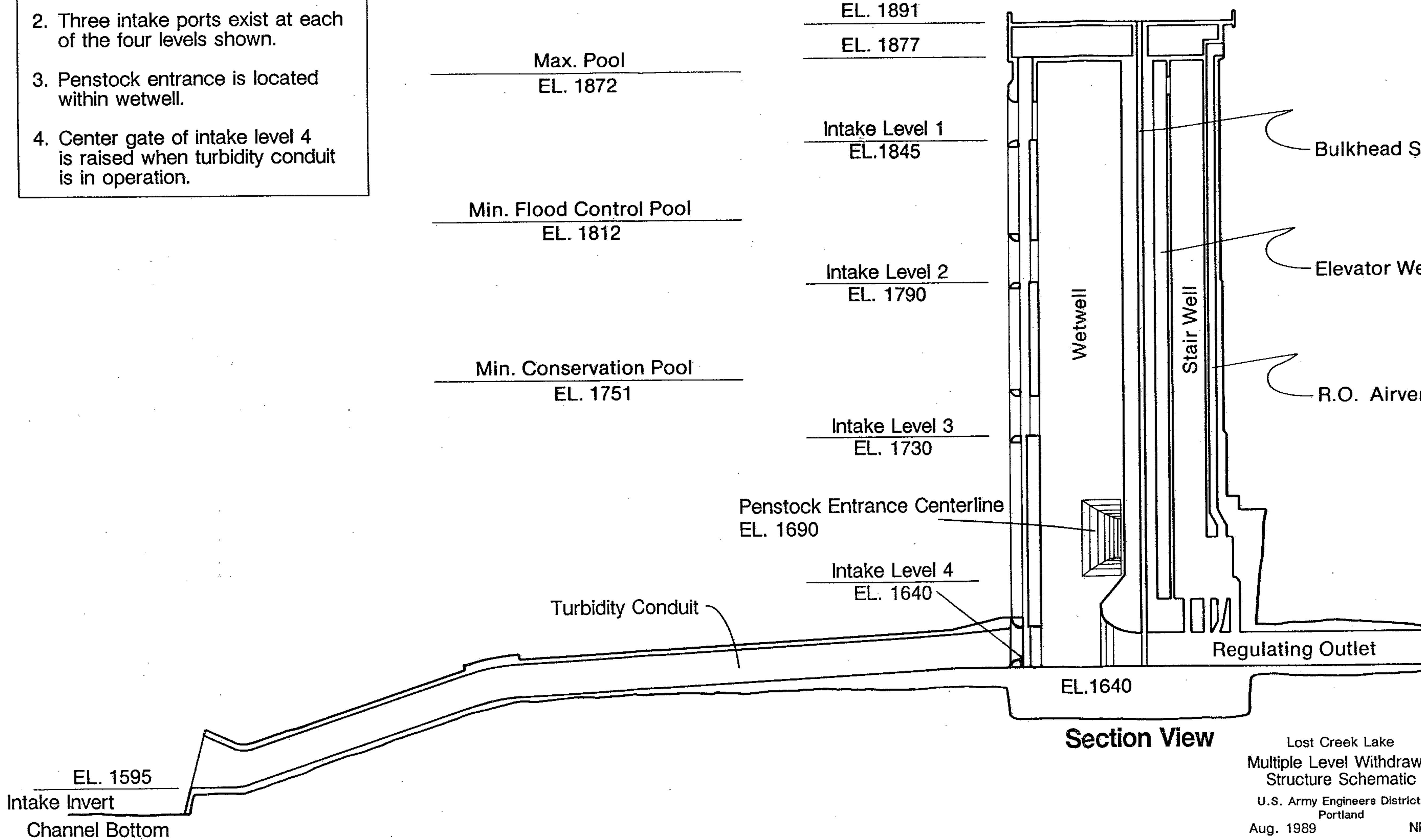
Multiple Level Withdrawal Structure at Lost Creek Lake

Lost Creek Lake
Multiple Level Withdrawal Structure Photograph
U.S. Army Engineers District, Portland
NPP

Plate 2-8

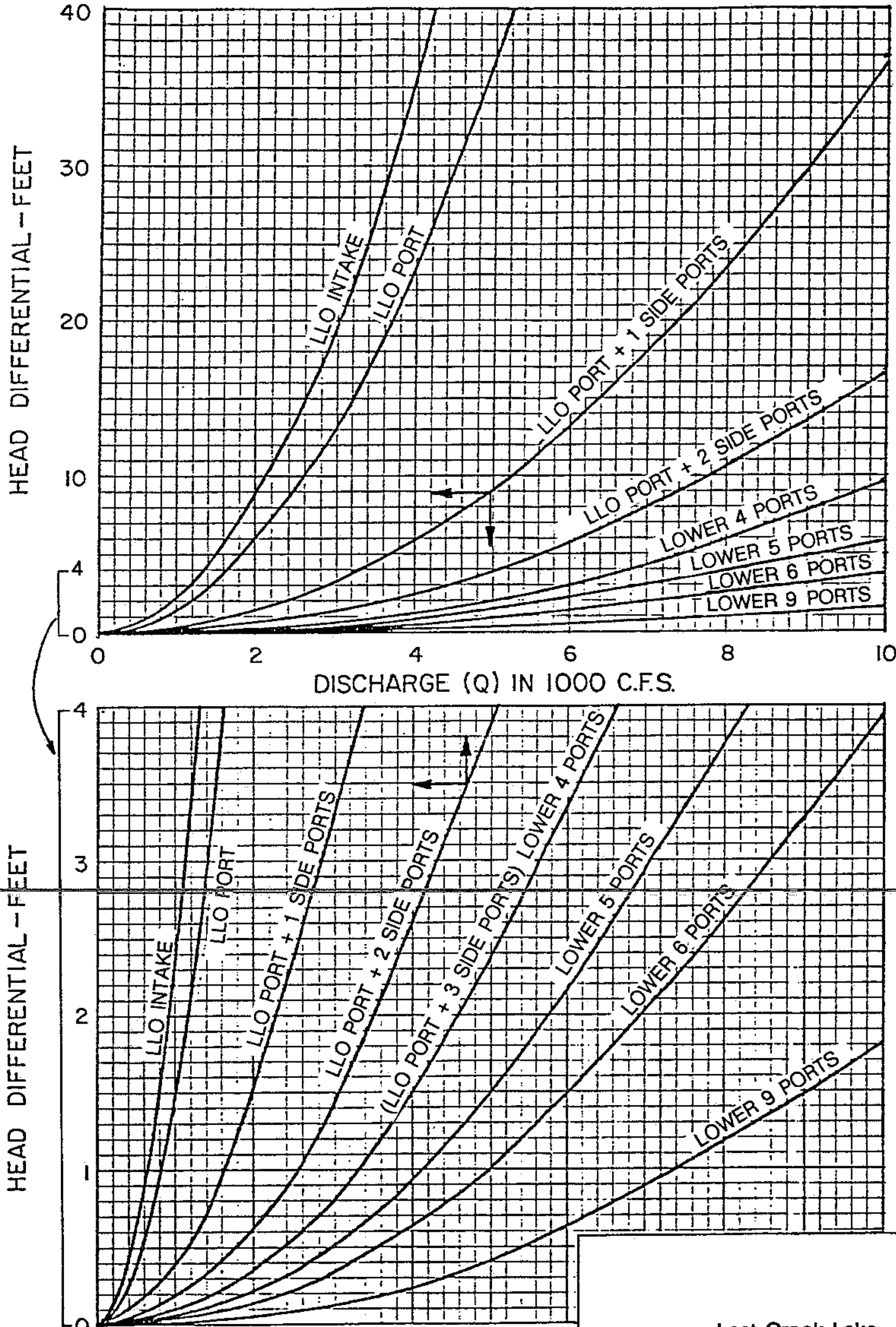
Lost Creek Lake Intake Structure

Note:
1. Schematic is not drawn to scale.
2. Three intake ports exist at each of the four levels shown.
3. Penstock entrance is located within wetwell.
4. Center gate of intake level 4 is raised when turbidity conduit is in operation.



Section View

Lost Creek Lake
Multiple Level Withdrawal
Structure Schematic
U.S. Army Engineers District, Portland
Aug. 1989 NPP



Notes:
1. Major Flood Evacuation Condition with Low Level Outlet (LLO) Port Operating in Conjunction With Other Ports.
2. LLO Bulkhead Slot Open – Bulkhead Raised Out of Flow Path.

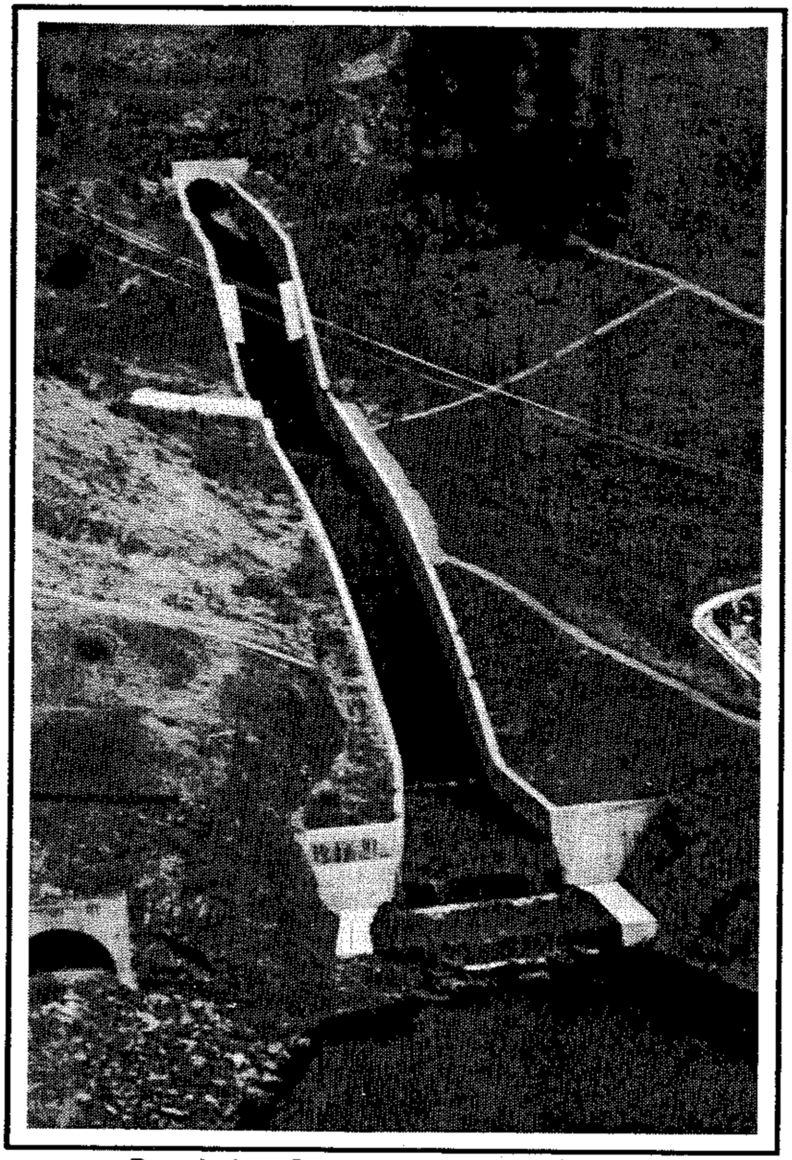
Lost Creek Lake

Discharge Versus Differential Head and Number of Ports Open for Regulating Outlet Works

U.S. Army Engineers District, Portland

July 1974 NPP

Plate 2–10



Regulating Outlet at Lost Creek Lake

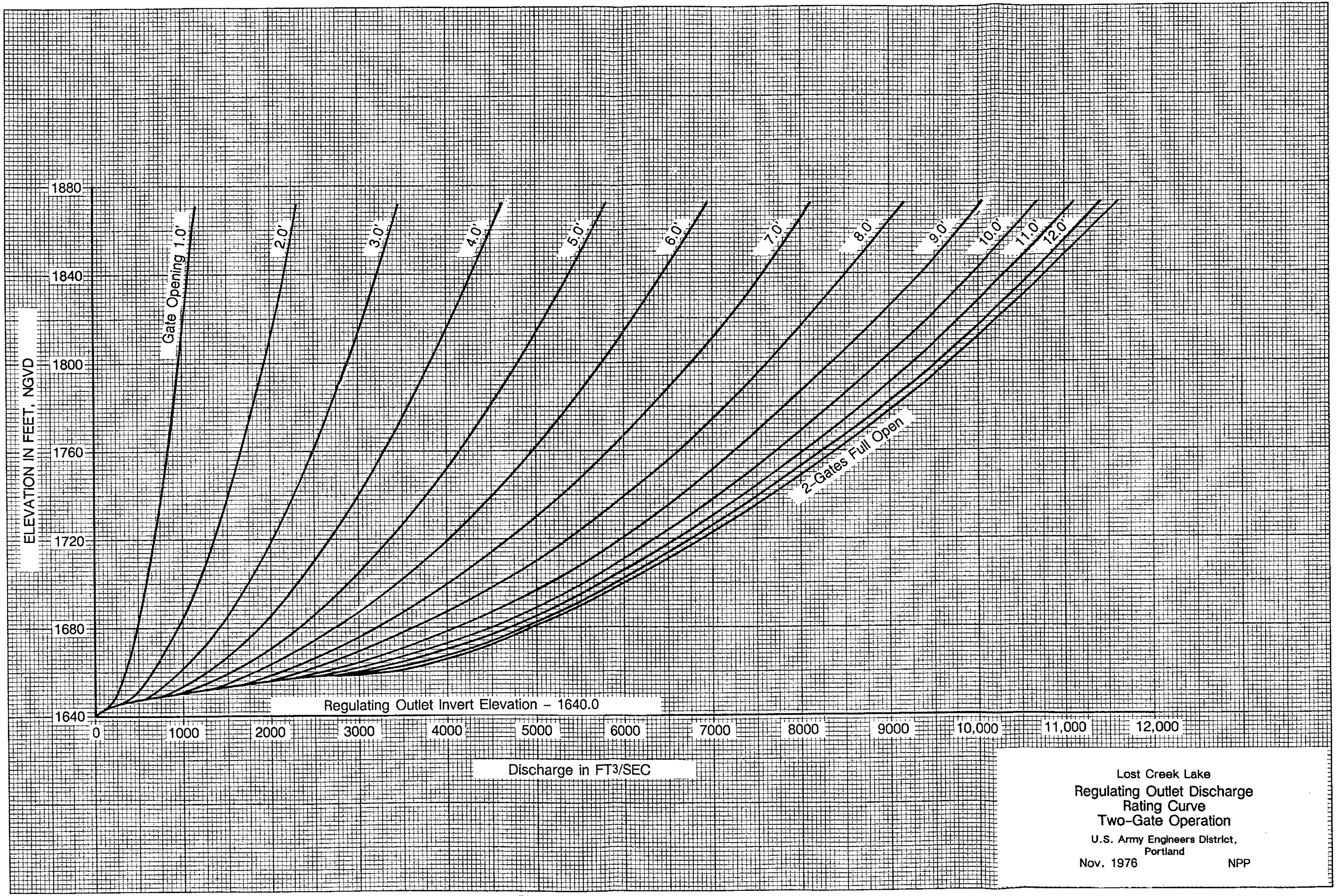
Lost Creek Lake

Regulating Outlet Photograph

U.S. Army Engineers District,
Portland

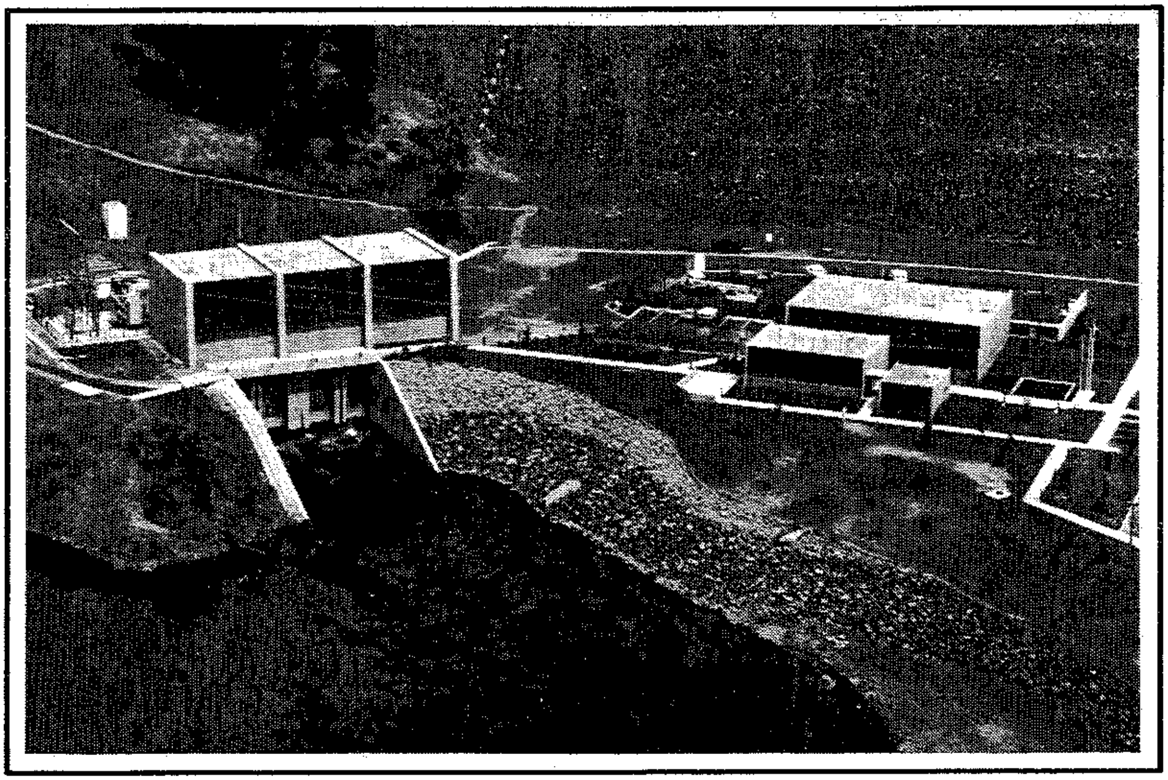
NPP

Plate 2-11



ELEVATION IN FEET, NGVD
1880
1840
1800
1760
1720
1680
1640
Gate Opening 1.0'
2.0'
3.0'
4.0'
5.0'
6.0'
7.0'
8.0'
9.0'
10.0'
11.0'
12.0'
2-Gates Full Open
Regulating Outlet Invert Elevation - 1640.0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
12,000
Discharge in FT3/SEC
Lost Creek Lake
Regulating Outlet Discharge
Rating Curve
Two-Gate Operation
U.S. Army Engineers District, Portland
Nov. 1976
NPP

Plate 2-12



Lost Creek Lake Powerhouse and Visitor Center

Lost Creek Lake
Powerhouse and Visitor Center
U.S. Army Engineers District,
Portland
NPP

Plate 2-13

Lost Creek Lake

Penstock Photograph

U.S. Army Engineers District,
Portland

NPP

Plate 2-14

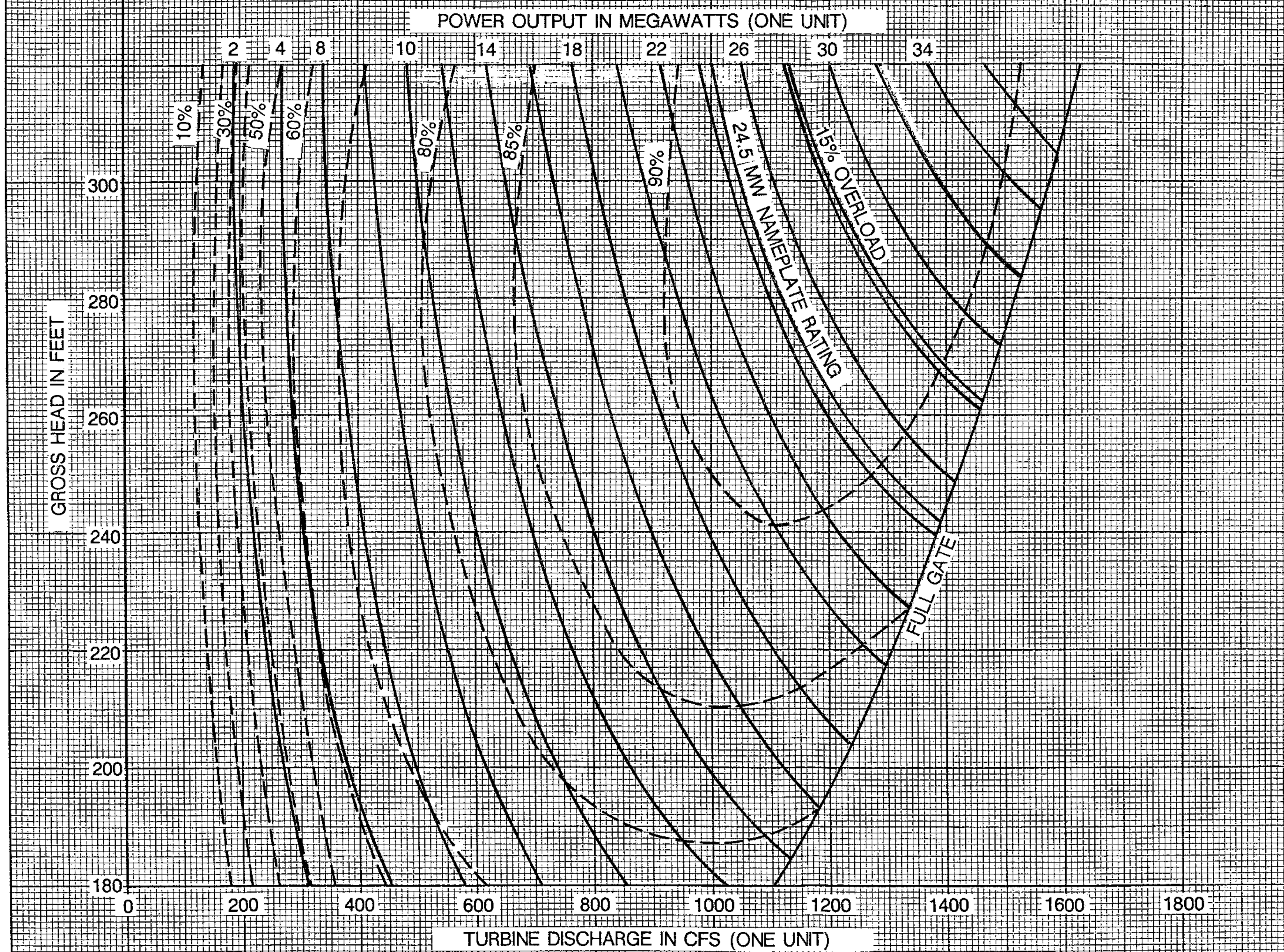
Lost Creek Lake

Turbines

U.S. Army Engineers District,
Portland

NPP

Plate 2-15



Notes:
1. Dashed lines are overall efficiency in percent
2. Data taken from NPD program No. 711-K5-G00ZB

Lost Creek Lake
Powerplant Operation Curves for Generators
U.S. Army Engineers District, Portland
March 1977 NPP

CHART 5

Plate 2–16

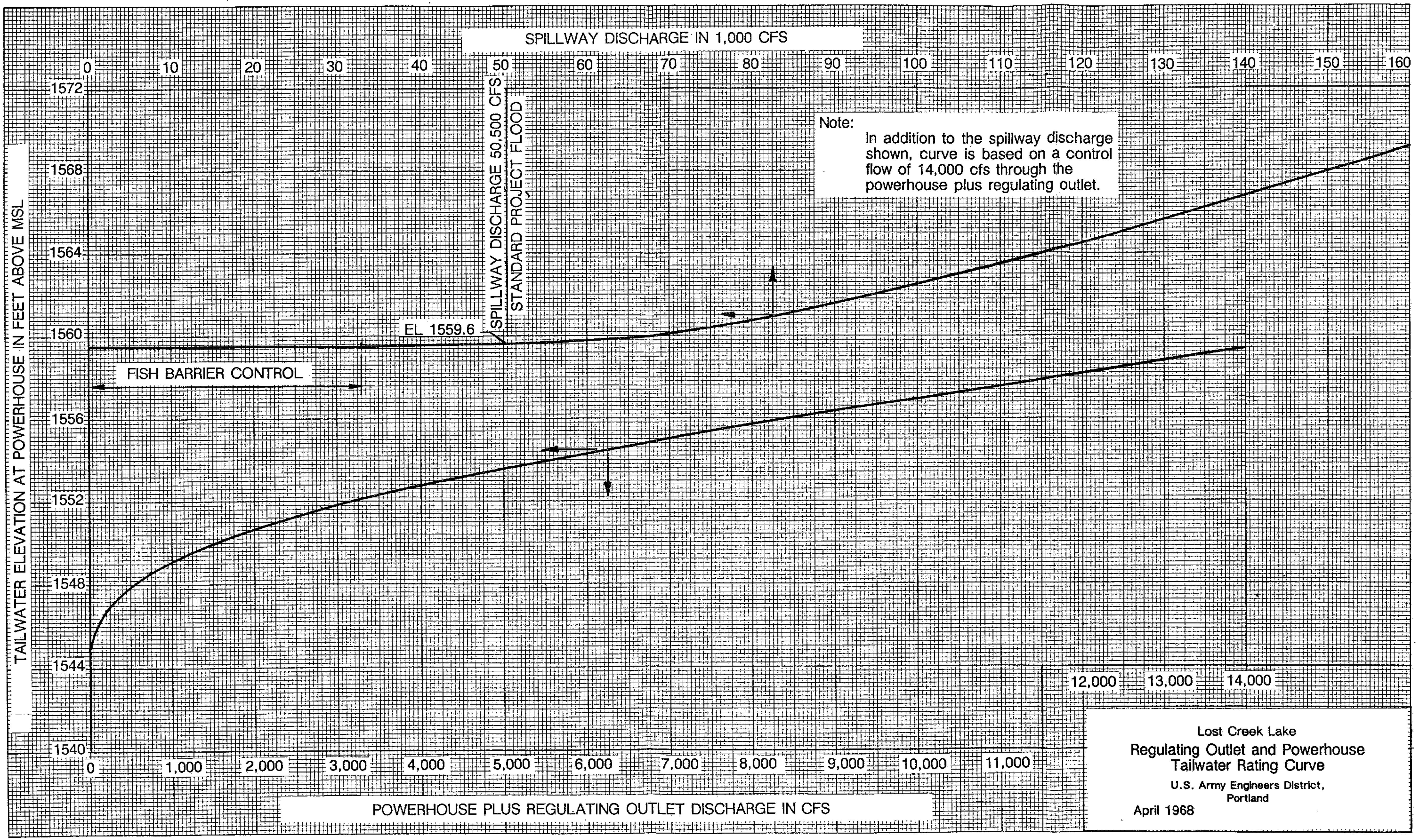
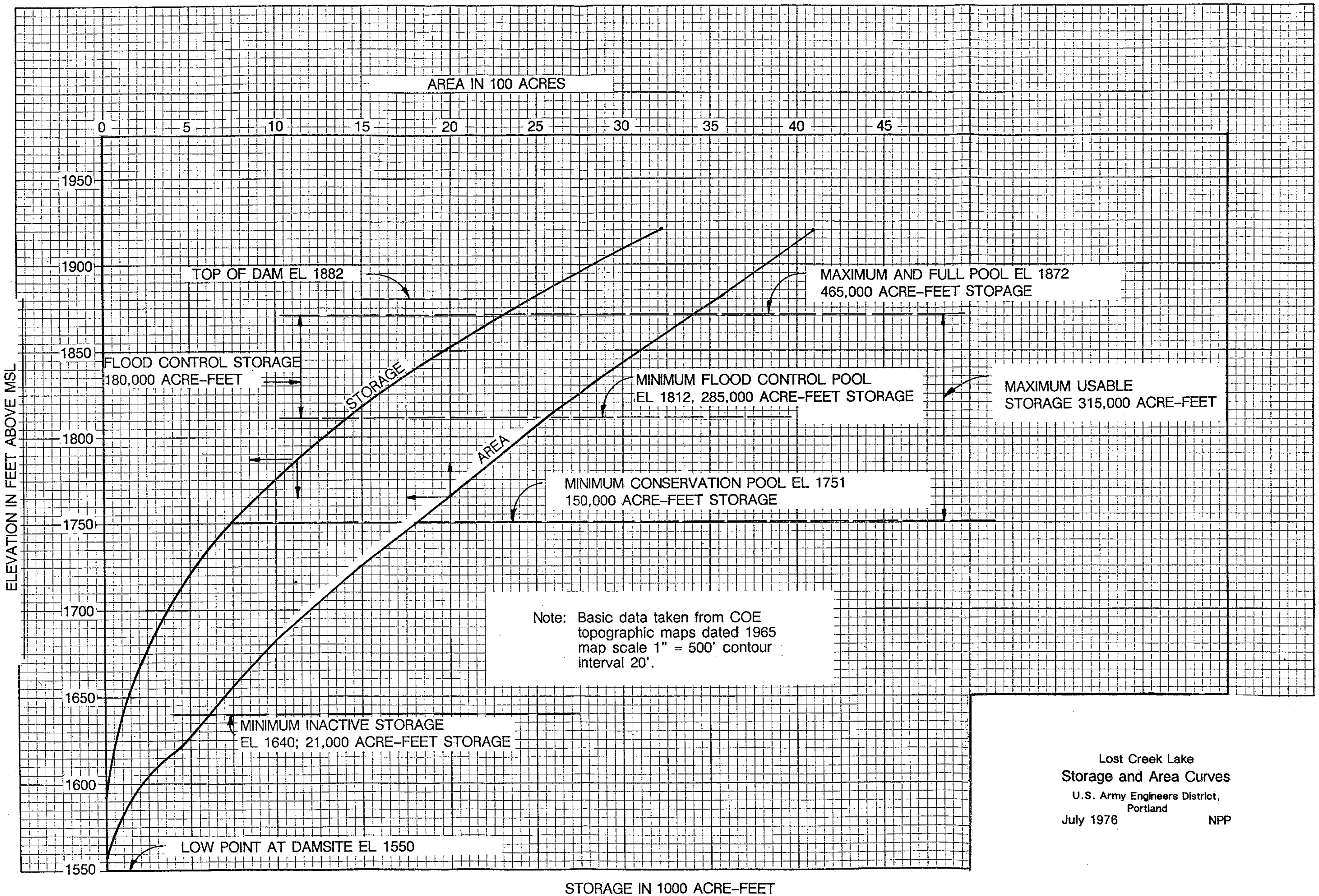
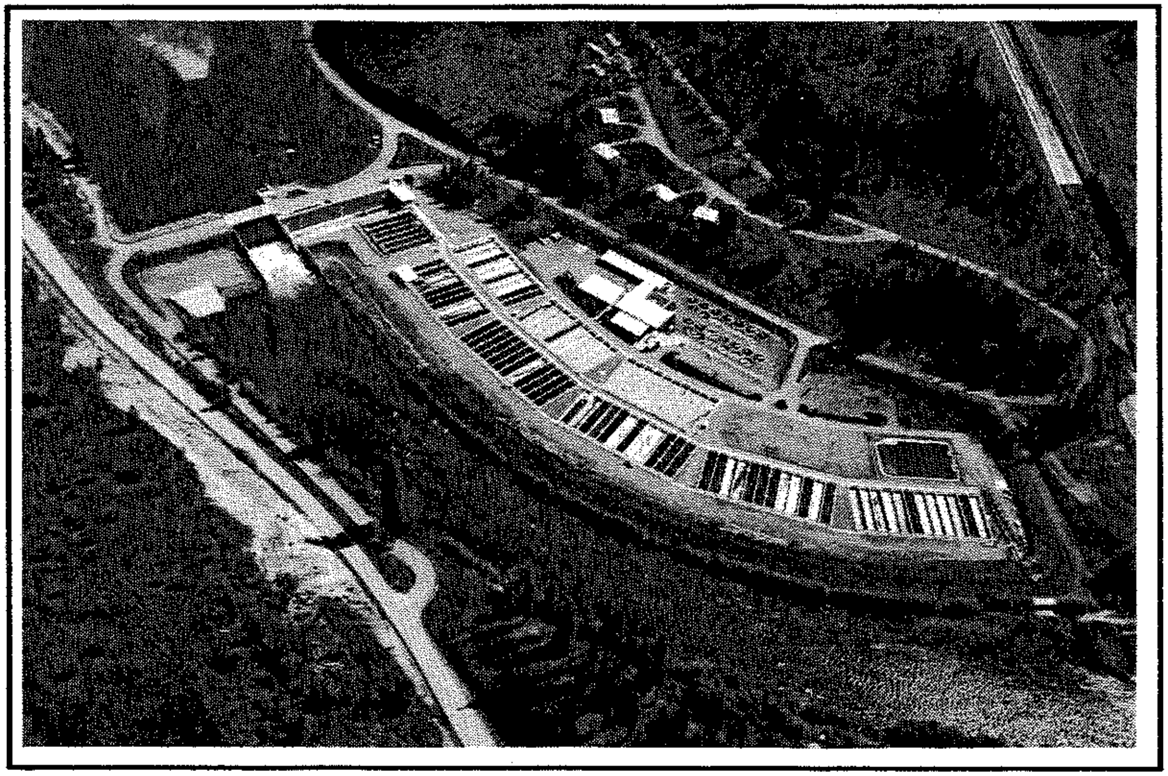

SPILLWAY DISCHARGE IN 1,000 CFS
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
TAILWATER ELEVATION AT POWERHOUSE IN FEET ABOVE MSL
1572 1568 1564 1560 1556 1552 1548 1544 1540
SPILLWAY DISCHARGE 50,500 CFS
STANDARD PROJECT FLOOD
Note:
In addition to the spillway discharge shown, curve is based on a control flow of 14,000 cfs through the powerhouse plus regulating outlet.
EL 1559.6
FISH BARRIER CONTROL
0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000 14,000
POWERHOUSE PLUS REGULATING OUTLET DISCHARGE IN CFS
Lost Creek Lake
Regulating Outlet and Powerhouse
Tailwater Rating Curve
U.S. Army Engineers District,
Portland
April 1968

Plate 2-17



Lost Creek Lake
Storage and Area Curves
U.S. Army Engineers District, Portland
July 1976 NPP

