

Redacted for Public Version



US Army Corps
of Engineers®
Portland District

**Appendix 1-A to Willamette Master Water
Control Manual**

**Water Control Manual
for
Blue River Lake**

Oregon

March 1971
Revision 3, July 2018



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

REPLY TO
ATTENTION OF

July 28, 2017

CENWD-PDW

MEMORANDUM FOR: Lance Helwig, Chief, CENWP-EC

SUBJECT: Approval of Willamette Drought Contingency Plan

Thank you for responding to our comments on your submission of the Willamette Drought Contingency Plan. You have done an excellent job addressing our concerns, and the plan is approved. Please contact Ron Malmgren (503) 808-3975, if you have any further questions regarding this subject.

A handwritten signature in blue ink, appearing to read "Steven B. Barton".

STEVEN B. BARTON, P.E.
Chief, Columbia Basin Water
Management Division

CF:
CENWD-PDW-R (Ammann)
CENWD-PDW-H (Proctor, Malmgren)
CENWP-EC-H (Hart)



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

CENWD-PDW

14 Aug 2013

MEMORANDUM THRU: Bruce Duffe, Chief, Reservoir Regulation and Water Quality Section (CENWP-EC-HR)

FOR: Lance Helwig, Chief, Engineering and Construction Division (CENWW-EC)

SUBJECT: Response on Request for Review and Approval for Incorporation of Interim Water Control Plans into the Water Control Manuals for Willamette Valley Projects

We have received your request on 2 July 2013 to review and approve temporary revisions to the Blue River, Cougar, Fall Creek, Green Peter, Hills Creek, and Lookout Point Water Control Manuals (WCMs) which incorporate Interim Risk Reduction Measures (IRRM) due to spillway gate deficiencies. We understand that the interim water control plans provide for the same gate tracking operations as described in the IRRM deviation requests that NWD approved on 20 November 2012 and the changes are expected to stay in place until spillway gates for each project have been strengthened.

The proposal modifies the operational guidance issued in the Water Control Manual (WCM) during the Winter Flood Season (November through February). It changes the Special Gate Regulation Curves (also known as special curves) by adding an upper envelope resulting in mandated releases which can occur earlier than in the existing special curves. This approach moves operational decisions from a strictly flood risk management based operation towards a dam safety operation.

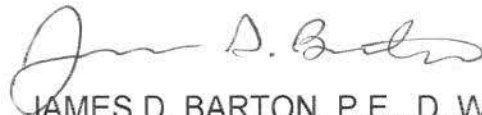
We request that while the gate tracking procedures are in place, a yearly letter is sent to NWD as a status update on which projects still require the gate tracking procedure and what measures NWP has undertaken to secure funding for repairs. We request this letter by July 31 of every year. If the gate tracking procedure is invoked during a real event, then an After Action Report will be required.

Based on the analysis, the proposed operation has minimal impact on peak flows downstream of the project. Therefore, we approve the proposed interim water control plan revisions to minimize stress on the gates by opening all of the gates as the pool rises. The replacements and additions listed in the 2 July 2013 memo are approved for each of the six projects. As gates are repaired, the gate restriction and the operational approach will be evaluated and modified if appropriate with a supporting deviation request to NWD. When it is determined that the operational restrictions may be removed, NWP will request approval to remove the section added to the WCMs that pertain to the Interim Water Control Plans.

CENWD-PDW

SUBJECT: Response on Request for Review and Approval for Incorporation of Interim Water Control Plans into the Water Control Manuals for Willamette Valley Projects

If you have any additional questions, please contact Ron Malmgren, 503-808-3975.



JAMES D. BARTON, P.E., D, WRE
Chief, Columbia Basin Water
Management Division

CF:

CENWD-PDW-R (Proctor, Kanbergs)

CENWD-PDW-H (Brooks, Malmgren)

CENWD-RBT (Berre, Bhamidipaty)

CENWP-EC-WM (Laurie Nicholas, Bruce Duffe)

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. Changes to individual pages must carry the date of revision, which is the Division's approval date.

Change No.	Page / Paragraph / Section	Statement of Review or Change	Approval Date
Rev. 0		Initial Blue River Water Control Manual	Mar 1971
Rev. 1*	Exhibit 1 added Insert page 34a	<ol style="list-style-type: none"> 1. An Interim Water Control Plan is added after the Plates as Exhibit 1, and includes Interim Risk Reduction Measures memorandums. 2. Add paragraph 6-00 to Section 6 for discussion of Interim Water Control Plan. 	Sept 3, 2013
Rev. 2	Appendix Replaced	Comprehensive Update, Drought Contingency Plan, Exhibit A	July 28, 2017
Rev. 3	Remove Exhibit 1 and page 34a	The Interim Water Control Plan is removed after repair of the Spillway Gates.	July 2018

*Rev. 1 is an interim water control plan describing modified spillway gate and flood operations as a result of Interim Risk Reduction Measures (IRRM). This interim plan is to be used until the spillway gates are repaired. IRRMs are in place because an analysis has shown that the spillway gates are overstressed and need to be strengthened to be compliant with EM 1110-2-2702. For simplicity, Exhibit 1 and page 34a will be revised as needed or removed when the IRRM is rescinded. No changes to the table of contents are made for this revision.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during duty hours (0730-1600 weekdays, excluding holidays), contact between Willamette River Basin Project staff and Reservoir Regulation and Water Quality staff (CENWP-ENC-HR) can be made by calling the CENWP-ENC-HR phone line at (503) 808-4896.

If CENWP-ENC-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. Willamette Primary Regulator

Work: (503) 808-4869

Cell: (503) 927-4642

2. Backup Regulator

Work: (503) 808- 4891

Cell: (503) 475-2492

3. Chief, Reservoir Regulation and Water Quality Section

Work: (503) 808-4887

Cell: (503) 819-4189

4. Lookout Point Dam Control Room

(541) 349-3072

Cell: (541) 514-5623

Satellite: 8816-2242-1180

In addition, the list of staff on call during non-duty hours is updated about once a week, and is provided in the after-hours call list provided through the Columbia Basin Telecommunications link at https://cbt.usace.army.mil/RCCLIST/Portland_District_Weekend_Duty_List.

WATER CONTROL MANUAL STATUS SHEET

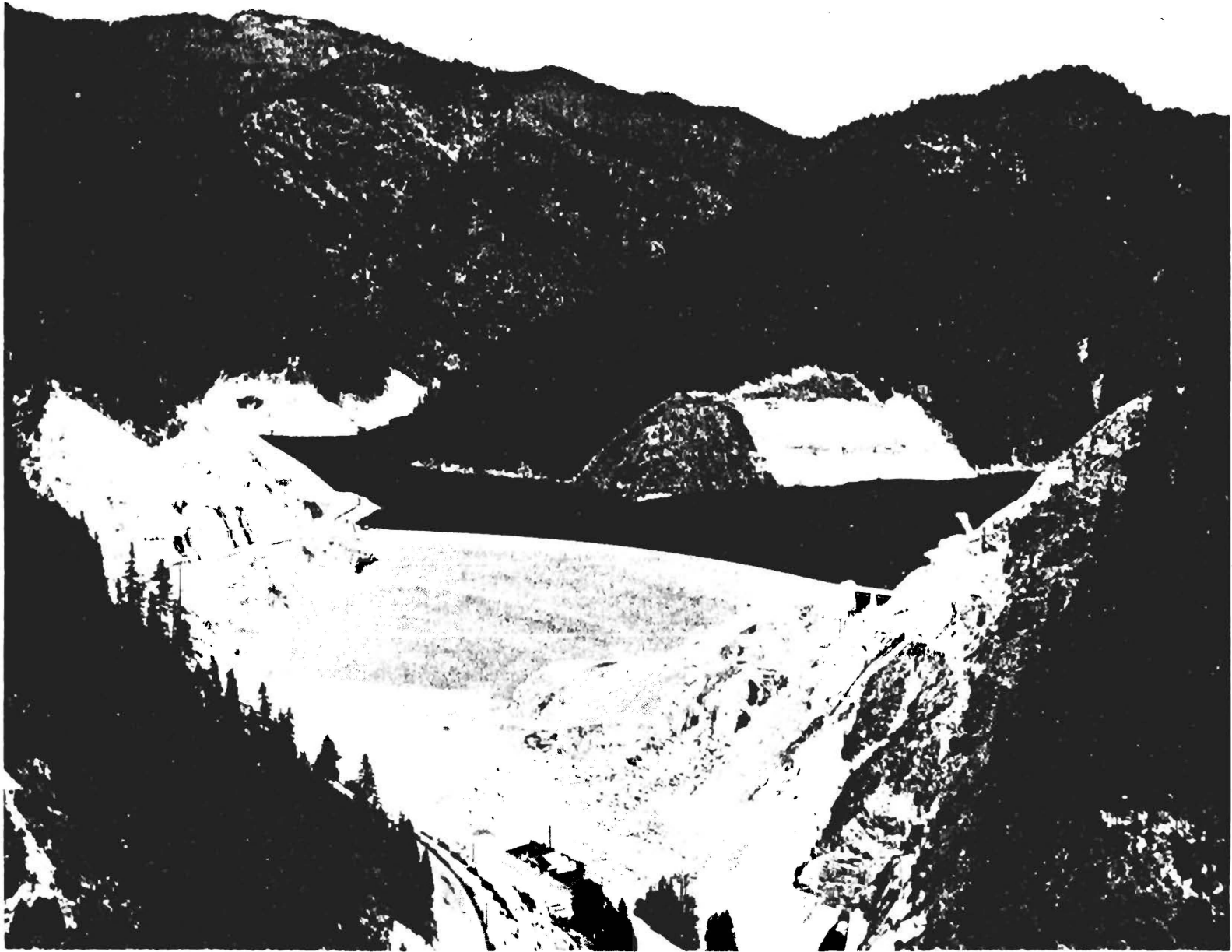
PROJECT: BLUE RIVER LAKE

CHAPTER	STATUS	PLANNED ACTION
I. INTRODUCTION	*** 2 *** *** *** *** ***	Update and revise RRMAN Section I, Introduction; add additional material
II. DESCRIPTION	*** 2 *** *** *** *** ***	Update and revise RRMAN Section II, Basin Description, and Section III, Project Description; add addl. material
III. HISTORY	*** 4 *** *** *** *** ***	Compile a new chapter using existing records and additional information
IV. WATERSHED CHARACTERISTICS	*** 2 *** *** *** *** ***	Update and revise RRMAN Section II, Basin Description
V. DATA COLLECTION	*** 4 *** *** *** *** ***	Update and revise RRMAN Section IV, Climatology; Section V, Hydrology; and Section IX, Hydrometeorological Facilities; Add additional material
VI. HYDROLOGIC FORECASTS	*** 2 *** *** *** *** ***	Update and revise RRMAN Section V, Hydrology; add additional material
VII. WATER CONTROL PLAN	*** 2 *** *** *** *** ***	Update and revise RRMAN Section VI, Flood Control Regulation, and Section VII, Storing For Conservation; add additional material
VIII.EFFECT OF WATER CONTROL PLAN	*** 4 *** *** *** *** ***	Update and revise RRMAN Section VIII, Utilization Of Stored Water; add additional material
IX. WATER CONTROL MANAGEMENT	*** 4 *** *** *** *** ***	Update and Revise RRMAN Section X. Responsibilities And Emergency Instructions Add additional materials
SUPPPORTING INFORMATION (photo,pertinent data, tables, graphs,etc)	*** 2 *** *** *** *** *** *** ***	Selected tables, charts, and graphs require revision and update

STATUS CODES:

- 1 - approved, up to date
- 2 - approved, needs revision
- 3 - preliminary draft
- 4 - incomplete and/or outdated

NOTE: RRMAN=Reservoir Regulation Manual



BLUE RIVER DAM



DEPARTMENT OF THE ARMY
PORTLAND DISTRICT, CORPS OF ENGINEERS
629 PITTOCK BLOCK
PORTLAND, OREGON 97205

NPPEN-PL-6

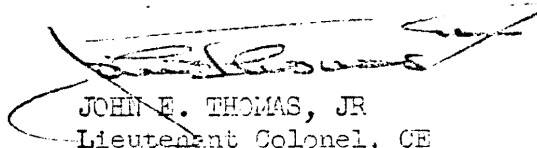
22 July 1968

SUBJECT: Blue River Reservoir Regulation Manual

Division Engineer, North Pacific

1. Four copies of the Blue River Reservoir Regulation Manual are submitted for review and comment by Office, Chief of Engineers. Installation of the spillway gates will be completed by the end of July. The project will become operative for flood control after the diversion tunnel closure is made in September.
2. The final manual will be documented with a number of pertinent photographs that will enhance the descriptive material.
3. Until the final manual is prepared, the preliminary draft will be used by this office in scheduling the operation of the project.

1 Incl (quad)
Reservoir Reg. Manual,
Blue River


JOHN E. THOMAS, JR
Lieutenant Colonel, CE
Acting District Engineer

Per 1305

NPDEN-WC (22 Jul 68) 1st Ind
SUBJECT: Blue River Reservoir Regulation Manual

DA, North Pacific Division, Corps of Engineers, 210 Custom House,
Portland, Oregon 97209 12 September 1968

TO: Chief of Engineers

The inclosed reservoir regulation manual is similar in scope and format to approved manuals prepared by Portland District for other dam and reservoir projects in the Willamette River Basin. Most pertinent comments and recommendations by OCE and NPD on previous manuals have been incorporated into the inclosed manual for Blue River Reservoir. A few minor comments will be discussed informally on a staff coordination basis. Approval of the inclosed Blue River Reservoir Regulation Manual is recommended.

FOR THE DIVISION ENGINEER:

1 Incl
3 cys wd

Per
[Signature]
C. A. CARROLL
Colonel, Corps of Engineers
Deputy Division Engineer

ENGW-EY (22 Jul 68) 2d Ind
SUBJECT: Blue River Reservoir Regulation Manual

DA, Office of the Chief of Engineers, Washington, D. C. 20315 30 Dec 68

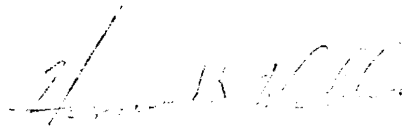
TO: Division Engineer, North Pacific

1. The compilation of a reservoir regulation master manual for the Willamette River basin should be scheduled because the need is strongly indicated by contents of the regulation manual for Blue River Reservoir.
2. The subject manual for Blue River Reservoir is approved as preliminary subject to the following comments:
 - a. Paragraphs 3-08, 7-01, and 7-06. More conclusive evidence should be included to justify the reduction in flood control storage space from 85,550 acre-feet during the spring runoff period to 6,700 acre-feet during the summer months.
 - b. Paragraphs 6-05 and 7-08. An explanation with references should be given for the development of Charts 14 and 18 including their relation, if applicable, to antecedent precipitation, duration of storms, snowpack conditions, temperature, and season.
3. The following items should be covered in either the master manual when it is prepared or in the final Blue River manual:
 - a. Explanation, including references and the value of "time of storage", T_s , should be given for Chart 15.
 - b. Water surface profiles and travel times for downstream reaches should be furnished.
4. The remaining comments apply only to the Blue River manual:
 - a. Paragraph 5-10. Channel capacities should be furnished for the dam-site and the reach below the dam-site.
 - b. Paragraph 5-14. "Primary" and "secondary" flood control storages shown on Chart 8 should be defined.
 - c. Paragraph 6-07. Permissible rates of release change, both for increasing and decreasing should be included in the notes on Charts 14 and 15.
 - d. Paragraph 9-04. Consideration should be given to the establishment of automatically reporting (radio) hydrologic stations upstream of the reservoir.

ENGW-EY (22 Jul 68) 2d Ind 30 Dec 68
SUBJECT: Blue River Reservoir Regulation Manual

e. Paragraph 10-17. The conditions should be defined for determining when to initiate evacuation of flood control storage.

FOR THE CHIEF OF ENGINEERS:



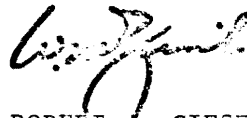
WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

NPDEN-WC (22 Jul 68) 3rd Ind
SUBJECT: Blue River Reservoir Regulation Manual

DA, North Pacific Division, Corps of Engineers, 210 Custom House,
Portland, Oregon 97209 9 January 1969

TO: District Engineer, Portland

1. This approval by CCE considers the subject manual as preliminary and contingent on satisfactory replies to nine comments. However, a conference has been scheduled for 28 and 29 January in your office and this office to discuss hydrology for the Applegate Project and other subjects.
2. It is suggested that a discussion be prepared for the conference concerning the comments of the 2nd Indorsement.



to ROBERT J. GIESEN
Colonel, Corps of Engineers
Acting Division Engineer

NPPEN-PL-6 (22 Jul 68) 4th Ind
SUBJECT: Lake Regulation Manual, Blue River Dam

DA, Portland District, Corps of Engineers, P.O. Box 2946,
Portland, Oregon 97208 17 May 1971

TO: Division Engineer, North Pacific

1. Inclosed are 5 copies of the Lake Regulation Manual for Blue River Dam. This final edition has incorporated changes suggested by higher authority and photographs have been added to enhance the effectiveness of the written description material.
2. The functional organizational charts reflect the recent change in the regulation responsibilities from the District to the Division Water Control Center.