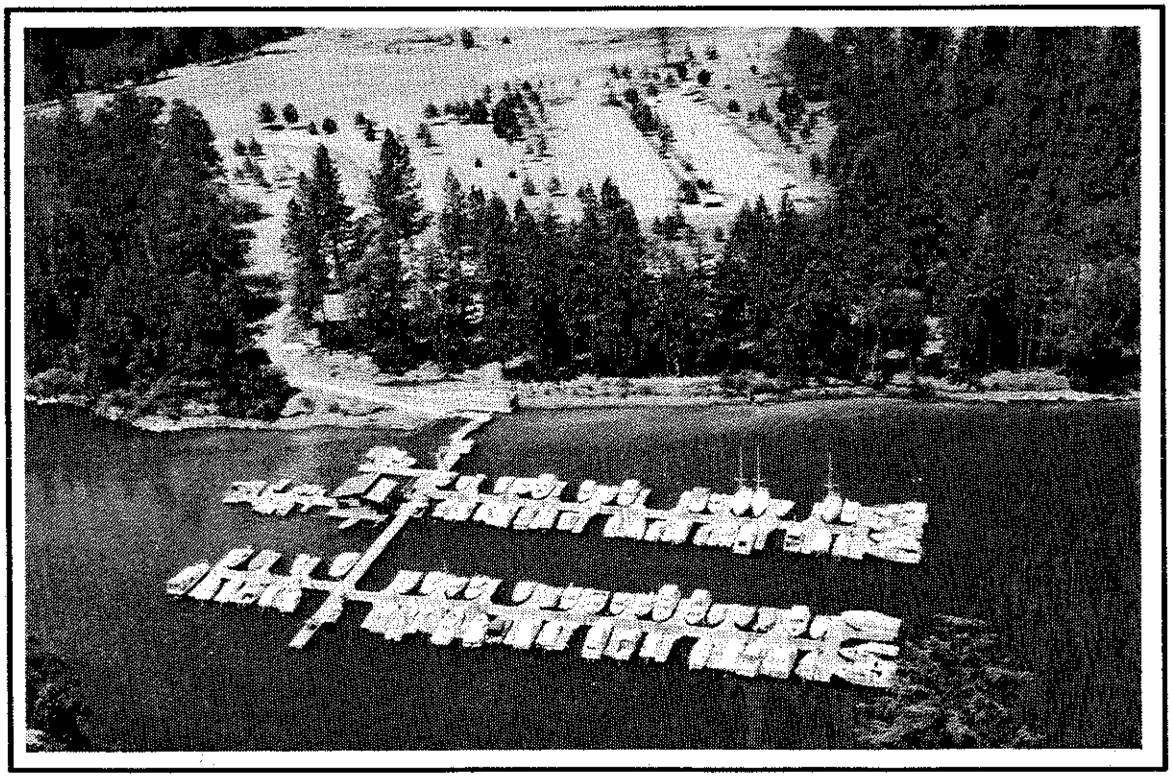
Plate 2-18



Cole M. Rivers Fish Hatchery for Lost Creek Lake

Lost Creek Lake
Cole M. Rivers
Fish Hatchery Photograph
U.S. Army Engineers District,
Portland
NPP

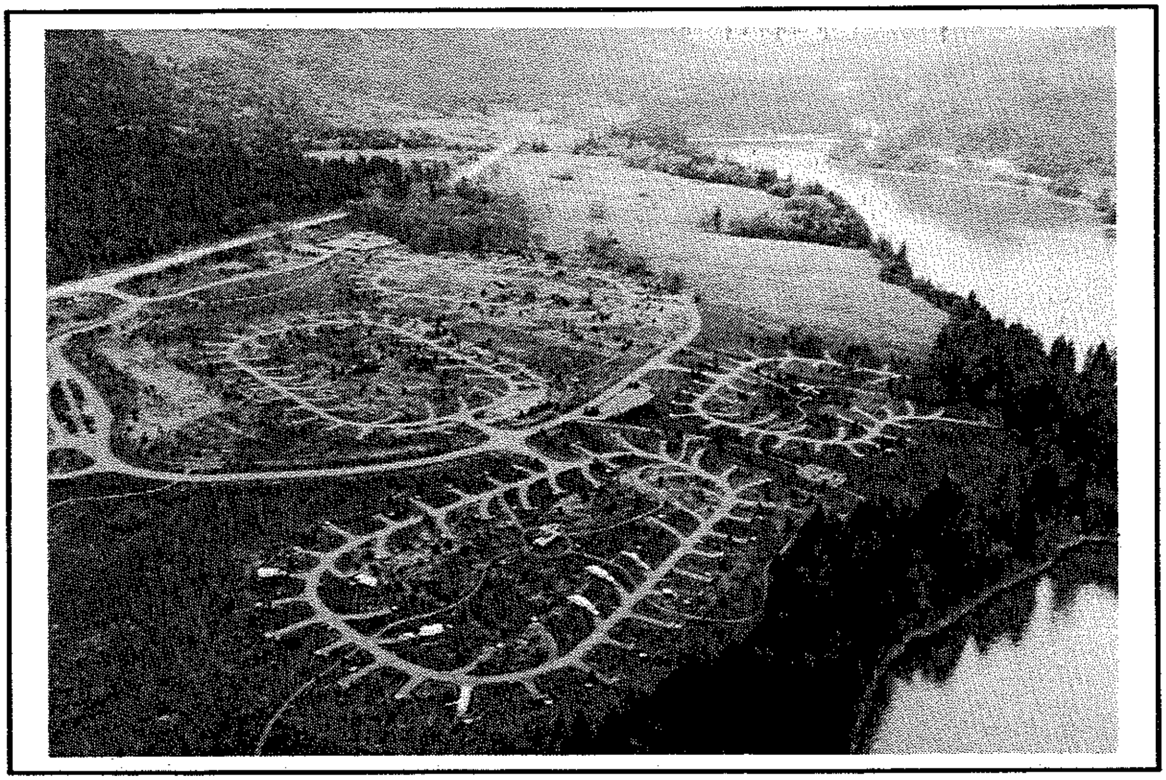
Plate 2-19



Lost Creek Lake Marina

Lost Creek Lake
Marina Photograph
U.S. Army Engineers District,
Portland
NPP

Plate 2-20



Stewart State Park at Lost Creek Lake

Lost Creek Lake
Stewart State Park Photograph
U.S. Army Engineers District,
Portland
NPP

Plate 2–21

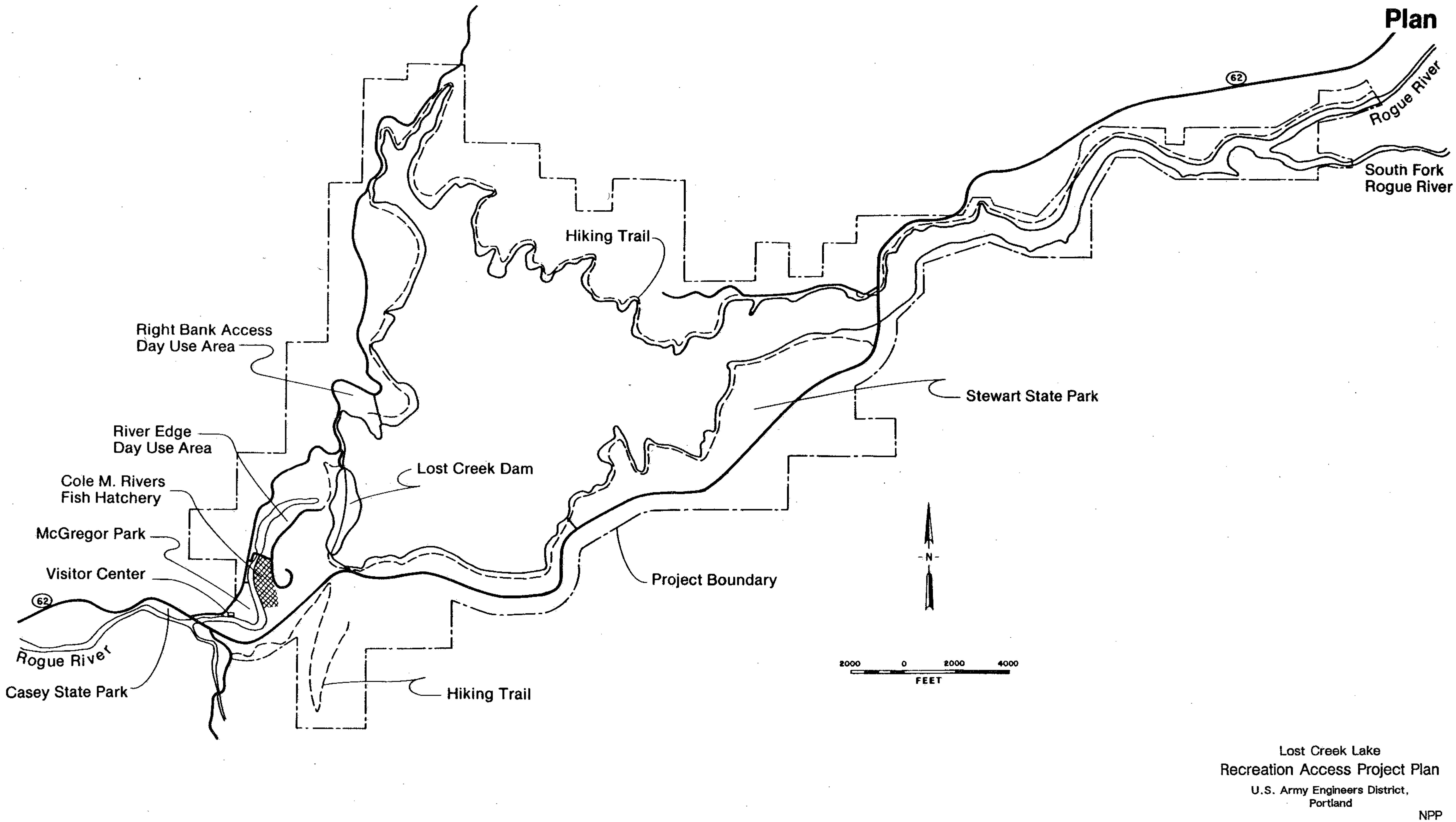

Plan
62
Rogue River
South Fork
Rogue River
Hiking Trail
Right Bank Access
Day Use Area
Stewart State Park
River Edge
Day Use Area
Lost Creek Dam
Cole M. Rivers
Fish Hatchery
McGregor Park
Visitor Center
Project Boundary
N
62
Rogue River
Casey State Park
Hiking Trail
2000 0 2000 4000
FEET
Lost Creek Lake
Recreation Access Project Plan
U.S. Army Engineers District,
Portland
NPP

Plate 2-22

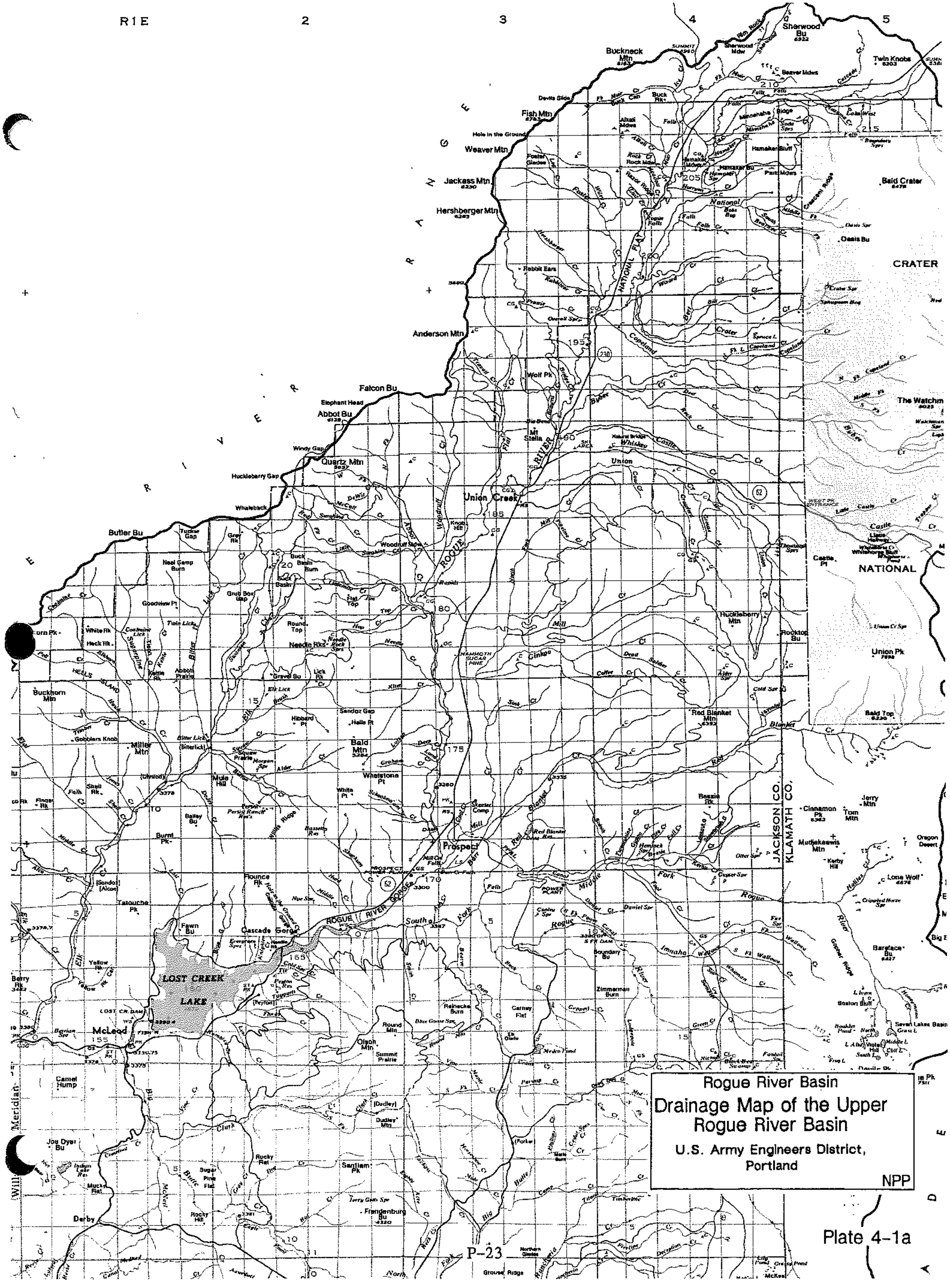
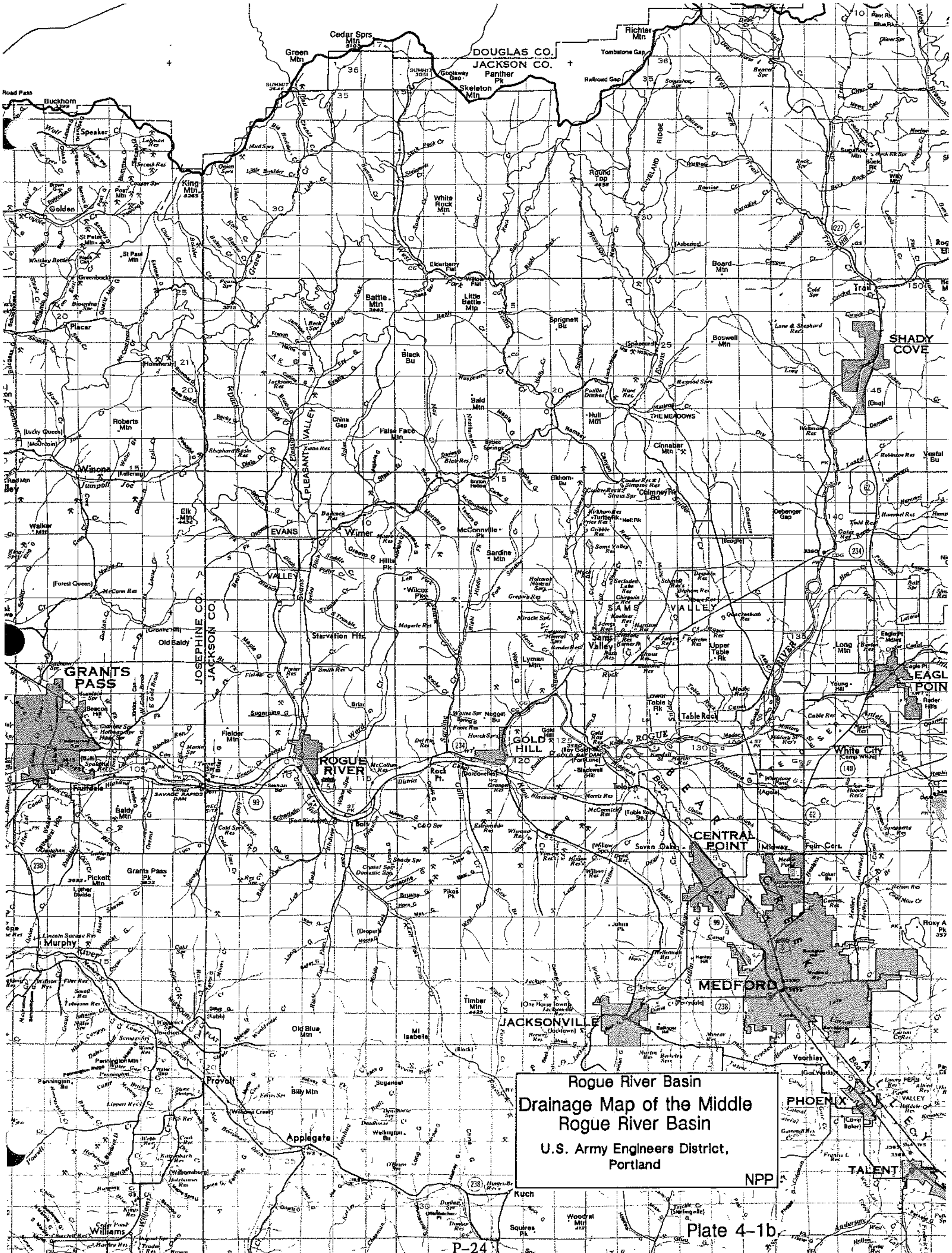

R1E
2
3
4
5
CRATER
NATIONAL
LOST CREEK
LAKE
Union Creek
Prospect
McLeod
Cascade Gorge
ROGUE RIVER GORGE
JACKSON CO.
KLAMATH CO.
Rogue River Basin
Drainage Map of the Upper
Rogue River Basin
U.S. Army Engineers District,
Portland
NPP

Plate 4-1a


Rogue River Basin
Drainage Map of the Middle Rogue River Basin
U.S. Army Engineers District, Portland
NPP
Plate 4-1b
DOUGLAS CO.
JACKSON CO.
JOSEPHINE CO.
JACKSON CO.
GRANTS PASS
ROGUE RIVER
GOLD HILL
CENTRAL POINT
MEDFORD
JACKSONVILLE
PHOENIX
TALENT
SHADY COVE
White City
EVANS VALLEY
PLEASANT VALLEY
SAMS VALLEY
BEAR CREEK VALLEY
Cedar Sprs Mtn
Green Mtn
Skeleton Mtn
Panther Pk
Richter Mtn
Buckhorn
Speaker
Golden
Placer
King Mtn
White Rock Mtn
Battle Mtn
Little Battle Mtn
Black Bu
Bald Mtn
Hull Mtn
THE MEADOWS
Cinnabar Mtn
Boswell Mtn
Round Top
Board Mtn
Trail
Roberts Mtn
Winona
Walker Mtn
Elk Mtn
Wimer
Hillis Pk
Wilcox Pk
Sardine Mtn
McConnville Pk
Starvation Flts
Old Baldy
Lyman Mtn
Sams Valley
Upper Table Rk
Lower Table Rk
Table Rock
Long Mtn
Young Hill
Eagle Pt
Fielder Mtn
Beacon Hill
Baldy Mtn
Grants Pass Pk
Pickett Mtn
Murphy
Rock Pt.
Tolo
Seven Oaks
Midway
Four Cors.
Timber Mtn
Mt Isabelle
Old Blue Mtn
Provolt
Applegate
Williams
Kuch
Squires Pk
Woodrat Mtn
Anderson Bu
Voorhies
Billy Mtn
Pennington Mtn
SAVAGE RAPIDS DAM
GOLD RAY DAM

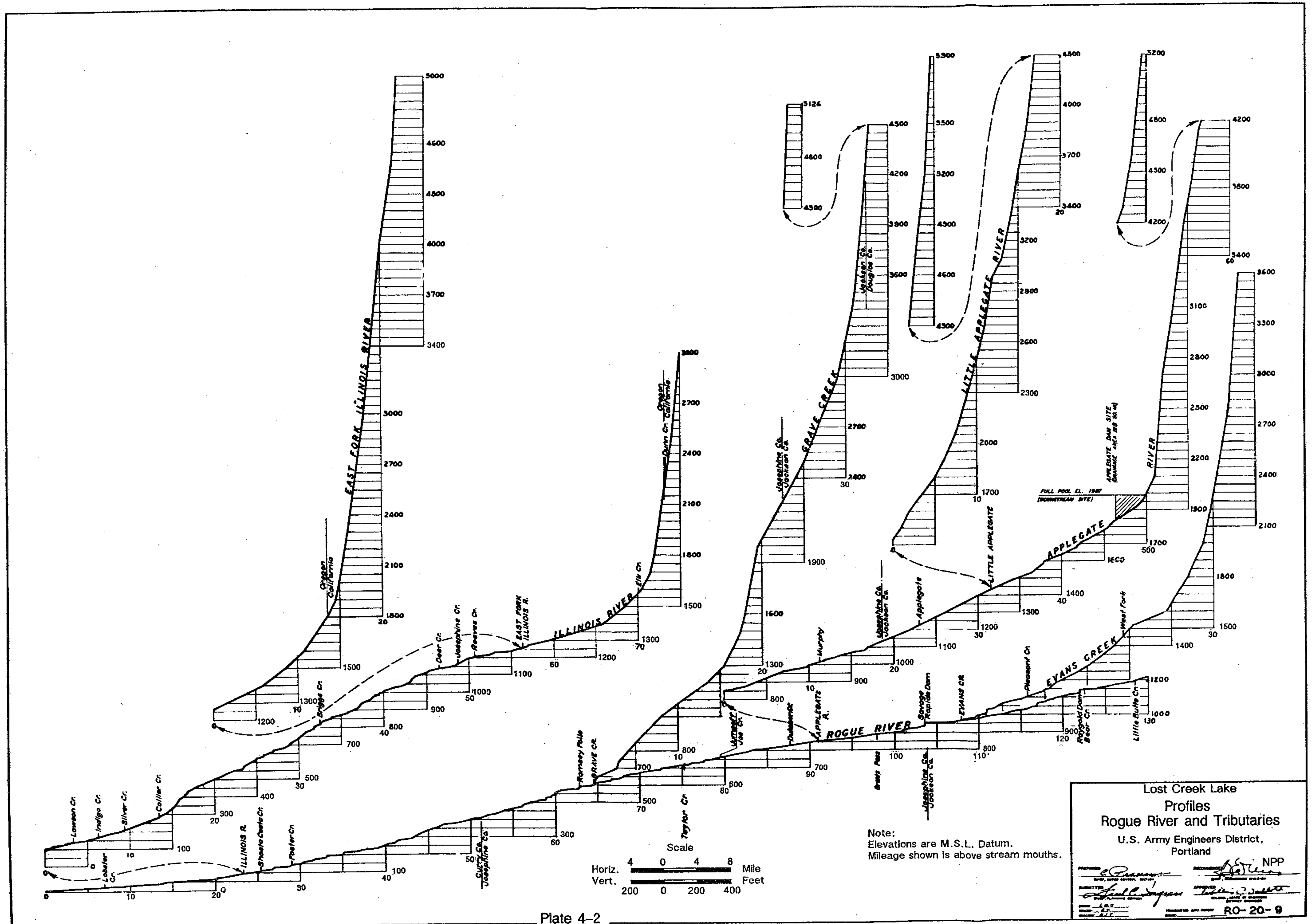
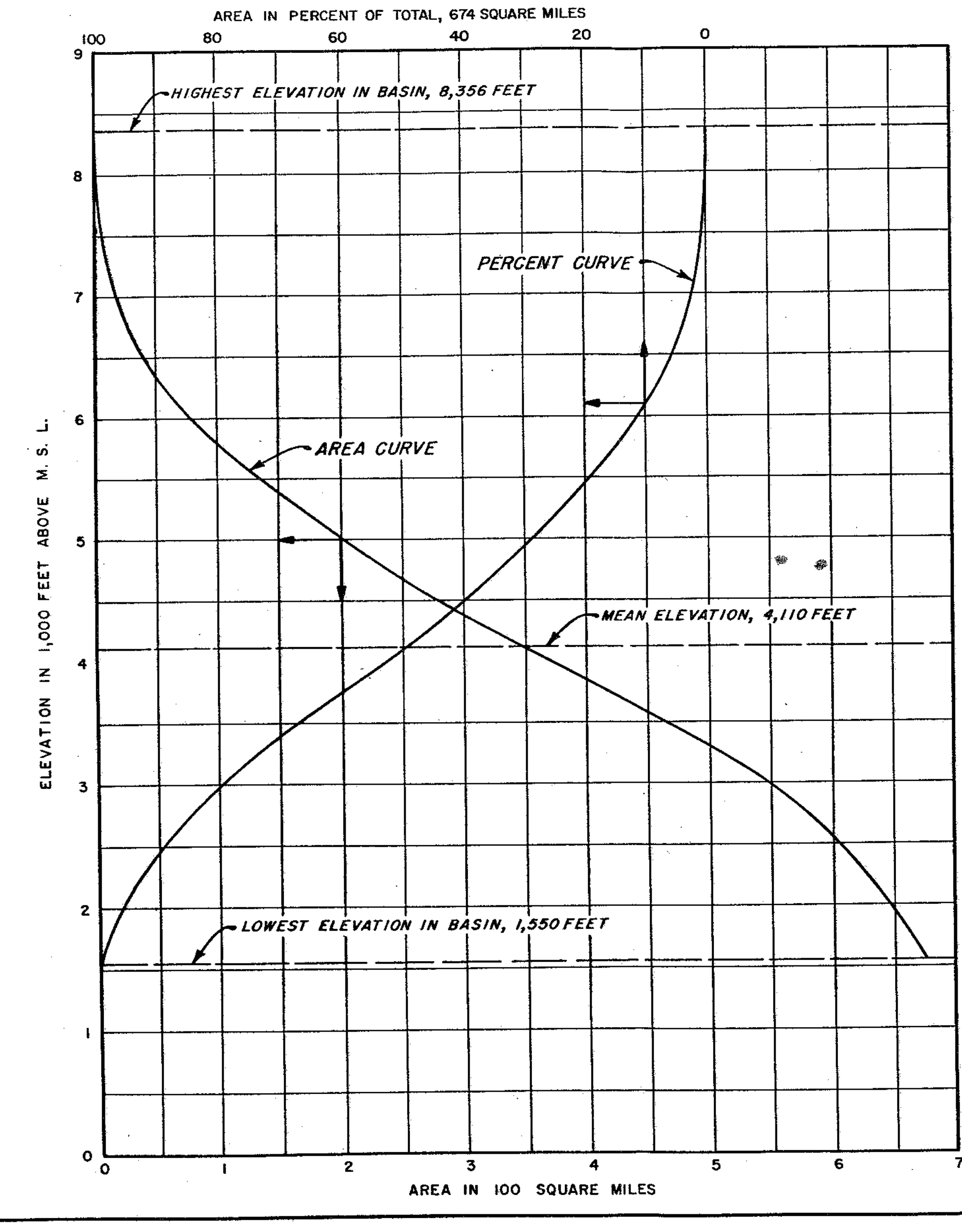

Lost Creek Lake
Profiles
Rogue River and Tributaries
U.S. Army Engineers District, Portland
Note:
Elevations are M.S.L. Datum.
Mileage shown is above stream mouths.
Scale
Horiz. 4 0 4 8 Mile
Vert. 200 0 200 400 Feet
ROGUE RIVER
ILLINOIS RIVER
EAST FORK ILLINOIS RIVER
GRAVE CREEK
APPLEGATE RIVER
LITTLE APPLEGATE RIVER
EVANS CREEK
FULL POOL EL. 1967
APPLEGATE DAM SITE
Lawson Cr.
Indigo Cr.
Silver Cr.
Collier Cr.
Lobster Cr.
Shasta Costa Cr.
Foster Cr.
Briggs Cr.
Deer Cr.
Josephine Cr.
Reeves Cr.
Elk Cr.
Dunn Cr.
Rainey Falls
Taylor Cr
Jumpoff Joe Cr.
Murphy
Savage Rapids Dam
Pleasant Cr.
West Fork
Bear Cr.
Little Butte Cr.
Curry Co.
Josephine Co.
Jackson Co.
Douglas Co.
Oregon
California
NPP
RO-20-9

Plate 4-2



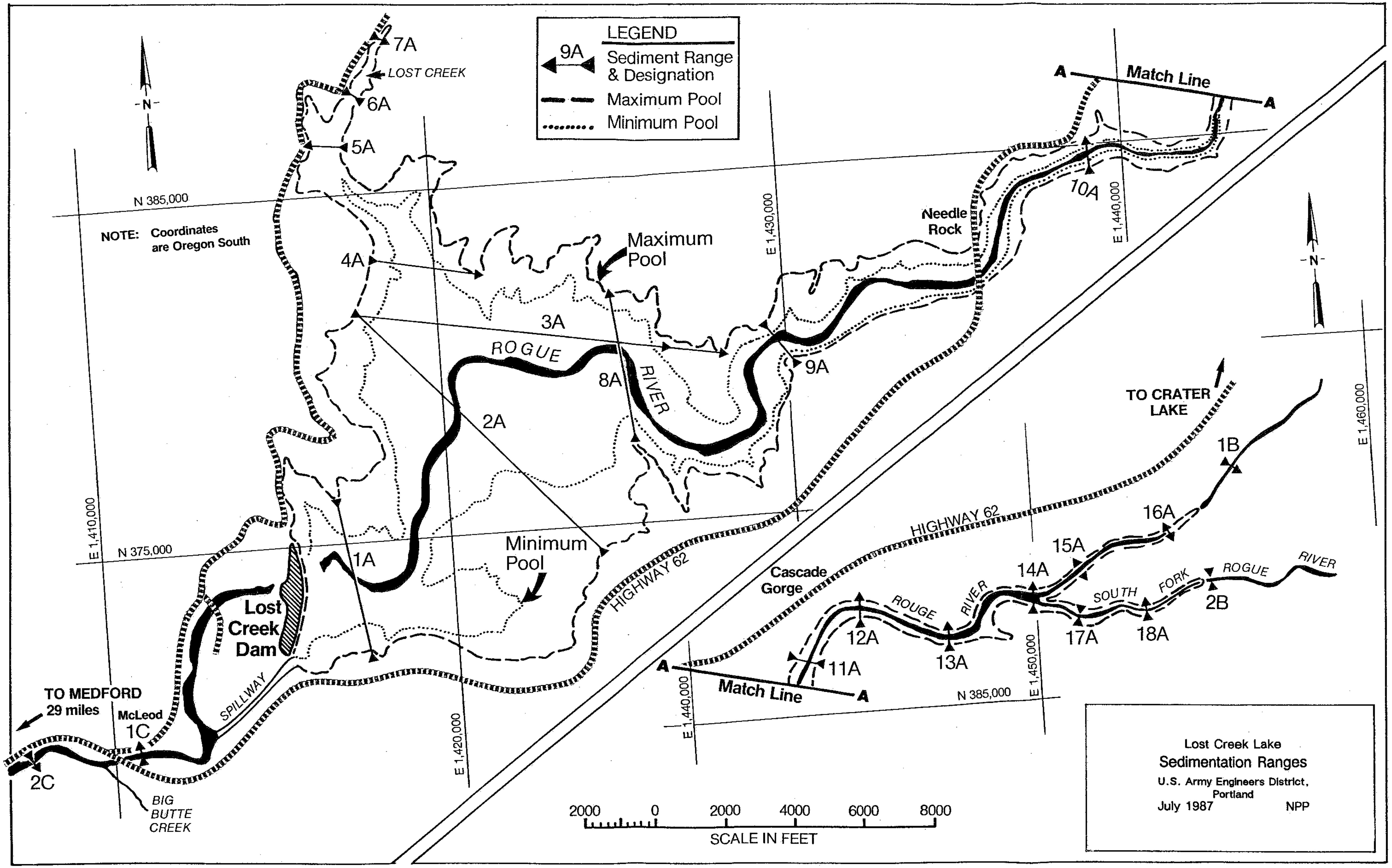
NOTE:

DATA TAKEN FROM AERONAUTICAL CHART, SCALE 1:1,000,000.