- 1 Incl (5 copies)
1. Lake Regulation Manual,
Blue River

C. B. Binkley LTC, CE
for PAUL D. TRIEM
Colonel, Corps of Engineers
District Engineer

NPDEN-WC (22 Jul 68) 5th Ind
SUBJECT: Blue River Reservoir Regulation Manual

DA, North Pacific Division, Corps of Engineers, 210 Custom House, Portland,
Oregon 97209 25 May 1971

TO: District Engineer, Portland, ATTN: NPPEN-PL-6

1. Reference:

a. EC-1130-2-75, Project Operation Name of Project, 10 August 1970.

b. ER-1120-2-111, Investigation, Planning and Development of Water
Resources Policy for Naming Civil Works Projects, 11 February 1971.


2. We have reevaluated the two referenced instructions concerning the terminology for naming the lakes behind Corps of Engineer projects. It is our conclusion that, though the name of the project should be changed to conform with the terminology "lake", as indicated in the references, the subject manual should remain a reservoir regulation manual. Therefore, we suggest the manual cover be revised as follows:

Blue River Lake
Blue River Oregon
Reservoir Regulation Manual

3. We have changed the subject of this indorsement to agree with the original letter and first three indorsements.

FOR THE DIVISION ENGINEER:

1 Incl (dup)
wd 3 cys of incl


GORDON H. FERNALD, JR.
Chief, Engineering Division

for

NPPEN-PL-6 (22 Jul 68) 6th Ind
SUBJECT: Blue River Reservoir Regulation Manual


DA, Portland District, Corps of Engineers, P.O. Box 2946,
Portland, Oregon 97208 11 June 1971

TO: Division Engineer, North Pacific

1. The cover on Blue River Reservoir Regulation Manual has been revised as instructed and the heading on page 1 has been revised to reflect the change on the cover. Page xi of the pertinent data sheet has been revised to show limiting rates of increasing releases from Blue River Lake.
2. We are forwarding 5 copies of the revised manual. If you have no further use for the three Blue River Manuals not returned in your 5th indorsement we would appreciate having them returned.

FOR THE DISTRICT ENGINEER

- 1 Incl (5 copies)
1. Blue River Reservoir
Regulation Manual



D. H. BASGEN
Chief, Engineering Division

NPDEN-WC (22 Jul 68) 7th Ind
SUBJECT: Blue River Reservoir Regulation Manual

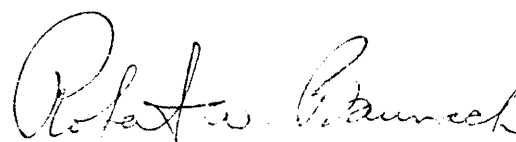
DA, North Pacific Division, Corps of Engineers, 210 Custom House, Portland,
Oregon 97209 16 June 1971

TO: District Engineer, Portland, ATTN: NPPEN-PL-6

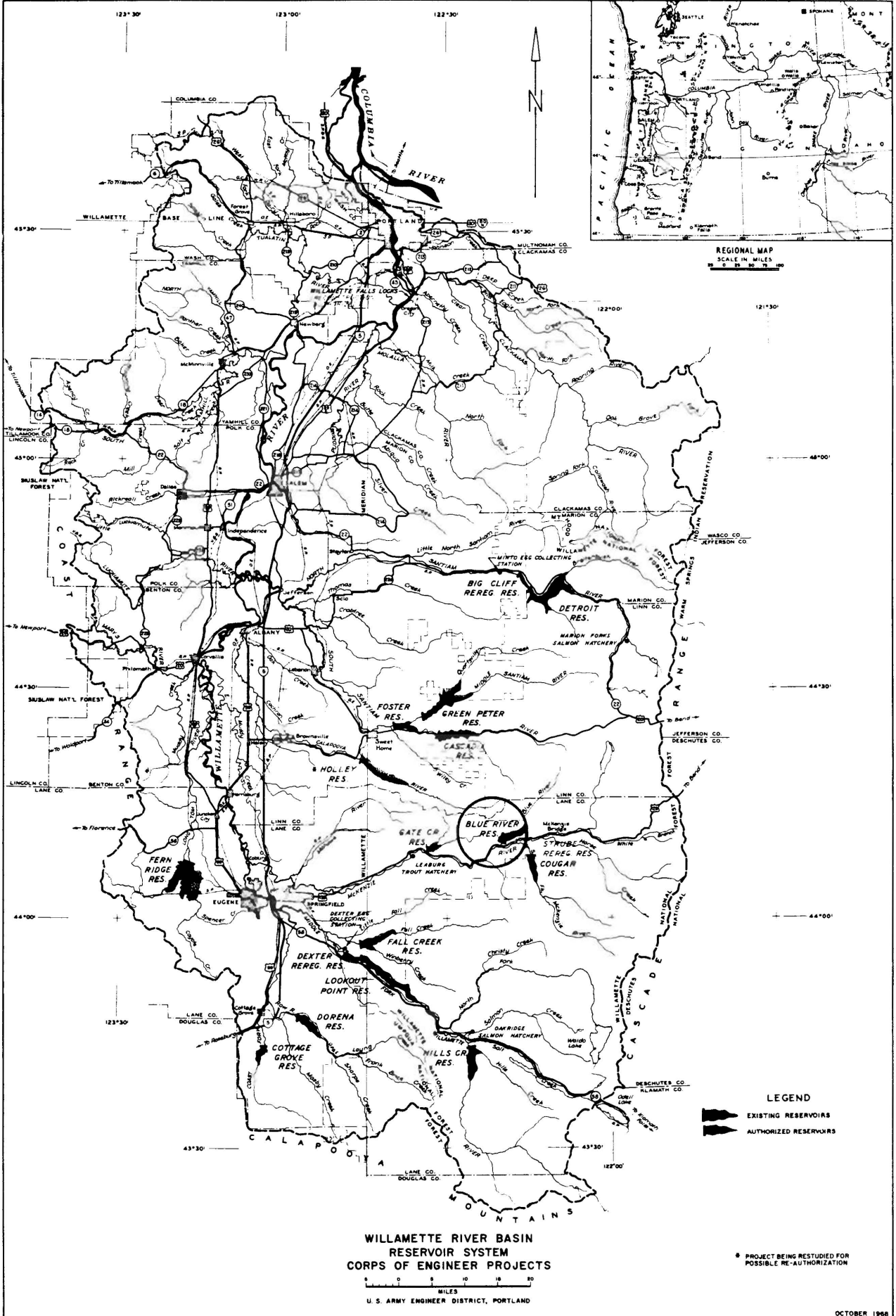
1. As requested by you in your 6th Indorsement to the Blue River Reservoir Regulation Manual, we are returning three copies of the manual.
2. Two information copies of the subject reservoir regulation manual are being forwarded to OCE.

FOR THE DIVISION ENGINEER:

1 Incl (3 cys)
wd 2 cys of Incl


GORDON H. FERNALD, JR.
Chief, Engineering Division

^{for}
Copy furnished: (with 2 cys of Incl)
OCE, ATTN: ENGCW-EY



WILLAMETTE RIVER BASIN
RESERVOIR SYSTEM
CORPS OF ENGINEER PROJECTS

LEGEND
 ■ EXISTING RESERVOIRS
 □ AUTHORIZED RESERVOIRS

◊ PROJECT BEING RESTUDIED FOR POSSIBLE RE-AUTHORIZATION

0 5 10 15 20
MILES
U.S. ARMY ENGINEER DISTRICT, PORTLAND

PRIOR DESIGN MEMORANDUMS AND REPORTS

BLUE RIVER LAKE

<u>Number</u>	<u>Subject</u>	<u>Date</u>
1	Site Selection (Revised)	Oct. 1962
2	Hydrology and Meteorology	Jan. 1963
3	General Design	July 1963
4	Preliminary Master Plan	Aug. 1963
5	Relocations	Aug. 1963
6	Real Estate (Limited Design Memo)	Feb. 1963
7	Real Estate	Aug. 1963
8	Clearing	Oct. 1963
9	Spillway and Outlet Works	Mar. 1964
10	Embankment	May 1964
11	Auxiliary Dam	Dec. 1964
12	Geology	July 1965
13	Lake Regulation	June 1965
14	Embankment Instrumentation	Dec. 1967
15	Reservoir Regulation Manual (Prelim.)	July 1968

TABLE OF CONTENTS

<u>Paragraph</u>		<u>Page</u>
	Willamette River Basin Map	Frontispiece
	Prior Design Memorandums	i
	Pertinent Data, Blue River Dam and Lake	viii
 <u>SECTION I - INTRODUCTION</u>		
1-01	Authority	1
1-02	Purpose and scope	1
1-04	Revisions to manual	1
 <u>SECTION II - BASIN DESCRIPTION</u>		
2-01	Location	3
2-02	Drainage area	3
2-03	Streams	4
2-05	Forest cover	4
2-06	Population	4
2-08	Industry and resources	5
2-11	Power transmission	7
2-13	Transportation	7
2-15	Flood damages	8
 <u>SECTION III - PROJECT DESCRIPTION</u>		
3-01	General	10
3-02	Project authority	10
3-03	Project purpose	11
3-05	Location of project	12
3-06	Taking line guide	12
3-07	Blue River Dam	12
3-08	Blue River Lake	13
3-09	Regulating outlets	13
3-10	Principal changes in the authorized project	14
3-12	Resume of construction activities	15
3-13	Construction contracts and project costs	15
3-14	Public use facilities	16
3-16	Debris control	17

TABLE OF CONTENTS (cont'd)

SECTION IV - CLIMATOLOGY

<u>Paragraph</u>		<u>Page</u>
4-01	General	18
4-02	Climatological records	18
4-03	Precipitation	19
4-06	Snow	20
4-07	Temperatures	20
4-08	Storms	21
4-11	Winds	22
4-12	Evaporation	23

SECTION V - HYDROLOGY

5-01	Discharge records	24
5-03	Streamflow characteristics	24
5-04	Runoff	25
5-05	Flood characteristics	25
5-07	Flood frequencies	26
5-08	Past floods	26
5-09	Channel velocity	27
5-10	Channel capacities	28
5-12	Outlet capacity	29
5-13	Lake capacity	29
5-16	Sedimentation	31
5-20	River temperatures	32
5-22	Lake temperatures	33
5-24	Water quality	33

SECTION VI - FLOOD CONTROL REGULATION

6-01	General criteria	35
6-04	Flood control regulation schedule	36
6-07	Special flood regulation schedule	37
6-08	Examples of regulation	38

SECTION VII - STORING FOR CONSERVATION

7-01	General	42
7-02	Filling schedule	42
7-03	Water supply more than adequate	43
7-04	Inadequate water supply	44
7-06	Occurrence of a flood	44
7-07	Flexibility in annual filling schedule	45
7-08	Residual runoff forecasts after February	45

TABLE OF CONTENTS (cont'd)

SECTION VIII - UTILIZATION OF STORED WATER

<u>Paragraph</u>		<u>Page</u>
8-01	General	47
8-03	Conservation release schedule	47
8-07	Water-use priorities	48
8-08	Prior water rights	49
8-10	Minimum low-water release	50
8-11	Irrigation	50
8-14	Power	52
8-15	Navigation	52
8-17	Water quality control	53
8-18	Recreation	53
8-20	Mosquito control	54

SECTION IX - HYDROMETEOROLOGICAL FACILITIES

9-01	General	55
9-03	Weather station	55
9-04	Precipitation stations	56
9-05	Snow courses	56
9-07	Communication facilities	57
9-12	Hydrologic reporting network	58
9-15	River forecast center	61

SECTION X - RESPONSIBILITIES AND EMERGENCY INSTRUCTIONS

10-01	Organization for lake regulation	62
10-03	Reservoir Control Center	63
10-06	Project Operations Division	64
10-07	Forms and reports	65
10-08	Responsibilities for maintenance of hydrologic and meteorologic stations	66
10-10	Collection and transmission of data	68
10-13	Emergency instructions	69
10-18	National emergency	71

TABLE OF CONTENTS (cont'd)

TABLES

<u>No.</u>	<u>Title</u>
1.	Service Outlet Rating Table, Blue River Dam (2 sheets)
2.	Climatological Summary, McKenzie Bridge Ranger Station
3.	Climatological Summary, Eugene, Oregon
4.	Climatological Summary, Selected Stations
5.	Snow Survey Summary, Selected Stations
6.	Evaporation and Related Data
7.	Monthly Discharge Data, Blue River Damsite (2 sheets)
8.	Maximum Annual Instantaneous Discharges, McKenzie River Basin
9.	Annual Filling Schedule, Blue River Reservoir
10.	Capacity of Blue River Reservoir (10 sheets)
11.	Annual Evacuation Schedule, Blue River Reservoir
12.	Rating Table, Lookout Creek near Blue River
13.	Rating Table, Blue River below Tidbits Creek near Blue River
14.	Rating Table, Blue River at Blue River
15.	Rating Table, McKenzie River near Coburg

TABLE OF CONTENTS (cont'd)

CHARTS

<u>No.</u>	<u>Title</u>
1.	Spillway Tainter Gate Rating Curves, 2-Bay Operation
2.	Storage and Area Curves, Blue River Reservoir
3-a.	Regulating Outlet Discharge Rating Curve, Single Gate Operation
3-b.	Regulating Outlet Discharge Rating Curve, 2-Gate Operation
4.	Low Flow By-Pass Rating Curves
5.	Runoff Summary, Blue River Reservoir
6.	Discharge Frequency Curve, Blue River Dam
7.	Flood Volume Frequency Curves
8.	Storage Reservation for Flood Regulation, Blue River Reservoir
9.	Observed Water Temperatures, Lookout Creek near Blue River
10.	Observed Water Temperatures, Lookout Creek near Blue River
11.	Observed Water Temperatures, Lookout Creek near Blue River
12.	Observed Water Temperatures, Lookout Creek near Blue River
13.	Observed Water Temperatures, Blue River below Tidbits Creek near Blue River
14.	Normal Flood Control Regulation Schedules, Blue River Reservoir
15.	Special Reservoir Regulation Curves, Blue River Reservoir
16.	Spillway Design Flood, Reservoir Routing
17.	Standard Project Flood, Reservoir Routing
18.	Seasonal Runoff Forecast
19-a.	Functional Organization Chart - General
19-b.	Functional Organization Chart - North Pacific Division - Detail
19-c.	Functional Organization Chart - Portland District - Detail
20.	Monthly Log of Reservoir Regulation, Form NPP 133, Mar. 1969.
21.	Daily Reservoir Data, From NPP 87 (Rev.) 1968
22.	Monthly Reservoir Regulation, Blue River Reservoir Form NPP 315 (BL) (1962)
23.	Computation Reservoir Inflow, Blue River Reservoir

TABLE OF CONTENTS (cont'd)

PLATES

<u>No.</u>	<u>Title</u>
1.	Basin Map and Hydrologic Stations
2.	Low-Water Profile
3.	Blue River Reservoir, Real Estate
4.	General Plan and Sections, Blue River Reservoir
5.	Climatic Characteristics
6.	Normal Annual Precipitation
7.	Daily Discharge Hydrograph, Blue River near Blue River
8.	Daily Discharge Hydrograph, Blue River near Blue River
9.	Daily Discharge Hydrograph, McKenzie River near Coburg
10.	Daily Discharge Hydrograph, McKenzie River near Coburg
11.	Sedimentation Range Control, Blue River Reservoir
12.	Examples of Regulation
13.	Seasonal Reservoir Regulation (1926-1955)

BLUE RIVER DAM AND LAKE

January 1971

PERTINENT DATA

1. Project location:

Public land survey	SE 1/4 Section 16, T. 16 S., R. 4E., Willamette Meridian
County and State	Lane County, Oregon
Stream	Blue River
Above mouth (Blue River)	1.8 river miles
Distance from Eugene, Oregon	42 roadway miles
Distance from Portland, Oregon	100 airline miles

2. Project basin, description, and hydrology:

Drainage area	88 square miles
Mean elevation (1929 adj., USC&GS)	3,050 feet, m.s.l.
Highest elevation	5,358 feet, m.s.l.
Elevation at damsite (low water)	1,102 feet, m.s.l.
Normal annual basin precipitation	90 inches
Average annual runoff (1926-1964)	313,600 acre-feet
Average annual discharge (1926-1964)	433 c.f.s.
Maximum observed flood peak (Dec. 1964)	22,000 c.f.s.
100-year flood	20,400 c.f.s.
Spillway design flood (lake inflow)	61,300 c.f.s.
Minimum mean daily flow (1936-1964)	15 c.f.s.
Minimum mean monthly flow (1936-1964)	21 c.f.s.
Maximum mean monthly flow (1936-1964)	2,120 c.f.s.