Lost Creek Lake
Basin Area and Elevation Curves
U.S. Army Engineers District, Portland
Nov. 1965 NPP

LC-20-16/1

Plate 4–3



LEGEND
9A
Sediment Range & Designation
Maximum Pool
Minimum Pool
NOTE: Coordinates are Oregon South
N 385,000
N 375,000
E 1,410,000
E 1,420,000
E 1,430,000
E 1,440,000
E 1,450,000
E 1,460,000
7A
LOST CREEK
6A
5A
4A
3A
2A
1A
8A
9A
10A
11A
12A
13A
14A
15A
16A
17A
18A
1B
2B
1C
2C
Match Line
A
ROGUE RIVER
Maximum Pool
Minimum Pool
Needle Rock
Lost Creek Dam
SPILLWAY
HIGHWAY 62
TO MEDFORD 29 miles
McLeod
BIG BUTTE CREEK
Cascade Gorge
TO CRATER LAKE
SOUTH FORK
N 385,000
2000 0 2000 4000 6000 8000
SCALE IN FEET
Lost Creek Lake
Sedimentation Ranges
U.S. Army Engineers District, Portland
July 1987
NPP

Plate 4-4

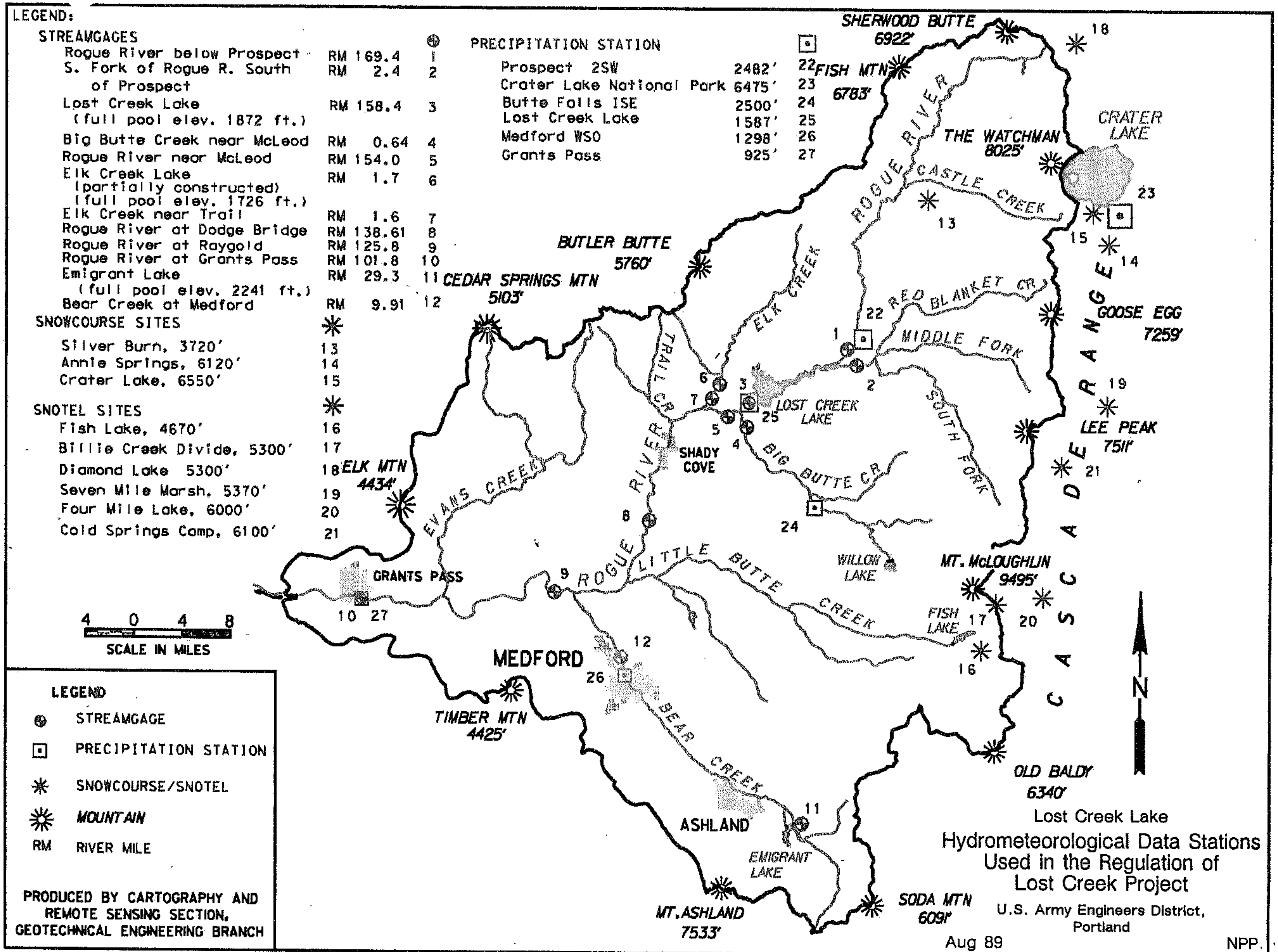
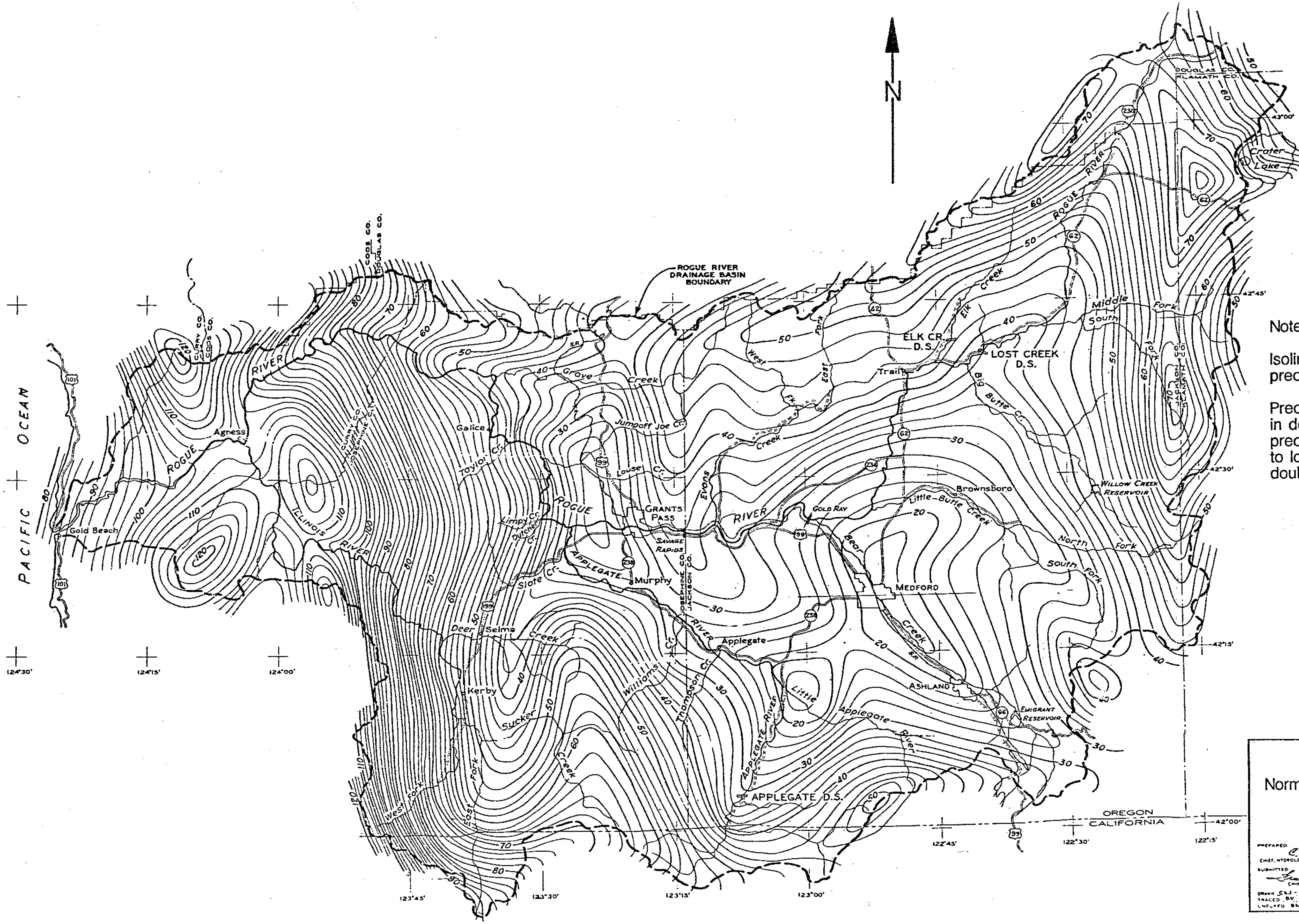

LEGEND:
STREAMGAGES
Rogue River below Prospect RM 169.4 1
S. Fork of Rogue R. South of Prospect RM 2.4 2
Lost Creek Lake (full pool elev. 1872 ft.) RM 158.4 3
Big Butte Creek near McLeod RM 0.64 4
Rogue River near McLeod RM 154.0 5
Elk Creek Lake (partially constructed) (full pool elev. 1726 ft.) RM 1.7 6
Elk Creek near Trail RM 1.6 7
Rogue River at Dodge Bridge RM 138.61 8
Rogue River at Raygold RM 125.8 9
Rogue River at Grants Pass RM 101.8 10
Emigrant Lake (full pool elev. 2241 ft.) RM 29.3 11
Bear Creek at Medford RM 9.91 12
SNOWCOURSE SITES
Silver Burn, 3720' 13
Annie Springs, 6120' 14
Crater Lake, 6550' 15
SNOTEL SITES
Fish Lake, 4670' 16
Billie Creek Divide, 5300' 17
Diamond Lake 5300' 18
Seven Mile Marsh, 5370' 19
Four Mile Lake, 6000' 20
Cold Springs Camp, 6100' 21
PRECIPITATION STATION
Prospect 2SW 2482' 22
Crater Lake National Park 6475' 23
Butte Falls ISE 2500' 24
Lost Creek Lake 1587' 25
Medford WSO 1298' 26
Grants Pass 925' 27
SHERWOOD BUTTE 6922'
FISH MTN 6783'
THE WATCHMAN 8025'
CRATER LAKE
BUTLER BUTTE 5760'
CEDAR SPRINGS MTN 5103'
GOOSE EGG 7259'
LEE PEAK 7511'
ELK MTN 4434'
MT. McLOUGHLIN 9495'
OLD BALDY 6340'
TIMBER MTN 4425'
MT. ASHLAND 7533'
SODA MTN 6091'
CASCADE RANGE
ROGUE RIVER
CASTLE CREEK
RED BLANKET CR
MIDDLE FORK
SOUTH FORK
ELK CREEK
TRAIL CR
LOST CREEK LAKE
SHADY COVE
BIG BUTTE CR
WILLOW LAKE
LITTLE BUTTE CREEK
FISH LAKE
EVANS CREEK
GRANTS PASS
MEDFORD
BEAR CREEK
ASHLAND
EMIGRANT LAKE
N
4 0 4 8
SCALE IN MILES
LEGEND
STREAMGAGE
PRECIPITATION STATION
SNOWCOURSE/SNOTEL
MOUNTAIN
RM RIVER MILE
PRODUCED BY CARTOGRAPHY AND REMOTE SENSING SECTION, GEOTECHNICAL ENGINEERING BRANCH
Lost Creek Lake
Hydrometeorological Data Stations Used in the Regulation of Lost Creek Project
U.S. Army Engineers District, Portland
Aug 89
NPP

Plate 4–5



Note:

Isolines denote normal annual precipitation in inches.

Precipitation and runoff data used in developing the normal annual precipitation pattern were adjusted to long-period normals by the double-mass curve method.

Rogue River Basin

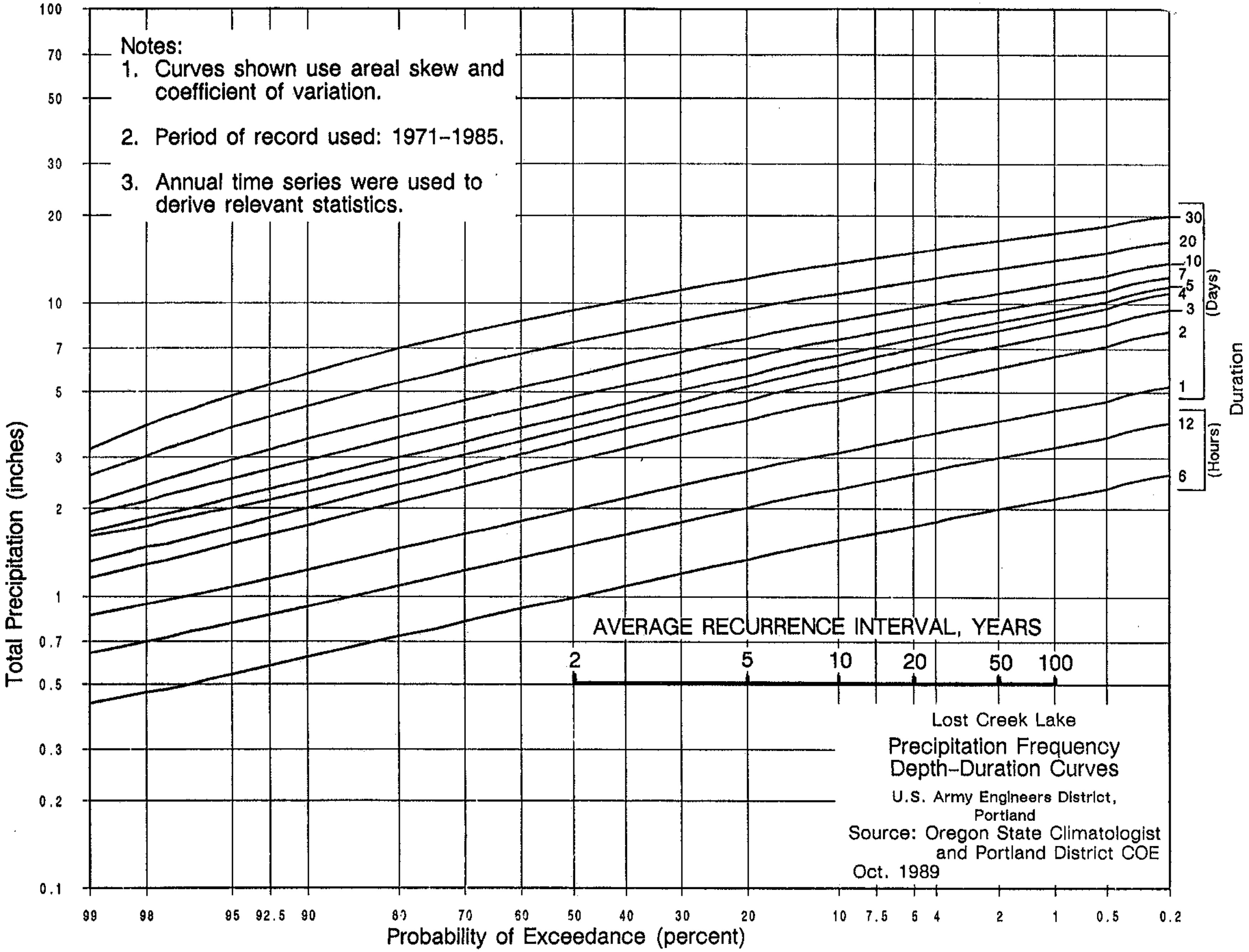
Normal Annual Precipitation Patterns

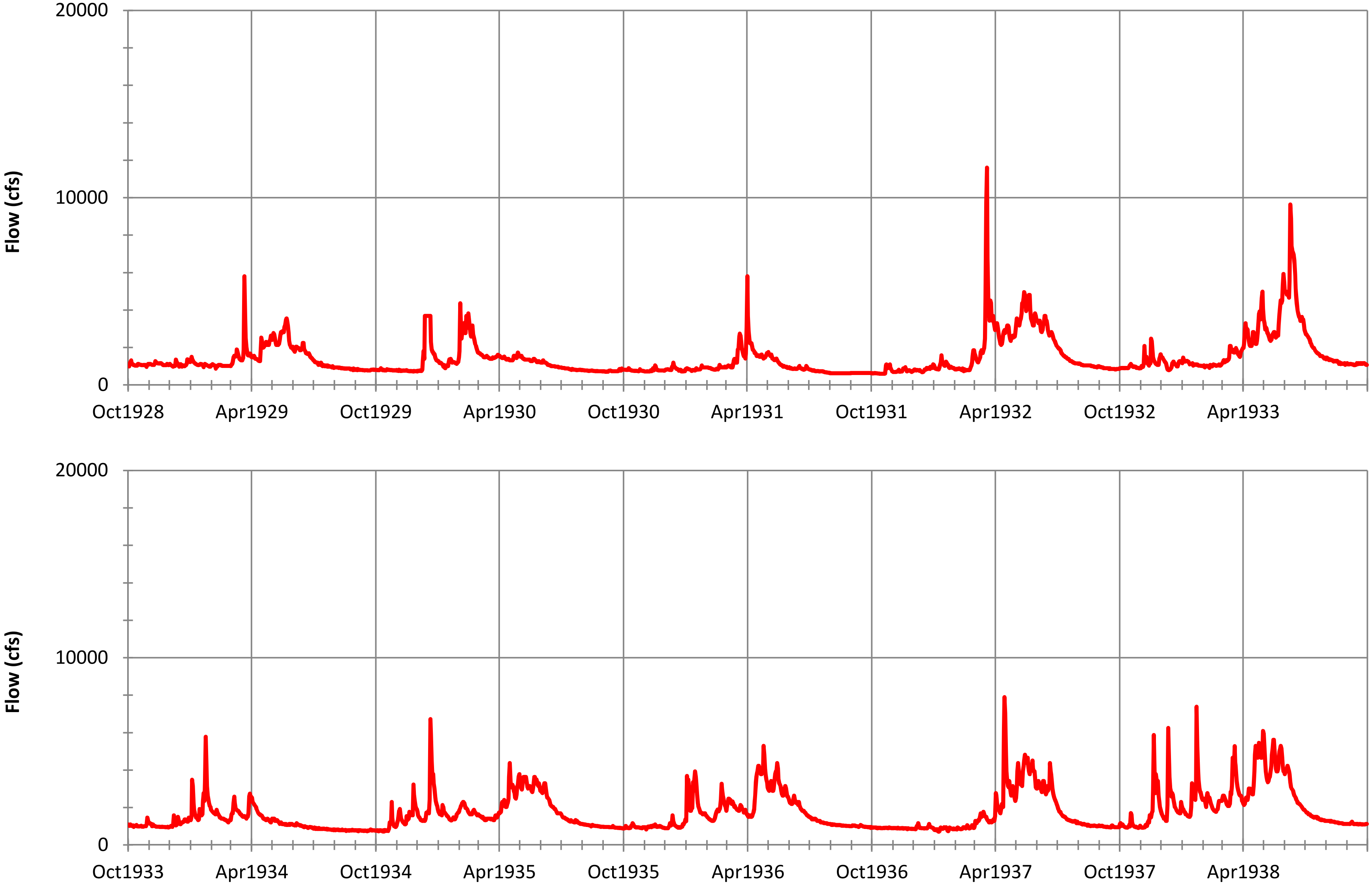
U.S. Army Engineers District, Portland

NPP

RO-20-1/27

Plate 4-6


Notes:
1. Curves shown use areal skew and coefficient of variation.
2. Period of record used: 1971-1985.
3. Annual time series were used to derive relevant statistics.
Total Precipitation (inches)
Probability of Exceedance (percent)
AVERAGE RECURRENCE INTERVAL, YEARS
Duration
(Days)
(Hours)
Lost Creek Lake
Precipitation Frequency
Depth-Duration Curves
U.S. Army Engineers District, Portland
Source: Oregon State Climatologist and Portland District COE
Oct. 1989

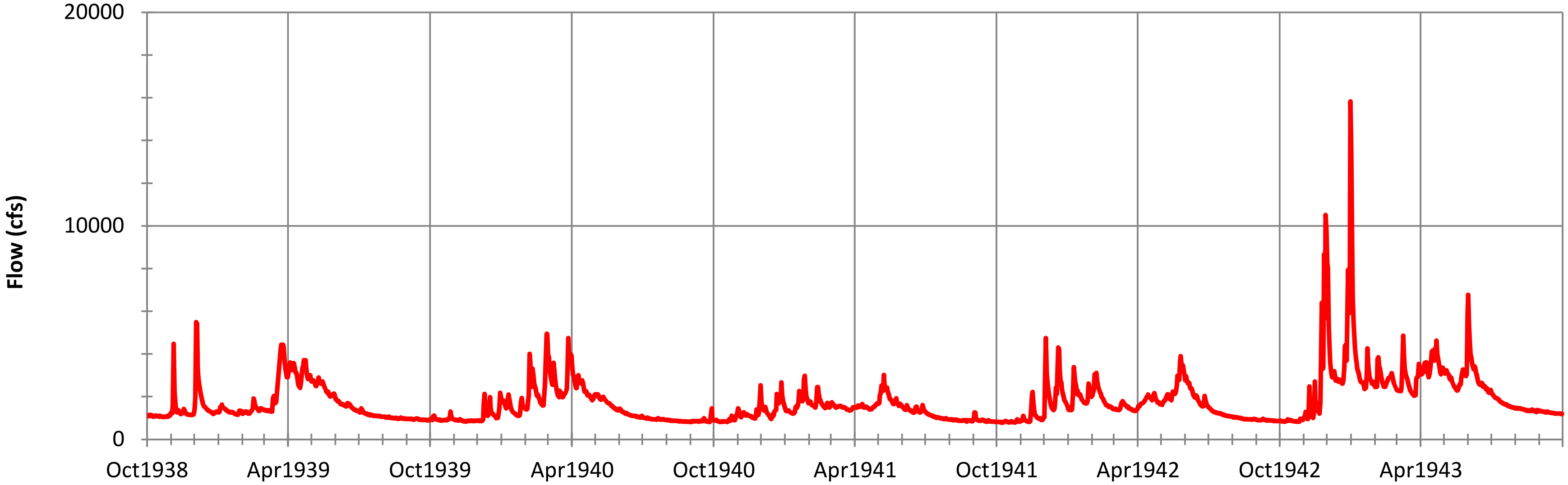


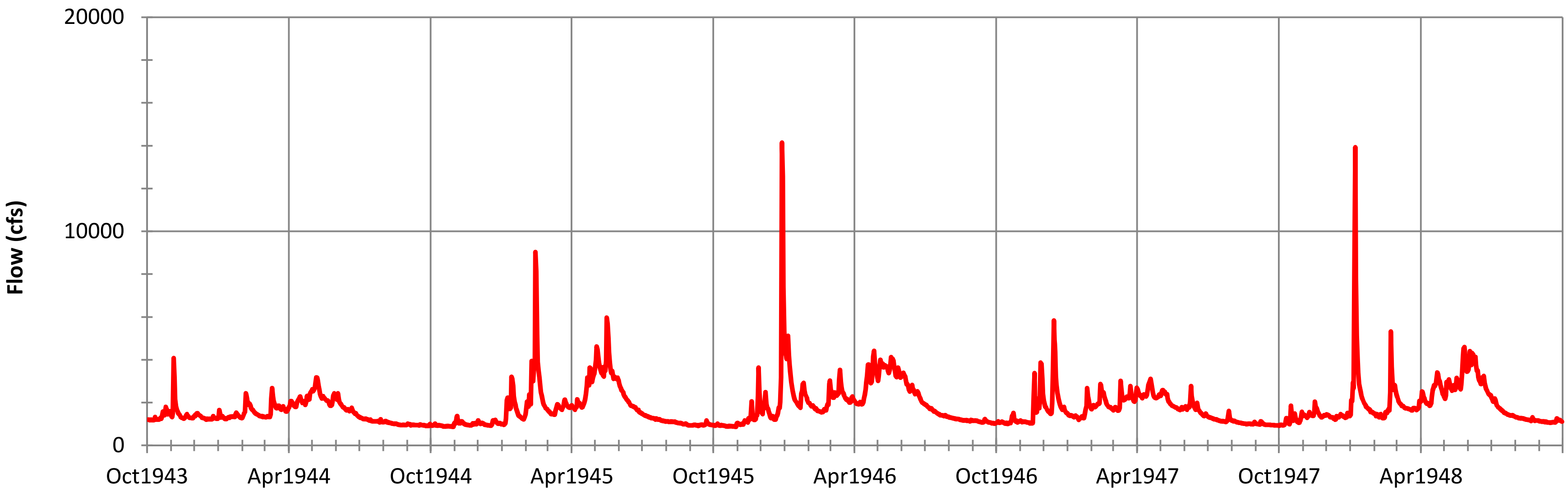
Lost Creek Lake

Daily Discharge Hydrographs of Flow at the Dam Site

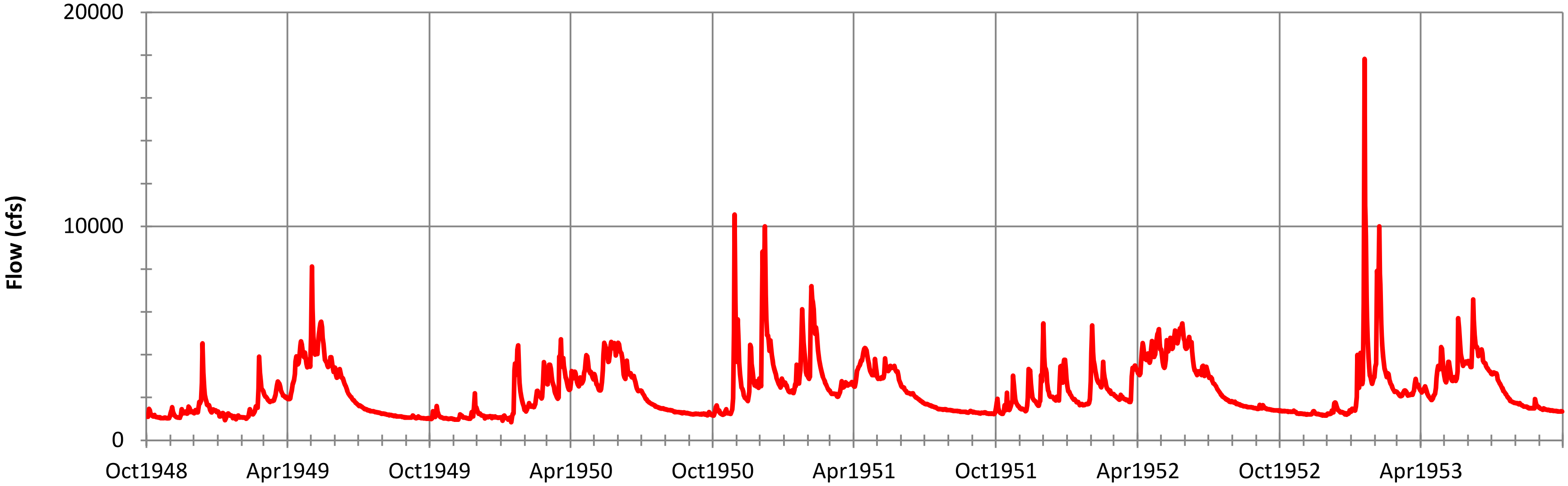
Water Years 1929 - 1938

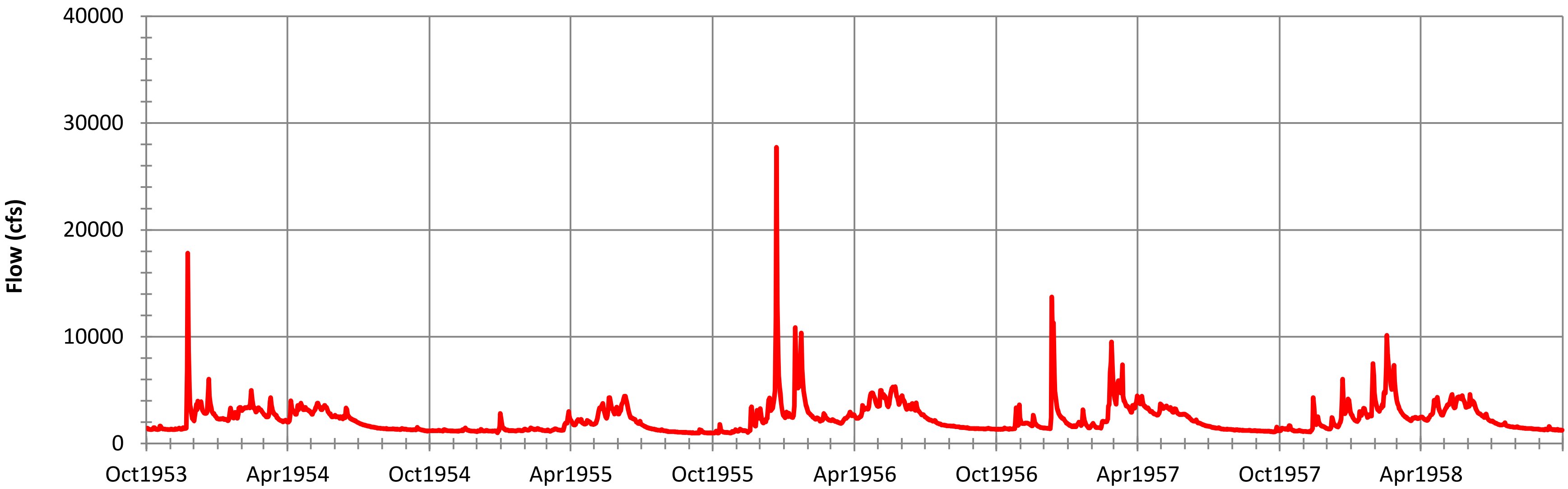
U.S. Army Corps of Engineers Portland District





Lost Creek Lake
Daily Discharge Hydrographs of Flow at the Dam Site
Water Years 1939 - 1948
U.S. Army Corps of Engineers Portland District



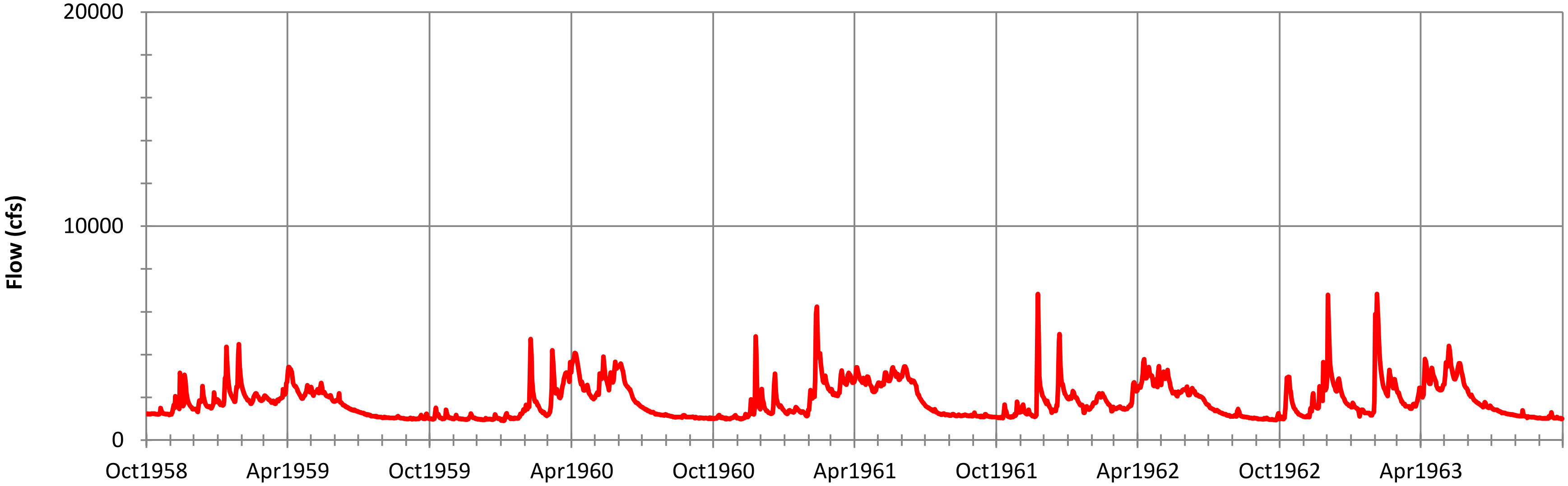


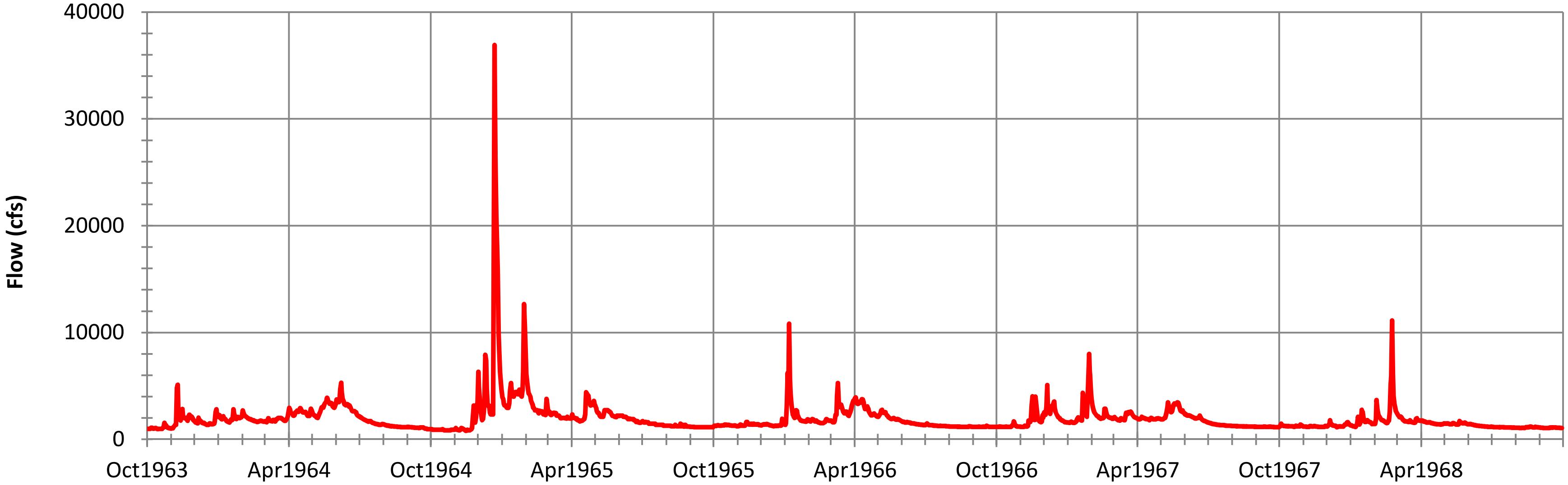
Lost Creek Lake

Daily Discharge Hydrographs of Flow at the Dam Site

Water Years 1949 - 1958

U.S. Army Corps of Engineers Portland District



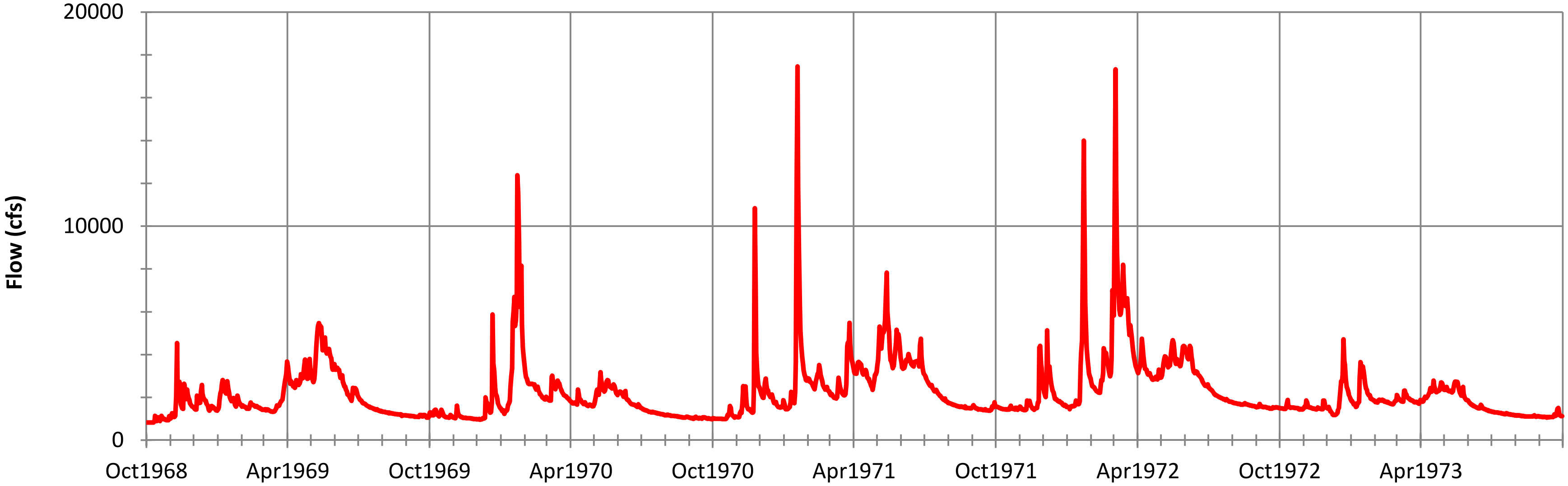


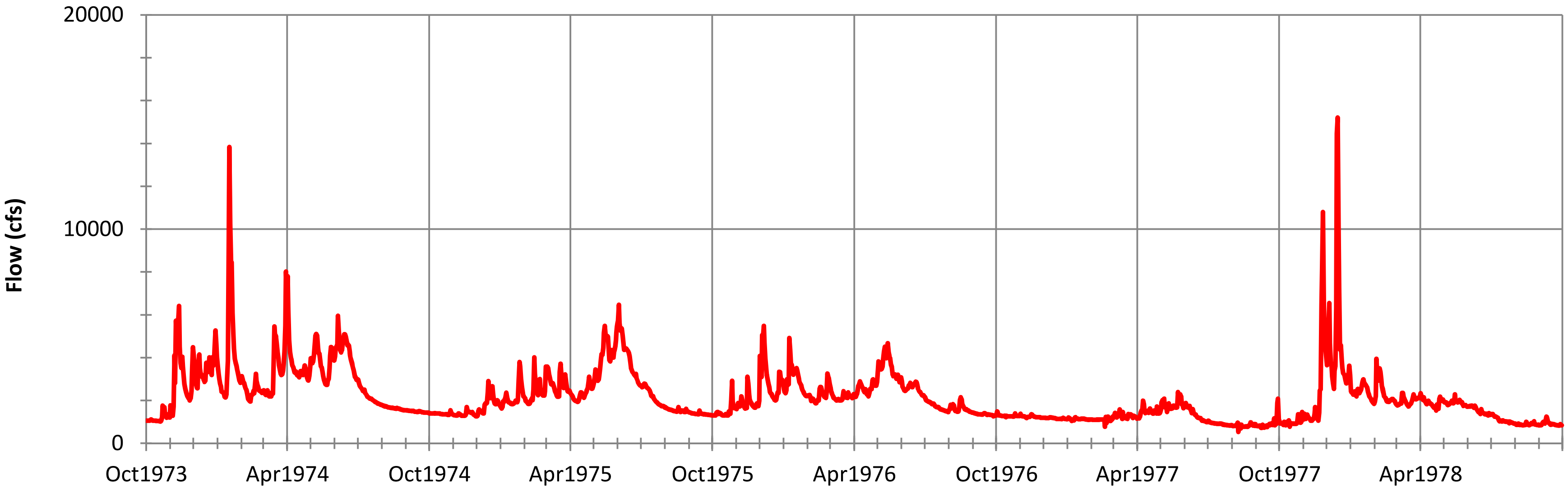
Lost Creek Lake

Daily Discharge Hydrographs of Flow at the Dam Site

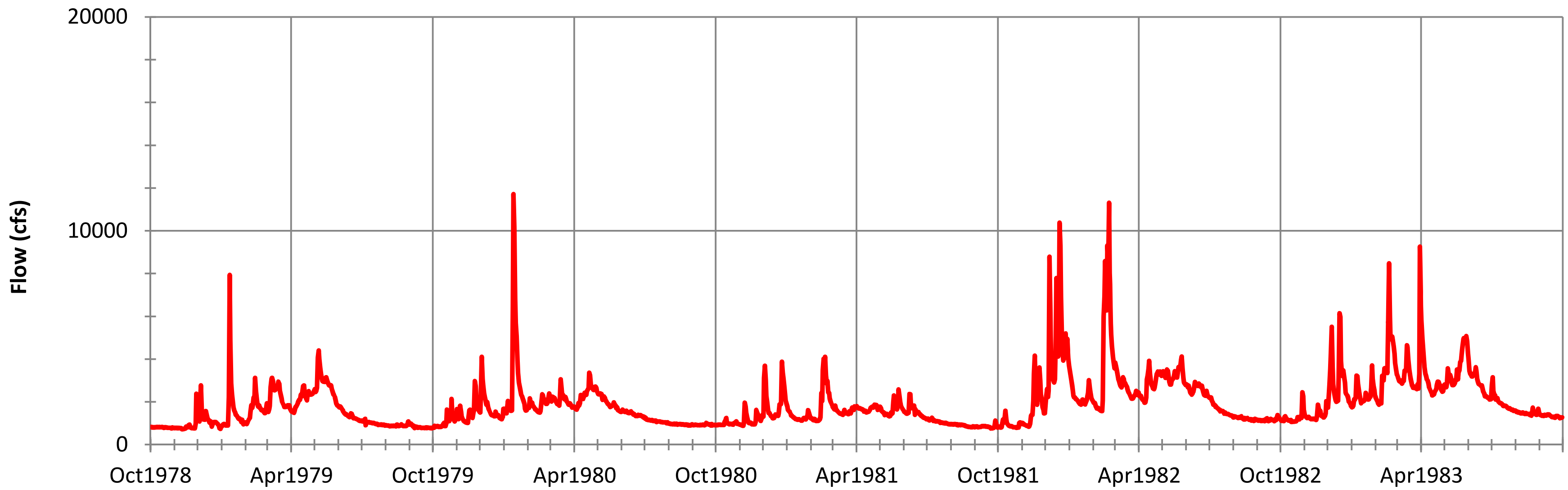
Water Years 1959 - 1968

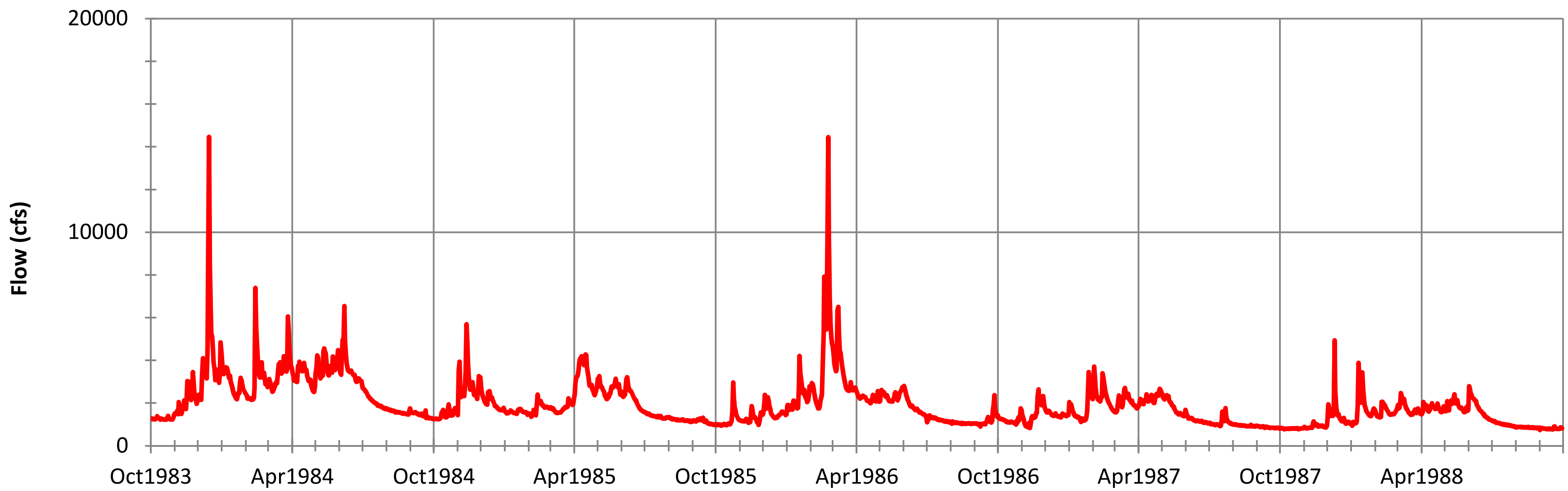
U.S. Army Corps of Engineers Portland District





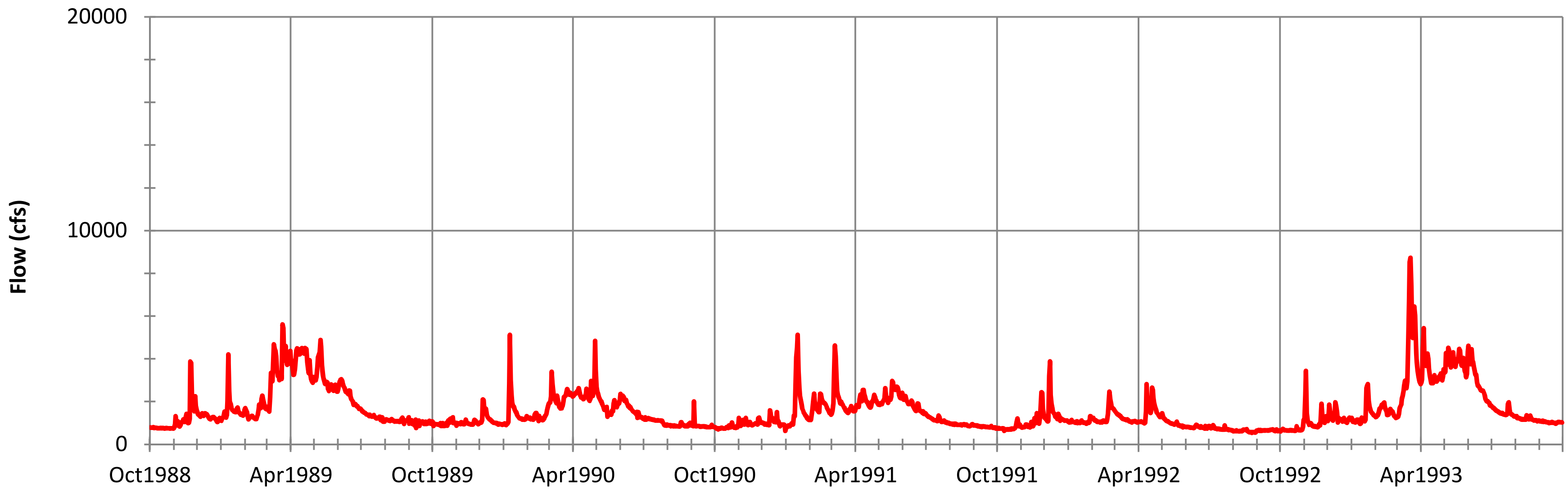
Lost Creek Lake
Daily Discharge Hydrographs of Flow at the Dam Site
Water Years 1969 - 1978
U.S. Army Corps of Engineers Portland District

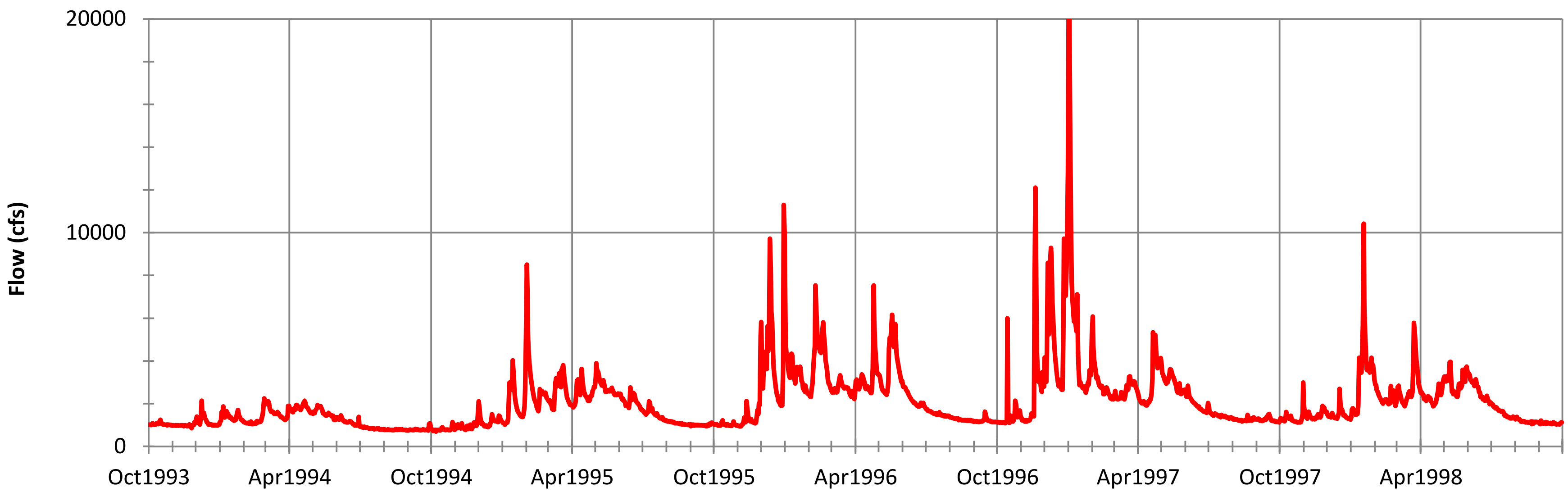




Lost Creek Lake
Daily Discharge Hydrographs of Flow at the Dam Site
Water Years 1979 - 1988
U.S. Army Corps of Engineers Portland District

Plate 4-8f



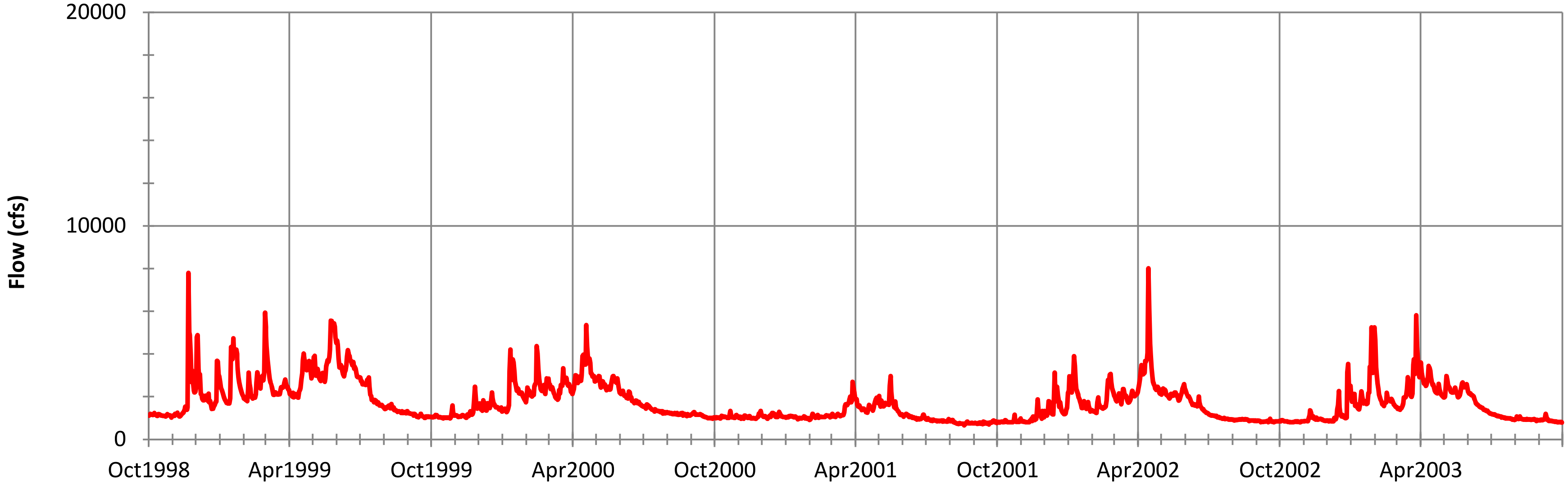


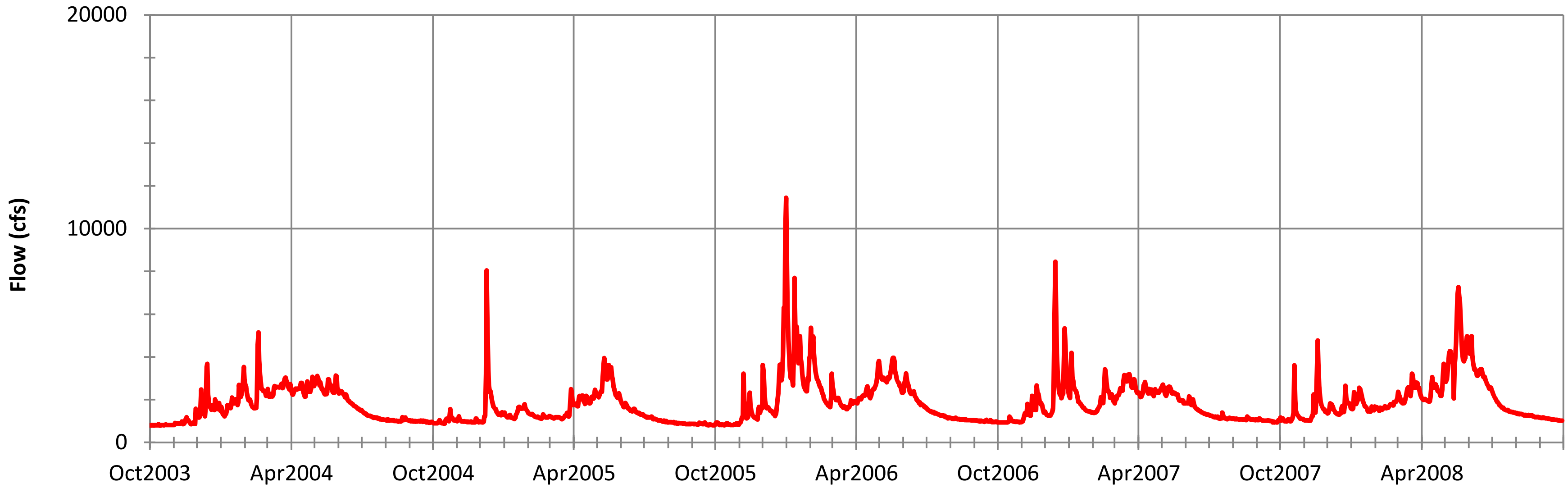
Lost Creek Lake

Daily Discharge Hydrographs of Flow at the Dam Site

Water Years 1989 - 1998

U.S. Army Corps of Engineers Portland District



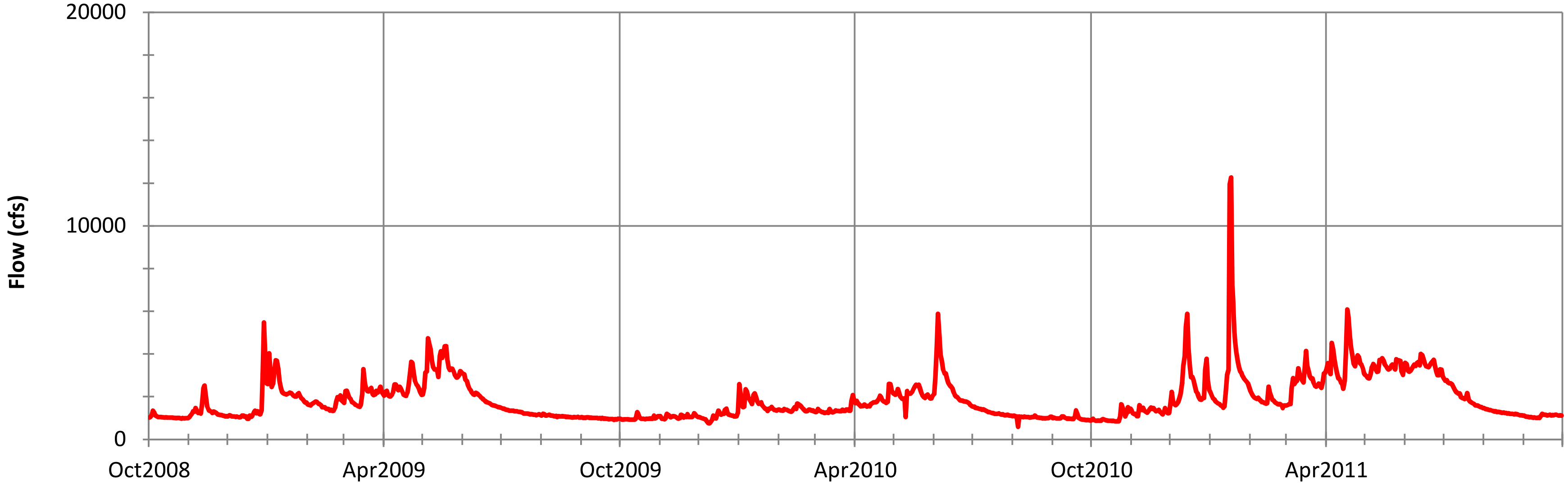


Lost Creek Lake

Daily Discharge Hydrographs of Flow at the Dam Site

Water Years 1999 - 2008

U.S. Army Corps of Engineers Portland District

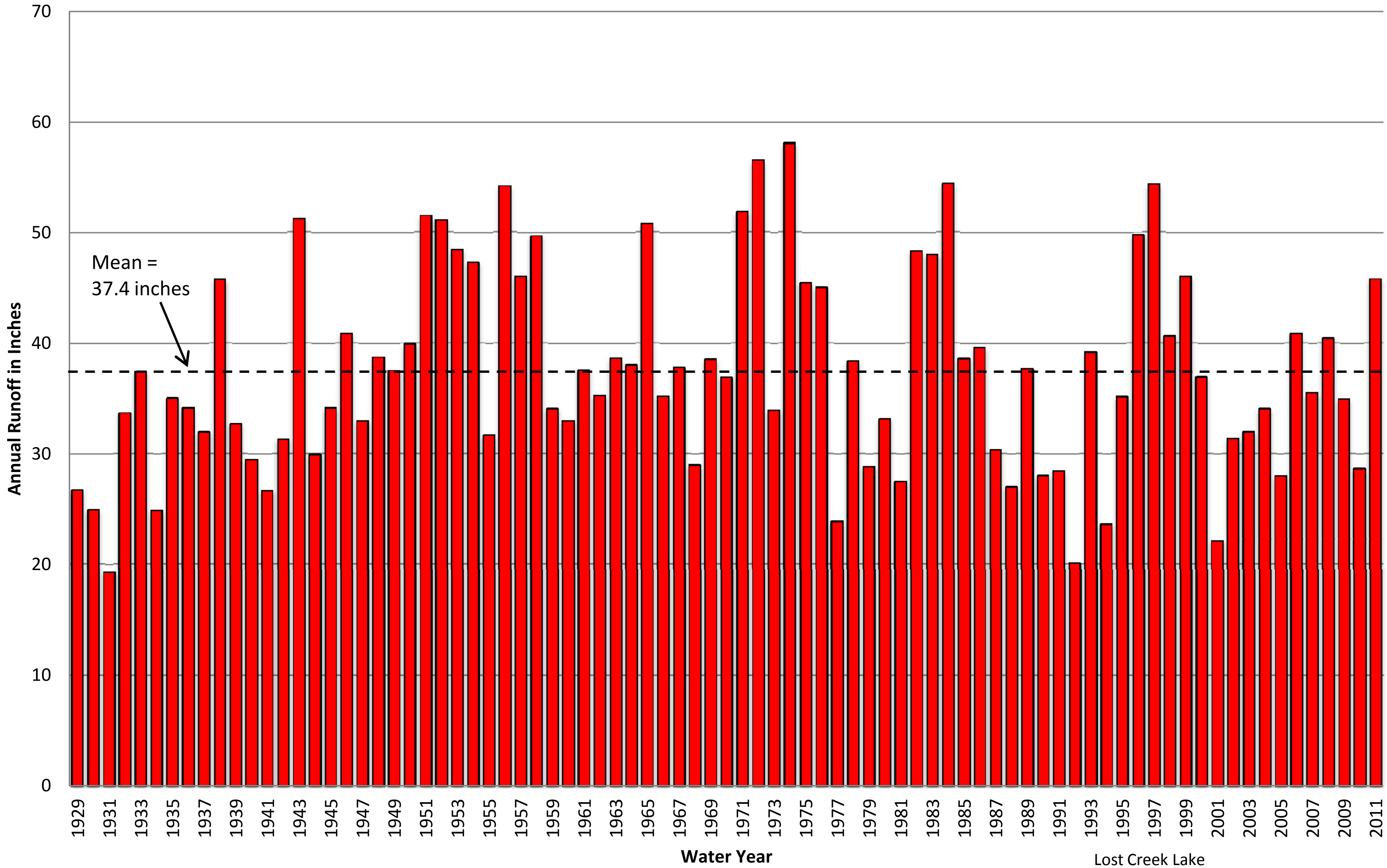


Lost Creek Lake

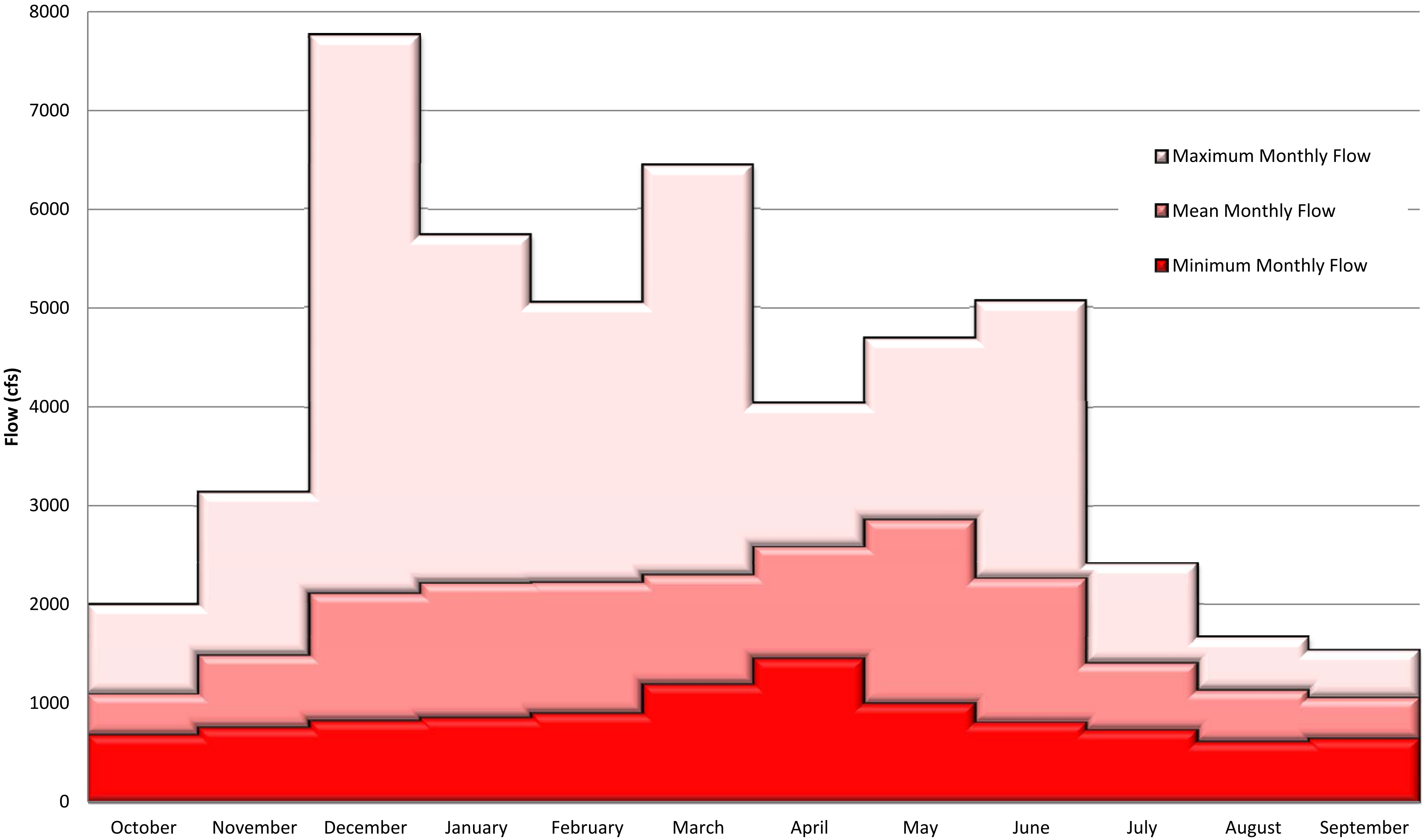
Daily Discharge Hydrographs of Flow at the Dam Site

Water Years 2009 - 2011

U.S. Army Corps of Engineers Portland District

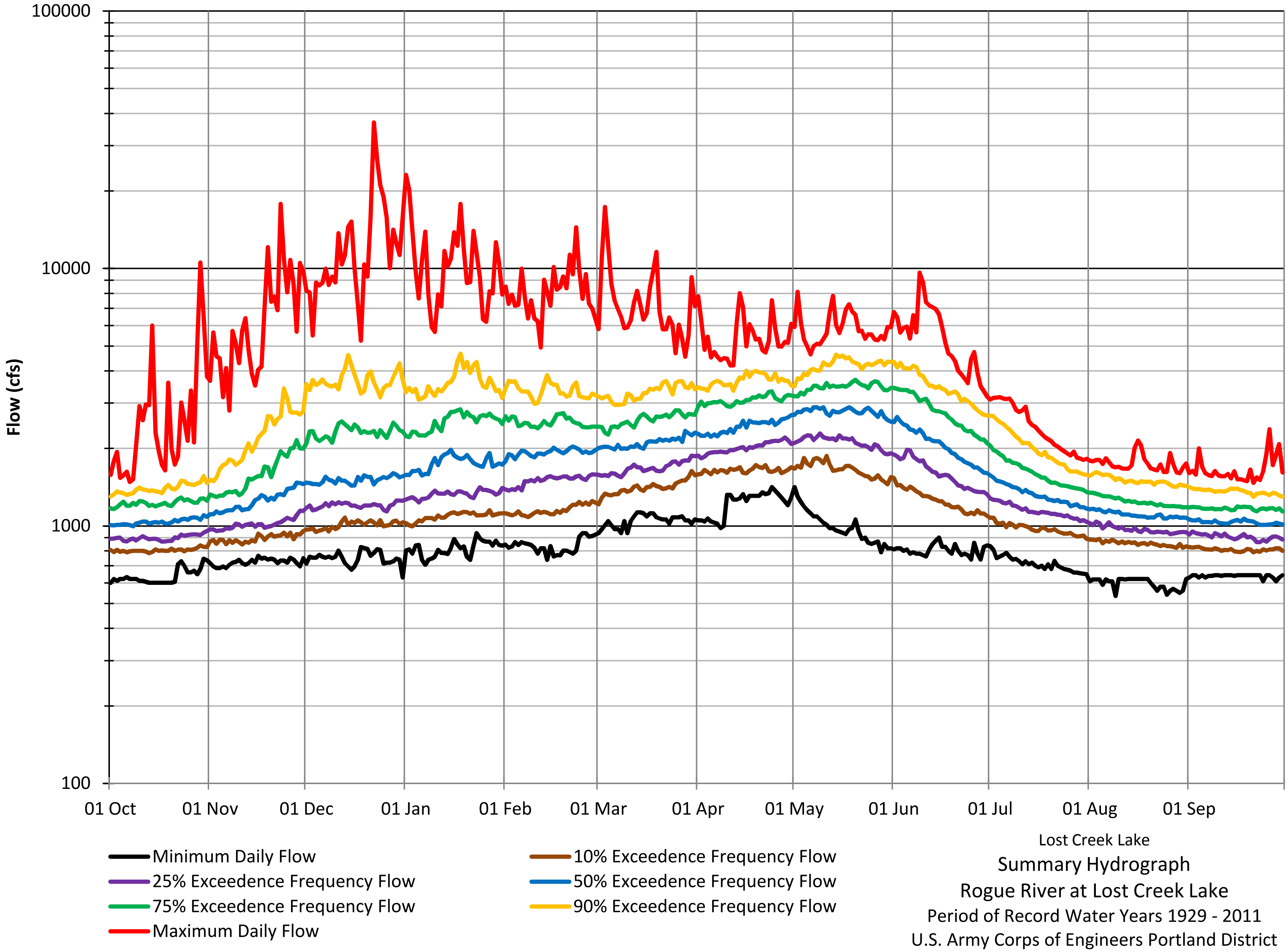


Lost Creek Lake
Annual Runoff
Period of Record 1929 - 2011
U.S. Army Corps of Engineers Portland District



Lost Creek Lake

Minimum, Mean, and Maximum Monthly Average
Streamflow at Lost Creek Lake
Period of Record Water Years 1929 - 2011
U.S. Army Corps of Engineers Portland District



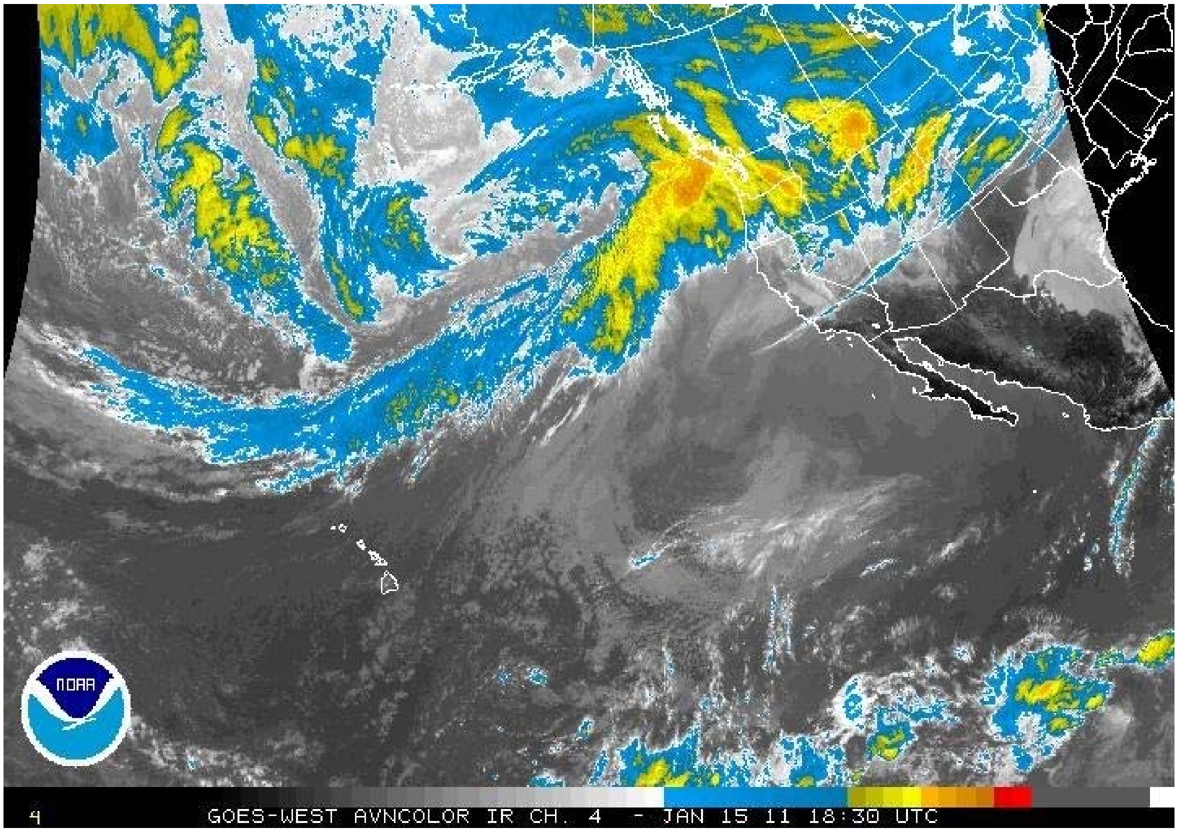
Lost Creek Lake

Summary Hydrograph

Rogue River at Lost Creek Lake

Period of Record Water Years 1929 - 2011

U.S. Army Corps of Engineers Portland District



Satellite Picture of Pacific Storm System

Lost Creek Lake

Satellite Photograph of

Typical Pacific Storm System

Source: National Weather Service

Plate 4-12

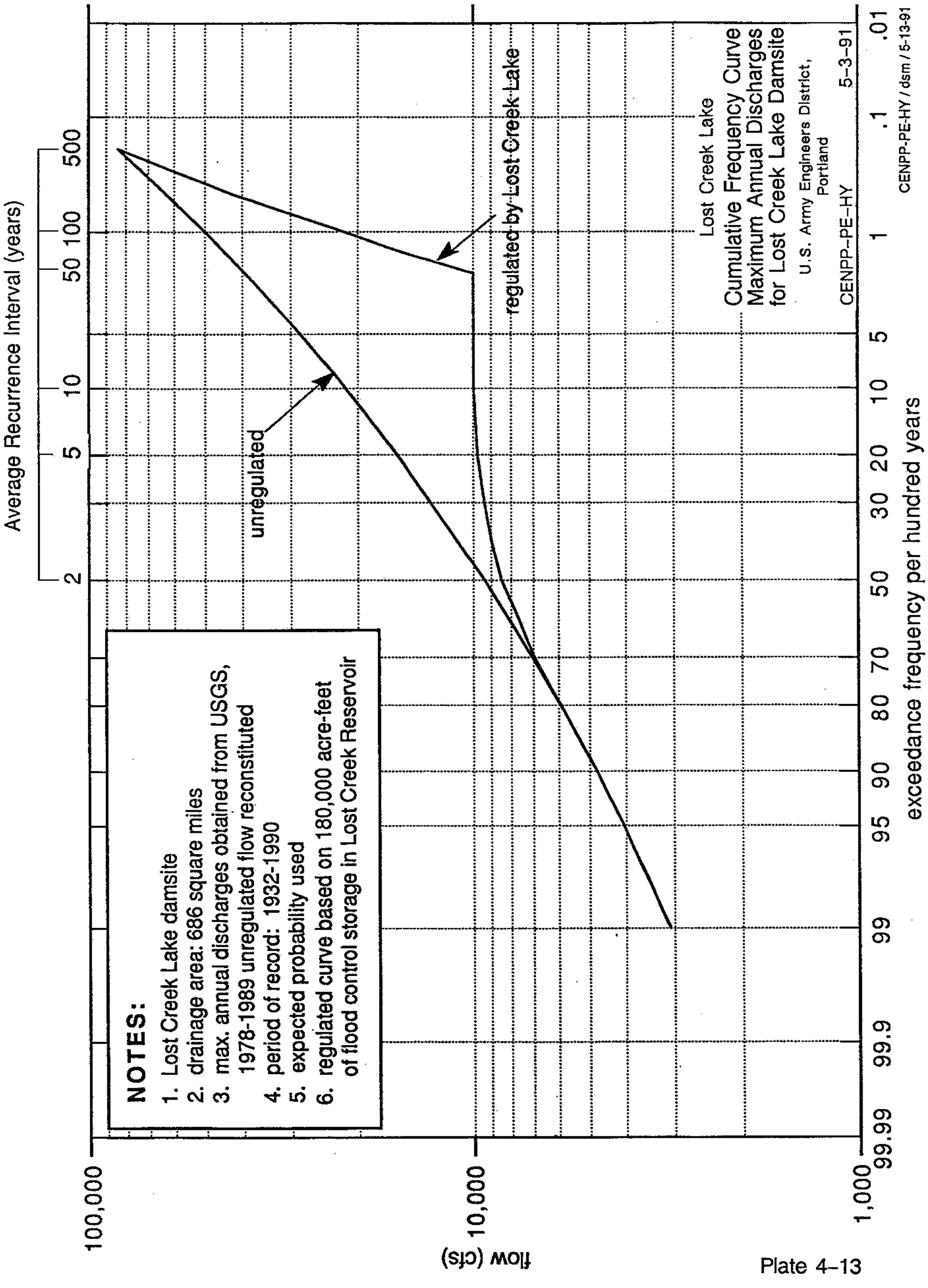

Average Recurrence Interval (years)
2
5
10
50 100
500
unregulated
regulated by Lost Creek Lake
NOTES:
1. Lost Creek Lake damsite
2. drainage area: 686 square miles
3. max. annual discharges obtained from USGS, 1978-1989 unregulated flow reconstituted
4. period of record: 1932-1990
5. expected probability used
6. regulated curve based on 180,000 acre-feet of flood control storage in Lost Creek Reservoir
Lost Creek Lake
Cumulative Frequency Curve
Maximum Annual Discharges
for Lost Creek Lake Damsite
U.S. Army Engineers District, Portland
CENPP–PE–HY
5–3–91
CENPP-PE-HY / dsm / 5-13-91
100,000
10,000
1,000
flow (cfs)
99.99
99.9
99
95
90
80
70
50
30
20
10
5
1
.1
.01
exceedance frequency per hundred years