January 1971

PERTINENT DATA (cont'd)

3. Lake data:

Feature	Elevation, (feet, m.s.l.)	Water surface area (acres)	Storage (1,000 acre-feet)
Low point in lake	1,102.0	- -	0
Minimum flood control pool	1,180.0	133	4.0
Spillway crest	1,321.0	775	58.0
Maximum conservation pool	1,350.0	940	83.0
Full and maximum pool	1,357.0	975	89.5

4. Storage allocation:

Dead and inactive storage (1,102-1,180)	3,970 acre-feet
Total flood control (1,180-1,357)	85,550 acre-feet

5. Spillway:

Type	Concrete gravity, gated, ogee section
Crest length (net)	70 feet
Crest elevation	1,321.0 feet, m.s.l.
Design discharge	53,220 c.f.s.
Control gates (tainter)	2 - 35' x 38'
Elevation, top of gates	1,359 feet, m.s.l.
Maximum static head on crest	36.0 feet

6. Outlets:

Type	Lined tunnel
------	--------------

January 1971

PERTINENT DATA (cont'd)

6. Outlets: (cont'd)

Operating slide gates	2 - 4' 9" x 8' 0"
Emergency slide gates	2 - 4' 9" x 8' 0"
Invert elevation	1,132 feet, m.s.l.
Discharge capacity at minimum flood control pool, elevation 1,180	3,710 c.f.s.
Discharge capacity at maximum pool, elevation 1,357	8,400 c.f.s.

7. Stilling basin:

Type	Hydraulic jump, horizontal apron
Length	90 feet
Width	40 feet
Floor elevation	1,050 feet, m.s.l.
Baffles	2 rows
Design discharge	8,460 c.f.s.
Elevation, tailwater (Q = 8,460 c.f.s.)	1,080 feet, m.s.l.

8. Diversion:

Blue River

Type	18.5' circular lined tunnel
Length	1,760 feet
Elevation, upstream invert	1,110 feet, m.s.l.
Elevation, downstream invert	1,075 feet, m.s.l.

January 1971

PERTINENT DATA (cont'd)

8. Diversion: (cont'd)

Capacity 13,300 c.f.s.
 Elevation, tailwater (Q = 13,300 c.f.s.) 1,082.5 feet, m.s.l.

9. Dam:

Type of embankment Earth and quarried rockfill
 Elevation, top of dam 1,362 feet, m.s.l.
 Length (approximate) 1,250 feet
 Maximum height, main dam, streambed to top of dam 270 feet

10. Planned reservoir releases:

Minimum releases
 February-November 15 50 c.f.s.
 Flood periods 50 c.f.s.
 Maximum releases
 Pre-flood and flood evacuation 3,700 c.f.s.

11. Limiting rates of increase in outflow:

<u>Release in c.f.s.</u>	<u>Maximum allowable rate of change</u>					
Below 100	50 cfs per half-hour	20%	25%	33%	50%	100%
100-500	100 cfs per half-hour	50%	40%	30%	20%	10%
500-1000	200 cfs per half-hour	20%	22	25%	28%	33%
1000-2000	400 cfs per hour	1000	900	800	700	600
Above 2000	600 cfs per hour					



1

BLUE RIVER LAKE
RESERVOIR REGULATION MANUAL

SECTION I - INTRODUCTION

1-01. Authority. - Authority for preparing this manual is contained in ER 1110-2-240, dated 22 April 1970. Its preparation has been in accordance with instructions presented in EM 1110-2-3600, dated 25 May 1959.

1-02. Purpose and scope. - The function of this manual is to document the plan of lake regulation and to provide a reference source for higher authority and for personnel who will be responsible for the regulation and coordination of Blue River Lake with other Willamette Valley Projects for flood control and conservation uses.

1-03. The manual contains a description of the river basin, project, coordinated plan of basin development, information necessary for understanding the objectives of the project, and instructions for regulating the lake. Full coverage is given to method of regulation, operating rules and schedules, hydrologic network, forecasting procedures, organization for lake regulation, communication facilities, and emergency flood regulation instructions.

1-04. Revisions to manual. - Changes and revisions to the manual will be made by the Engineering Division of the Portland District as techniques of regulation and forecasting are developed which will improve the effectiveness of the project. Any change in the manual which affects the authorized functions of the lake or involves a significant deviation from the approved plan will be submitted to the North

Pacific Division Office for approval^{1/} All revisions will be dated and a master file will be kept by the Portland District.

1/ References:

ER 1110-2-1400, Reservoir Control Centers: Functions
and Management Provisions

ER 1110-2-240, Reservoir Regulation

SECTION II - BASIN DESCRIPTION

2-01. Location. - McKenzie River Basin is located in western Oregon on the west slope of the Cascade Range, approximately 100 miles south and east of Portland, Oregon. Blue River, on which Blue River Dam is located, is a major tributary of McKenzie River and joins that stream near the town of Blue River, Oregon. Plate 1 and the frontispiece show the location of the project and basin with respect to other geographical features in western Oregon, including the 11 existing storage projects, and 3 authorized storage projects in Willamette River Basin. One of the authorized projects, Cascadia Lake on South Santiam River is scheduled for construction. Gate Creek Lake is waiting for construction funds and Holley Lake on Calapooia River, has been restudied for possible re-authorization which will include downstream channel improvement for flood control as well as provision for additional functions. Results of the study were referred to higher authority in January 1971.

2-02. Drainage area. - Blue River drains an area of 92 square miles in the northeastern section of McKenzie River watershed. Ninety-six percent of the basin, 88 square miles, is tributary to Blue River Dam. Most of the basin lies within the Willamette National Forest and the terrain is rugged and, in general, heavily forested. The mean elevation of the basin above Blue River Dam is 3,050 feet, m.s.l., varying from 1,102 feet at the dam to 5,358 feet in the headwaters. A basin map and an area-elevation curve for the area tributary to Blue River Dam are shown on plate 1.

2-03. Streams. - Plate 1 shows the stream system of the entire McKenzie River Basin, of which Blue River is a principal tributary. Blue River flows generally in a southwesterly direction. Major tributaries of Blue River in upstream order are: Quartz Creek, Lookout Creek, Tidbits Creek, Cook Creek, and Quentin Creek. All of the streams flow in deep canyons and have steep gradients.

2-04. The stream gradients for Blue River vary from more than 200 feet per mile in the upper reach to 30 feet per mile in the lower reach of the basin. Low-water profiles for Blue River and McKenzie River are shown on plate 2.

2-05. Forest cover. - The mountainous terrain above Blue River Dam is covered with a heavy stand of coniferous trees. Logging in this area has been less severe than in other parts of McKenzie River Basin. Most of the watershed tributary to Blue River Dam is Government-owned and is administered by either the Forest Service or the Bureau of Land Management. The forest cover provides several beneficial effects, namely: (1) shields the soil mantle from intense storms and resulting erosion, (2) improves the permeability and infiltration capacity of the soil, and (3) shields the basin snow cover which results in a more controlled snowmelt runoff.

2-06. Population. - Approximately 70 percent of the population of Oregon resides in the Willamette Valley, with the greatest concentration at the northern end of the basin in the Portland metropolitan area. Other large metropolitan areas are Salem, Albany, Corvallis, and Eugene-Springfield. Parts of these areas are subject to flooding from

Willamette River and will benefit from the operation of Blue River Lake. Outside of the major urban centers, the valley population resides on farms and in small towns. Willamette Valley has sustained a rapid increase in population since 1900, and present indications are that this trend will continue. Population in Springfield, at the head of the valley, tripled between 1940 and 1950, and nearly doubled between 1950 and 1960. The following tabulation shows the increase in population between 1940 and 1966 at principal cities and towns in the upper Willamette area.

City or town	Population in year				Percent increase in population	
	1940	1950	1960	1966	1950-1960	1950-1966
Eugene	20,838	35,879	50,977	75,300	42	110
Springfield	3,805	10,807	19,616	24,000	82	122
Coburg	456	693	754	810	9	17
Harrisburg	622	862	939	1,200	9	39
Junction City	1,187	1,475	1,614	2,000	9	36

2-07. The 1966 population of the McKenzie River Basin was estimated to be 18,000. Within a 50-mile radius of Blue River Lake the population is estimated to be about 160,000. The area tributary to the lake is uninhabited. Springfield and Eugene, the principal cities nearest to the project, are located approximately 40 miles west of and downstream from Blue River Dam.

2-08. Industry and resources. - The Springfield-Eugene metropolitan area is the industrial center of the upper Willamette Valley. At the

present time the economy of that area is dependent to a major degree upon the production of lumber and wood products, and, to a lesser degree, upon agricultural products. Ten wood-products industries are located in the Springfield area, the headquarters for more than 40 logging and lumber operations. The annual lumber production within the McKenzie River Basin is estimated to be 100 million board feet. About 15 additional logging, lumber, and plywood operations are dispersed among the small communities along McKenzie and Mohawk Rivers.

2-09. There is no agricultural development upstream of Blue River Lake. Agricultural lands within the McKenzie Basin are located on the valley floor downstream from the project. They are divided by usage as follows: field and special crops, 55 percent; pasture, 25 percent; fruit and nuts, 20 percent. At the present time much of the McKenzie River flood plain is irrigated for the production of higher revenue producing crops. The McKenzie Ditch Company diverts water at river mile 26 for irrigating along the left bank in the vicinity of Thurston. Muddy Creek Irrigation Company diverts water near river mile 8 for use along East Muddy Creek below Coburg. Many farmers irrigate with water pumped directly from the stream. Present irrigation water rights in the McKenzie River Basin total about 300 c.f.s.

2-10. Mineral deposits in the McKenzie River Basin are of minor importance. Small amounts of gold have been extracted, but no commercial operations are known to be active. There are three known points where mineral hot springs exist.

2-11. Power transmission. - Electric service in the McKenzie Basin from Springfield to a point east of Leaburg is furnished by the Eugene Water and Electric Board. From Leaburg east to about McKenzie Bridge, electric service is furnished by the Lane County Electric Cooperative, whose source of energy is Bonneville Power Administration's Cougar-Eugene transmission line. At present, power is transmitted from the Leaburg and Walterville plants to Eugene, through a Eugene Water and Electric Board 69-kv. line. The Eugene Water and Electric Board also has a 115-kv. line from their Carmen substation to the Cougar switchyard, where it connects with the Bonneville Power Administration's 115-kv. line between Cougar Dam and Eugene.

2-12. No facilities were provided for generating hydroelectric power at the Blue River project.

2-13. Transportation. - U.S. Highway 126 follows McKenzie River from Springfield eastward and crosses the Cascade Range to Bend. About 42 miles from Eugene, a paved road branches off from U. S. Highway 126 and follows South Fork McKenzie River to Cougar Dam. Blue River Dam is readily accessible by a paved-surfaced county road from the town of Blue River. Improved roads parallel the larger tributaries and logging roads provide access to timber areas.

2-14. The Southern Pacific Railroad crosses McKenzie River near Hayden Bridge and follows a course up Mohawk River. Regular bus service is available on U.S. Highway 126 and charter service on other roads. Irregular freight truck service is available on all roads.

2-15. Flood damages. - Flooding in the Willamette Valley has been extensive and extremely damaging in the past years. The Eugene-Springfield industrial area, which has been subjected to many damaging floods in past years, was the major damage center in the southern part of Willamette River Basin before the upstream lakes were constructed. With the completion of five flood control lakes above Eugene, the Eugene-Springfield area is relatively free of flooding. Downstream from Eugene, the cities of Junction City, Harrisburg, Corvallis, Albany, Salem, Oregon City, and Portland, as well as many small communities and intervening agricultural areas, have experienced serious flood damages. These areas all benefit substantially from the construction of upstream flood control lakes.

2-16. The damage survey following the flood of December 1964 established that properties within the flooded areas of McKenzie River and Willamette River were valued at approximately \$7,500,000 and \$500,000,000, respectively. It is estimated that about 31 miles of the lower McKenzie River are subject to various degrees of flooding. Without flood control at Cougar and Blue River Lakes, average annual flood damages would be \$570,000 in the McKenzie Basin, based on 1966 price levels and existing conditions. The corresponding average annual damages along Willamette River, without lake control, are estimated to be \$16,430,000. Flood damages have been appraised for the 1943, 1945, 1955, and 1964 floods. At 1966 prices and development in the flood plain, the damages that would result from the recurrence of the above uncontrolled floods are as follows:

Date of flood	McKenzie River	Willamette River
December 1942- January 1943	\$ 1,240,000	\$ 16,100,000
December 1945	4,170,000	18,700,000
December 1955	990,000	19,700,000
December 1964	13,700,000	512,000,000

2-17. Numerous floods of smaller magnitude, which may occur several times during a year, would do damage along McKenzie River without flood regulation at Cougar and Blue River Lakes. Operation of Blue River Lake will reduce damages about 20 percent along the McKenzie River and 3 percent along Willamette River.

SECTION III - PROJECT DESCRIPTION

3-01. General. - A need for flood control was recognized early in the history of Willamette Valley, but flood control was not recognized as an appropriate activity of the Federal Government prior to adoption of the 1936 Flood Control Act. Further, development in the valley prior to 1936 apparently would not have warranted expenditures for flood control. As late as 1932 the Corps of Engineers reported that no extensive flood control project was economically justified. After that date, population growth and industrial development was rapid. With the accelerated growth of the region, demands for flood protection became increasingly urgent, leading to congressional authorization of studies and the development of a general comprehensive plan for the control of floods and utilization of the water resources in Willamette River Basin.

3-02. Project authority. - Project authorization for Blue River Lake was provided by the Congress during actions leading to adoption of the Flood Control Act of 1950 (Public Law 516, 81st Congress, 2d session, HR 5472), approved 17 May 1950. The original plan of improvement for McKenzie River Basin was authorized by the Flood Control Act of 1938 (Public Law 761, 75th Congress, Chapter 795, 3d session), which approved a comprehensive plan for flood control, navigation, and other purposes in the Willamette River Basin, on the basis of recommendations set forth in House Document 544, 75th Congress, 3d session. The initial plan called for a single dam at the Quartz Creek site on McKenzie River. Subsequent to authorization, the need and desire of local people for

SECTION III - PROJECT DESCRIPTION

3-01. General. - A need for flood control was recognized early in the history of Willamette Valley, but flood control was not recognized as an appropriate activity of the Federal Government prior to adoption of the 1936 Flood Control Act. Further, development in the valley prior to 1936 apparently would not have warranted expenditures for flood control. As late as 1932 the Corps of Engineers reported that no extensive flood control project was economically justified. After that date, population growth and industrial development was rapid. With the accelerated growth of the region, demands for flood protection became increasingly urgent, leading to congressional authorization of studies and the development of a general comprehensive plan for the control of floods and utilization of the water resources in Willamette River Basin.

3-02. Project authority. - Project authorization for Blue River Lake was provided by the Congress during actions leading to adoption of the Flood Control Act of 1950 (Public Law 516, 81st Congress, 2d session, HR 5472), approved 17 May 1950. The original plan of improvement for McKenzie River Basin was authorized by the Flood Control Act of 1938 (Public Law 761, 75th Congress, Chapter 795, 3d session), which approved a comprehensive plan for flood control, navigation, and other purposes in the Willamette River Basin, on the basis of recommendations set forth in House Document 544, 75th Congress, 3d session. The initial plan called for a single dam at the Quartz Creek site on McKenzie River. Subsequent to authorization, the need and desire of local people for



SADDLE DAM



LAKE VIEW

other uses of McKenzie River led to formulation of an alternative plan consisting of three headwater dams as set forth in House Document 531, 81st Congress, 2d session. Subsequently, House-Senate conferees, in action leading to authorization of other projects in Willamette Basin recommended in House Document 531, stated that the Blue River and Cougar Lake in the McKenzie River Basin could be considered authorized as alternates to the previously authorized Quartz Creek Dam. In 1962, Gate Creek Lake, the third unit in the alternate headwater plan, was authorized.