Plate 4–13

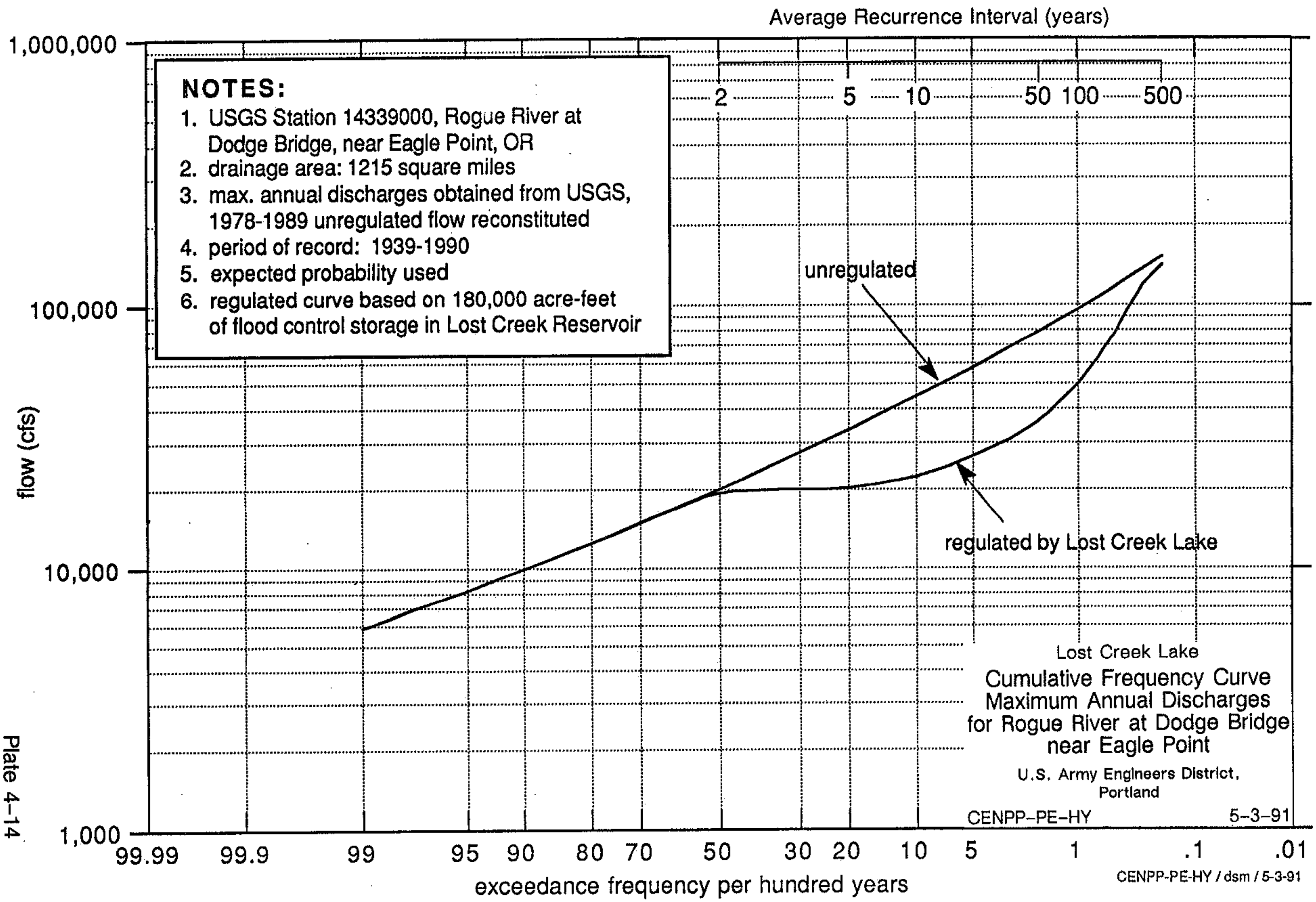

Average Recurrence Interval (years)
2
5
10
50
100
500
NOTES:
1. USGS Station 14339000, Rogue River at Dodge Bridge, near Eagle Point, OR
2. drainage area: 1215 square miles
3. max. annual discharges obtained from USGS, 1978-1989 unregulated flow reconstituted
4. period of record: 1939-1990
5. expected probability used
6. regulated curve based on 180,000 acre-feet of flood control storage in Lost Creek Reservoir
unregulated
regulated by Lost Creek Lake
1,000,000
100,000
10,000
1,000
flow (cfs)
99.99
99.9
99
95
90
80
70
50
30
20
10
5
1
.1
.01
exceedance frequency per hundred years
Lost Creek Lake
Cumulative Frequency Curve
Maximum Annual Discharges
for Rogue River at Dodge Bridge
near Eagle Point
U.S. Army Engineers District,
Portland
CENPP-PE-HY
5-3-91
CENPP-PE-HY / dsm / 5-3-91

Plate 4-14

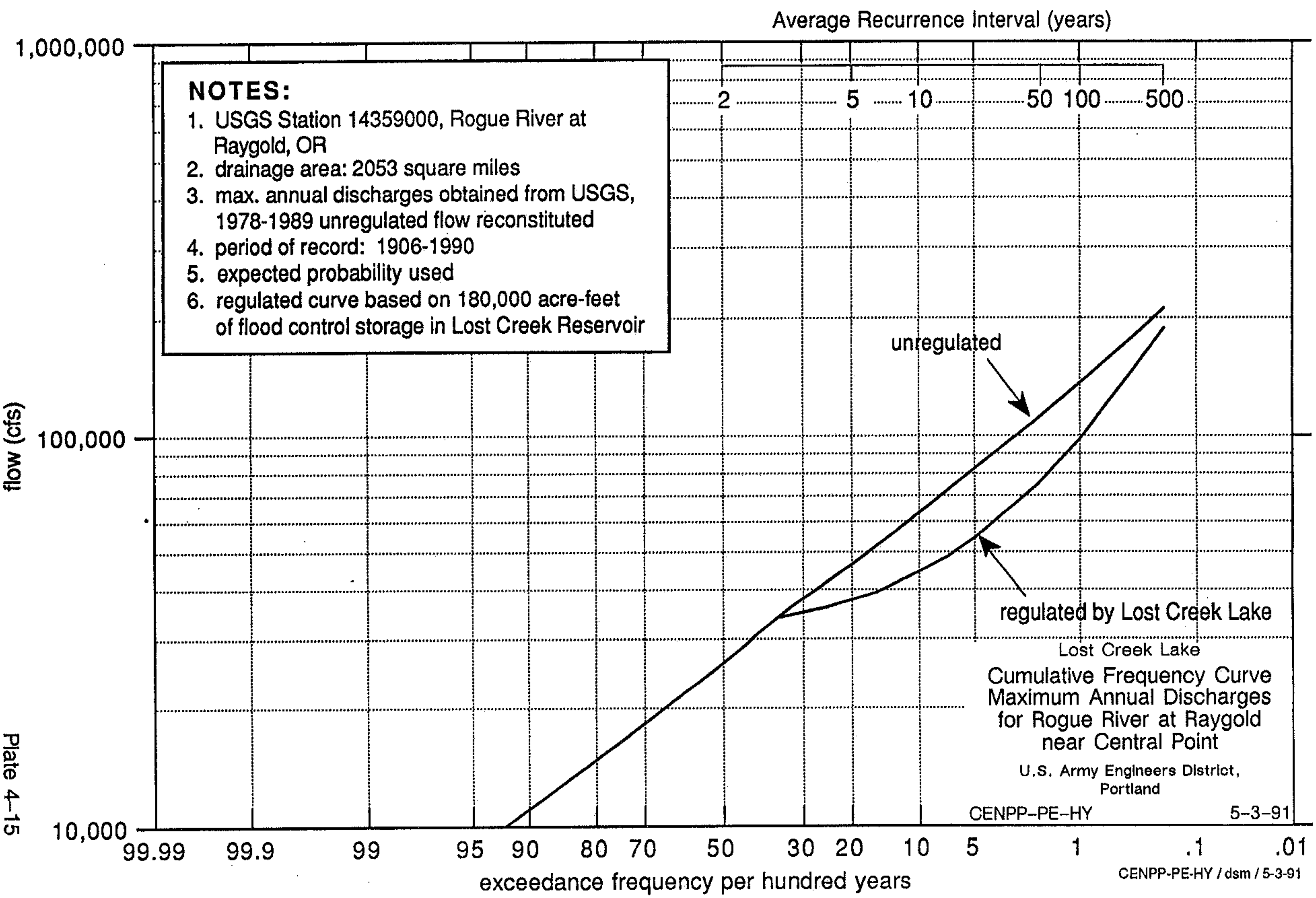
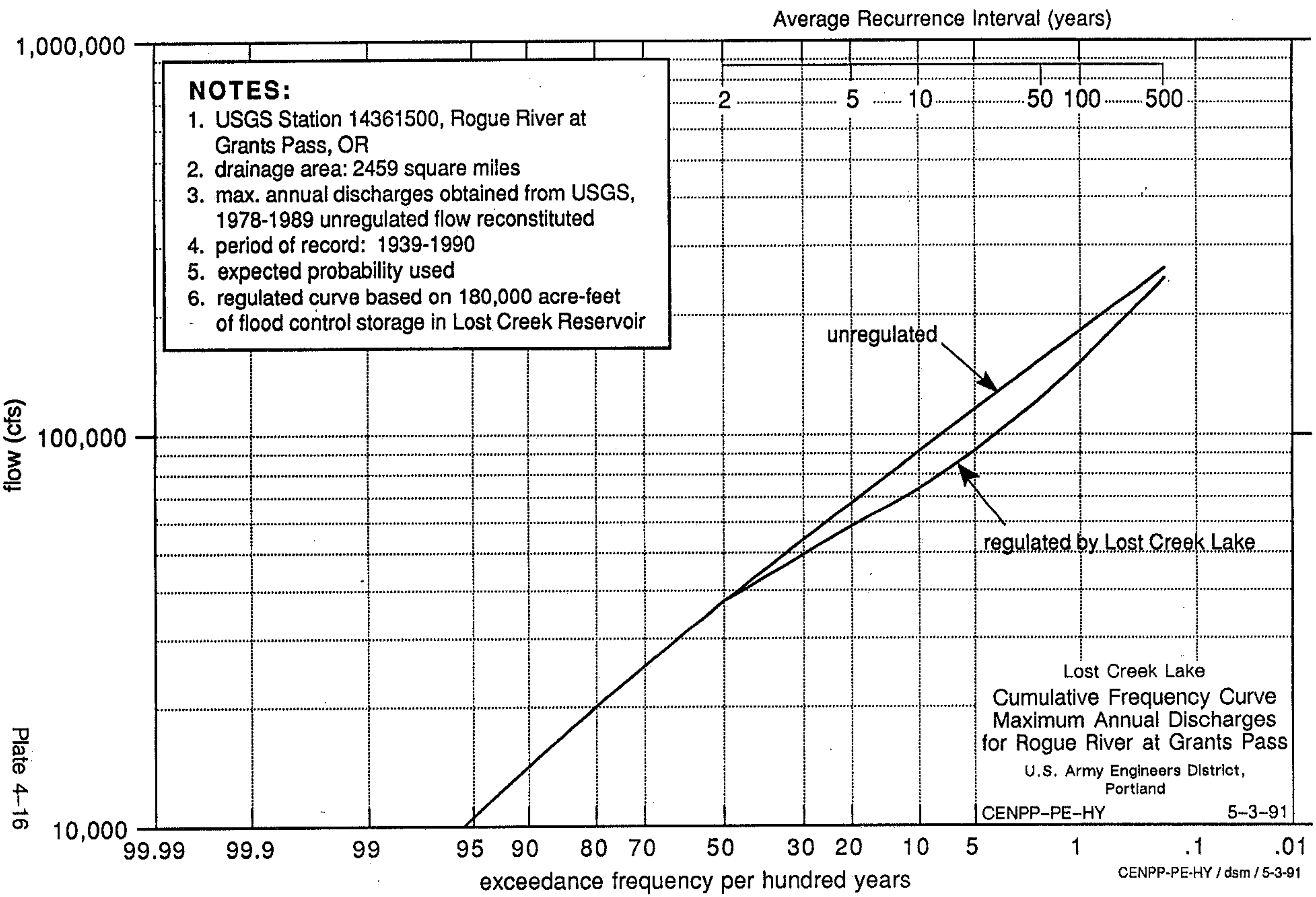

Average Recurrence Interval (years)
2 5 10 50 100 500
NOTES:
1. USGS Station 14359000, Rogue River at Raygold, OR
2. drainage area: 2053 square miles
3. max. annual discharges obtained from USGS, 1978-1989 unregulated flow reconstituted
4. period of record: 1906-1990
5. expected probability used
6. regulated curve based on 180,000 acre-feet of flood control storage in Lost Creek Reservoir
unregulated
regulated by Lost Creek Lake
Lost Creek Lake
Cumulative Frequency Curve
Maximum Annual Discharges
for Rogue River at Raygold
near Central Point
U.S. Army Engineers District,
Portland
CENPP-PE-HY
5-3-91
flow (cfs)
1,000,000
100,000
10,000
99.99 99.9 99 95 90 80 70 50 30 20 10 5 1 .1 .01
exceedance frequency per hundred years
CENPP-PE-HY / dsm / 5-3-91

Plate 4–15


Average Recurrence Interval (years)
2 5 10 50 100 500
NOTES:
1. USGS Station 14361500, Rogue River at Grants Pass, OR
2. drainage area: 2459 square miles
3. max. annual discharges obtained from USGS, 1978-1989 unregulated flow reconstituted
4. period of record: 1939-1990
5. expected probability used
6. regulated curve based on 180,000 acre-feet of flood control storage in Lost Creek Reservoir
unregulated
regulated by Lost Creek Lake
flow (cfs)
1,000,000
100,000
10,000
99.99 99.9 99 95 90 80 70 50 30 20 10 5 1 .1 .01
exceedance frequency per hundred years
Lost Creek Lake
Cumulative Frequency Curve
Maximum Annual Discharges
for Rogue River at Grants Pass
U.S. Army Engineers District,
Portland
CENPP–PE–HY
5–3–91
CENPP-PE-HY / dsm / 5-3-91

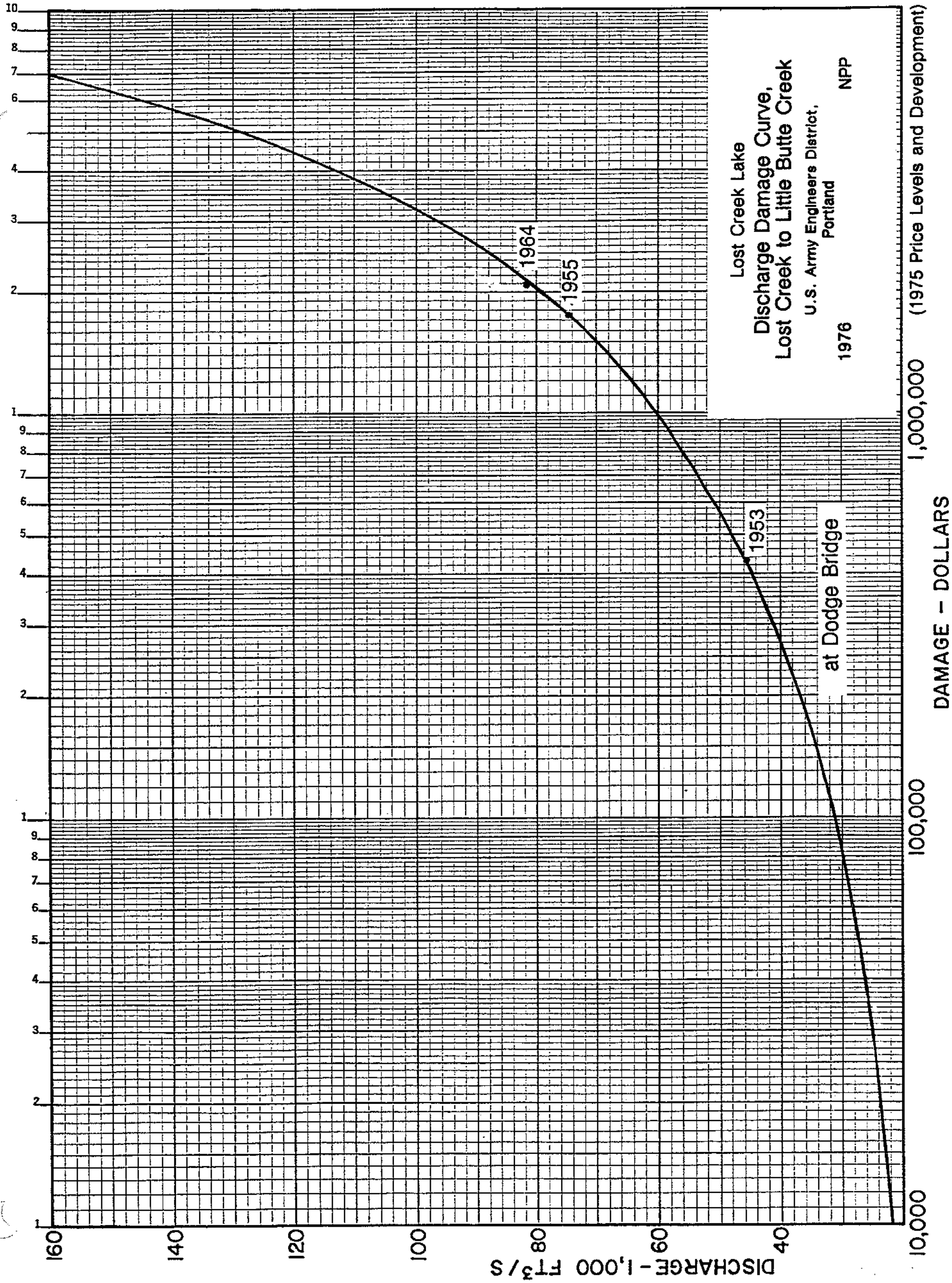

Lost Creek Lake
Discharge Damage Curve,
Lost Creek to Little Butte Creek
U.S. Army Engineers District, Portland
1976
NPP
(1975 Price Levels and Development)
at Dodge Bridge
1964
1955
1953
DAMAGE – DOLLARS
10,000
100,000
1,000,000
DISCHARGE - 1,000 FT3/S
160
140
120
100
80
60
40

Plate 4–17

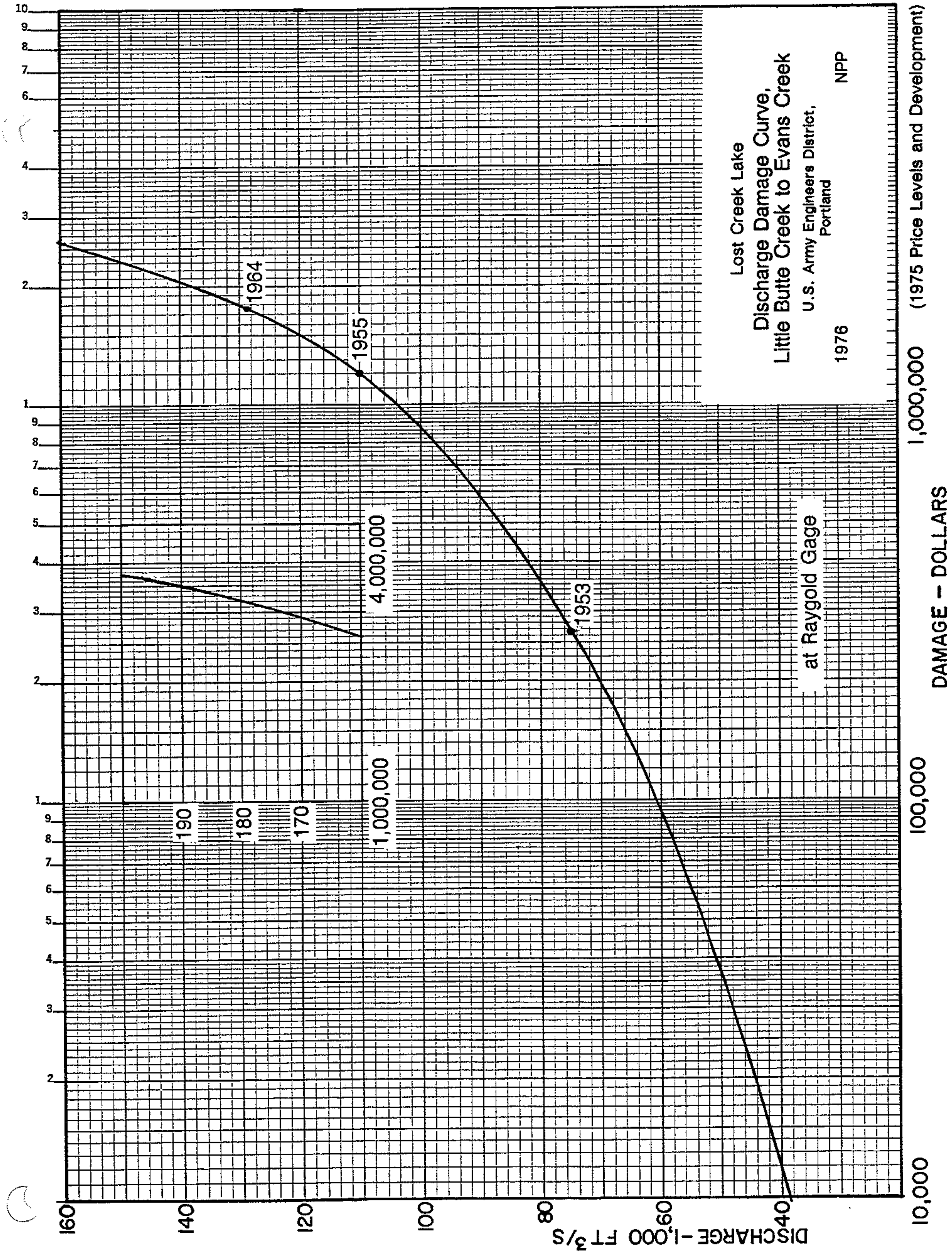

Lost Creek Lake
Discharge Damage Curve,
Little Butte Creek to Evans Creek
U.S. Army Engineers District,
Portland
1976
NPP
(1975 Price Levels and Development)
at Raygold Gage
1964
1955
1953
4,000,000
1,000,000
190
180
170
DAMAGE – DOLLARS
10,000
100,000
1,000,000
DISCHARGE-1,000 FT³/S
160
140
120
100
80
60
40

Plate 4–18

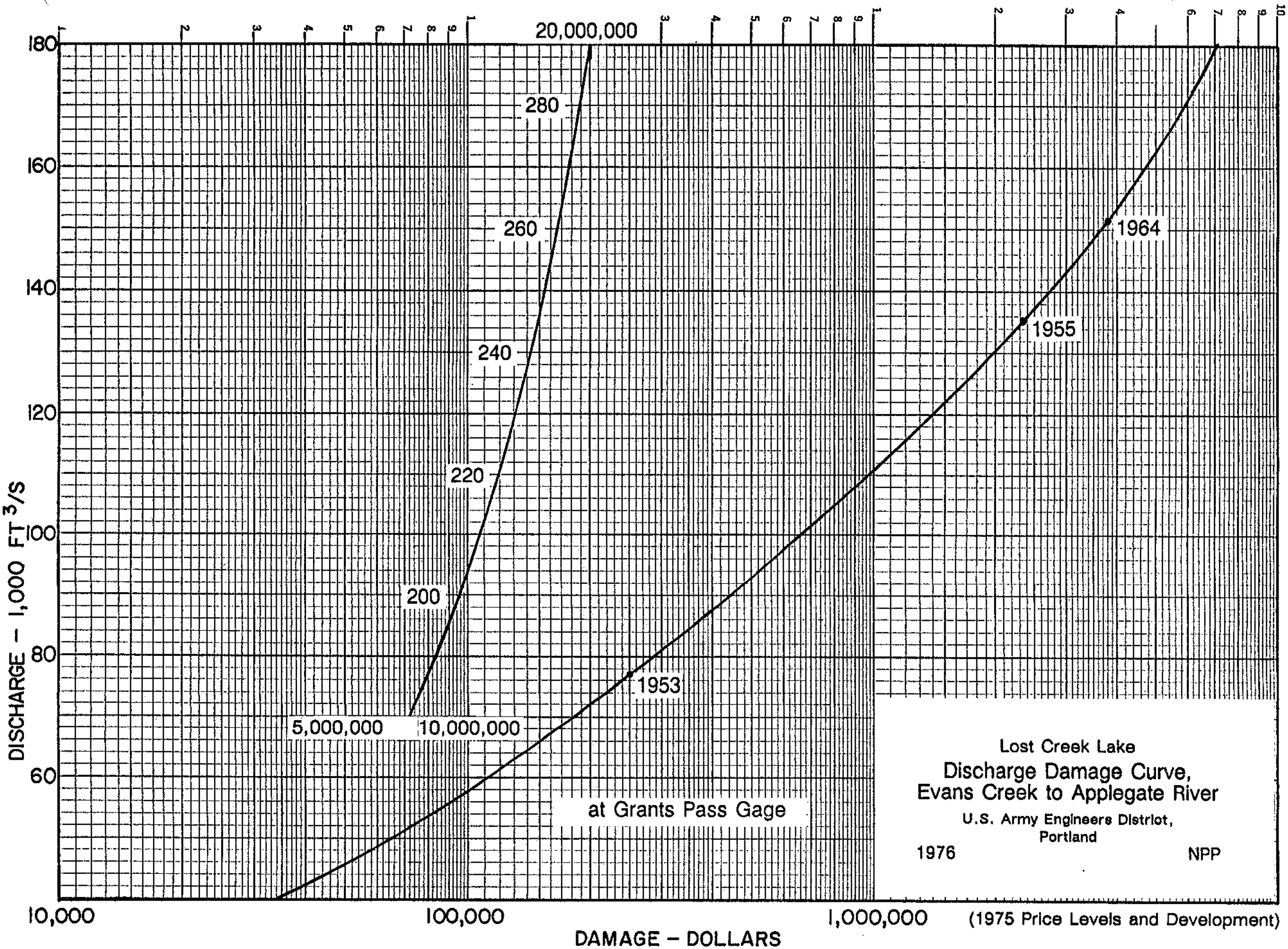

Lost Creek Lake
Discharge Damage Curve,
Evans Creek to Applegate River
U.S. Army Engineers District,
Portland
1976
NPP
at Grants Pass Gage
DISCHARGE – 1,000 FT³/S
DAMAGE – DOLLARS
(1975 Price Levels and Development)
10,000
100,000
1,000,000
5,000,000
10,000,000
20,000,000
60
80
100
120
140
160
180
200
220
240
260
280
1953
1955
1964