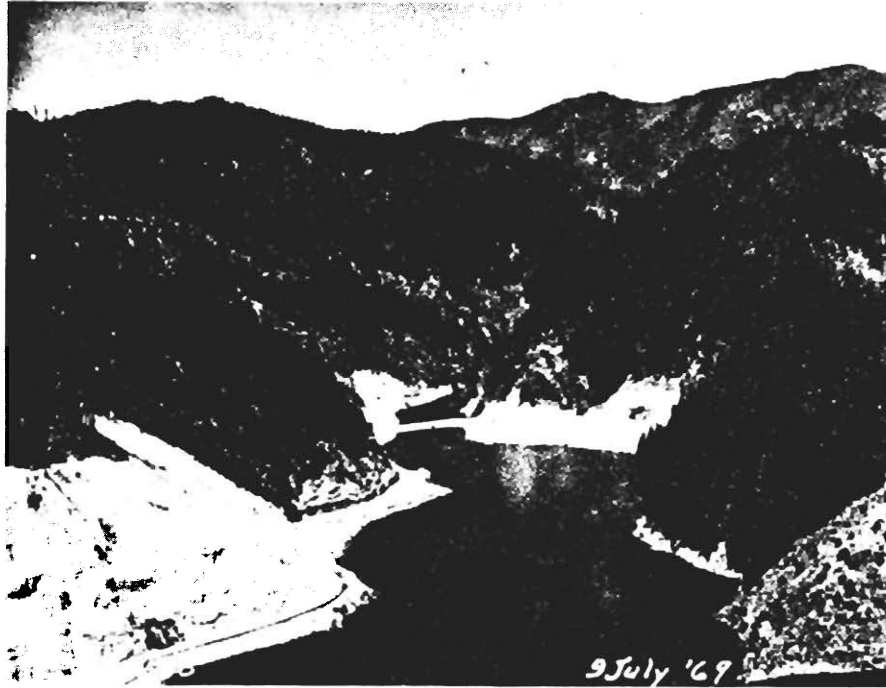
3-03. Project purpose. - Blue River Dam and Lake is one unit in a system of lakes authorized for the comprehensive development of the water resources in Willamette River Basin. The status and location of those lakes are shown on the frontispiece. Blue River project was authorized for the primary purposes of flood control and conservation of water for irrigation and navigation. Storage space in Blue River Lake will contribute effectively to reducing flood stages along the lower McKenzie River as well as along Willamette River downstream from mouth of McKenzie River. Blue River and Cougar Lakes control runoff from 22 percent of the total drainage area of McKenzie River upstream from Coburg.

3-04. In addition to serving the primary conservation purposes of irrigation and navigation, project operation will enhance power benefits at the existing city of Eugene plants on McKenzie River and at a private power installation on Willamette River at Oregon City. Also, the increase in low-water flows will aid in improving water quality in Willamette River, and the lake will provide a potential for recreation usage.

3-05. Location of project. - Blue River Dam and Lake is located 1.8 miles upstream from mouth of Blue River, which flows into McKenzie River near Blue River, Oregon, approximately 54 miles upstream from the junction of McKenzie River with Willamette River. The frontispiece shows the geographical location of the project.

3-06. Taking line guide. - The general criterion for establishing the taking line for Blue River Lake was that taking should include a 300-foot strip horizontally landward from full pool, elevation 1,357, mean sea level. Wherever road location or relocation rights-of-way were within or close to the 300-foot taking, the taking did not conform to the general criterion. In such cases the landward boundary of the right-of-way was the guide taking line. Where the road relocation was not close to the 300-foot limit, the right-of-way was a separate taking. Other exceptions to the 300-foot taking limit were lands required for construction, material, and public access and recreation sites, where the taking was made sufficient to cover the needed areas. Plate 3 shows the boundary of the lands acquired by the Government for the operation of Blue River Dam and Lake.

3-07. Blue River Dam. - Blue River Dam is an earth-and-rockfill embankment with a gated spillway in the left abutment. The earth-and-rockfill embankment of the dam is approximately 1,250 feet long with a maximum height of 270 feet from a streambed to top of dam. The gated ogee-type spillway has a net length of 70 feet. Also located in the left abutment are a combination diversion and outlet works. The spillway has a discharge capacity of 53,220 c.f.s. at maximum pool, elevation 1,357,



QUARTZ CREEK ARM



BLUE RIVER ARM

with the gates fully open. In addition to the main dam, there is an embankment dam about 1,535 feet long and 70 feet high constructed in a low saddle between Blue River and McKenzie River on the left side of the lake about 3 miles upstream from the main damsite. Plate 4 shows the general plan, typical sections, and other principal features of the project. Discharge rating curves for the spillway are shown on chart 1.

3-08. Blue River Lake. - At full pool, elevation 1,357, Blue River Lake is about 6.4 miles long, 0.5 mile wide at maximum width, and has a surface area of 975 acres. At this level the total capacity of the lake is 89,520 acre-feet. Below minimum pool, elevation 1,180, there will be 3,970 acre-feet of dead and inactive storage. Between elevations 1,180 and 1,357, a total of 85,550 acre-feet of storage space will be reserved for flood regulation during the flood season. During the summer 6,700 acre-feet of storage space between elevations 1,350 and 1,357 will be reserved for control of summer floods; the remaining space will be filled for conservation use. Lake storage and area curves are shown on chart 2. Backwater studies indicate that the water surface in the lake will be practically level except during flood periods and then the only significant backwater effect in the pool will be confined to the upper end where the pool intersects the streams flowing into the lake. No backwater problem is anticipated as the upper end of the lake is in a relatively steep canyon.

3-09. Regulating outlets. - The outlet works, located in the left abutment, consist of an intake tower and a regulating outlet tunnel with a stilling basin at the downstream end. The two outlets are controlled



by 4-foot 9-inch by 8-foot slide gates at the upstream end. Each outlet will have two slide gates, one for normal operation and the other for emergency operation. The outlets can discharge 3,710 c.f.s. when the pool is at minimum flood control pool, elevation 1,180, and 8,400 c.f.s. at full pool, elevation 1,357. Discharge rating curves for the regulating outlets are shown on charts 3-A and 3-B and in tabular form in table 1. One 14-inch diameter and one 18-inch diameter low-flow by-passes have been provided to allow low-flow releases to be made without using the regulating slide gates. Discharge rating curves for the by-passes are shown on chart 4.

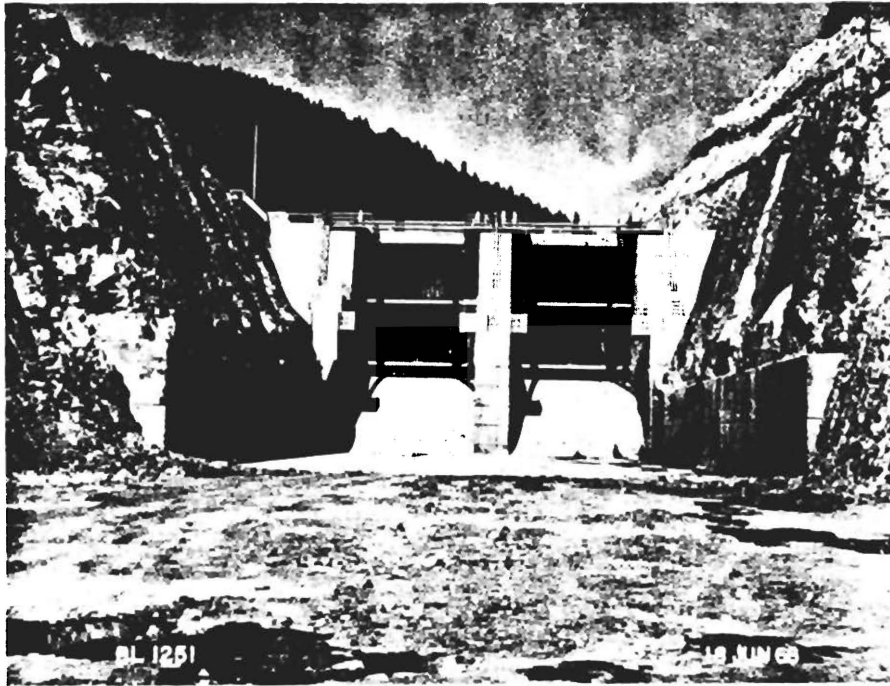
3-10. Principal changes in the authorized project. - The final plan adopted for construction of Blue River Dam embodies several changes from the project document plan as shown in House Document 531, 81st Congress, 2d session. Changes are as follows:

a. The dam was constructed at a site approximately 0.7 mile upstream from the project document site, with a gated spillway in lieu of a free overflow spillway. Location of spillway also was changed.

b. Outlet works are located in a high intake structure in the left abutment upstream from the dam.

c. Additional road relocations were required.

3-11. The General Design Memorandum, dated July 1963, outlines the studies and justification for the changes made to the original project document plan. The changes were approved by the Office, Chief of Engineers, with certain comments and recommendations that were incorporated into other design memorandums. Page i shows a complete list of



SPILLWAY GATES



SPILLWAY IN OPERATION
(SPECIAL SITUATION)

prior design memorandums and the dates they were prepared.

3-12. Resume of construction activities. - Construction of Blue River project began in April 1963 with improvements to an existing county road which provided access to the project site. In the following months, major contracts were awarded including the main dam, auxiliary dam, road and bridge construction, and lake clearing. Construction of main dam began in November 1965, and the project became operative for flood control regulation in October 1968.

3-13. Construction contracts and project costs. - The following table lists (1) contract, (2) principal contractor, (3) contract award date, and (4) construction cost or prefinal estimate:

MAJOR CONTRACTS

Contract	Principal contractor	Award date	Construction cost
Improve county road	George A. Moore	25 Apr 63	\$ 84,700
Diversion tunnel	Radso-Assum Constr Co	23 Jun 65	737,500
Damsite clearing left abutment	Hubner & Michner	7 Feb 64	45,000
County road Simmonds Creek to Quartz Creek	Beaver State Contr	2 Mar 65	1,805,700
Upstream portal and tunnel lining	White Bros & Atwater Co	9 Mar 65	1,880,100
Auxiliary dam and left bank road	P. J. Anderson	30 Apr 65	833,500
Lake clearing	Bill Broderick	11 Jun 65	143,500
Slide gates	Goslin-Birmingham Mfg Co	26 Jul 65	183,500
Main dam	Lockheed Ship Bldg & Const	10 Nov 65	16,848,500
USFS Road 149 and clearing	U.S. Forest Service	9 Mar 66	735,500
USFS upper lake right bank road and bridge	Groesbeck-Durbin Inc.	16 Jun 67	576,000
Quartz Creek to North Fork road	Cecil James	18 Sep 67	397,000

As of 1 April 1968 the estimated total cost of Blue River project was \$30,100,000.

3-14. Public use facilities. - Section 4 of the Flood Control Act of 1944, as amended, authorizes the development and management of park and recreation facilities at lake projects by the Corps of Engineers,

other agencies, groups, or individuals. While recreation is not an authorized function of the project, the land and water areas offer potential for outdoor activities. The water-associated potential of Blue River project is limited because of the steep topography surrounding the pool and the early season drawdown. One large site, 3 miles upstream from the dam on the south shore, offers an opportunity for a major public use development. Several smaller sites in the upper reaches of the lake provide development opportunities; however, use may be limited by early water releases. Recreation will be given as much consideration as possible consistent with the optimum beneficial use of stored water as outlined in the project document plan, and consistent with Federal and Oregon water laws.

3-15. In accordance with a proposed memorandum of understanding between the Secretaries of Agriculture and Army, the development and management of project lands in the lake area will be the responsibility of the U.S. Forest Service. The Willamette National Forest Supervisor's office will be responsible for the nature and extent of development, and the issuance of special use permits and concession contracts. A limited area in the immediate vicinity of the dam will be administered by the Corps for operational purposes.

3-16. Debris control. - The watershed above Blue River Lake is extensively timbered and logging operations in the area will be a constant source of debris, which will accumulate on the pool. The debris will be collected, beached, and disposed of whenever the accumulation becomes a hazard to the operation of the project.



SECTION IV - CLIMATOLOGY

4-01. General. - The climate of the area upstream from Blue River Dam is characterized by mild, wet winters and warm, dry summers. With the exception of occasional periods of continental air mass control, maritime air masses dominate the area throughout the year. Principal climatic controls are topography, proximity to the Pacific Ocean, and location near the center of the belt of prevailing westerly winds. The area is subject to storms of varied intensity which occur most frequently during the winter months. Summer storms occur occasionally and are generally of the convective type, characterized by short duration and small areal coverage. Winter temperatures are often below freezing at the higher elevations, resulting in considerable accumulation of snow.

4-02. Climatological records. - No climatological stations are located in the Blue River Basin. The nearest station with a significant record is at McKenzie Bridge Ranger Station, located about 10 miles east of Blue River Dam on McKenzie River at elevation 1,478 feet, mean sea level. Records extend back to 1902, with the period 1914 through 1930 missing. Short records are available for several other nearby stations; namely, Cascadia State Park, Holley, Leaburg, and Marcola. The longest and most complete climatological record in the southern portion of the Willamette Basin is at Eugene. The Eugene record extends from October 1890 to date. Plate 1 shows the location and length of record of climatological stations, stream gages, and snow courses in and adjacent to the Blue River Basin.

4-03. Precipitation. - Normal annual precipitation over the area tributary to Blue River Dam is approximately 90 inches, ranging from about 70 inches at the dam to more than 100 inches in the headwaters. About two-thirds of the annual precipitation normally falls during the 5-month period, November through March. Normal amounts are less than 1 inch during each of the months of July and August, and rainless periods of 30 to 60 days are not uncommon during the summer. Precipitation data for stations in the vicinity of the project are shown on plate 5 and in tables 2, 3, and 4.

4-04. The areal distribution of normal annual precipitation over the McKenzie River Basin, including the area tributary to Blue River Dam, is shown on plate 6. Except for short records taken at the Willamette Basin Snow Laboratory, no precipitation records are available within the Blue River Basin. The normal annual isohyetal pattern was developed as a part of a comprehensive study for the Willamette River Basin. Available precipitation, streamflow, and snow course data and topography were taken into consideration in preparing the annual isohyetal map for the basin.

4-05. At McKenzie Bridge Ranger Station, where the weather and climatic conditions are considered to be similar to those at the dam, the greatest 1-day precipitation of record was 5.40 inches on 22 November 1909. The wettest month of record was December 1964 when 26.94 inches of precipitation was measured at the station. On the average, 0.01 inch or more of precipitation occurs on 145 days per year. Tables 2 and 3 present climatological data by months for McKenzie Bridge Ranger Station

and Eugene, respectively. Table 4 summarizes climatological data for selected stations adjacent to the basin.

4-06. Snow. - Approximately 10 percent of the precipitation at McKenzie Bridge Ranger Station falls as snow, and it is reasonable to assume that a similar percentage falls as snow at Blue River Dam. Snow survey data for selected stations representative of snow conditions in Blue River drainage basin are shown in table 5. Plate 5 graphically illustrates the variations in depth and water equivalent of the snowpack by months at representative snow courses. It is estimated that at the mean elevation of the basin, 3,050 feet, approximately one-fourth of the annual precipitation occurs as snow. Above 4,000 feet more than one-third of the annual precipitation occurs as snow, which tends to accumulate until March or April. Snow cover below 2,000 feet is transient and may accumulate and disappear several times during a winter season. Heavy rain accompanied by high temperatures has produced significant snowmelts which contributed appreciably to the magnitude of floods, particularly their volumes. A notable example was the December 1964 flood when an excessive snowmelt contributed significantly to the flood volume and to the flood peak.

4-07. Temperatures. - Because of the moderating influence of maritime air from the Pacific Ocean, seasonal variations of temperatures are comparatively small. Average monthly temperatures at McKenzie Bridge Ranger Station, as shown in table 2, range from 34.9° F. in January to 66.5° F. in July. The average daily minimums range from 25.4° F. in January to 46.4° F. in July. Average daily maximums for

January and July are 42.9 and 85.4^oF., respectively. These temperatures are representative of conditions at Blue River damsite. Temperatures generally decrease about 3^oF. per 1,000-foot rise in elevation. A summary of temperature data at stations adjacent to the basin is shown in table 4 and on plate 5.

4-08. Storms. - Flood-producing storms occur chiefly during the winter season but are not uncommon in late fall and early spring. The seasonal storm pattern is largely a result of the southward displacement of the Aleutian Low during the winter season. With the increased pressure gradient between the Aleutian Low and the Pacific High, a strong westerly to southwesterly flow of moist maritime air occurs over the area. Lifting of the air over topographic barriers, augmented by convergence and frontal lifting, results in intense precipitation of flood-producing proportions. Frontal activity generally consists of a series of north-south-oriented, occluded fronts moving eastward over the area. Frequently, however, a quasi-stationary front will develop over the ocean and extend over the area in an east-west direction. The strong westerly flow of moist air and minor waves associated with such fronts result in continuous precipitation, generally of high intensity, in the frontal area.

4-09. The sequence of meteorological events in December 1964 produced the greatest flood of record in the Willamette Basin. The synoptic situation prior to the storm consisted of a high pressure area dominating the Pacific Northwest. Beginning on the 18th, a weakening of the high and the passage of several fronts resulted in light to

moderate precipitation through the 20th. Prior to the 21st, freezing levels were generally below 3,000 feet; thus, a large percentage of the precipitation between the 18th and 21st occurred as snow. A strong westerly flow of moist air accompanied by several storm fronts resulted in intense rains on the 21st and 22d, with lesser amounts occurring thereafter. Freezing levels began rising on the 19th, reaching elevation 10,000 feet over Salem on the 22d, resulting in high snowmelt, thus augmenting the runoff resulting from the intense rainfall. A sharp drop in temperatures and diminished precipitation on the 31st marked the end of a 13-day storm period.

4-10. On the basis of reports from adjacent stations it is estimated that 25 inches of precipitation fell over the Blue River Basin during the 13-day storm period, 0700 18 December to 0700 31 December. Maximum 24-hour and 72-hour basin precipitation depths are estimated to be 6 and 13 inches, respectively.

4-11. Winds. - No data are available on wind speed in the Blue River Basin. For reference purposes wind data observed at Eugene, Oregon, from 1941 to 1965 were cited. On the average, the wind at Eugene is 3 miles per hour or less about 37 percent of the time. Sixty-one percent of the time the wind speed is between 4 and 15 miles per hour. For the remaining 2 percent of the time the wind speeds vary from 16 to 45 miles per hour with gusts in excess of 80 miles per hour. The highest wind of record at Eugene occurred on 12 October 1962 with a maximum 1-minute velocity of 63 miles per hour and a maximum gust of 86 miles per hour. Velocities ranging from 45 to 55 miles per hour were sustained for about

2 hours during that storm.

4-12. Evaporation. - The Blue River Basin is characterized by climatic conditions which are conducive to high rates of evaporation during the summer months. No evaporation records are available for the Blue River Lake area. Records at Fern Ridge Lake, located about 25 miles northwest of the basin, show an annual land pan evaporation of 38.5 inches, of which approximately 40 percent occurs during July and August. Evaporation is negligible during the winter months. It increases progressively during the spring months and decreases during the autumn months. Table 6 shows estimated average monthly evaporation amounts for Blue River Lake. Those values are based on data observed at Fern Ridge Lake which have been adjusted in accordance with studies made by Corps of Engineers at Lookout Point Lake. Using pan evaporation values obtained at Fern Ridge Lake, and applying pan coefficients estimated for Blue River Lake as shown in table 6 and weighted seasonal surface area of Blue River Lake, it is estimated that over 1,200 acre-feet of water will be lost each year by evaporation.

SECTION V - HYDROLOGY

5-01. Discharge records. - Discharge records for Blue River near Blue River, Oregon, are available for the period September 1935 through December 1964. The area tributary to the station is about 15 percent less than the area tributary to the dam. Discharges and runoff at the station were adjusted for the difference in drainage area and used at the dam. Two new gaging stations were established in September 1963 to record the inflow to Blue River Lake, one on Blue River and one on Look-out Creek. A station was established August 1966 downstream from the dam to record lake releases. A lake gage was established in October 1968. Plate 1 shows the location, period of record, and other data for stations pertinent to Blue River Dam.

5-02. The McKenzie River station near Coburg is the primary downstream control point for flood regulation at Blue River Lake. Other significant control points are Willamette River at Harrisburg and Albany.

5-03. Streamflow characteristics. - The streamflow regimen of Blue River and tributaries is similar to the seasonal precipitation pattern. Low flows normally prevail from June through September, the season of low precipitation. Higher flows, which may fluctuate widely, prevail during the remainder of the year, the season of high precipitation. Snowmelt at the high elevations sustains a moderate base flow until early summer. From July through September the streams recede to their minimum flows. Daily discharge hydrographs shown on plates 7

through 10 illustrate the streamflow pattern, the frequency of high and low water periods, and the flashy character of the floods in the Blue River and McKenzie River Basins. Nearly 90 percent of the annual runoff occurs during the 8-month period, November through June.

5-04. Runoff. - A runoff summary of minimum, maximum, and mean monthly flows at Blue River Dam, including a flow-duration curve, is shown on chart 5. Those data show that the inflow to Blue River Reservoir, based on past records, will equal or exceed 300 c.f.s., 50 percent of the time and will equal or exceed 30 c.f.s., 90 percent of the time. Annual runoffs at Blue River Dam, for the period 1926-1964, are shown in table 7 and are graphically illustrated on chart 5. The mean annual runoff at Blue River Dam is 433 c.f.s., 313,600 acre-feet, or 66.82 inches. Extremes in annual runoff are 480,600 acre-feet in 1956 and 152,800 acre-feet in 1931.

5-05. Flood characteristics. - Floods on Blue River and tributaries are produced by intense precipitation of 2 to 4 days duration, augmented to varying degrees by snowmelt runoff. The snowmelt contribution is largely from areas of low and intermediate elevations and generally increases the volume with relatively little effect on the flood peak. A notable exception was the December 1964 flood when excessive snowmelt not only contributed to the flood volume but likewise to the peak. Frozen ground prior to the flood contributed to the excessive runoff. The bulk of the high-level snowpack usually melts and runs off without damaging effects after the first of March. When periods of intense rainfall, which occur frequently during the rainy season, are preceded by an

extended period of moderate precipitation that saturates the ground, a flood develops. Double-crested floods are not uncommon and may at times create lake regulation problems because of the excessive volumes.

5-06. The area tributary to Blue River Dam is heavily timbered and normally little damage occurs in the upstream reaches of the basin. An exception was the December 1964 flood when trees were swept from the hillsides into the channel and bank erosion was extensive. The duration of the average flood in the upper reaches is usually from 3 to 5 days, but a series of storms have extended the period of downstream flooding to a week or more. The maximum high water in any year can occur in any month from October through April.

5-07. Flood frequencies. - Recorded and computed maximum annual discharges through 1965 at the Blue River damsite were used in the derivation of the maximum annual flood frequency curve shown on chart 6. The following tabulation shows computed peak discharges for Blue River Dam for selected recurrence intervals.

<u>Average recurrence interval in years</u>	<u>Maximum discharge in c.f.s.</u>
5	10,200
10	12,400
25	15,500
50	18,000
100	20,400

5-08. Past floods. - The maximum flood peak observed since the establishment of the gate on Blue River near Blue River, Oregon, was 19,600 c.f.s. in December 1964, which corresponds to 22,000 c.f.s. at

Blue River Dam. This peak discharge was not only higher than any other peak of record, but was also greater than the estimated peak of 18,000 c.f.s. for the historical flood of December 1861. Table 8 lists annual peak discharges at selected stations in the basin. The 8-day volume of the December 1964 flood was 114,800 acre-feet which was greater than any of the other past floods of record. It has been estimated that the historical flood of December 1861 had an 8-day volume of about 106,600 acre-feet. Flood volume frequencies for several durations are shown on chart 7. The 8-day volume of the December 1964 flood has a probable recurrence frequency of once in more than 100 years on the average.

5-09. Channel velocity. - Blue River has an average slope of about 100 feet per mile. The slope at the head of Blue River Lake is about 80 feet per mile. The following tabulation shows average stream velocities that were experienced in the natural channel in vicinity of the dam prior to its completion. They are based upon velocities observed at the former gaging station located upstream from the dam.

Discharge in c.f.s.	Average velocity in feet per second
50	0.6
500	2.2
2,000	5.0
6,000	9.3
10,000	12.4
12,000	13.8

Maximum velocity may be as much as 50 percent greater than the average velocity. The normal maximum release from Blue River will be 3,700 c.f.s.; therefore, velocities greater than 7 feet per second will seldom occur.

5-10. Channel capacities. - In the 1.8 mile reach from Blue River Dam to the mouth of Blue River, the channel capacity is greater than 5,000 c.f.s. Normal maximum scheduled release from the dam is 3,700 c.f.s. In the McKenzie River from the mouth of Blue River to river mile 31, the channel capacity is adequate. Below river mile 31 the McKenzie River Valley widens, the stream meanders, and the riverbanks become lower. In the lower reach, the channel capacity is 22,000 c.f.s. In the past, the downstream areas near the confluence with Willamette River have experienced damaging floods, often several times in one flood season.

5-11. Flood regulation at Blue River Lake will first consider protecting lands along lower McKenzie River, using the stage at the gaging station near Coburg as an index. Existing bankfull capacity in that reach of the river is approximately 22,000 c.f.s. As the Blue River project controls runoff from only 7 percent of the area above Coburg, its effectiveness will depend upon operation to supplement regulation provided by other storage projects in the McKenzie River Basin. Even then, the channel capacity of 22,000 c.f.s. will be exceeded frequently by runoff from the uncontrolled area. Bankfull capacities at downstream locations pertinent to the operation of Blue River Lake are shown in the following tabulation:

Station	Stream	Drainage area in square miles	Bankfull data	
			c.f.s.	Stage
Coburg	McKenzie River	1,337	22,000	8.7
Harrisburg	Willamette River	3,420	47,000	9.0
Albany	Willamette River	4,840	60,000	19.2

5-12. Outlet capacity. - The outlets in Blue River Dam are designed to discharge 3,710 c.f.s. at minimum flood control pool, elevation 1,180. Maximum discharge at maximum pool, elevation 1,357, is 8,400 c.f.s. The outlets will seldom be utilized at maximum capacity as normal maximum scheduled release is 3,700 c.f.s. A full lake can be evacuated in approximately 2 weeks without exceeding the normal maximum scheduled release. Discharge rating of the outlets is given in table 1 and on charts 3 and 4. During a spillway design flood, the outlets will complement the spillway. The spillway capacity at elevation 1,357 is 53,220 c.f.s. The outlets and spillway combined will discharge a total of 61,620 c.f.s., which is adequate to pass the spillway design flood with the lake at maximum pool at start of the flood.

5-13. Lake capacity. - The principal criterion, in determining the flood control storage requirement for Blue River Lake, was that the lake should be capable of effectively regulating floods the magnitude of the December 1861 and December 1964 floods. Regulation would be effected until such time that the controlled spill would not result in a secondary flood crest at Coburg in excess of that caused by the peak runoff from the uncontrolled area between the dam and Coburg. A lake capacity of 85,500 acre-feet will provide that degree of flood regulation. All floods of record, with the exception of the December 1964 flood, can be completely controlled at the dam with the flood control storage space provided in Blue River Lake, which is equivalent to 18 inches of runoff from the area tributary to the lake.

5-14. Total capacity of Blue River Lake at full pool, elevation 1,357, is 89,520 acre-feet. Of that amount, 3,970 acre-feet is dead and inactive storage below minimum flood control pool, elevation 1,180. The 85,550 acre-feet of storage space between elevations 1,180 and 1,357 will be reserved for flood regulation between 16 November and 31 January. See chart 8 for the annual flood control storage reservation schedule. After the major flood season, 1 February, 78,850 acre-feet of the space reserved for flood regulation will be filled gradually for conservation use. Storage space between elevations 1,350 and 1,357, amounting to 6,700 acre-feet, will be reserved for summer flood regulation. Lake storage and area curves are shown on chart 2.

5-15. The total flood control storage space is a combination of primary and secondary storage space. Primary storage space will control all floods of record with the exception of the December 1861 and December 1964 floods. The secondary flood control storage space provides the extra space to effectively control floods the magnitude of the December 1861 and December 1964 floods. Floods of the 1861 and 1964 magnitude are most apt to occur during the major flood period, December and January. The records show flood magnitudes decrease gradually after 1 February. Therefore, the secondary flood control storage space can be filled in February along with the pro-rated portion of the primary storage space. Early filling of the secondary flood control storage space enhances the probability of the multiple-use storage space being filled by early May. This is all accomplished with a minimum risk to the flood control effectiveness of the project.

5-16. Sedimentation. - The channel of Blue River in the vicinity of Blue River Lake is typical of the tributaries which originate high in the Cascade Range. The riverbed is composed largely of gravel and boulders underlain with solid rock. Where vertical banks exist, alluvial material composed of topsoil and sand interspersed with gravel and boulders is in evidence. Only during intense storms is there any appreciable erosion of the watershed and riverbanks. No significant bedload movement is anticipated because of the nature of the streambed.

5-17. Sedimentation studies made in the Willamette River Basin from 1949 to 1951 showed that suspended sediment concentrations in mountainous streams similar to Blue River in the vicinity to Blue River dam were not significant except during flood periods. In addition to the 1949-1951 suspended sediment studies, surveys have been of the sediment ranges established at Cottage Grove, Fern Ridge, and Dorena Lakes which show that silting has had no appreciably adverse effect on the capacities of the existing lakes.

5-18. No suspended sediment observations have been made in the vicinity of Blue River Lake. Between 1949 and 1951, 331 samples of suspended sediment were taken at the gaging station on McKenzie River near Coburg. Analysis of those samples showed that, during low flows, only a trace of sediment was evident. A maximum concentration of 240 parts per million was observed during a flood. Suspended sediment rates in Blue River Lake should be approximately the same as those observed on McKenzie River at Coburg. On the basis of those suspended sediment data and surveys of existing lakes, it is estimated that the average annual

silting of Blue River Lake will not exceed 25 acre-feet. Therefore, loss of lake storage space will be small and will not materially affect the storage capacities during the economic life of the project.

5-19. A system of eight permanent index-type sedimentation ranges for evaluating degradation and aggradation of the river channel above and below the dam, and future silting in the lake, has been established. Experience at existing lakes in Willamette River Basin indicates that resurveys would be required infrequently. Plate 11 shows the sediment ranges established at Blue River. For complete information on the sedimentation ranges refer to the report: "Sedimentation Ranges Established 1968, Blue River Reservoir", dated October 1969.

5-20. River temperatures. - Observations of water temperatures in Blue River began in July 1961 at the Blue River gaging station near Blue River and the data are available through December 1964. At Blue River below Tidbits Creek, an inflow station, records are available from September 1963 to date. Lookout Creek, another inflow station, has water-temperature records available for the periods September 1950 to September 1955 and September 1963 to date. Records of water temperatures for Blue River at Blue River below Blue River Dam were started in August 1966.

5-21. Water temperatures at the inflow stations will be fairly representative of water temperatures in the vicinity of Blue River dam-site. At Lookout Creek, the station with the longest record, water temperatures have varied from a low of 33^oF. in March 1951 to a high of 69^oF. in July 1965. Charts 9 through 13 show water temperatures for the inflow stations of Lookout Creek and Blue River for their periods

of record. Because of the short period of record at the station below the damsite, no comparison can be made in water temperatures above and below the dam.

5-22. Lake temperatures. - Temperature observations at existing lakes in Willamette Basin show the water to be isothermal from about 1 November through February with the temperature in the low forties. After 1 March a thermocline starts to develop which reaches a maximum in late August. After 1 September, surface cooling will result in a gradual recession in the thermocline until the lake becomes isothermal about 1 November. Maximum surface temperatures will occur in late July or August and normally will not exceed 68°F. In an unusually warm summer a surface temperature in the low seventies is possible.

5-23. The temperature of water released from Blue River will vary from 40°F. during the winter months to a maximum of 62°F. in late summer as the pool nears minimum flood control elevation. A major portion of the stored water will be released during July and early August at an average temperature of about 55°F. The released water will be 10 to 15 degrees cooler than the temperature of the inflow to the lake. Outlets at Blue River are located near the bottom of the lake and will draw off the cooler water at the bottom of the lake first. As the cooler water is depleted, the accumulated warmer water near the surface will gradually recede to the level of the outlets. When this occurs in late August and September the temperatures of the released water may exceed 60°F.

5-24. Water quality. - Experience at existing lakes in Willamette Basin indicates that the dissolved oxygen content of the water in the

lake will vary from 10 to 8 parts per million throughout most of the year. There has been one instance, in an initial year of operation, where a layer of low-quality water, with zero dissolved oxygen and some hydrogen sulfide content, developed near the bottom of a Willamette Basin Lake in late summer. This was only one lake out of ten where this situation became an operational problem. Since then it has become an operational policy during the first years of operation to monitor the dissolved oxygen content and temperature of water in the lake during the late summer months. That policy will be followed at Blue River. The amount of vegetation inundated when the lake becomes operative could be related to this hydrogen sulphide problem. A lake area that is relatively free of vegetation should provide water of an acceptable dissolved oxygen content at all times. Blue River would be in this classification.

6

SECTION VI - FLOOD CONTROL REGULATION

6-01. General criteria. - Both during a flood and the evacuation of stored floodwaters, flood control regulation at Blue River Lake will be closely coordinated with the regulation of Cougar Lake on South Fork McKenzie River, as well as with the regulation at all other flood control projects in the Willamette River Basin. During floods and the evacuation of stored floodwaters, releases from the lake, insofar as possible, will be regulated so as to maintain downstream flows within banks.

6-02. If a series of small floods or a large flood results in a situation wherein the remaining storage space in Blue River Lake will not completely regulate the remaining flood runoff at the site, 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 the flood is too large to be completely controlled by the remaining storage in the lake; this will avoid an abrupt increase in outflow resulting from an uncontrolled spill. This operation will also result in a lower maximum release than that which would occur if the lake were permitted to fill and spill.

6-03. Blue River has 85,550 acre-feet of storage space allocated to flood control, which will regulate effectively, at the dam, the December 1964 flood which has a recurrence probability of once in more than 100 years. The watershed tributary to Blue River Lake, 88 square miles, experiences a mean annual runoff of 67 inches, much greater than that experienced in many watersheds in the Willamette Basin. Therefore,

regulation of floods on Blue River is essential to controlling floods in the lower McKenzie River Basin. Downstream control points are Coburg on McKenzie River, drainage area 1,337 square miles, and Harrisburg on Willamette River, drainage area 3,420 square miles.