Plate 4–19

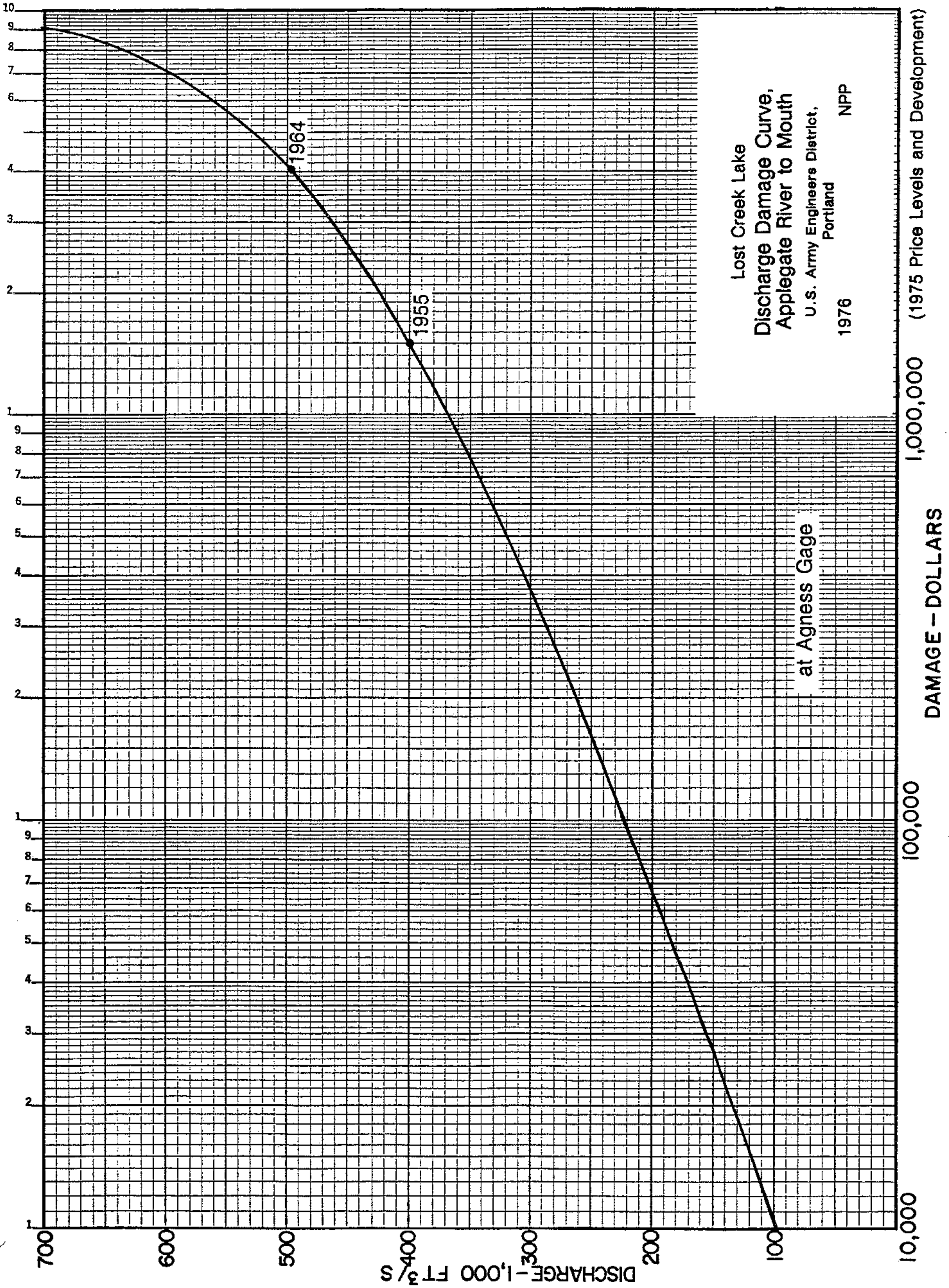
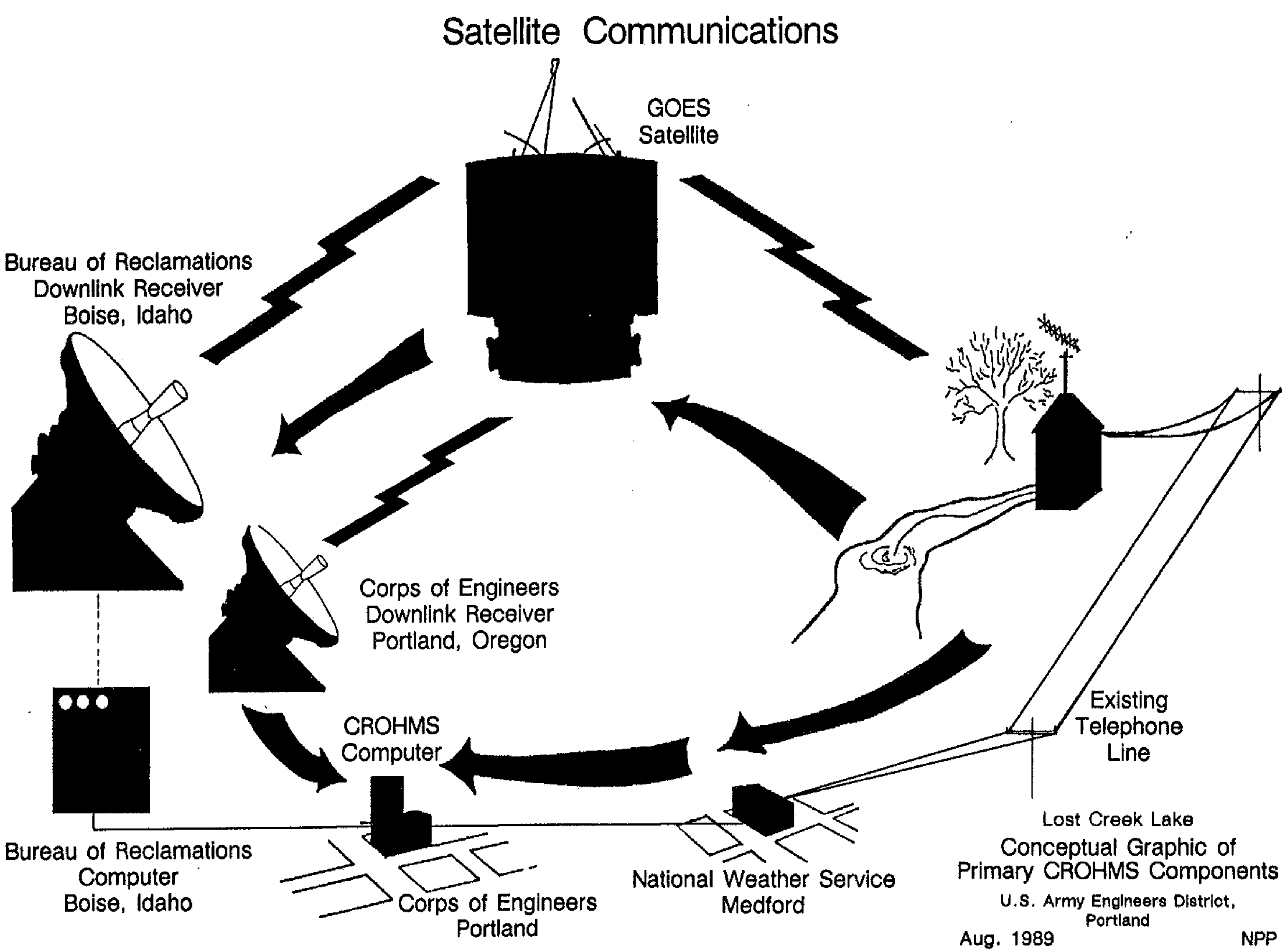
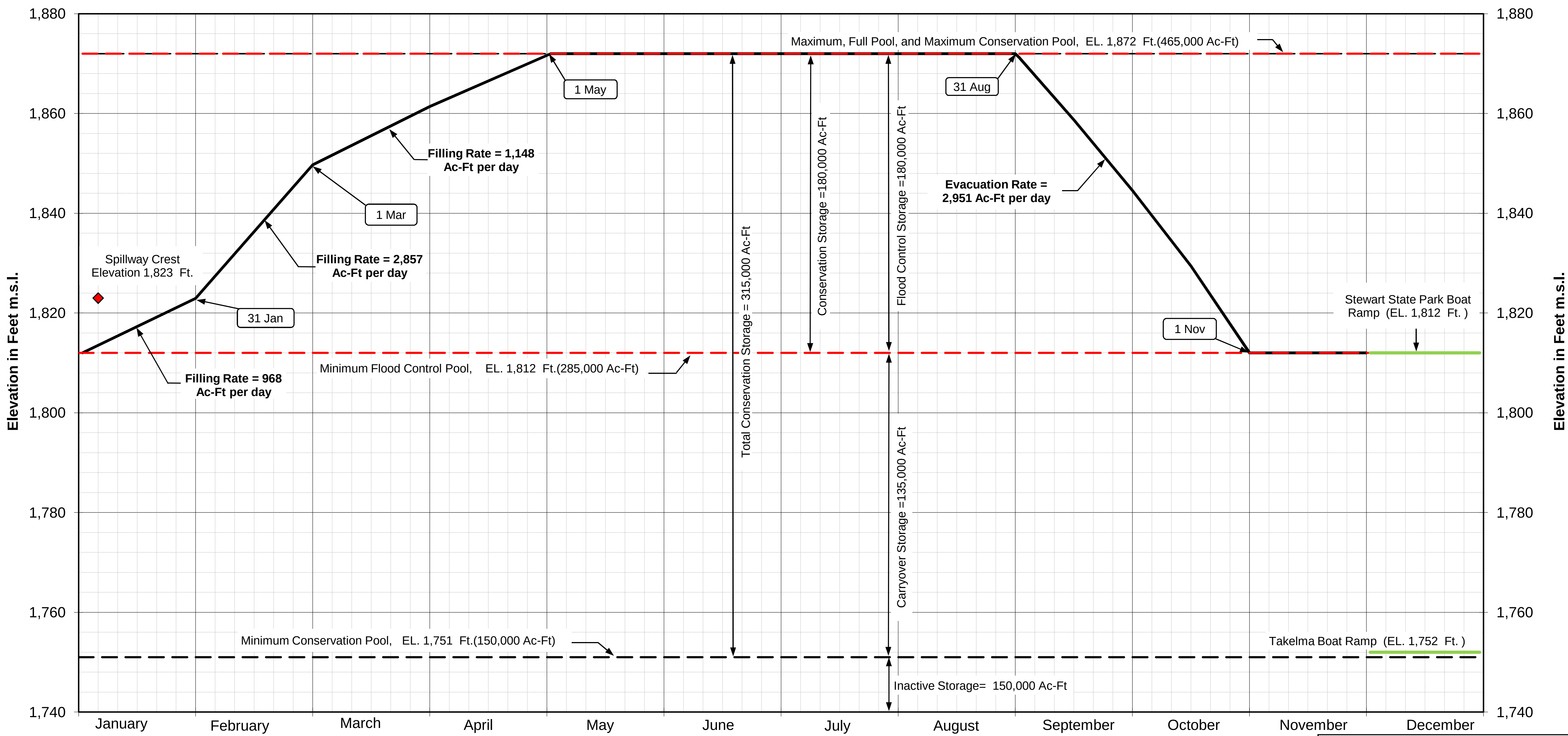

Lost Creek Lake
Discharge Damage Curve,
Applegate River to Mouth
at Agness Gage
U.S. Army Engineers District,
Portland
1976
NPP
(1975 Price Levels and Development)
1964
1955
DAMAGE – DOLLARS
10,000
100,000
1,000,000
DISCHARGE – 1,000 FT³/S
700
600
500
400
300
200
100

Plate 4–20



Conceptual Graphic of Primary CROHMS Components
U.S. Army Engineers District, Portland
Aug. 1989 NPP

Plate 5-1



Notes:
Pool elevations and corrsponding storage applicable at 2400 hours.

Lost Creek Project

Scheduled Water Control Diagram

U.S. Army Corps of Engineers
Portland District January 2013

Created by CENWP-EC-HR

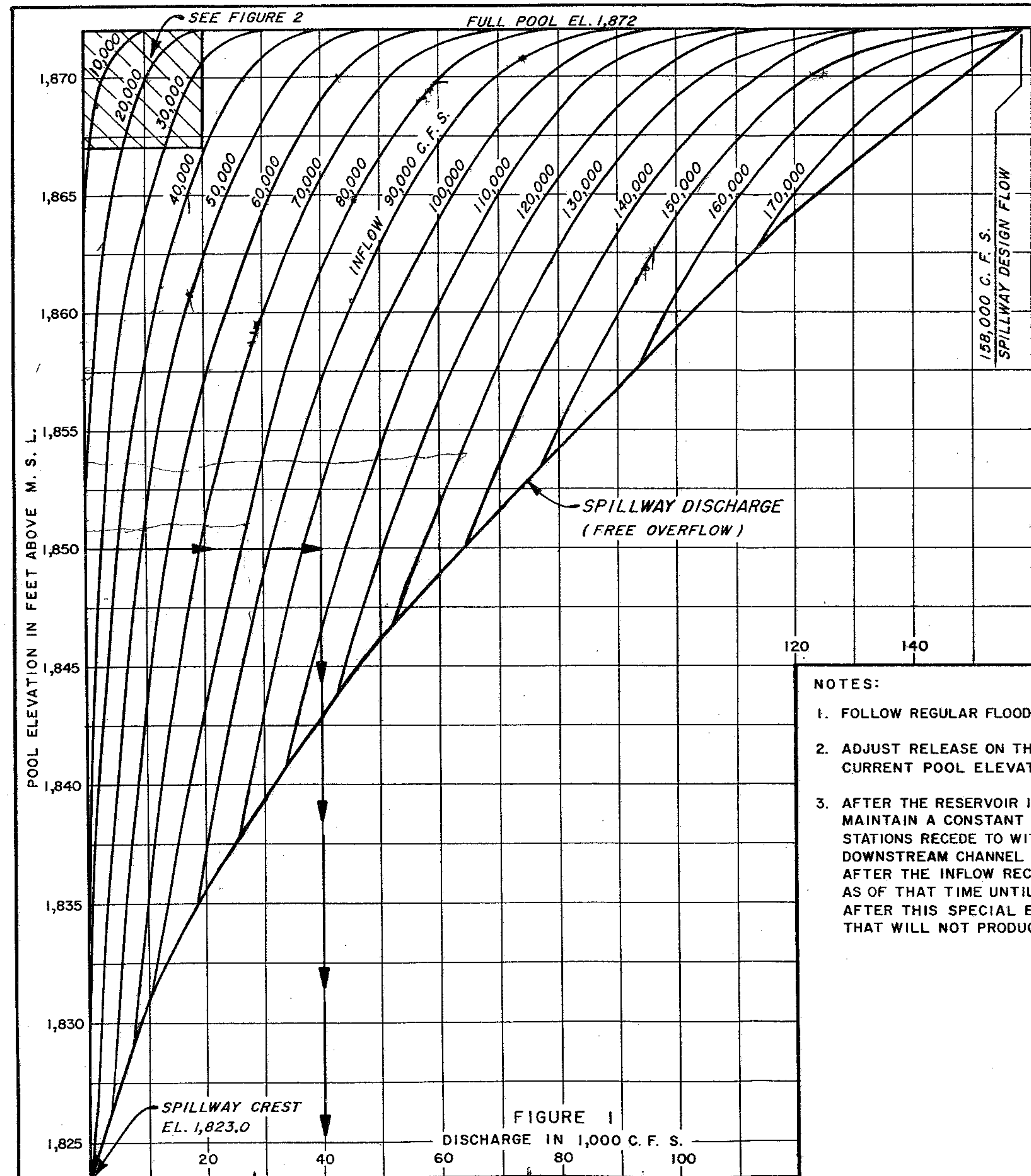


FIGURE 1

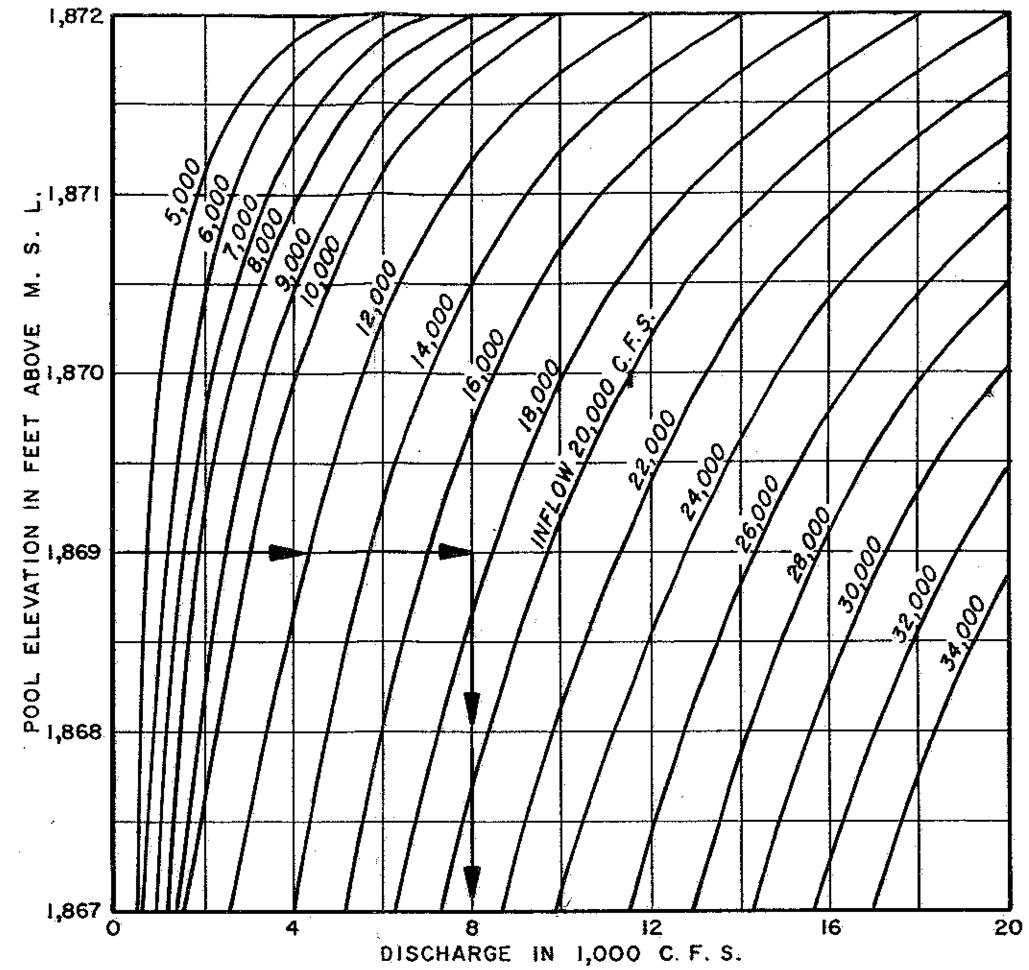


FIGURE 2

NOTES:

1. FOLLOW REGULAR FLOOD CONTROL REGULATION UNTIL LARGER RELEASES ARE INDICATED BY THIS CHART.

2. ADJUST RELEASE ON THE BASIS OF THE AVERAGE HOURLY INFLOW FOR THE PRECEDING TWO HOURS AND THE CURRENT POOL ELEVATION AS INDICATED ON THIS CHART.

3. AFTER THE RESERVOIR INFLOW RECEDES TO LESS THAN THE OUTFLOW, THE NORMAL OPERATION WILL BE TO MAINTAIN A CONSTANT POOL, PASSING ONLY THE INFLOW UNTIL THE RIVER STAGE AT KEY DOWNSTREAM STATIONS RECEDE TO WITHIN THEIR BANKS. EVACUATION OF FLOOD WATERS WILL NOT BE FASTER THAN DOWNSTREAM CHANNEL CAPACITIES WILL PERMIT. HOWEVER, SHOULD A FLOOD POTENTIAL STILL EXIST AFTER THE INFLOW RECEDES TO LESS THAN OUTFLOW, THE PROCEDURE WILL BE TO MAINTAIN THE OUTFLOW AS OF THAT TIME UNTIL 5-PERCENT OF THE FLOOD CONTROL STORAGE RESERVATION HAS BEEN RESTORED. AFTER THIS SPECIAL EVACUATION HAS BEEN EFFECTED THE RELEASE SHOULD BE REDUCED TO AN AMOUNT THAT WILL NOT PRODUCE OVERBANK STAGES DOWNSTREAM FROM THE PROJECT.

Lost Creek Lake

Special Flood Regulation Schedule

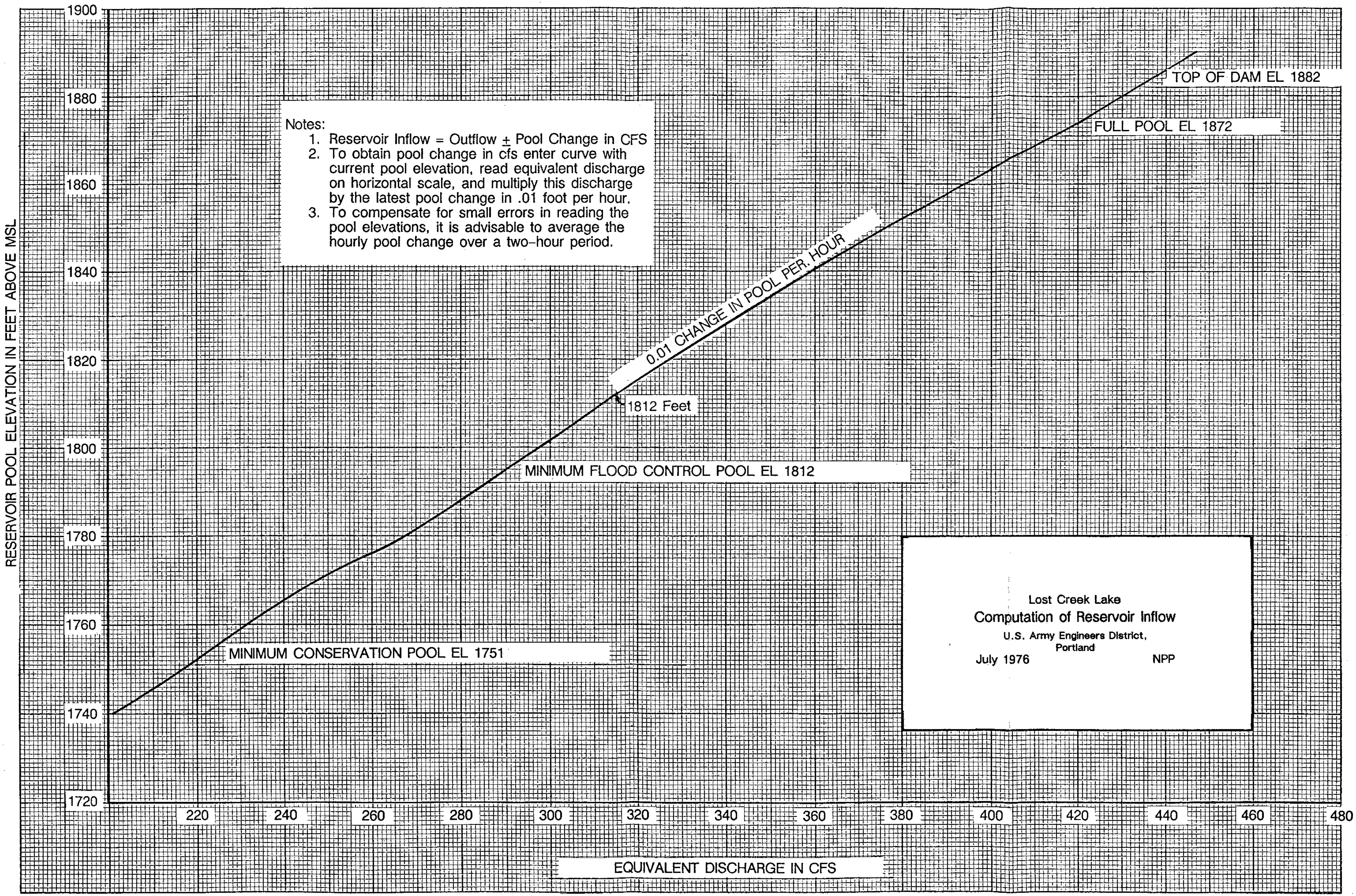
U.S. Army Engineers District, Portland

REVISED FEB. 1983

NPP

8175-85

Plate 7–2



Notes:
1. Reservoir Inflow = Outflow ± Pool Change in CFS
2. To obtain pool change in cfs enter curve with current pool elevation, read equivalent discharge on horizontal scale, and multiply this discharge by the latest pool change in .01 foot per hour.
3. To compensate for small errors in reading the pool elevations, it is advisable to average the hourly pool change over a two-hour period.
TOP OF DAM EL 1882
FULL POOL EL 1872
0.01 CHANGE IN POOL PER. HOUR
1812 Feet
MINIMUM FLOOD CONTROL POOL EL 1812
MINIMUM CONSERVATION POOL EL 1751
RESERVOIR POOL ELEVATION IN FEET ABOVE MSL
1900
1880
1860
1840
1820
1800
1780
1760
1740
1720
220
240
260
280
300
320
340
360
380
400
420
440
460
480
EQUIVALENT DISCHARGE IN CFS
Lost Creek Lake
Computation of Reservoir Inflow
U.S. Army Engineers District, Portland
July 1976
NPP

Plate 7-3

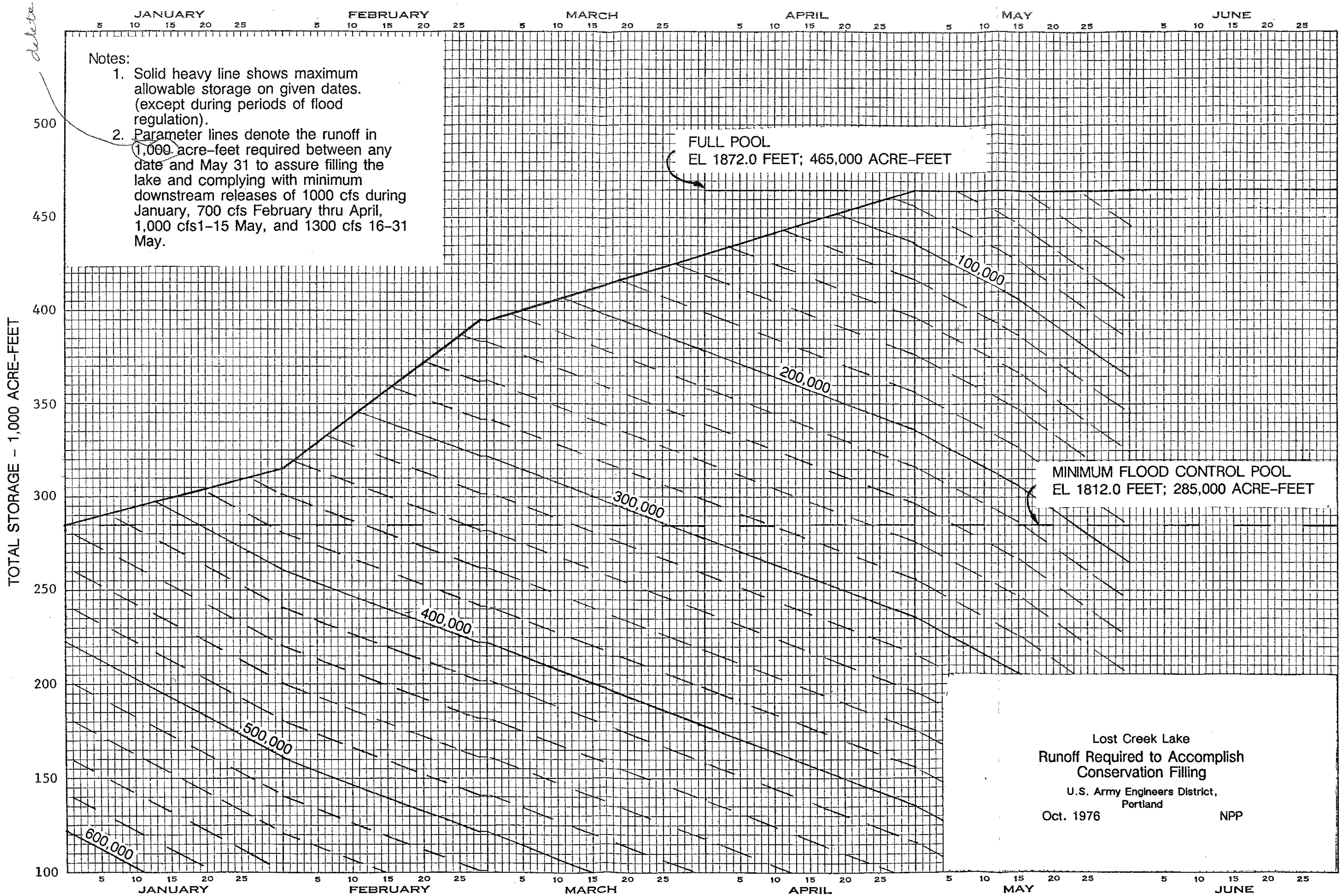
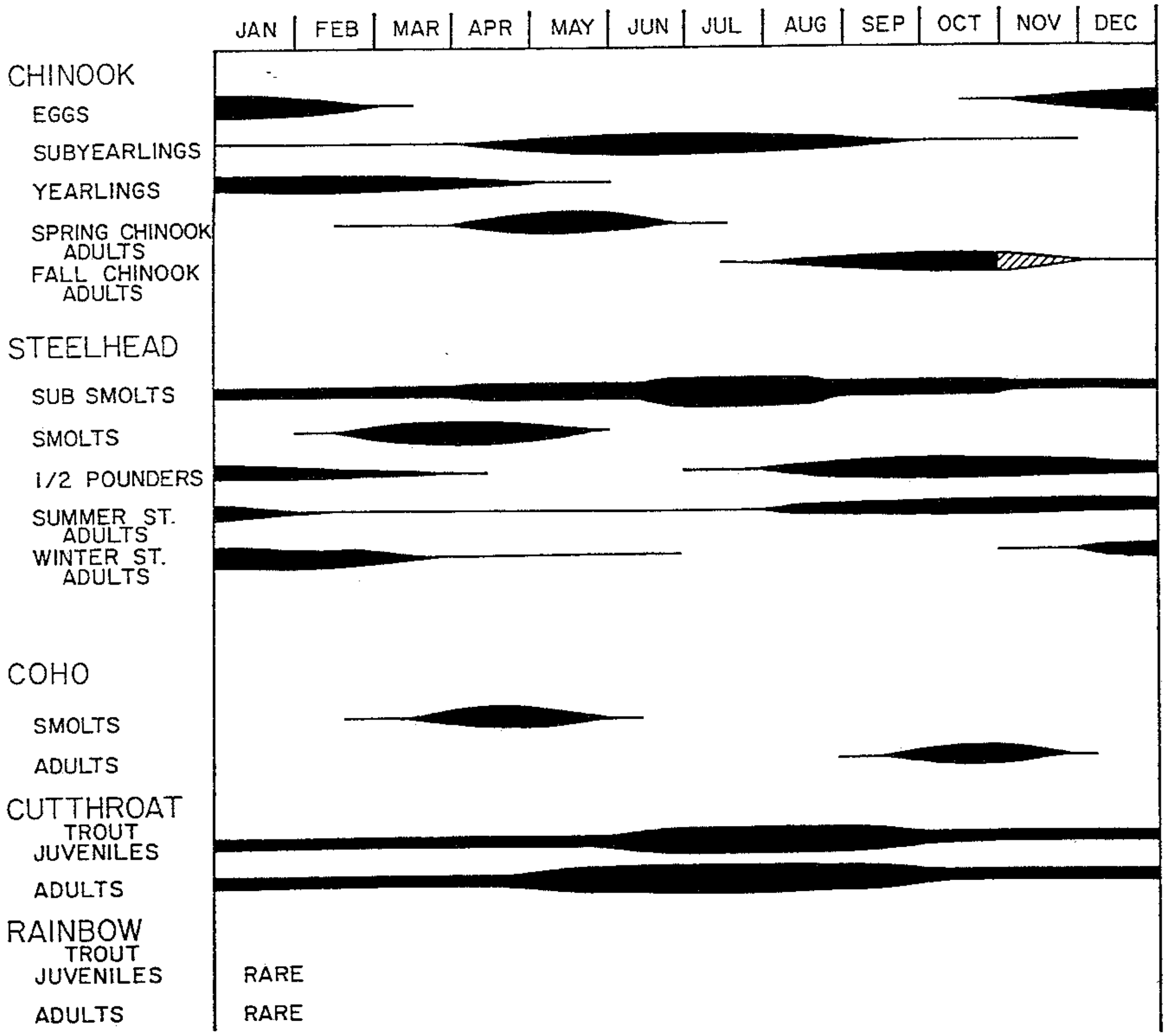

JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
Notes:
1. Solid heavy line shows maximum allowable storage on given dates. (except during periods of flood regulation).
2. Parameter lines denote the runoff in 1,000 acre-feet required between any date and May 31 to assure filling the lake and complying with minimum downstream releases of 1000 cfs during January, 700 cfs February thru April, 1,000 cfs1-15 May, and 1300 cfs 16-31 May.
delete
FULL POOL
EL 1872.0 FEET; 465,000 ACRE-FEET
100,000
200,000
300,000
400,000
500,000
600,000
MINIMUM FLOOD CONTROL POOL
EL 1812.0 FEET; 285,000 ACRE-FEET
TOTAL STORAGE - 1,000 ACRE-FEET
Lost Creek Lake
Runoff Required to Accomplish Conservation Filling
U.S. Army Engineers District, Portland
Oct. 1976
NPP

Plate 7-4

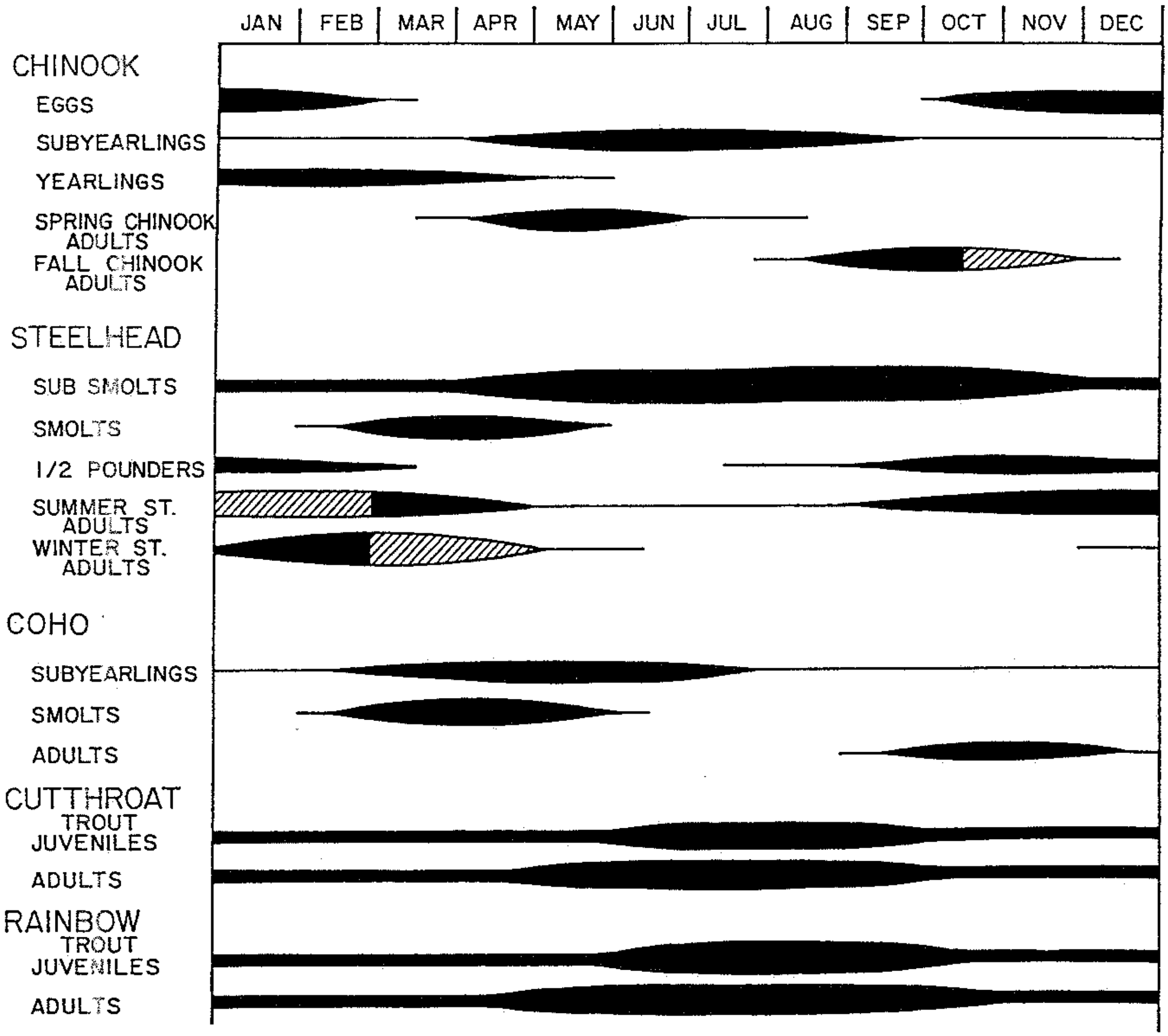
Abundance of each life stage of Salmonids relative to time of year in the Rogue River from Grave Creek to the mouth (KM 110-0, MI 68-0), ▨ = Spawning Fish



Lost Creek Lake
Salmonid Population
Rogue River Miles 0-68
U.S. Army Engineers District, Portland
Source: ODFW & NPP

Plate 7-5a

Abundance of each life stage of Salmonids relative to time of year in the Rogue River from Gold Ray Dam to Grave Creek (KM 202-110, MI 125-68), [hatched] = Spawning Fish