6-04. Flood control regulation schedule. - The annual flood control storage reservation schedule for Blue River Lake is shown on chart 8. Flood regulation will not be initiated as long as the lake inflow can be passed without it contributing to over-bankfull stages at the downstream control points. When precipitation and forecasted streamflows indicate that a release from Blue River Lake will contribute to flows at Coburg in excess of 22,000 c.f.s., the bankfull discharge, the release from Blue River Lake will be reduced as shown on chart 14, and the excess water will be stored. Even with the release from Blue River and Cougar Lakes reduced to a minimum, there will be frequent occasions when the flow at Coburg will exceed 22,000 c.f.s. Blue River and Cougar Lakes control runoff from only 22 percent of the area tributary area to the Coburg gaging station. Runoff from more than 1,000 square miles in McKenzie River Basin is uncontrolled by Blue River and Cougar projects.

6-05. Precipitation-index parameters and the runoff from the uncontrolled area between Cougar Dam, Blue River Dam, and the control station at Coburg are the bases for scheduling releases from Blue River and Cougar Lakes. Chart 14 shows the combined release from Blue River and Cougar Lakes for various precipitation indices and corresponding uncontrolled runoffs from the 1,042 square miles of area downstream from Blue River and Cougar projects. The combined releases are predicated

on Coburg not exceeding bankfull stage. Distribution of the indicated reduction in release from Blue River and Cougar would take into consideration the flow in the two streams and the storage space available in the two projects. Normally the combined release would be proportional to their usable flood control capacities, 35 percent from Blue River and 65 percent from Cougar. Precipitation and local runoff conditions will be observed at regular intervals and adjustments will be made in the lake release as indicated by the flood regulation curves. Runoff forecasts are indirectly incorporated into the flood regulation curves by the precipitation-index method of scheduling the lake releases as they were derived using observed data. The curves represent the best fit of the numerous plotted points.

6-06. Evacuation of stored floodwater should not be initiated until streams below the project have receded to within-bank stages; ~~then~~ the evacuation should be scheduled so as not to exceed bankfull stages. An exception to this normal procedure would occur when the lake is full or near full and there are indications of another flood. In that situation a limited evacuation should be undertaken before the streams receded to bankfull in order to be prepared for a second flood. Evacuation under no circumstances should create a downstream flow greater than that experienced during the flood.

6-07. Special flood regulation schedule. - A special flood regulation 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 Blue River Lake is a deviation from the normal

flood control regulation schedule and is shown on chart 15. The special flood regulation curves shown on chart 15 were derived using a " T_s " that varied from 0.6 for high flows to 1.2 for lower flows. The variable " T_s " adequately reproduced the recession of the larger volume floods. The 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 spill avoided. The special curves should be entered with current pool elevation and lake inflow to determine what the outflow should be to make optimum use of the remaining storage. The procedure results in a gradual increase in the outflow and a lower maximum lake release than that which would occur should no special action be taken. Maximum increase in outflow should be limited to 600 c.f.s. per hour. Experience has shown that a reduction in a previously established outflow on the basis of the special flood regulation curves should not be made on the basis of one observation; this is to avoid excessive fluctuations in the outflows. Usually two successive observations will establish a definite trend. This procedure of waiting to observe a trend only applies to reducing the outflow, not increasing the outflow; the latter operation should comply with the special curves or the maximum of 600 c.f.s. per hour whenever indicated. Maximum pool level reached from using special curves should be maintained until evacuation of stored water is initiated.

6-08. Examples of regulation. - Examples of flood regulation are illustrated on plate 12 for the flood of December 1964, the largest observed flood of record in Willamette River Basin; the flood of December

1955, and the flood of December 1945. All of the floods were of major flood proportions.

6-09. In studying each flood it was assumed that the lakes at Hills Creek, Lookout Point, Fall Creek, Dorena, Cottage Grove, Cougar, and Blue River functioned and that all were at their minimum flood control pools at the beginning of each flood. Data essential to operation of the lake (precipitation, Blue River inflow, regulated outflow, and pool elevation) are shown for each sample of flood regulation. Flow for McKenzie River at Coburg is shown for three conditions: (1) natural, (2) as modified by Cougar, and (3) as modified by Cougar and Blue River. Also illustrated are three flow conditions of Willamette River at Harrisburg: (1) natural; (2) as modified by Hills Creek, Lookout Point, Fall Creek, Dorena, Cottage Grove, and Cougar; and (3) as modified by lakes listed in condition (2) plus Blue River. The third situation in each instance illustrates the effectiveness of Blue River Lake.

6-10. The December 1964 flood had a peak discharge of 22,000 c.f.s. and an 8-day volume of 114,800 acre-feet at Blue River Dam. Based upon both maximum discharge and volume, the 1964 flood was greater than a 100-year flood. As shown on plate 12, Blue River Lake release would have been maintained at 50 c.f.s. during most of the flood, after which the special flood regulation schedule would have prescribed a gradual increase in the outflow. The maximum release which occurred near the end of the flood would have been 6,400 c.f.s. At Coburg, the natural peak discharge was reduced from 112,000 c.f.s. to 83,700 c.f.s. by Cougar Lake. Blue River would have effected an additional reduction of 17,300

c.f.s., reducing the Coburg regulated flow to 70,000 c.f.s. The natural discharge at Harrisburg would have been reduced from 280,000 c.f.s. to 115,000 c.f.s. by six of the lakes listed in paragraph 6-09. Blue River would have effected an additional 16,000 c.f.s. reduction, reducing the Harrisburg regulated flow to 99,000 c.f.s. which is approximately twice the existing channel capacity of Willamette River in the vicinity of Harrisburg.

6-11. The December 1955 flood had a total volume of 53,000 acre-feet at Blue River Dam, and a peak discharge of 10,700 c.f.s. This flood which has a 7-year recurrence frequency based on peak discharge, could have been completely controlled at Blue River Dam using about 50 percent of the flood control storage. The peak discharge at Coburg would have been reduced from 73,500 c.f.s. to 60,000 c.f.s. by Cougar Lake. Blue River would have effected an additional reduction of 7,500 c.f.s., reducing the Coburg regulated flow to 52,500 c.f.s. The natural discharge at Harrisburg would have been reduced from 190,000 c.f.s. to 92,000 c.f.s. by six of the reservoirs listed in paragraph 6-09. Blue River would have effected an additional 9,000 c.f.s. reduction, reducing the Harrisburg regulated flow to 83,000 c.f.s.

6-12. The flood of December 1945, a 20-year flood based on maximum discharge, had a total volume of 52,000 acre-feet and a peak discharge of 15,000 c.f.s. at Blue River Dam. The flood could have been completely controlled at the dam using 50 percent of the flood control storage. At the same time, a minimum release from the lake of 50 c.f.s. would have been maintained throughout the flood. At Coburg, the natural peak

discharge would have been reduced from 88,200 c.f.s. to 72,000 c.f.s. by Cougar Lake. Blue River would have effected an additional reduction of 10,000 c.f.s., reducing the Coburg regulated flow to 62,000 c.f.s. The natural discharge at Harrisburg would have been reduced from 213,000 c.f.s. to 106,000 c.f.s. by six of the lakes listed in paragraph 6-09. Blue River would have effected an additional reduction of 12,000 c.f.s., reducing the Harrisburg regulated flow to 94,000 c.f.s.

6-13. Regulation of the spillway design and standard project floods for Blue River Lake, shown on charts 16 and 17, respectively, offers examples of unusual flood regulation as both floods exceeded the flood control capacity of the project and special flood regulation had to be effected to make optimum use of the available storage. An empty lake at the start of the flood was assumed in both routings. Results of routing the two floods are as follows:

a. Spillway design flood. - Chart 16, shows it was necessary to start using the special lake regulation curves about 4 hours before the inflow to the lake crested. The peak inflow of 61,300 c.f.s. was reduced to a discharge of 48,800 c.f.s., which occurred about 7 hours after the peak inflow and represents a reduction of 12,500 c.f.s. at the damsite.

b. Standard project flood. - The peak inflow of the standard project flood of 24,000 c.f.s., shown on chart 17, was reduced to a maximum release of 13,380 c.f.s. Special flood regulation curves were utilized before the inflow to the lake peaked. Maximum release occurred about 9 hours after the flood crested.

7

Blue River

SECTION VII - STORING FOR CONSERVATION

7-01. General. - Willamette River Basin is unique in that the same storage space can be scheduled for flood control and water conservation uses. Space reserved for flood control during the winter rainy season can be filled gradually for conservation near the end of the flood season as the storm activity decreases, without jeopardizing the flood control effectiveness of the project. After 1 February, storms over the Blue River Basin decrease in both intensity and frequency. By mid-May the probability of a flood capable of producing overbank stages is small; therefore, during the period, 1 February through 10 May, 78,850 acre-feet of the 85,550 acre-feet reserved in Blue River Lake for flood regulation will be gradually filled for conservation use. Six thousand, seven hundred acre-feet of space is retained for summer flood regulation. The largest late-spring or summer flow of observed record at Blue River project from 1935 to 1965 occurred in May 1949. Although the high water had an estimated recurrence frequency of once in 100 years, the high water could have been effectively controlled at Blue River by the scheduled storage space reserved for late season floods.

7-02. Filling schedule. - The filling schedule for Blue River Lake, shown on chart 8 and in table 9, permits storing at an average accumulative rate of 1,188 acre-feet per day during February and 642 acre-feet per day during the remainder of the filling season. The schedule permits filling of the lake to elevation 1,350, maximum conservation pool level, by 11 May and at the same time provides adequate storage space to control probable floods during the filling season. Scheduled pool elevations,

shown on chart 8 and in table 9, should not be exceeded, except in case of a flood. Above elevation 1,350, maximum conservation pool, 6,700 acre-feet of space is reserved for control of late-season floods. The filling schedule shown on chart 8 is the upper limit line which should not be exceeded by more than a few feet except in case of a flood. This schedule reserves flood control storage space consistent with the normal decrease of the flood potential during the conservation storing season. Flood control, a principal function of Blue River Lake, would be jeopardized by indiscriminate encroachment above the filling schedule. There is no objection to filling at a lesser rate than indicated by the rule curve provided the action does not jeopardize the conservation filling, which can be forecast from the water content of the snowpack upstream from Blue River Lake. The minimum rate of storing, which will provide reasonable assurance of filling the lake, varies from year to year depending upon weather and snow conditions in the basin above the lake. Departures from the filling schedule shown on chart 8 may occur as the result of: (1) a water supply in the basin snowpack that is more than adequate to fill the lake, (2) an inadequate water supply, and (3) the occurrence of a flood. Each of the above conditions is discussed in the following paragraphs.

7-03. Water supply more than adequate. - Should an excessive snowpack exist upstream from the lake, filling will be temporarily curtailed in the interest of providing a greater flood reservation to insure adequate storage space for regulating any flood that might develop from an abnormal snowmelt. An excessive snowpack would exist when the forecasted

runoff, based upon minimum precipitation for the remainder of the storing period, indicates that the volume of runoff will exceed the storage space to be filled after providing for minimum downstream releases. Runoff forecast curves that would be used to effect this particular storage regulation are discussed in paragraph 7-08.

7-04. Inadequate water supply. - There may be times when the lake inflow will not be adequate to maintain the minimum release of 50 c.f.s. and fill at the scheduled rate. Under such circumstances, conservation storing will fall behind schedule, as minimum release takes precedence over storing for conservation uses. Any deficiency in filling, regardless of the reason, will be made up at a later date if there is an excess of streamflow after providing for downstream minimum flow requirements.

7-05. Plate 13 illustrates a hypothetical regulation of Blue River Lake, based on monthly flows during a 30-year period, 1926-1955. This study shows that runoff during the filling seasons was sufficient to meet all water requirements and still fill the lake to maximum conservation pool, elevation 1,350, in all but 3 years. In 1941, the most critical storing year, the lake would have filled only 74 percent at the end of the storing season. Plate 13 also shows the computed natural inflows, the regulated outflow, and the water stored. A storage capacity curve for Blue River Lake is shown on the same plate. Table 10 shows lake capacities in tabular form to the tenth of a foot.

7-06. Occurrence of a flood. - Although the flood potential of the basin 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 Section VI of this manual, using the schedules shown on charts 14 and 15. Following any flood that might occur during the conservation storing season, excess floodwater stored in Blue River Lake will be evacuated and the pool will be drawn down to the pool elevation indicated by the rule curve.

7-07. Flexibility in annual filling schedule. - The scheduled pool elevations, shown on chart 8 and in tables 9 and 11, should not be exceeded, except in case of a flood or when the season runoff forecast clearly indicates a limited storing above the scheduled pool level is desirable. The annual filling schedule provides sufficient storage space to regulate all but the most infrequent floods during the February-May storing period. Frequent forecasts of residual runoff into the lake will be made during the filling season in order to establish the minimum storing rate which will provide reasonable assurances of filling the lake.

7-08. Residual runoff forecasts after February. - Any deviation in the rate of filling of Blue River Lake will be made on the basis of residual runoff forecasts which will be made at about 15-day intervals, starting on 1 February. The forecasted runoff determined from chart 18 will be for the period between the date of forecast and the end of June. Enter chart 18 with the residual runoff for Cougar Lake to determine the expected runoff into Blue River Lake during the same forecast period.

7-09. Each year forecasts of inflow to Cougar Lake, which are the bases of the Blue River forecasts, all made during the filling season. The forecasting method used is contained in NPP report "Procedure for Forecasting Inflow to Willamette Basin Power Reservoirs After 1 February", dated August 1965, revised January 1968.

SECTION VIII - UTILIZATION OF STORED WATER

8-01. General. - From 11 May through 15 November, stored water in Blue River Lake will be regulated primarily in the interest of the authorized conservation purposes of irrigation and navigation. Consideration will be given, however, to preservation of fish life and to water quality control and public use. Conservation benefits from Blue River project will be realized along lower McKenzie River, as well as along Willamette River below the mouth of McKenzie River.

8-02. By 16 November the lake must be evacuated to minimum flood control pool, elevation 1,180. Total conservation storage in Blue River Lake between minimum flood control pool, elevation 1,180, and maximum conservation pool, elevation 1,350, is 78,850 acre-feet.

8-03. Conservation release schedule. - The annual flood control storage reservation schedule for Blue River Lake, shown on chart 8, indicates the maximum pool elevations which should not be exceeded during all seasons of the year except in cases of floods.

8-04. Floods will rarely occur during the conservation release season from 11 May through 31 August; however, 6,700 acre-feet of flood control storage space will be reserved for control of minor freshets during that period. As the lake is drawn down after 1 September, storage space is gradually made available for flood regulation, and by 16 November 85,550 acre-feet, the maximum allocated to flood regulation, will be available, see chart 8 and table 11.

8-05. Should a flood occur during the conservation release season, the lake will be regulated in accordance with Section VI of this manual, and floodwaters will be stored to effect downstream flood regulation. 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.

8-06. Demands for stored water during the conservation release season will vary widely from year to year. Because of this variable demand and the variations in precipitation and streamflow, it is not practicable to establish a fixed schedule of lake releases during the low-water season. A provisional schedule for Blue River Lake, incorporating the basic principles outlined in the preceding paragraphs, will be prepared each year. This provisional schedule, which will be prepared on the basis of available stored water, will be reviewed periodically during the season and changes will be made should conditions warrant the changes.

8-07. Water-use priorities. - The priority of the use of stored water in Blue River Lake is as follows:

1. Domestic and municipal water supply
2. Maintenance of minimum flows
3. Irrigation (authorized project purpose)
4. Navigation (authorized project purpose)
5. Water quality control (secondary project purpose)
6. Recreation (secondary project purpose)

The above priorities on stored water are consistent with authorized project functions, State water laws, and policy. The project is committed to maintaining a minimum flow of 50 c.f.s. for fish life below the dam. Irrigation has a high priority on stored water with the Bureau of Reclamation having the responsibility of administering contracts for irrigation use. However, at the present time no contracts have been negotiated with irrigators for stored water in Blue River Lake. Present system policy is to supply early season irrigation requirements and low-water augmentation from nonpower lakes. Only a nominal draft on stored water at the power projects will be made prior to mid-August. No specific amount of stored water is reserved for navigation. The residual storage after providing for the higher priority usages will be released in the interest of navigation, and incidental water quality control. Releases made for all nonconsumptive uses will benefit both navigation and water quality control. Recreation, although not an authorized primary project function, will be extended as much consideration as possible so long as it does not jeopardize the authorized primary functions.

8-08. 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. The administration of the water laws of the State of Oregon is vested in the State Engineer, who issues permits for the use of water and is

generally recognized as an authority on all matters concerning adjudication and appropriation of water rights. Since January 1956, a seven-man Water Resources Board created by the 1955 session of the Oregon State Legislature has been active in programming beneficial uses of the waters of the State.

8-09. Prior water rights granted in accordance with Oregon law will be honored to the extent of the natural inflow into Blue River Lake. The proposed minimum release of 50 c.f.s. from Blue River Lake, during the July-November period, is in excess of all existing water rights for Blue River streamflow downstream from Blue River Dam. No problems associated with appropriated flows are anticipated in the regulation of Blue River project.

8-10. Minimum low-water release. - In the interest of maintaining an adequate flow of water downstream from the dam to sustain fish life during the low-water season, a minimum regulated release of 50 c.f.s. from Blue River Dam has been adopted. This minimum release was determined in cooperation with the U.S. Fish and Wildlife Service, the Oregon State Game Commission, and the Fish Commission of Oregon. Past streamflow records show the observed minimum mean daily discharge of Blue River at the dam to be 14 c.f.s. Normally the release from Blue River Dam will be in excess of 50 c.f.s. The 50 c.f.s. minimum is most likely to occur during a critical filling season or in the late fall after the lake has experienced an early drawdown for conservation purposes.

8-11. Irrigation. - Since both precipitation and natural flow of Willamette River and tributaries are low in July and August, irrigation

is becoming more dependent on storage as the acreage under irrigation increases. At the present time about 200,000 acres are being irrigated in the Willamette Valley. If the anticipated growth in irrigation continues, full development will be reached about the year 2010. Of the 552,300 acres of irrigable area in the Willamette River Basin, the Bureau of Reclamation estimated that 455,200 productive acres ultimately could be irrigated. About 88,500 acres of this total may be irrigated with McKenzie River water, which includes the Springfield and Coburg projects. The average annual diversion requirement from storage for the Springfield and Coburg projects is estimated to be 92,000 acre-feet. Approximately 57 percent, or 53,000 acre-feet, may be provided from Blue River Lake. In addition, Blue River Lake may ultimately be expected to supply about 4.4 percent of the water required to irrigate about 170,000 acres along the main Willamette River downstream from Eugene.

8-12. Under existing State law, irrigation has a high priority on stored water. If irrigation demands should develop, in the interim before all the authorized lakes in McKenzie River Basin are built, Blue River Lake could be called upon to furnish a greater amount of stored water for irrigation than the amounts indicated above.

8-13. The Bureau of Reclamation, which is responsible for the sale of stored water from Federal projects for irrigation, receives all payments for the United States Government. That agency has filed with the State Engineer on all multiple-purpose conservation storage in five of the 10 existing Willamette River Basin lakes: Lookout Point, Dorena, Cottage Grove, Fern Ridge, and Detroit. As of 1 May 1968, no filing had

been made on storage in Hills Creek, Cougar, Fall Creek, Green Peter, Foster, or Blue River projects. The Bureau will keep the Portland District informed of irrigation needs, so that long-range and day-to-day lake releases can include the irrigators' requirements. The Corps of Engineers will release stored water for irrigation at the request of the Bureau of Reclamation if a valid contract is in force.

8-14. Power. - No facilities were provided for production of hydroelectric power at the Blue River Project.

8-15. Navigation. - Natural flows during the summer and early fall are inadequate for navigation on Willamette River downstream from Corvallis and the situation is growing more acute as increased pumping from the river for irrigation depletes the natural flow. Dredging is done each year on Willamette River to supplement the streamflows at critical locations. Scheduled release of stored water from Blue River Lake, in coordination with releases from the other lakes in Willamette River Basin, will be made to provide increased flows for navigation.

8-16. When the authorized system of lakes is in operation, minimum flows of 5,000 c.f.s. at Albany and 6,000 c.f.s. at Salem will be maintained in all but the more critical low-water years. A system study, for the period 1926-1955, of the 14 lakes proposed for the Willamette River Basin, showed that the above minimum flows could have been maintained in all but 3 years during that 30-year period. The interim objective is to maintain as high a flow in Willamette River during the low-water season as is possible with the available volume of stored

water. In most years this will be less than the flows prescribed under ultimate system operation.

8-17. Water quality control. - Nonconsumptive releases from Blue River Lake will benefit stream purification by diluting the domestic and industrial wastes that are discharged into McKenzie and Willamette Rivers. In recent years, the quality of water in Willamette River has improved as the result of increased treatment of wastes and increased low-water flows maintained with stored water released from existing upstream lakes. No special regulation of Blue River Lake is contemplated for water quality control.

8-18. Recreation. - Blue River Lake provides opportunity for varied recreational use. This includes camping, picnicking, fishing, and boating. The U.S. Forest Service will manage the recreation resource at the lake as the project lies within the Willamette National Forest. Because of early drawdown of Blue River Lake for downstream water requirements, public use after mid-summer becomes limited. The steep shoreline topography along most of the shoreline is a factor in limiting the development of public use facilities.

8-19. Chinquapin Park site, along the south shore about 2 miles upstream from the dam, offers an opportunity for a significant park development. Sites on the upper reach of the lake have been partially developed for picnicking, camping, and boat launching by the Forest Service, and it is expected the Chinquapin site will be developed in the near future. Consideration is being given by the Corps to provide streamside improvement with limited public use facilities along Blue

River downstream from the dam. This is being studied in conjunction with a program for general environmental improvement.

8-20. Mosquito control. - No health control studies have been conducted at the project. Because of the sparseness of population in the vicinity and upstream from the lake, the possibility of the project becoming a malaria hazard is extremely remote. No facilities or special operational procedures are proposed for mosquito control.

8-21. Establishment of a special pool fluctuation schedule for mosquito control will be resorted to only if the hazard should become serious after other control methods have proved to be ineffectual. In most years, the required conservation releases will cause Blue River Lake to recede gradually during the low-water season. As the lake is drawn down, any mosquito breeding areas will be eliminated.

SECTION IX - HYDROMETEOROLOGICAL FACILITIES

9-01. General. - Effective regulation of Blue River Lake is dependent upon short- and long-range weather forecasts and daily quantitative precipitation forecasts for all zones in western Oregon during the rainy season, October through March. Those forecasts are prepared in the Seattle office of the National Weather Service and are relayed to North Pacific Division office and to the District office through the National Weather Service office in Portland by teletype.

9-02. In addition to the National Weather Service weather analysis and forecasts, supplementary forecasts will be made by the Division meteorologist as required. Weather maps are received in Division and District offices over the national weather facsimile circuit, which provides service 24 hours a day, 7 days a week. Normally, one set of surface and upper air charts are received each morning, Monday through Friday. During critical flood situations additional sets of weather charts can be made available at 6-hour intervals and over the weekends. In addition, there is close coordination with the Division office and the local Weather Bureau offices during flood periods, so that special lake, hydrologic, and weather information can be interchanged with a minimum of delay.

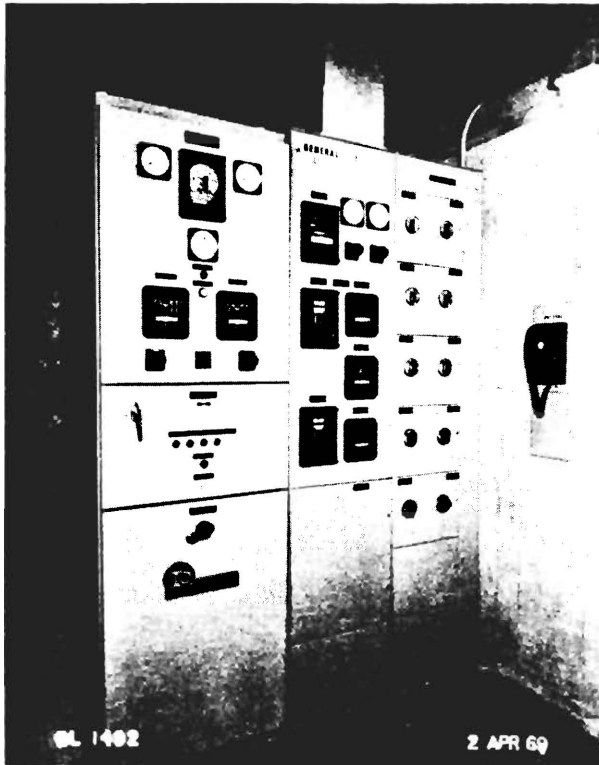
9-03. Weather station. - Only a limited amount of weather data will be collected at Blue River Dam because the project is operated by remote control from Cougar Dam. Only during critical periods when the pool is approaching full pool level will Blue River project be

manned. Weather stations are only operated at manned flood control and multiple-purpose lakes in Willamette River Basin. The nearest first-order Weather Bureau station from Blue River project is at Eugene, about 40 miles south and west.

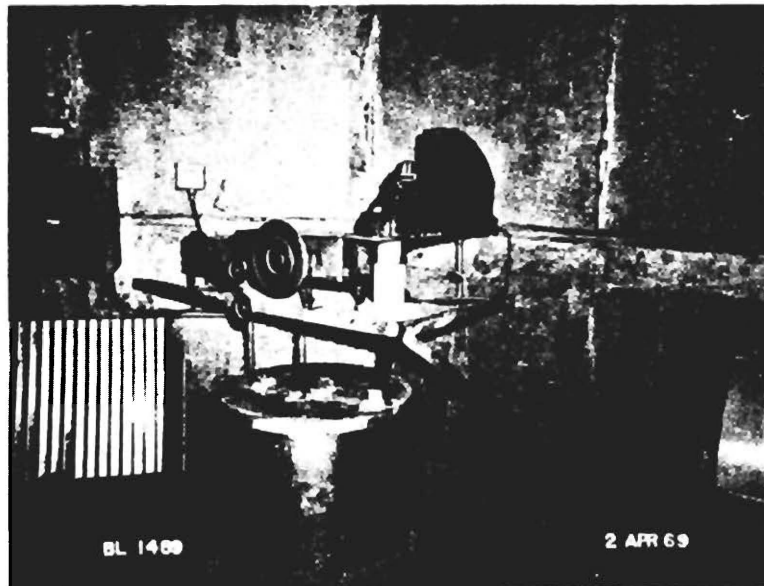
9-04. Precipitation stations. - No climatological stations are located in the Blue River Basin. The nearest station with a significant record is McKenzie Bridge Ranger Station, located about 10 miles east of Blue River project on McKenzie River at elevation 1,478 feet, mean sea level. Records extend back to 1902, with the period 1914 through 1930 missing. Short records are available for several other nearby stations; namely, Cascadia State Park, Holley, Leaburg, and Marcola. The longest and most complete climatological record in the southern portion of the Willamette Basin is at Eugene. The Eugene record extends from October 1890 to date. Locations, elevations, and periods of record of pertinent precipitation stations are shown on plate 1.

9-05. Snow courses. - Snow depth and water content of the snowpack are measured at a number of snow courses in the general area of Blue River Lake. None of those snow courses are located within the basin tributary to Blue River Lake, but several are located in adjoining watersheds. Snow conditions in those adjacent watersheds are considered representative of conditions at comparable elevations in the Blue River Lake watershed. Locations, elevations, and periods of record of pertinent snow courses are shown on plate 1.

9-06. In addition to the standard snow courses, special snow



CONTROL PANEL



FOREBAY GAGING EQUIPMENT

measurements are made bi-monthly starting on 1 January and ending 1 May at several locations along Willamette Pass and McKenzie Pass highways. Data from those snow courses, together with snow-course data obtained at other locations, will be utilized in estimating a profile of snow depth and water equivalent in the Blue River Basin as described in Section VII. Plate 1 shows the location of snow courses pertinent to the Blue River project.

9-07. Communication facilities. - Teletype communication is maintained between Portland and all major power projects in the Willamette Basin. In Portland teletype drops are maintained in offices of North Pacific Division, Portland District, National Weather Service and Bonneville Power Administration.

9-08. At the present time the teletype is the principal means of communicating with Cougar Dam, the control center for regulating Blue River Dam. The commercial telephone supplements the teletype.

9-09. Plans are currently under way to establish radio and microwave communication facilities to transmit hydrologic and project data to the Reservoir Control Center, North Pacific Division, Portland, Oregon.

9-10. Water stages essential to the operation of Blue River Lake are transmitted by wire to Cougar powerhouse. Composite data from those gages is continuously recorded on charts by means of telemetering equipment. Cougar powerhouse is the central control point for operating all projects in McKenzie River Basin. Hydrologic data are transmitted by teletype to Water Control in the Portland District office and the

North Pacific Division office where the data are used by the Division office in formulating reservoir regulation instructions issued to the project.

9-11. A number of stream-gaging stations in Willamette River Basin are equipped with automatic telephone transmitting devices (telemarks) which transmit gage height as a series of audible buzzes when the station is interrogated by telephone. The majority of the stations equipped with telemarks are operated by the Corps of Engineers, the remainder being operated by the National Weather Service. The stations with telemarks which are most directly associated with the regulation of the Blue River project are at Coburg, approximately 50 miles downstream from Blue River project, on McKenzie River; and at Harrisburg, located on Willamette River. No additional telemetering equipment is planned for the Blue River project; however, should the need develop as a result of operating experiences, the required facilities would be provided.

9-12. Hydrologic reporting network. - Basic hydrologic data for forecasting floods and regulating the flood control lakes in Willamette River Basin originate from three categories of stations which make up the hydrologic reporting network. One group of stations is operated and financed by the Corps of Engineers as a project function. Those stations are equipped with telemetering or telemarks and can be contacted without the services of an observer. Reports from that group of stations are collected by Corps of Engineers' personnel. Another group of stations, referred to as the FC-5 reporting network, is partially financed by the Corps of Engineers through a transfer of funds to



LOOKOUT CREEK



BLUE RIVER GAGE HOUSE

INFLOW GAGING STATIONS

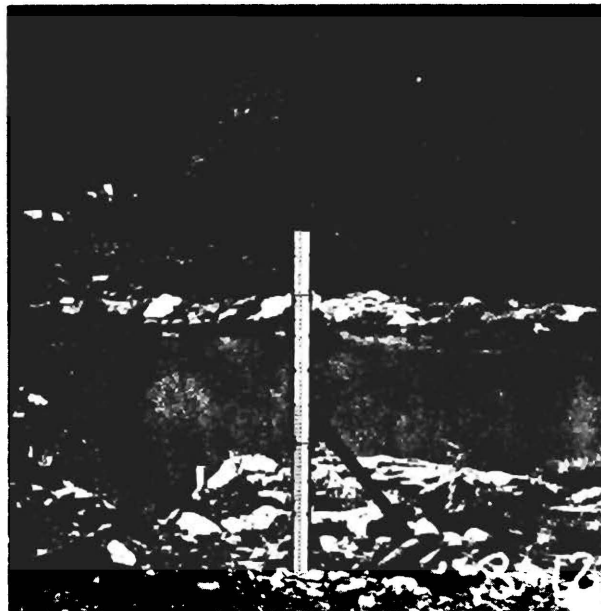
the National Weather Service, who are responsible for their operation including the collection and dissemination of special reports during flood periods. Individual station observers report by telephone on a criteria basis or on call. The third category of stations in the network are the regular U.S. Weather Bureau stations. Data from all stations are disseminated by teletype or telephone to those interested, which includes the Corps of Engineers. As a result of this coordinated network of reporting stations there is a free and continuous exchange of weather, lake, and streamflow information between the National Weather Service and the Corps of Engineers. The following tabulation lists the stations in the reporting network that are most pertinent to the regulation of Blue River Lake. Geographical location of those stations is shown on plate 1.

9-13. Plans are currently under way for the establishment of an automated hydrologic data reporting network for the Willamette River Basin. Under that plan, all pertinent hydrologic data at the Blue River project would be automatically sensed and recorded at the Reservoir Control Center, North Pacific Division, Portland, Oregon.

Station number	Station	Stream or watershed	Type of communication	Information reported
1611	Above Blue River	Blue River	Telemetering ^{1/}	River (lake inflow)
1615	Above Blue River Lake	Lookout Creek	Telemetering ^{1/}	River (lake inflow)
	Blue River Dam	Blue River	Telemetering ^{1/}	Pool elevation
1622	Blue River below dam	Blue River	Telemetering ^{1/}	River (lake releases)



CABLE CAR AND GAGE HOUSE



STAFF GAGE

DOWNSTREAM GAGING STATION

(Continued)

Station number	Station	Stream or watershed	Type of communication	Information reported
1622	Cougar Dam	South Fork McKenzie R.	Telephone ^{2/}	Precip., temp., weather data
1655	Coburg	McKenzie R.	Telemark ^{3/}	River stage
1660	Harrisburg	Willamette R.	Telemark ^{3/}	River stage
2709	Eugene	Willamette R.	Teletype ^{3/}	Precip., temp., weather (first-order, U.S.W.B. station)

1/ Recorded at Cougar Dam and relayed by teletype to Portland.

2/ Collected at Cougar Dam and relayed to Portland.

3/ Collected by National Weather Service and relayed to Division office.

Tables 12 through 15 are rating tables for four gaging stations pertinent to the regulation of Blue River Lake.