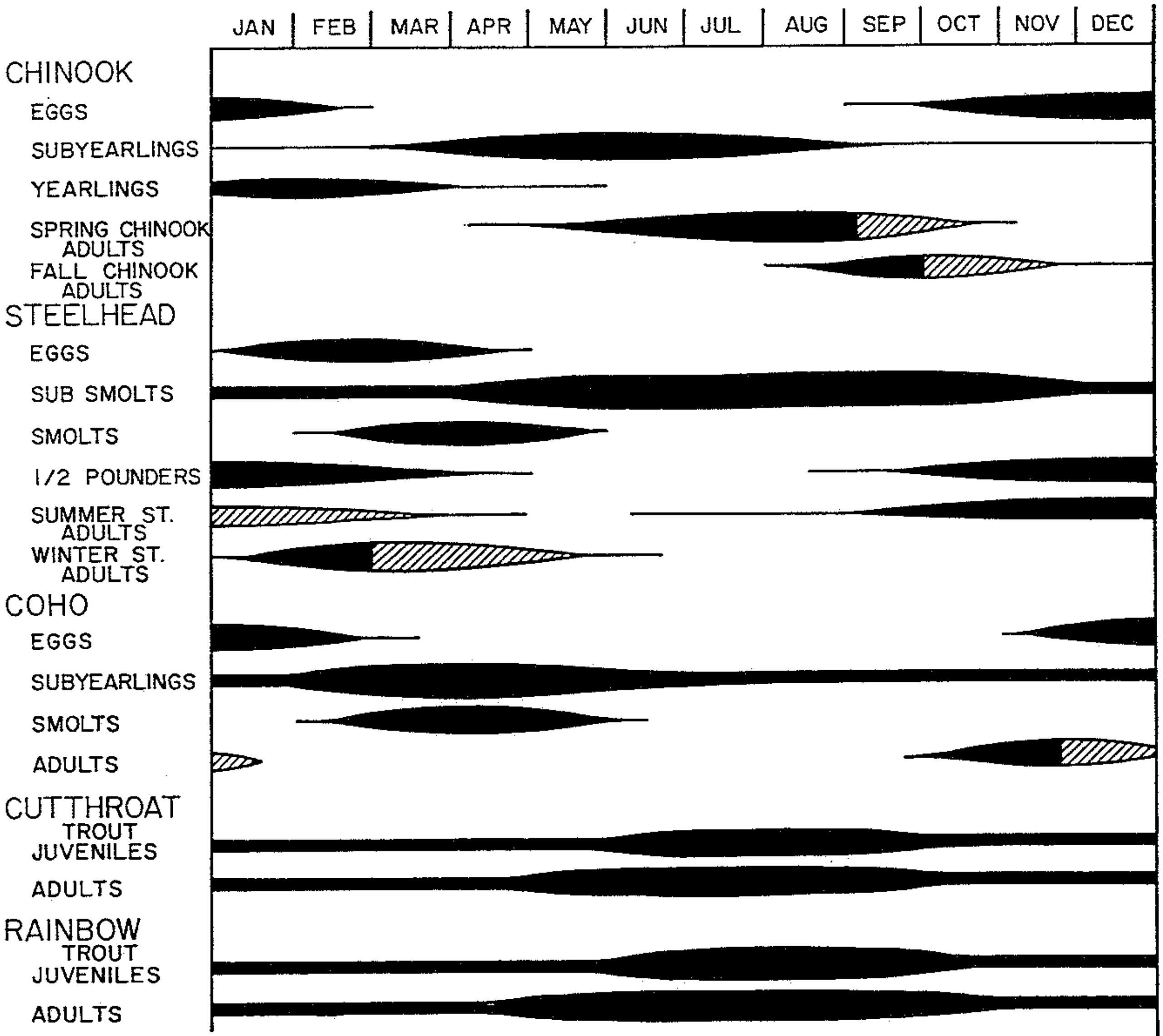


Lost Creek Lake
Salmonid Population
Rogue River Miles 68-125

U.S. Army Engineers District, Portland
Source: ODFW & NPP

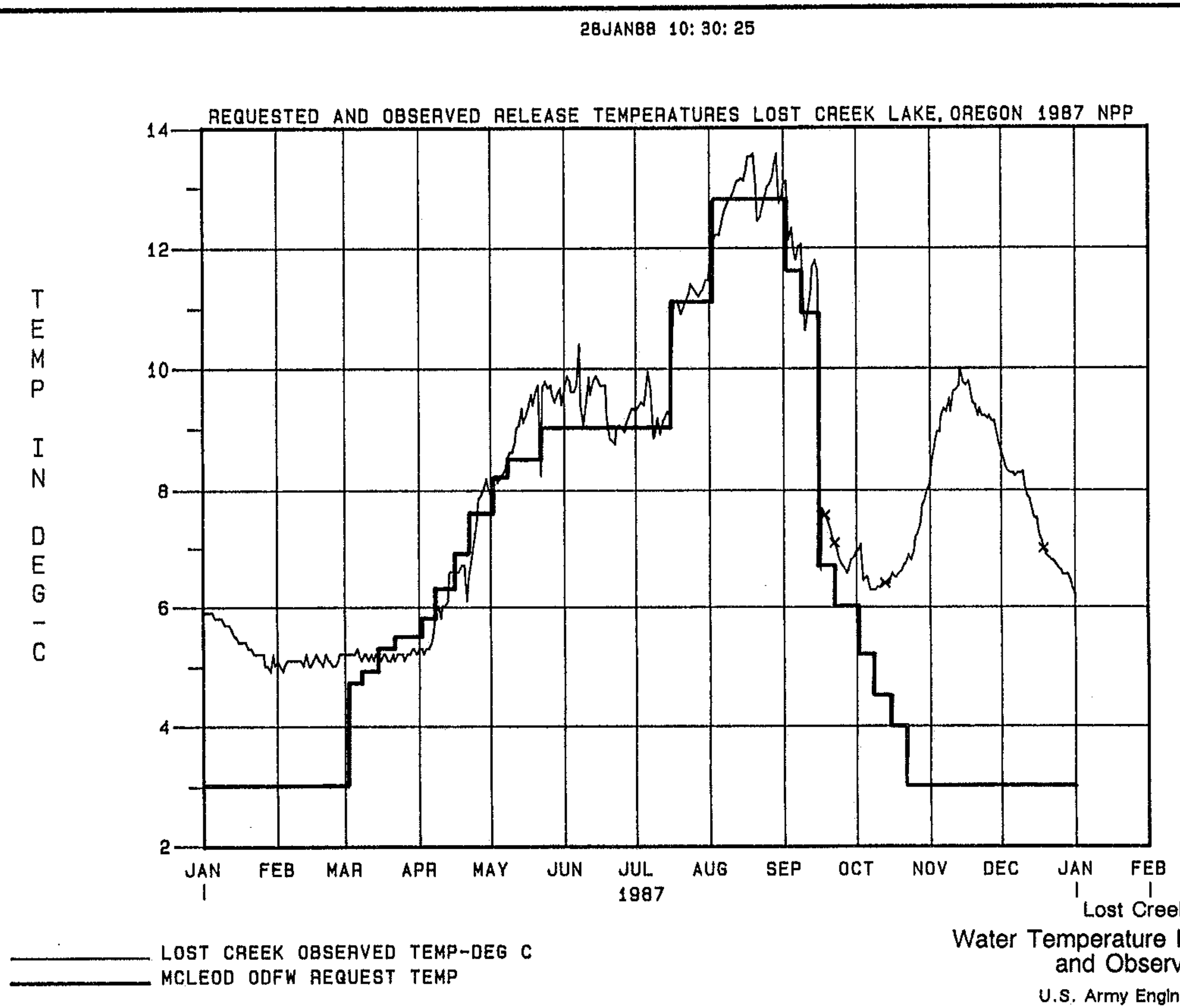
Plate 7-5b

Abundance of each life stage of Salmonids relative to time of year in the Rogue River from Cole Rivers Hatchery to Gold Ray Dam (KM 1253-202, MI 157-125),
▨ = Spawning Fish



Lost Creek Lake
Salmonid Population
Rogue River Miles 125-157
U.S. Army Engineers District, Portland
Source: ODFW & NPP

Plate 7-5c



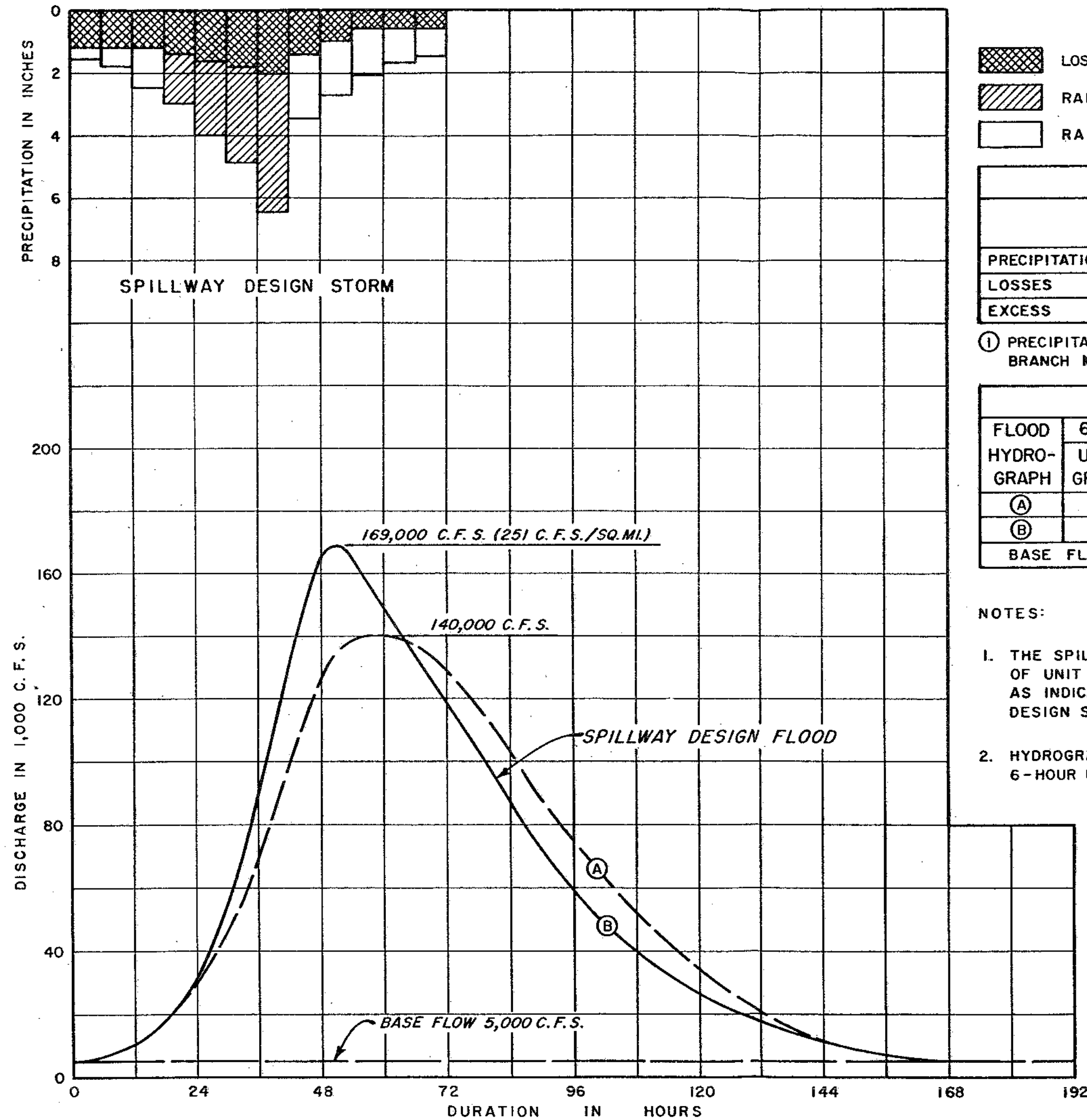
Lost Creek Lake

Water Temperature Release Schedule and Observed Data

U.S. Army Engineers District, Portland

1987 NPP

Plate 7–6



LEGEND

- LOSSES (INFILTRATION, TRANSPIRATION, EVAPORATION, SURFACE DETENTION, ETC.)
- RAINFALL EXCESS USED WITH UNIT HYDROGRAPHS (a) AND (b)
- RAINFALL EXCESS USED WITH UNIT HYDROGRAPH (a)

PRECIPITATION DATA IN 6-HOUR PERIODS

	DAYS												TOTAL
	1				2				3				
PRECIPITATION (1)	1.55	1.80	2.45	2.97	4.00	4.89	6.45	3.41	2.70	2.01	1.66	1.42	35.31
LOSSES	1.20	1.20	1.20	1.40	1.60	1.80	2.00	1.40	1.00	0.60	0.60	0.60	14.60
EXCESS	0.35	0.60	1.25	1.57	2.40	3.09	4.45	2.01	1.70	1.41	1.06	0.82	20.71

(1) PRECIPITATION FROM RAIN PLUS SNOWMELT USING HYDROMETEOROLOGICAL BRANCH METHOD OF APRIL 1965.

HYDROGRAPH DATA

FLOOD HYDRO-GRAPH	6-HOUR HYDROGRAPH			FLOOD PEAK DISCHARGE			RUNOFF	
	UNIT GRAPH	PEAK DISCHARGE						
		C. F. S.	% OF (a)	C. F. S.	C.F.S./SQ. MI.	% OF (A)	INCHES	ACRE-FEET
(A)	(a)	10,600	100	140,000	208	100	20.71	744,400
(B)	(b)	16,500	156	169,000	251	121	20.71	744,400
BASE FLOW 7.25 DAYS AT 5,000 C. F. S.							2.02	72,600

NOTES:

1. THE SPILLWAY DESIGN FLOOD (B) WAS OBTAINED BY THE APPLICATION OF UNIT HYDROGRAPHS (a) AND (b) TO THE PRECIPITATION EXCESSES AS INDICATED BY THE LEGEND AND CROSS-HATCHING ON THE SPILLWAY DESIGN STORM BAR GRAPH.
2. HYDROGRAPH (A) WAS DERIVED BY THE APPLICATION OF THE NORMAL 6-HOUR UNIT HYDROGRAPH ORDINATES TO THE PRECIPITATION EXCESSES.

Lost Creek Lake

Spillway Design Flood

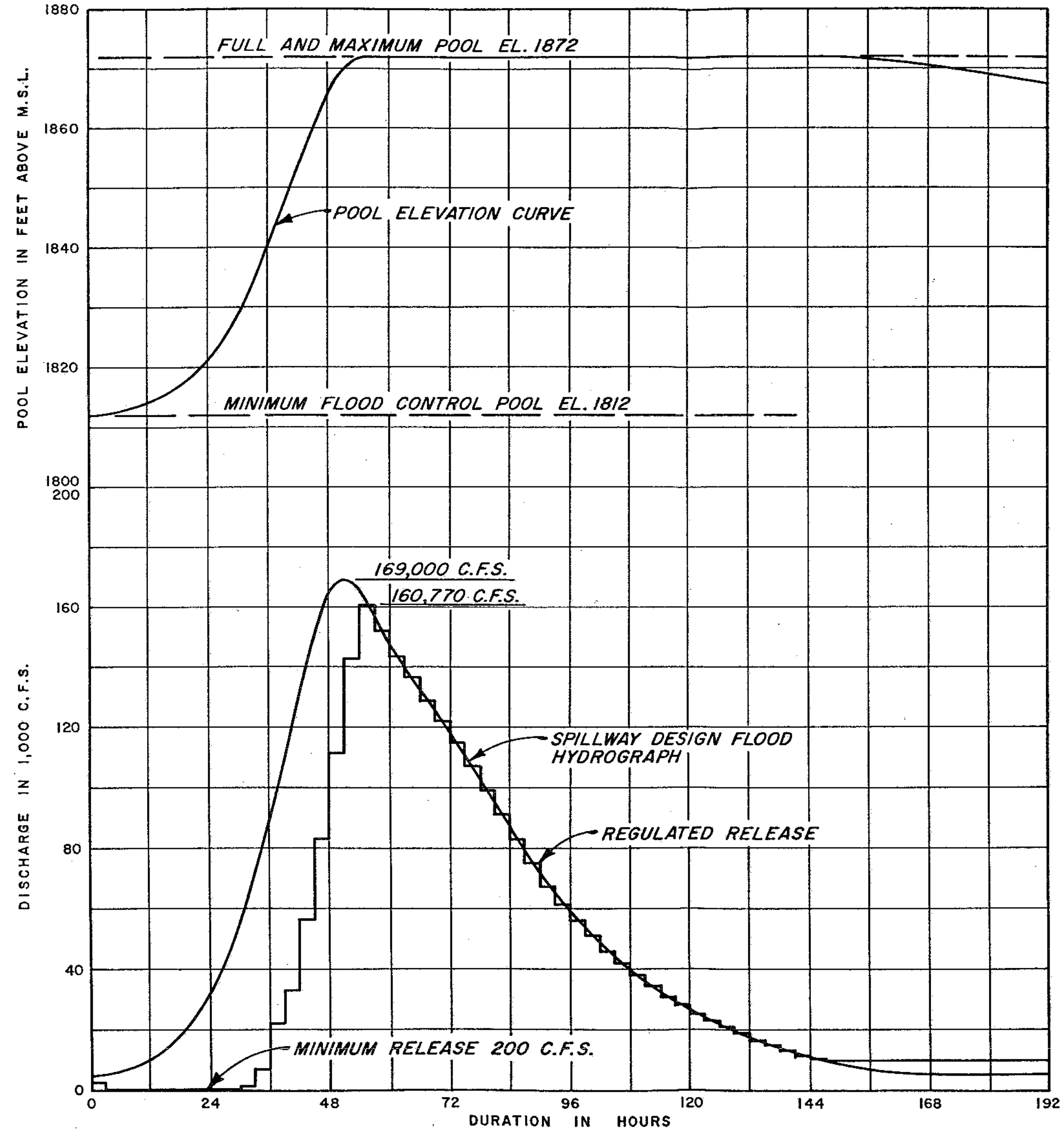
U.S. Army Engineers District, Portland

Nov. 1965 NPP

8175-65

RO-20-8/10

Plate 8-1



NOTES:

1. SPILLWAY DESIGN FLOOD ROUTING ASSUMING POOL ELEVATION AT MINIMUM FLOOD CONTROL POOL, ELEVATION 1812, AT BEGINNING OF FLOOD.
2. SPECIAL RESERVOIR REGULATION CURVES WERE USED IN ROUTING THE SPILLWAY DESIGN FLOOD THROUGH THE RESERVOIR.

Lost Creek Lake

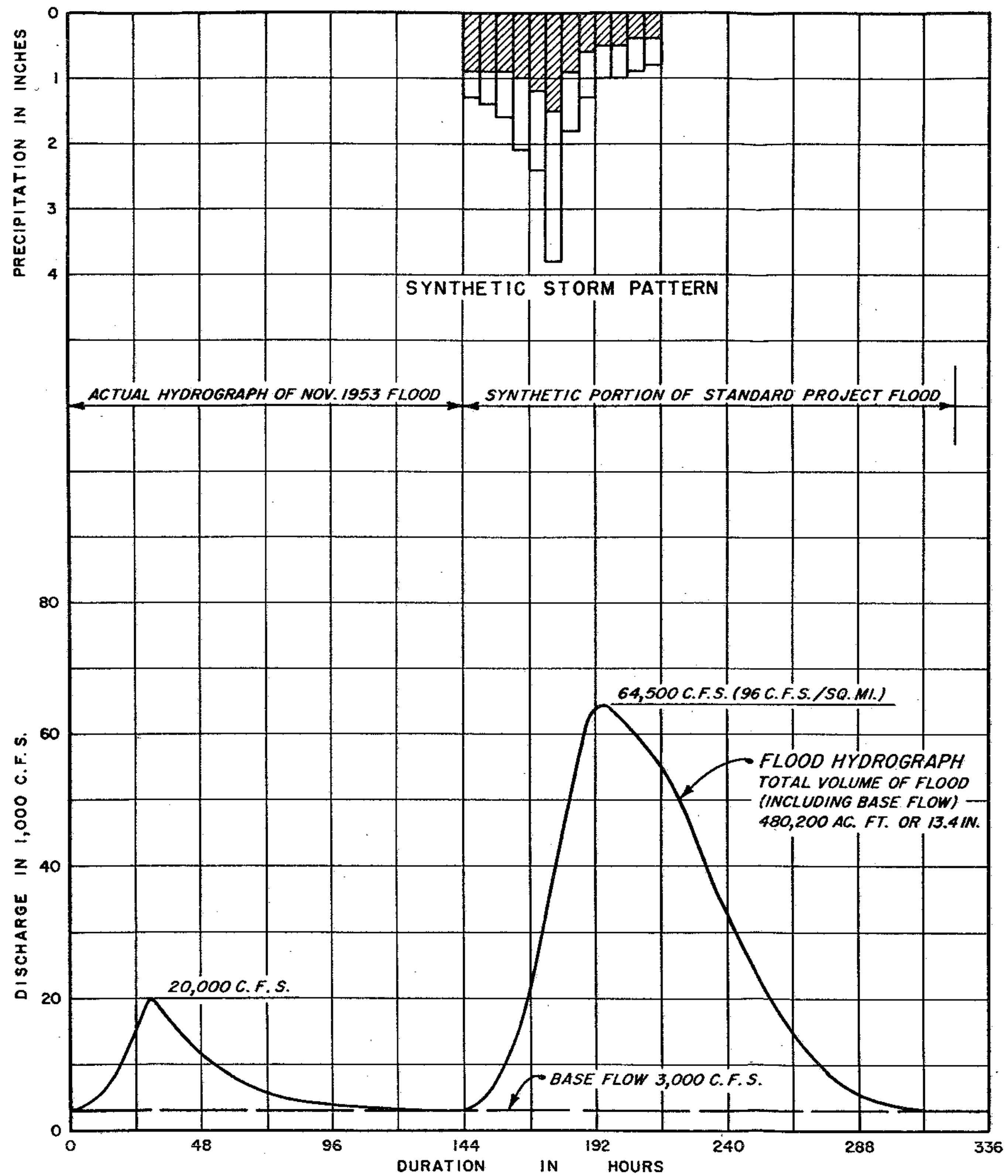
Spillway Design Flood Reservoir Routing

U.S. Army Engineers District, Portland

May 1971 NPP

LC-20-16/5

Plate 8-2



LEGEND

LOSSES (INFILTRATION, TRANSPIRATION, EVAPORATION; SURFACE DETENTION, ETC.)

WATER EXCESS

NOTES:

1. THE SYNTHETIC STORM PATTERN SHOWN ABOVE DEPICTS THE WATER EXCESS CONTRIBUTING TO THE FLOOD RUNOFF, AND NET SURFACE LOSSES.
2. THE SYNTHETIC PORTION OF THE STANDARD PROJECT FLOOD WAS COMPUTED BY THE APPLICATION OF THE NORMAL 6-HOUR UNIT HYDROGRAPH ORDINATES TO THE WATER EXCESSES SHOWN ABOVE.
3. SURFACE LOSSES AND WATER EXCESS ARE EXPRESSED IN TERMS OF THE ENTIRE BASIN EVEN THOUGH AT TIMES NOT ALL OF THE BASIN IS CONTRIBUTING TO THE RUNOFF.
4. THE STANDARD PROJECT FLOOD SERIES IS A COMPOSITE OF THE ACTUAL NOVEMBER 1953 FLOOD AND THE SYNTHETIC STANDARD PROJECT FLOOD.
5. THE NOVEMBER 1953 FLOOD PORTION OF THE STANDARD PROJECT FLOOD WAS DRAWN FROM MEAN DAILY VALUES AS PUBLISHED IN THE U. S. G. S. WATER SUPPLY PAPERS.

Lost Creek Lake

Standard Project Flood

U.S. Army Engineers District, Portland

Nov. 1965 NPP

8175-65

RO-20-8/12

Plate 8-3

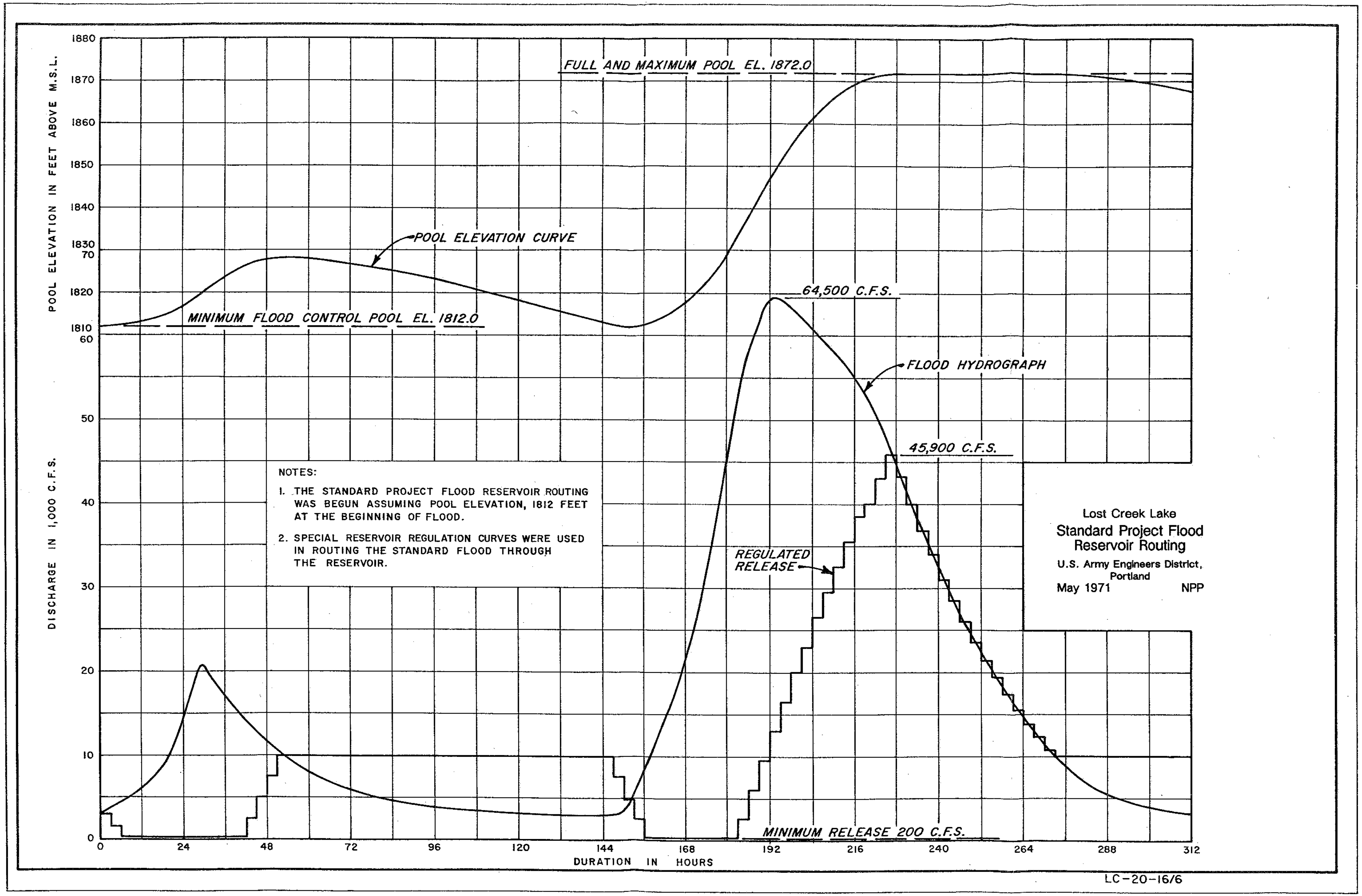
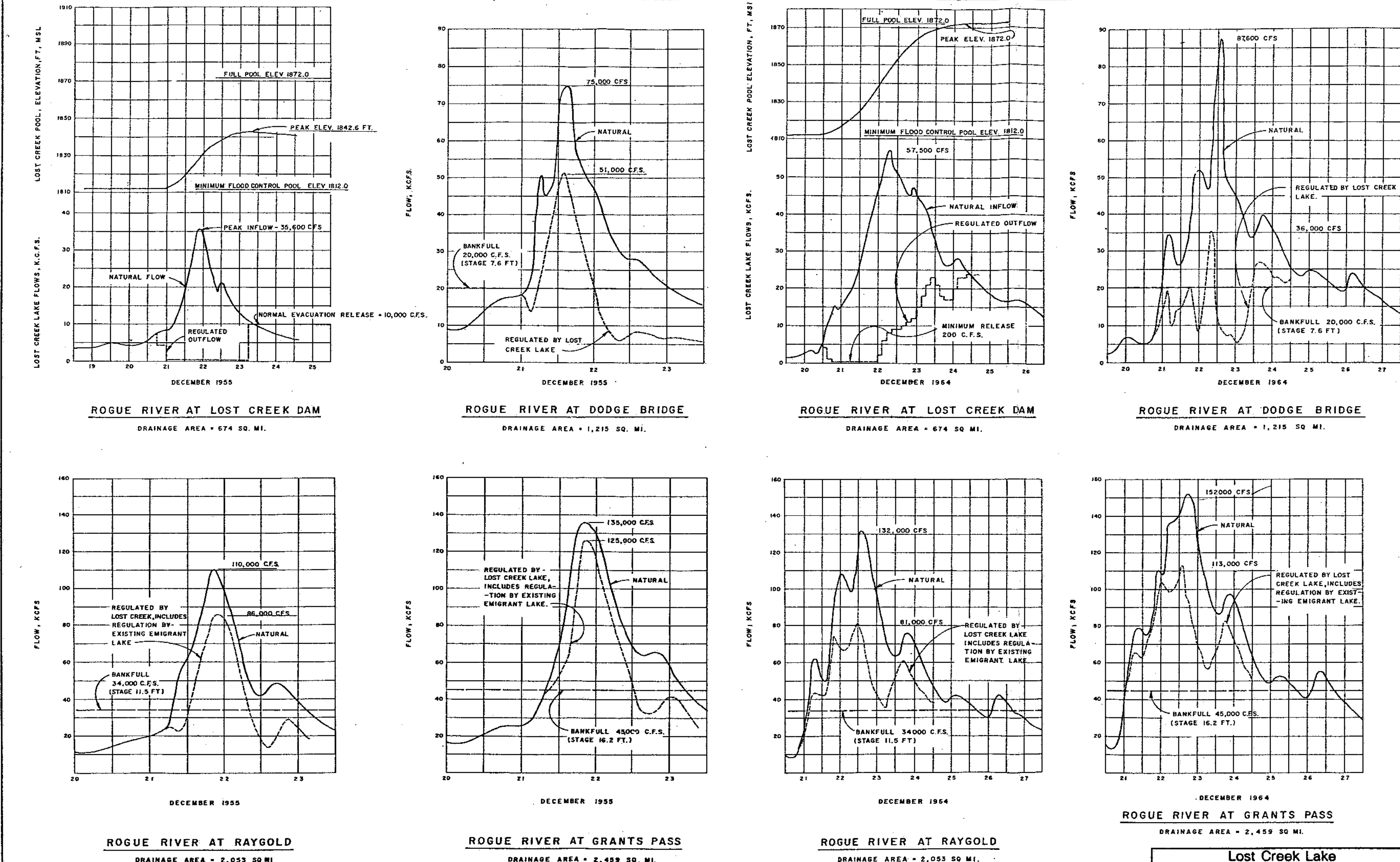

FULL AND MAXIMUM POOL EL. 1872.0
POOL ELEVATION CURVE
MINIMUM FLOOD CONTROL POOL EL. 1812.0
64,500 C.F.S.
FLOOD HYDROGRAPH
45,900 C.F.S.
REGULATED RELEASE
MINIMUM RELEASE 200 C.F.S.
POOL ELEVATION IN FEET ABOVE M.S.L.
DISCHARGE IN 1,000 C.F.S.
DURATION IN HOURS
NOTES:
1. THE STANDARD PROJECT FLOOD RESERVOIR ROUTING WAS BEGUN ASSUMING POOL ELEVATION, 1812 FEET AT THE BEGINNING OF FLOOD.
2. SPECIAL RESERVOIR REGULATION CURVES WERE USED IN ROUTING THE STANDARD FLOOD THROUGH THE RESERVOIR.
Lost Creek Lake
Standard Project Flood
Reservoir Routing
U.S. Army Engineers District, Portland
May 1971
NPP
LC-20-16/6

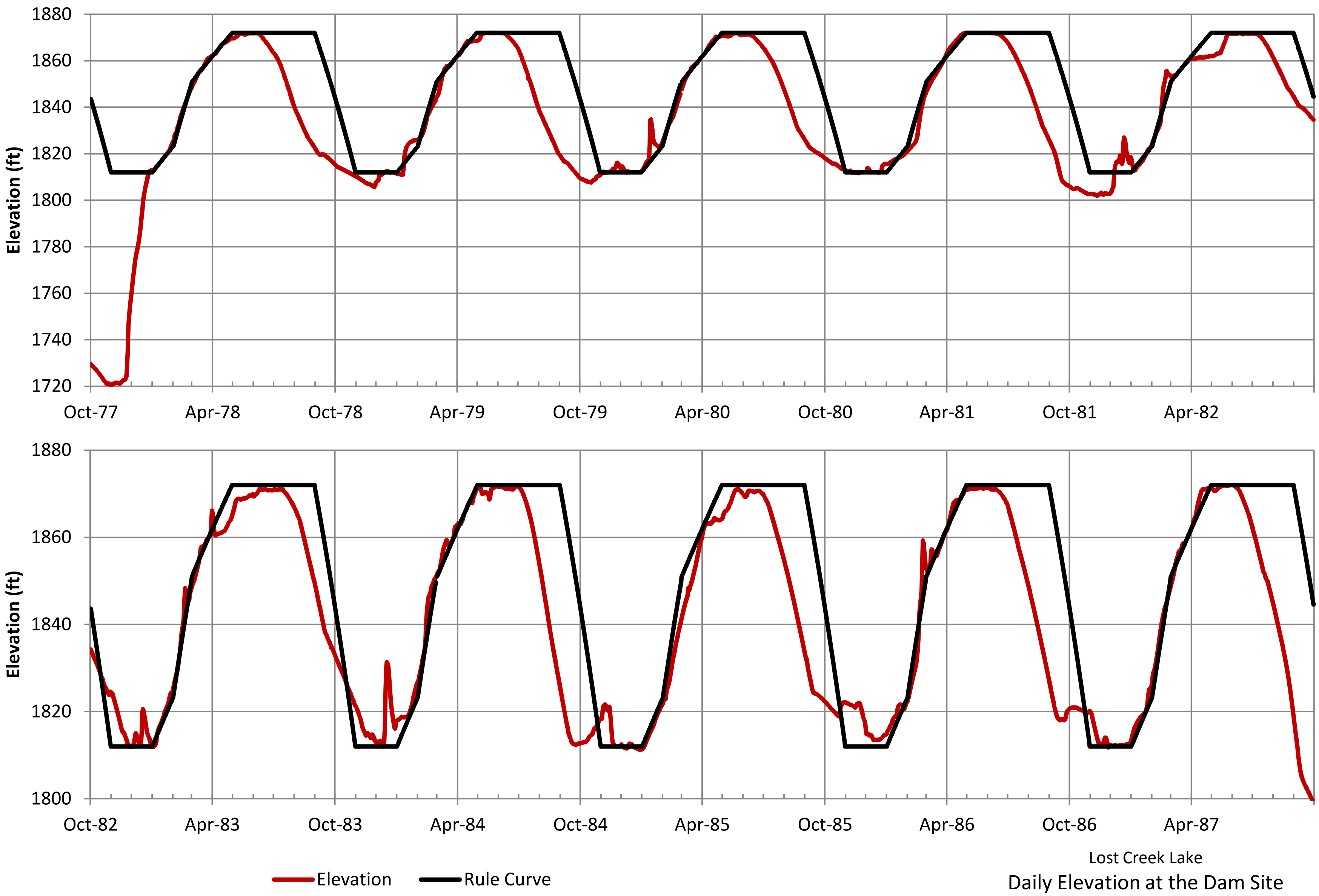
Plate 8–4



Lost Creek Lake
Flood Regulation Example
U.S. Army Engineers District, Portland
Aug. 1971 NPP

LC-20-28/1

Plate 8-5



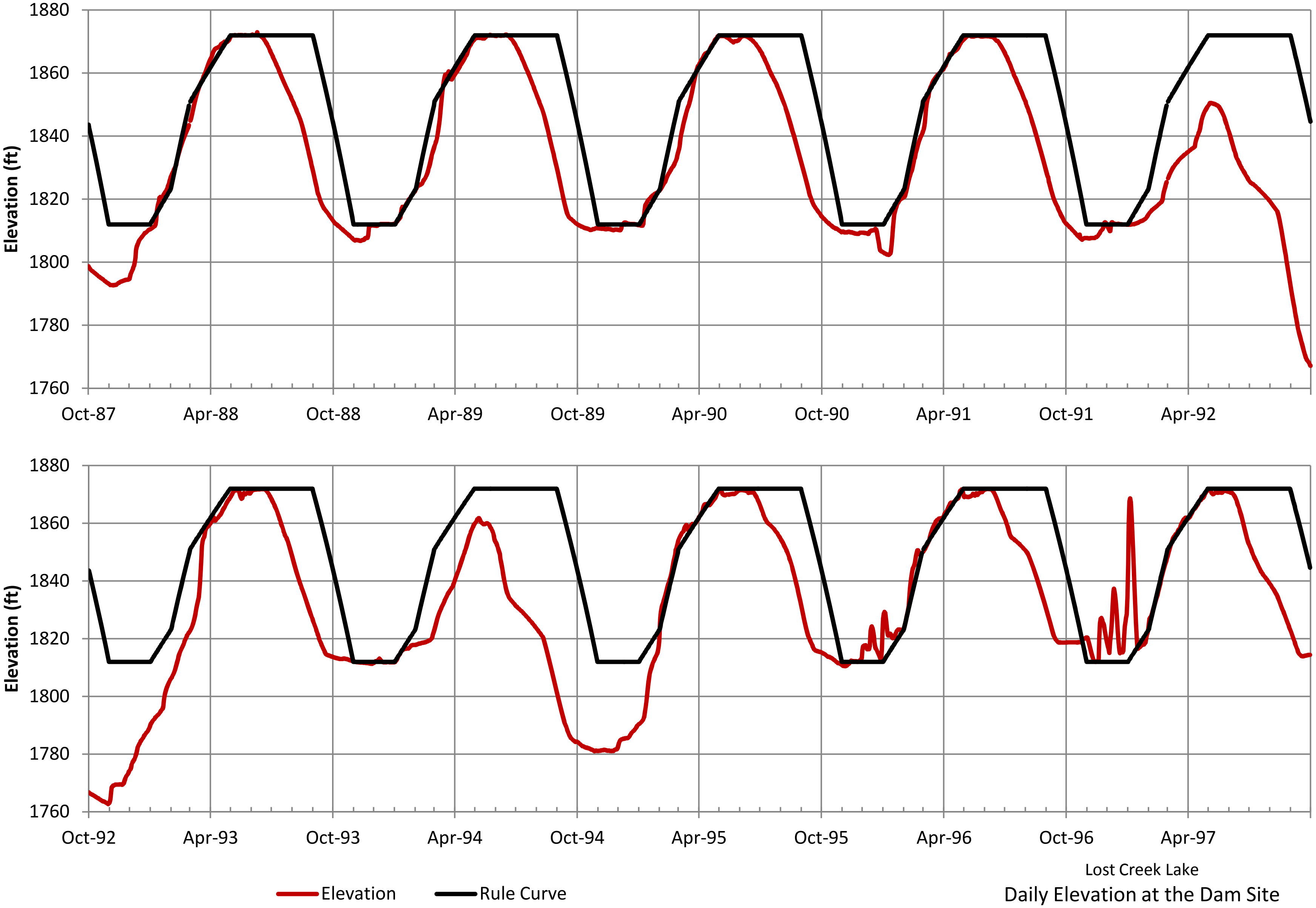
Lost Creek Lake

Daily Elevation at the Dam Site

Water Years 1978 - 1987

U.S. Army Corps of Engineers Portland District

Plate 8-6a

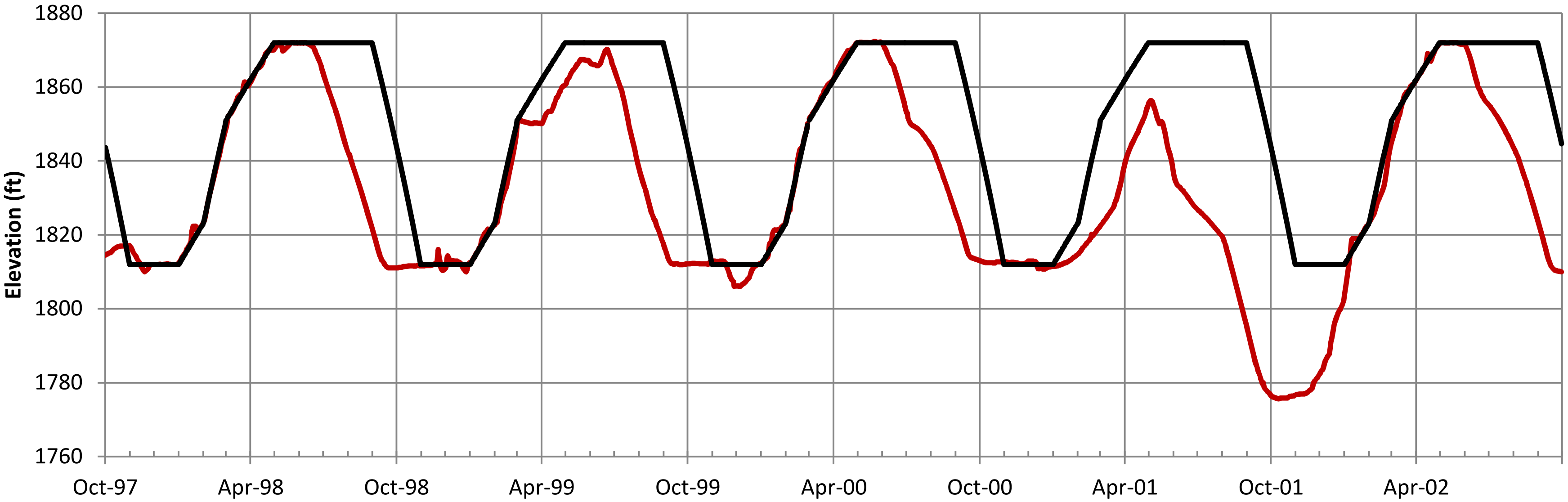


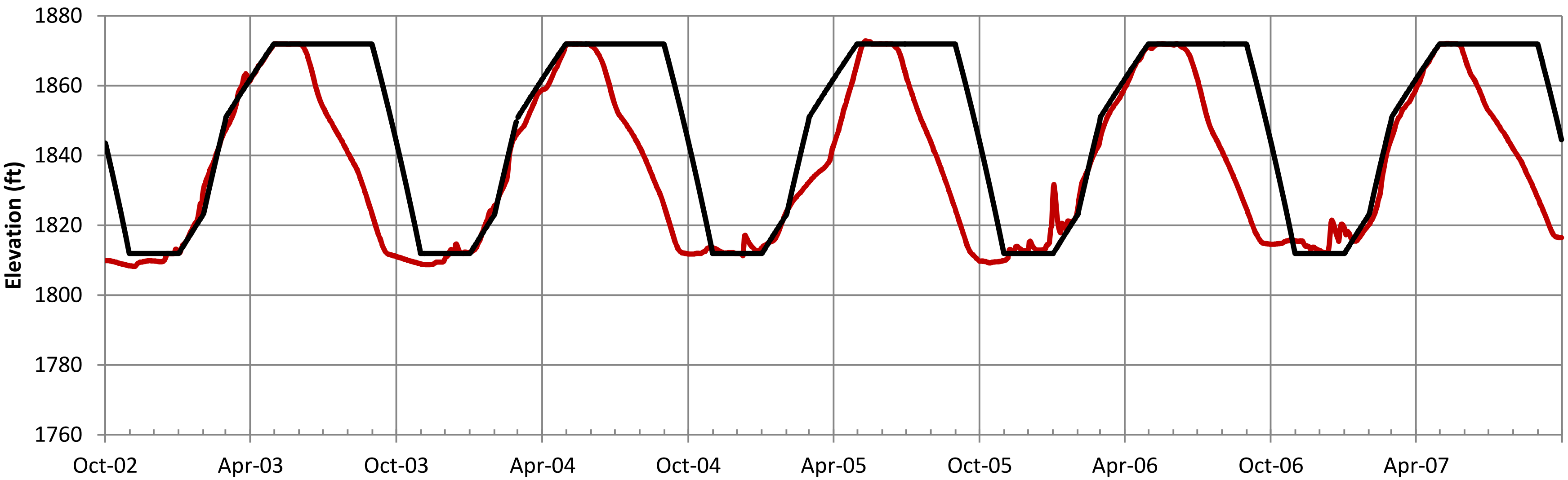
Lost Creek Lake

Daily Elevation at the Dam Site

Water Years 1988 - 1997

U.S. Army Corps of Engineers Portland District





Elevation Rule Curve

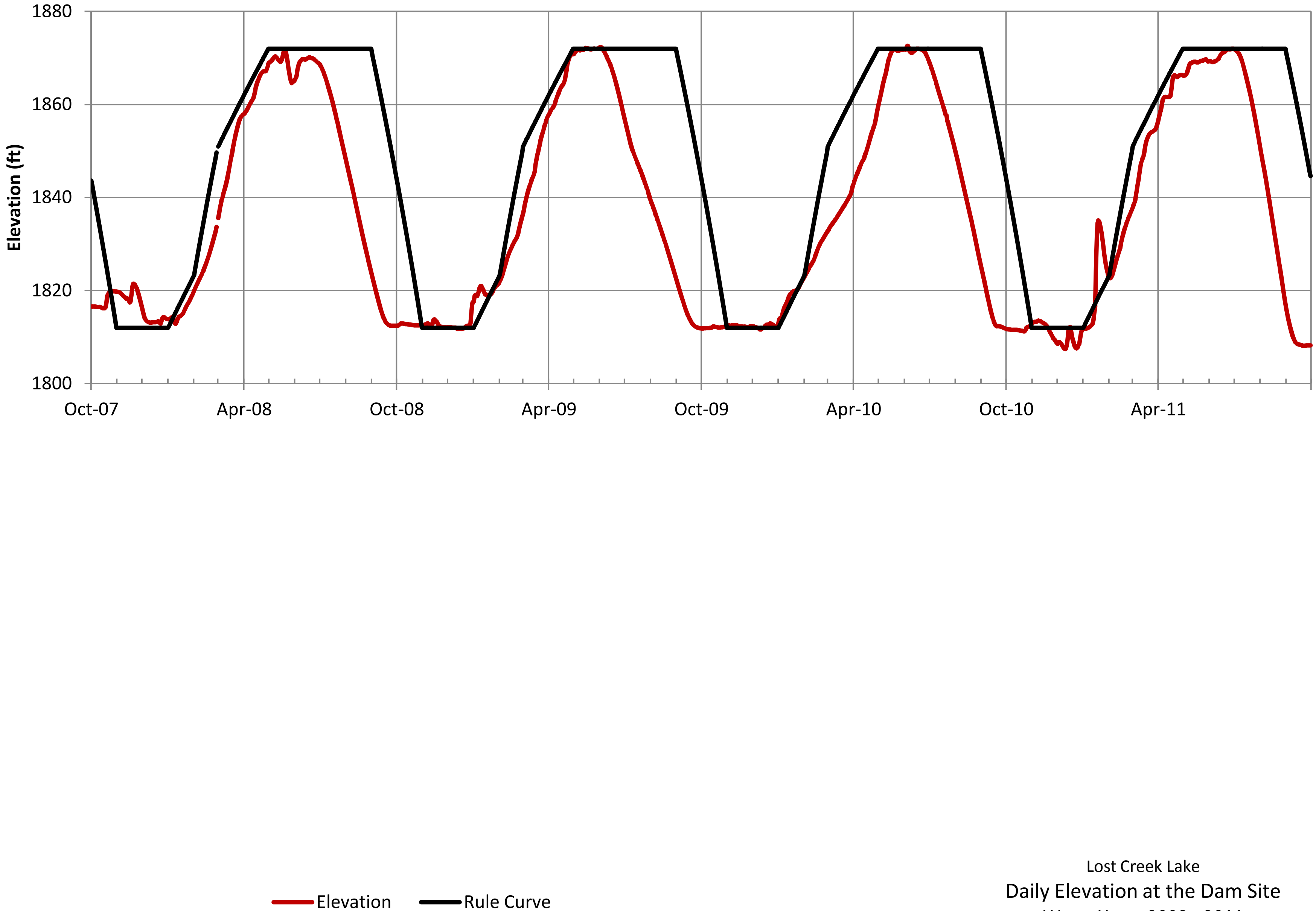
Lost Creek Lake

Daily Elevation at the Dam Site

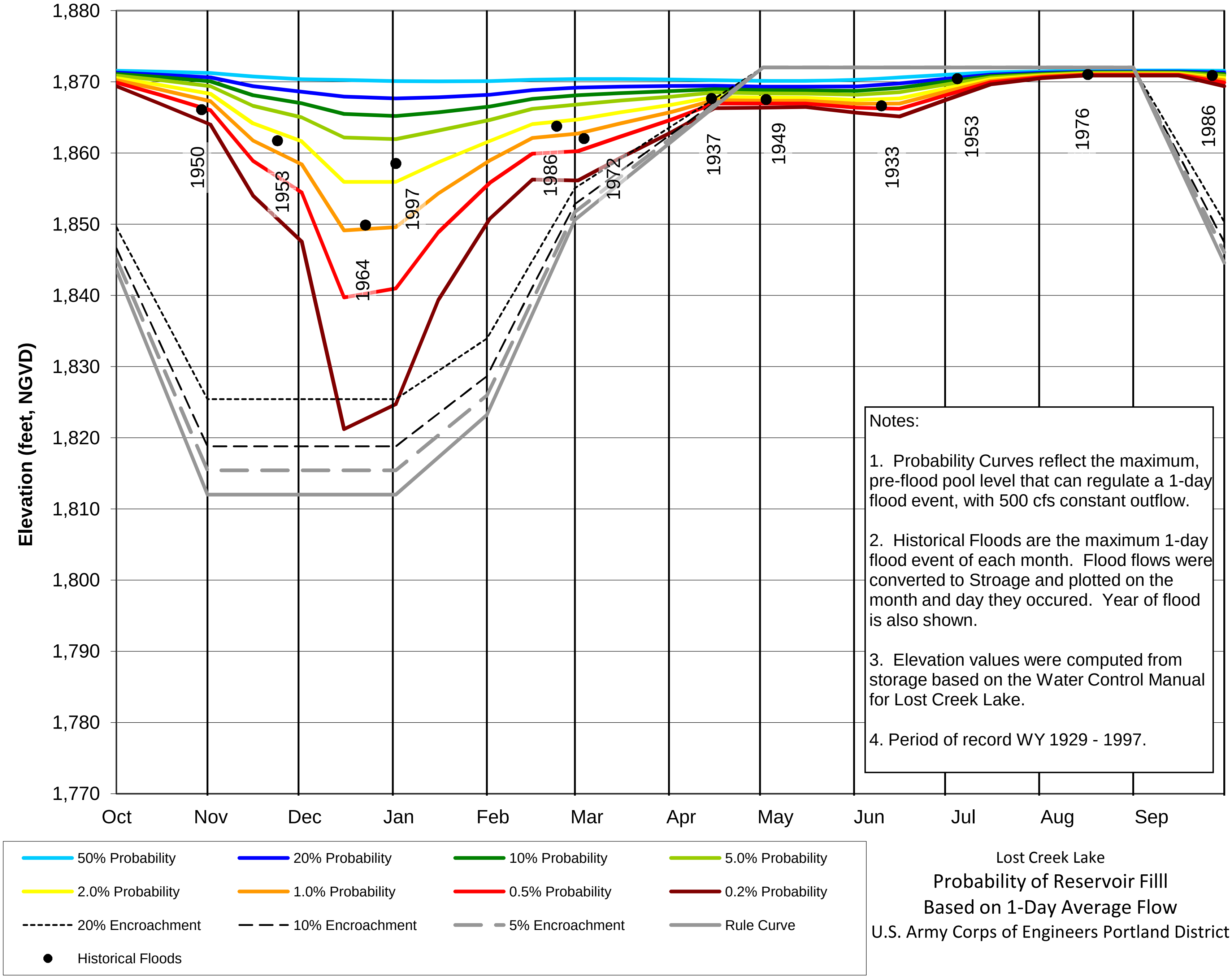
Water Years 1998 - 2007

U.S. Army Corps of Engineers Portland District

Plate 8-6c

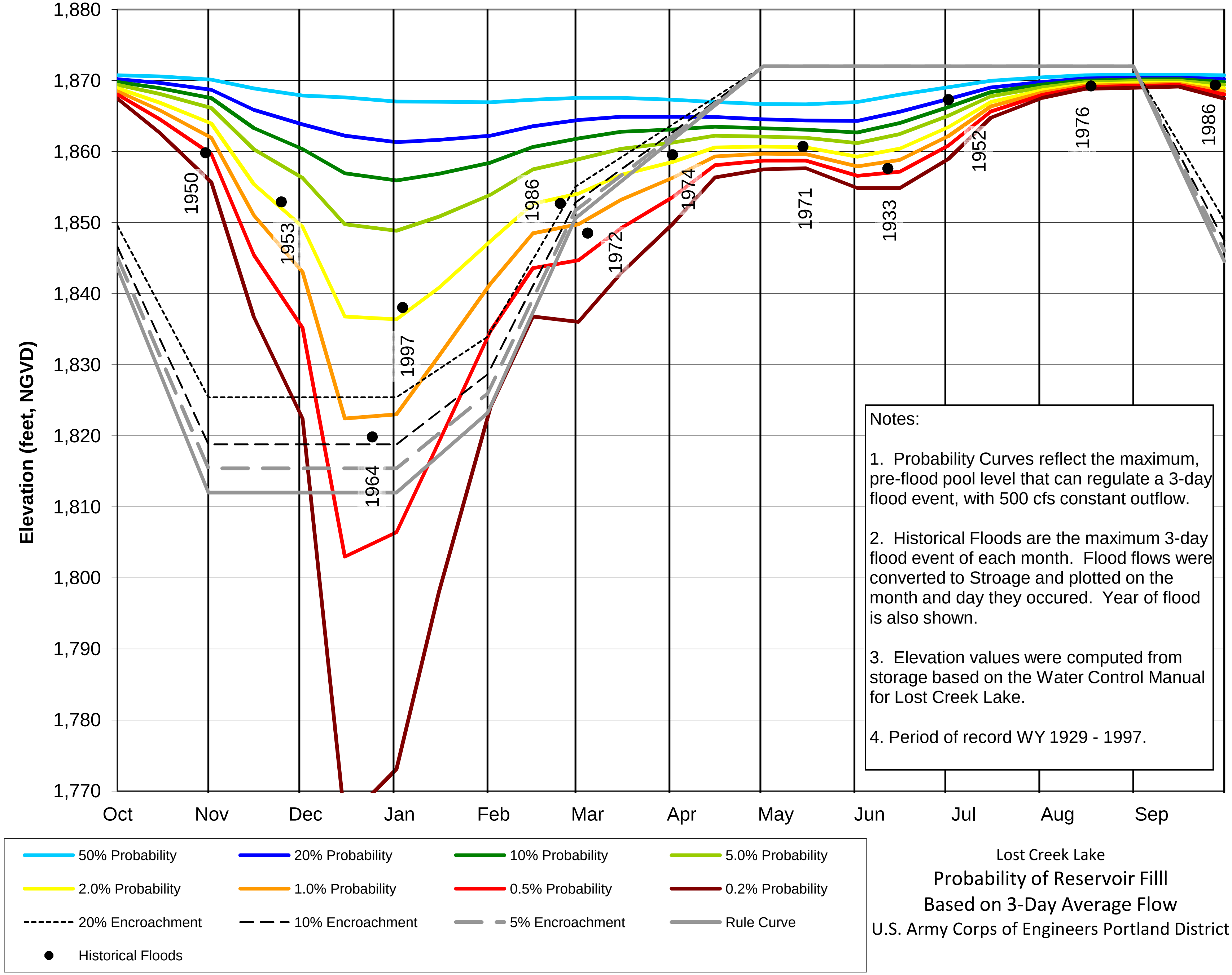


Lost Creek Lake
Daily Elevation at the Dam Site
Water Years 2008 - 2011
U.S. Army Corps of Engineers Portland District



Lost Creek Lake
Probability of Reservoir Filll
Based on 1-Day Average Flow
U.S. Army Corps of Engineers Portland District

Plate 8-7

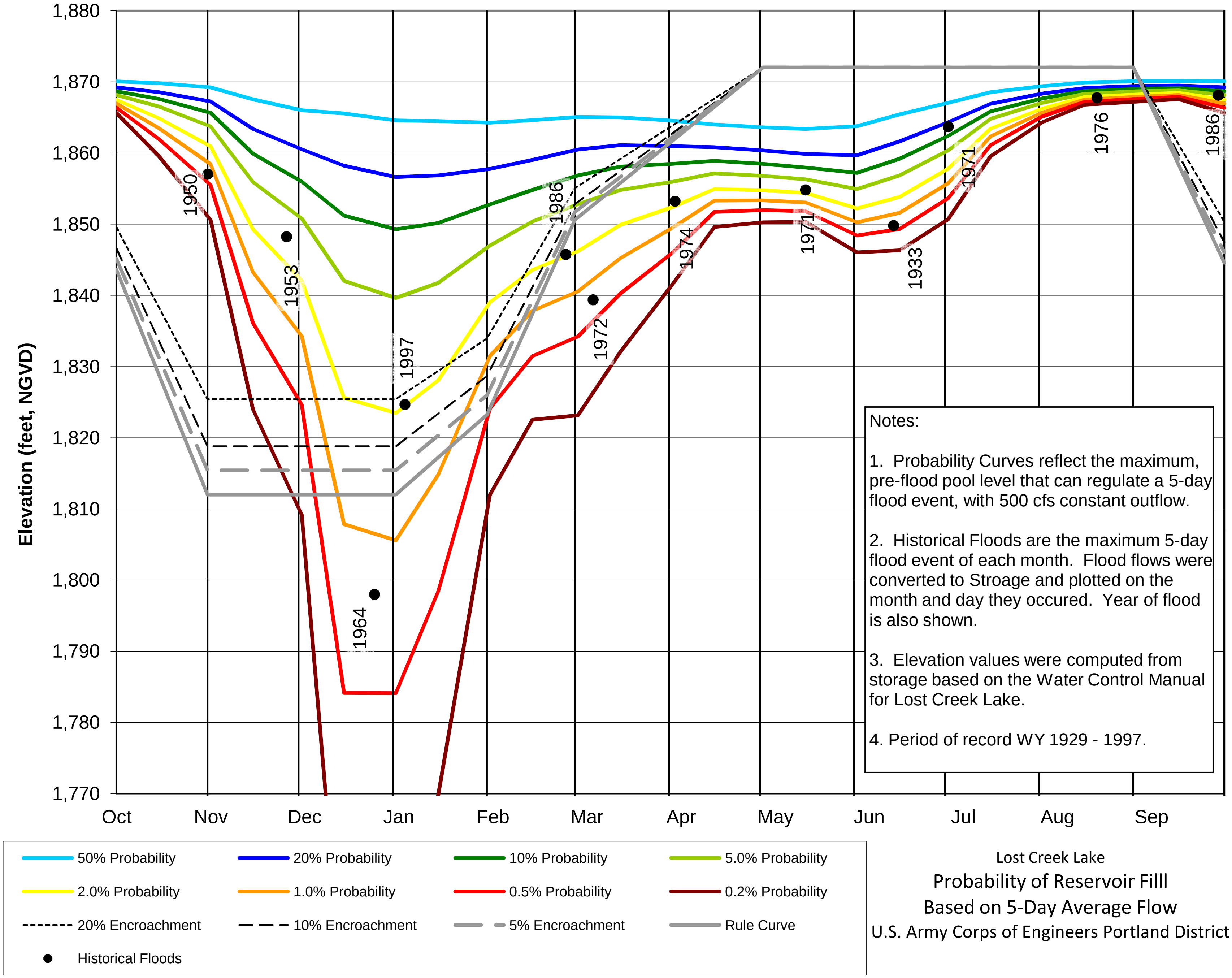


Lost Creek Lake

Probability of Reservoir Filll

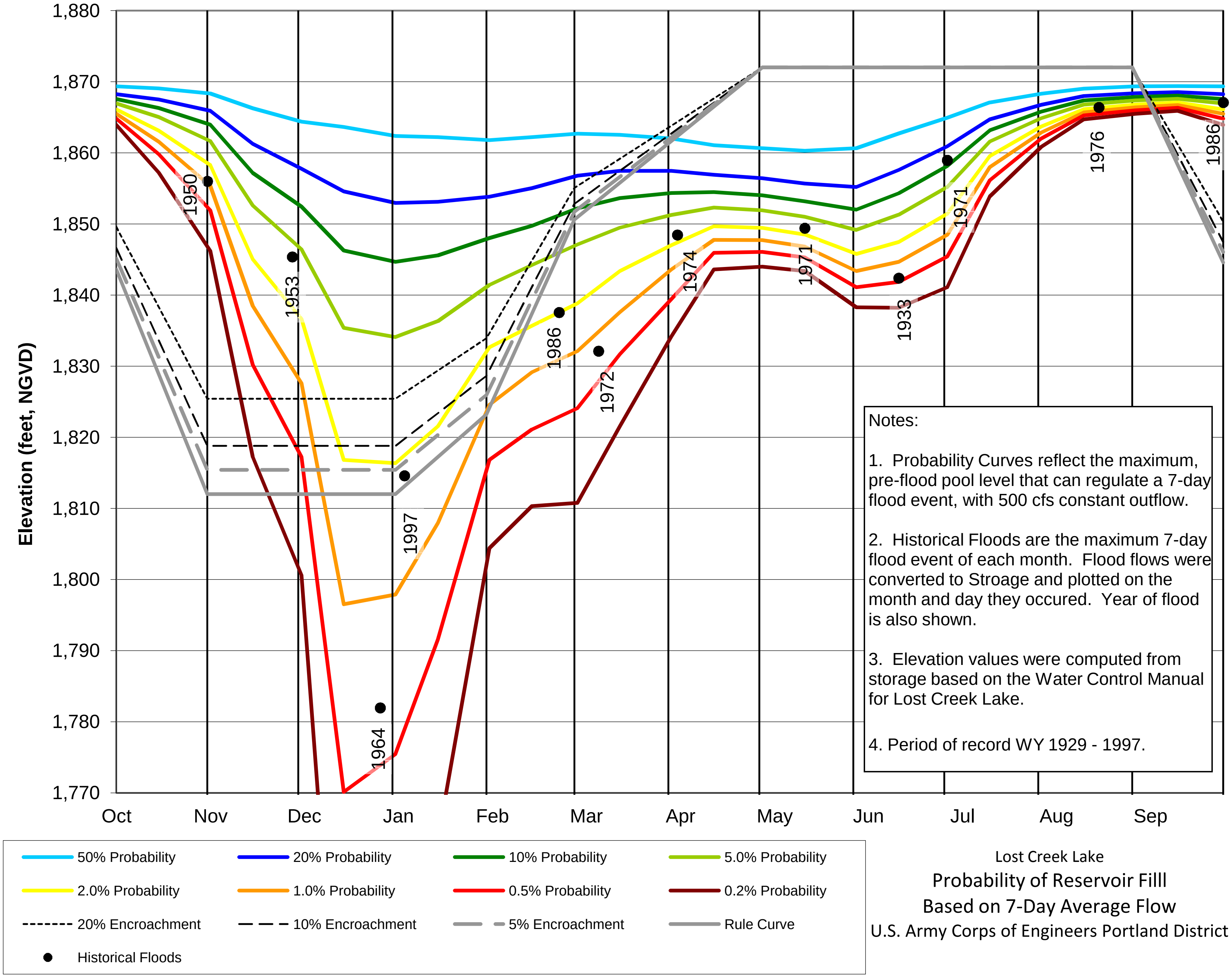
Based on 3-Day Average Flow

U.S. Army Corps of Engineers Portland District

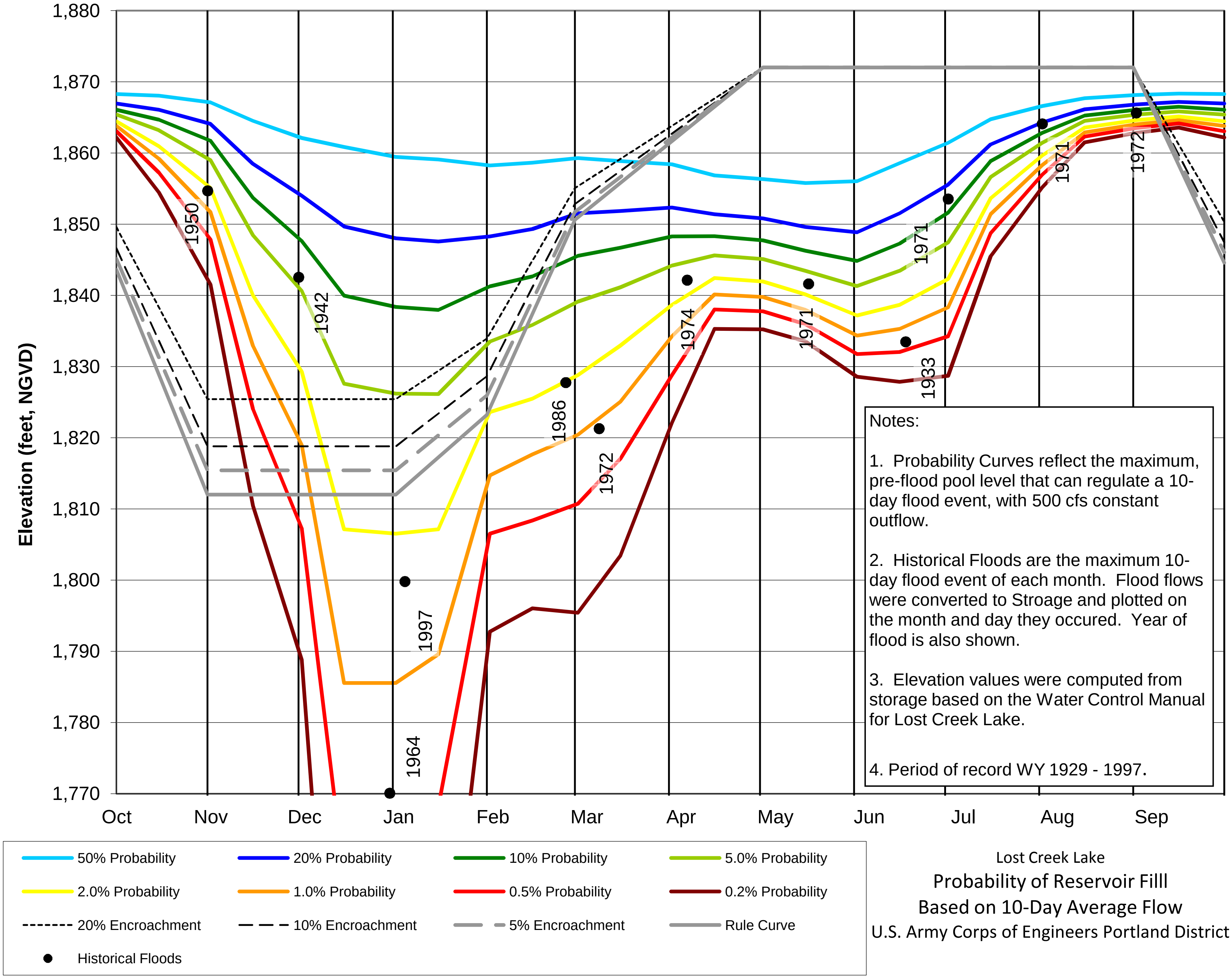


Lost Creek Lake
Probability of Reservoir Filll
Based on 5-Day Average Flow
U.S. Army Corps of Engineers Portland District

Plate 8-9



Lost Creek Lake
Probability of Reservoir Filll
Based on 7-Day Average Flow
U.S. Army Corps of Engineers Portland District



Lost Creek Lake
Probability of Reservoir Filll
Based on 10-Day Average Flow
U.S. Army Corps of Engineers Portland District

Functional Organization Chart
for
Operation of the Rogue River Basin Project

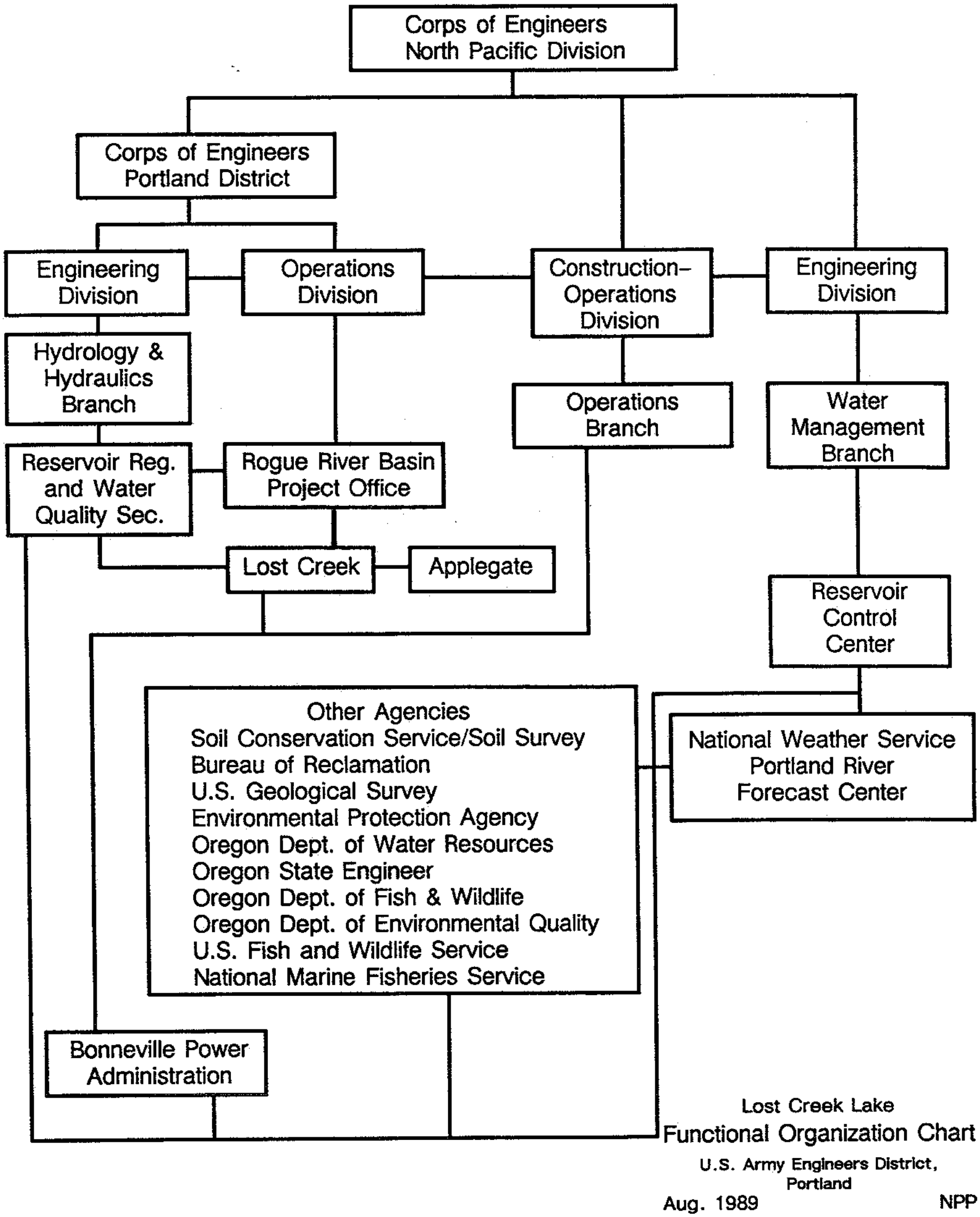


Plate 9-1