9-14. Data from the above stations are collected and forwarded to Portland on a daily basis, except during the summer low-water season when reports are not submitted over the weekends and holidays. Six-hour weather reports are received by Civil Aeronautics Administration teletype service from the first-order National Weather Service at Portland, Roseburg, Eugene, and Salem. Stream-gaging stations equipped with telemarks may be called at any hour from any telephone. For reasons of economy they are usually called by the Corps of Engineers or Weather Service office in the vicinity of the telemark and the data transmitted to Portland as a part of a regular report, thus keeping long-distance telephone calls to a minimum. Special reports are received when the streams approach or exceed bankfull capacities, or on request from the Reservoir Control Center. FTS service provides a very convenient and

economical means of contacting the projects and gages equipped with telemark from the Division and District offices.

9-15. River forecast center. - Arrangements have been made for the River Forecast Center of the National Weather Service in Portland, Oregon and the Corps of Engineers to cooperate in forecasting floods in Willamette and Columbia River Basins. The National Weather Service has the responsibility of furnishing the public with flood-warning services where the Corps of Engineers is involved in regulating floods in both the Willamette and Columbia River Basins. Therefore 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 venture with a maximum of cooperation wherein the National Weather Service in making their forecasts, utilizes the Corps of Engineers' electronic computer, regulated discharges from Corps of Engineers' projects, and basic hydrologic data collected at the many Corps of Engineers' projects. The only stage forecasts disseminated to the public are those made by the National Weather Service.

Exhibits

SECTION X - RESPONSIBILITIES AND EMERGENCY INSTRUCTIONS

10-01. Organization for lake regulation. - Under authority contained in Sections 1 and 2 of the Flood Control Act of 22 June 1936, the Chief of Engineers is responsible for establishing overall policy for the regulation of lakes for flood control. In the Portland District, lake regulation plans and schedules for flood control projects are formulated in the Engineering Division in accordance with instructions contained in Engineering Manual 1110-2-3600, dated May 1959, and are submitted to the North Pacific Division for approval. Any future changes in the lake regulation plan that affect the authorized functions of the lakes, or constitute major changes in the approved regulation plan, will be submitted to the North Pacific Division for approval.

10-02. Functional organization for the regulation of Blue River project are shown on charts 19-A, 19-B and 19-C, which shows names and telephone numbers of personnel and the lines of communication by which instructions are transmitted both administratively and for water management. Blue River Lake will be manned only during critical periods when the lake is approaching full pool level. Other than during critical flood periods, the project is operated by remote control from the powerhouse at Cougar Dam. All orders pertaining to regulation of Blue River project will be relayed or executed by personnel at Cougar Dam. Coordination and liaison are maintained with the National Weather Service and U.S. Geological Survey at all times for the purpose of obtaining basic meteorologic and hydrologic data essential to the regulation of Blue River and other multiple-purpose lakes in Willamette River Basin.



RESERVOIR CONTROL CENTER

NORTH PACIFIC DIVISION

10-03. Reservoir Control Center. - In accordance with the provisions of ER 1110-2-1400, functional regulation of Blue River Lake and other multiple-purpose lakes in the Portland District is the responsibility of the North Pacific Division with the primary responsibility delegated to the Reservoir Control Center of the Water Control Branch. Within the Reservoir Control Center are personnel assigned to lake regulation and power scheduling. The project engineer at Lookout Point Dam is furnished with the names of Division personnel authorized to issue lake regulation and power generation instructions to the project. This list will be revised as changes in personnel assigned to lake regulation are made. All significant lake regulation instructions issued by the Reservoir Control Center will be confirmed in writing. All instructions pertaining to water management will emanate from the Reservoir Control Center. During the flood season personnel will be on duty on weekends and holidays to instruct the flood control projects in an emergency.

10-04. Duties of District Engineering Division personnel assigned to water control activities related to regulations of District flood control projects are:

- a. Develop a plan of lake operation including regulation schedules and rule curves which incorporates the concept of system regulation.
- b. Maintain a continuing program of study to improve lake regulation technique and rule curves for more efficient operation of Blue River Lake for flood control and water conservation.
- c. Prepare and distribute lake regulation manuals and make revisions when necessary.

d. Monitor the operation of lakes in the District. Maintain records and display charts of all hydrologic data pertinent to the operation of those lakes. Issue daily bulletin of pertinent lake operational data.

e. Develop schedules and coordinate the use of water impounded in Blue River Lake. The Bureau of Reclamation is the Government agency responsible for the sale of stored water for irrigation. Stored water will be dispatched from Blue River Lake for that purpose on the basis of the Bureau of Reclamation's requests.

f. Prepare charts of Monthly Reservoir Regulation and provide applicable portions of special flood reports, survey reports, definite project reports, and design memorandums.

10-05. During the flood season, hydrologic reports are collected and analyzed on a continuous basis. Personnel assigned to lake regulation are responsible for keeping a constant surveillance of weather and streamflow conditions. Normally, personnel are not assigned to weekend and holiday duty. The District will rely on the Reservoir Control Center to alert the District should an emergency develop on off-duty days.

10-06. Project Operations Division. - Physical operation and maintenance of multiple-purpose projects in the Portland District is the responsibility of the Project Operations Division under the direct supervision of a Project Engineer, who is responsible to the Chief, Project Operations Division. The Project Engineer is also responsible for carrying out lake regulation instructions received from the Reservoir Control

Center through dam tenders and powerhouse operators, who normally are the direct recipients of the instructions from the North Pacific Division Reservoir Control Center. All instructions pertaining to the regulation of Blue River Lake shall be logged by the Cougar Dam attendant receiving them.

10-07. Forms and reports. - Several reports pertaining to Blue River project will be prepared by personnel at Cougar Dam. These reports are to keep the many interested parties informed on project activities and to provide a permanent record of those activities. In general, those reports are made on standard forms and have a prescribed distribution. Some are for project use only; others are prescribed by regulations and require off-the-project distribution. This manual is primarily concerned with those reports pertaining to flood regulation that have an off-the-project distribution. The standard forms pertinent to this manual are shown in charts 20 through 22 and are listed in the following tabulation:

Forms for Reports

<u>Form number</u>	<u>Description and disposition</u>
NPP 133 (Blue River) March 1969	Monthly Log of Reservoir Regulation (Initiated at Cougar Project)
Copies	3
Routing	1 - Engineering Division, NPP 1 - Geological Survey, Portland 1 - Lookout Point Dam
<hr/>	
NPP 87 (Rev)	Daily Reservoir Data (Initiated by NPD)
Copies	1
Routing	1 - Engineering Division, NPP
Frequency	Daily
<hr/>	
NPP 315 (BL)	Monthly Reservoir Regulation (Initiated by NPP)
Copies	13
Routing	1 - Office, Chief of Engineers 1 - North Pacific Division 1 - Mail and Records, NPP 1 - Project Operations Division, NPP 1 - Engineering Division, NPP 1 - Cougar Dam 1 - Lookout Point Dam 6 - Outside Agencies

Distribution is made by Reservoir Regulation Subsection, Portland District

10-08. Responsibilities for maintenance of hydrologic and meteorologic stations. - Maintenance and operation of the weather station at Cougar project is the responsibility of the Project Engineer at Lookout Point project. Personnel at Cougar receive instructions from the National Weather Service and NPP, Reservoir Regulation Subsection

regarding the method of taking and recording observations. Cougar personnel will also collect and transmit river and reservoir stage data used in the regulation of Blue River Lake to the Reservoir Control Center. Project personnel will be responsible for making occasional inspection of the water stage and weather stations and will report to the Portland District Reservoir Regulation Subsection any equipment malfunction they are unable to repair. In addition, the project personnel will take special observations as needed by the NPP, Reservoir Regulation Subsection for study purposes.

10-09. The Corps of Engineers contributes funds to the National Weather Service and U. S. Geological Survey for installing, servicing, maintaining, processing, and disseminating hydrologic and meteorologic data required for the regulation of Blue River Lake. Each agency inspects, from time to time, the condition of the equipment in which it has a direct interest and makes the necessary repairs and replacements deemed necessary to minimize failures. Each agency is responsible for instructing the project personnel regarding the care and operation of those instruments under their management in the immediate vicinity of the project and the procedures in taking and recording observations. All supplies, such as parts, charts, forms, etc., necessary for recording and disseminating the hydrologic and meteorologic data are furnished by those agencies. They also supply the Corps of Engineers with special reports and publications needed in the regulation of Blue River project and the study of special problems.

10-10. Collection and transmission of data. - The following hydrologic data are collected and transmitted by teletype to the following locations: Lookout Point Project, Reservoir Control Center, Portland District and Bonneville Power Administration.

a. Lake inflow, outflow, and pool elevation. Those data are automatically recorded in the Cougar powerhouse control room.

b. Weather data including precipitation, current weather conditions, maximum and minimum air temperatures, and wind, observed at Cougar, the control center for the Blue River project.

10-11. During major storm periods, meteorological and hydrological reports may be required at 3-hour intervals, particularly if the special flood regulation curves are in use. A situation similar to December 1964 would be an example where frequent reports would be required. Generally, 6-hour reports are adequate for flood regulation. During nonflood periods, daily reports are adequate. Special river and weather reports are sent to the Reservoir Control Center on request.

10-12. For the immediate future, teletype and telephone will be the principal means of communicating between Cougar Dam and the Reservoir Control Center. Current plans are to provide a complex automated radio-microwave communications system that will collect, transmit and process all hydrologic, weather and reservoir data automatically.

10-13. Emergency instructions. - 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 Project Engineer at Lookout Point, or a subordinate, will promptly contact the NPD Reservoir Control Center, report existing field conditions, and request instructions. In the event of a communication failure, repeated efforts will be made to contact the Reservoir Control Center. If all efforts fail, the decision as to the action to be taken must be made in the field. Should such an event occur, all circumstances and emergency actions taken will be reported in writing to the Center as soon as possible.

10-14. Should communications to Portland fail during a flood, but remain operative to the stream-gaging stations at Blue River, Coburg, and the inflow stations, the Project Engineer or an authorized representative will direct the regulation of Blue River Lake, using the schedules shown on chart 14 or 15, whichever is applicable. Cougar weather station will be used in computing the precipitation index.

10-15. Should the remote control facilities or communication facilities between Blue River and Cougar Dams fail during a major flood, the Project Engineer will dispatch an employee to Blue River who is familiar with and capable of regulating the project as specified in this manual. During an emergency, the employee dispatched to Blue River will operate it as follows:

- a. Reduce the outflow to 50 c.f.s., immediately upon arrival at the project.
- b. Determine the inflow. - Compute the inflow by means of the storage equation using chart 23.
- c. Consult special curves. - Every 3 hours, consult chart 15, 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 3 hours to determine the required lake release.
- d. Repeat step "c" every 3 hours, or until communications with Cougar have been restored.
- e. Limit any increase in release indicated by the special regulation curves so as not to exceed 600 c.f.s. in any 1-hour period.
- f. Maintain a continuous hydrograph of computed or observed inflows as a check on the latest computed inflow. A graph of this type provides a useful tool for forecasting 12 to 24 hours in advance.

10-16. During the period that special regulation curves are applicable, the lake release will be determined every 3 hours on the basis of the average inflow for the preceding 3 hours and the current lake elevation. Adjustments, however, should not increase the outflow by more than 600 c.f.s. in any 1-hour period.

10-17. After the lake reaches maximum elevation, maintain that elevation by adjusting the lake release to equal the lake inflow until postflood evacuation is initiated. Post flood evacuation will normally not be initiated until streams have receded to within their banks. An exception to the normal rule would be made on special occasions when

weather forecasts of an approaching storm indicate that accelerated lake evacuation should be made to provide storage space in the lake for flood control. On these special occasions, the rate of evacuation may result in downstream overbank flow. The release from the project, however, should not result in downstream flow that would be greater than the peak flow from the uncontrolled area.

10-18. National emergency. - If all personnel are ordered to evacuate from the project during a national emergency, the outlets at Blue River Lake should be adjusted to discharge the following flows before leaving the project:

June - October	100 c.f.s.
November - May	1,000 c.f.s.

Tables

TABLE 1

BLUE RIVER LAKE

Service Outlet Rating Table
(Two Gate)

Sheet 1 of 2

Gate Opening ft.	Pool Elevation in Feet, M.S.L.					Gate Opening ft.
	1132	1135	1140	1145	1150	
0.1	0	5	15	20	23	0.1
0.2	0	14	31	40	46	0.2
0.3	0	26	47	60	69	0.3
0.4	0	40	63	80	92	0.4
0.5	0	50	77	101	115	0.5
0.6	0	50	90	115	138	0.6
0.7	0	50	100	134	161	0.7
0.8	0	50	110	150	184	0.8
0.9	0	50	119	165	207	0.9
1.0	0	50	127	180	230	1.0
1.1	0	50	135	200	252	1.1
1.2	0	50	145	215	274	1.2
1.3	0	50	153	230	296	1.3
1.4	0	50	160	250	318	1.4
1.5	0	50	168	265	340	1.5
1.6	0	50	175	282	362	1.6
1.7	0	50	182	300	384	1.7
1.8	0	50	190	315	406	1.8
1.9	0	50	197	330	428	1.9
2.0	0	50	205	340	450	2.0
2.1	0	50	230	355	472	2.1
2.2	0	50	230	385	494	2.2
2.3	0	50	230	405	516	2.3
2.4	0	50	230	420	538	2.4
2.5	0	50	230	440	560	2.5
2.6	0	50	230	455	582	2.6
2.7	0	50	230	470	604	2.7
2.8	0	50	230	480	626	2.8
2.9	0	50	230	480	648	2.9
3.0	0	50	230	480	670	3.0
3.1	0	50	230	480	691	3.1
3.2	0	50	230	480	711	3.2
3.3	0	50	230	480	732	3.3
3.4	0	50	230	480	752	3.4
3.5	0	50	230	480	773	3.5
3.6	0	50	230	480	794	3.6
3.7	0	50	230	480	814	3.7
3.8	0	50	230	480	835	3.8
3.9	0	50	230	480	855	3.9
4.0	0	50	230	480	876	4.0

Minimum flood control pool, el. 1180.0
Maximum flood control pool, el. 1357.0
Invert, elevation 1132.0

TABLE 1

TABLE 1

HAJE RIVER RESERVOIR

Service Outlet Rating Table
(Two Gate)

Sheet 2 of 2

Gate Opening ft.	Pool Elevation in Feet, M.S.L.																			Gate Opening ft.			
	1150	1160	1170	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300	1310	1320	1330		1340	1350	1357
0.1	23	29	34	38	42	45	49	52	55	57	60	65	65	67	70	72	74	76	78	80	82	83	0.1
0.2	46	58	68	75	84	92	98	104	110	115	120	125	131	135	139	144	148	152	156	160	164	166	0.2
0.3	69	87	101	113	126	136	146	155	164	172	180	188	196	202	209	215	221	228	234	239	245	250	0.3
0.4	92	116	135	150	168	182	195	207	219	230	240	250	262	270	278	287	295	304	312	319	327	333	0.4
0.5	115	145	169	188	210	227	244	259	274	287	300	313	327	337	348	359	369	380	390	399	409	416	0.5
0.6	138	174	203	226	252	272	293	311	329	344	360	376	392	404	418	431	443	456	468	479	491	499	0.6
0.7	161	203	237	263	294	318	342	363	384	402	420	438	458	472	487	503	517	532	546	559	573	582	0.7
0.8	184	232	270	301	336	363	390	414	438	459	480	501	523	539	557	574	590	608	624	638	654	666	0.8
0.9	207	261	304	338	378	409	439	466	493	517	540	563	589	607	626	646	664	684	702	718	736	749	0.9
1.0	230	290	338	376	420	454	488	518	548	574	600	626	654	674	696	718	738	760	780	798	818	832	1.0
1.1	252	318	371	414	461	499	536	569	602	631	660	688	718	741	765	789	811	835	857	878	899	915	1.1
1.2	274	346	404	452	503	544	584	620	656	688	719	750	782	808	834	860	885	911	935	957	981	997	1.2
1.3	296	374	438	490	544	589	633	672	710	745	779	813	846	874	904	932	958	986	1012	1037	1062	1080	1.3
1.4	318	402	472	528	586	634	681	723	764	802	838	875	910	941	973	1003	1032	1062	1090	1116	1144	1162	1.4
1.5	340	430	504	566	627	679	729	774	818	859	898	937	974	1008	1046	1074	1105	1137	1167	1196	1225	1245	1.5
1.6	362	458	537	604	668	724	777	825	872	916	958	997	1038	1075	1111	1145	1178	1212	1244	1276	1306	1328	1.6
1.7	384	486	570	642	710	769	825	876	926	973	1017	1061	1102	1142	1180	1216	1252	1288	1322	1355	1388	1410	1.7
1.8	406	514	604	680	751	814	874	928	980	1030	1077	1124	1166	1208	1250	1288	1325	1363	1399	1435	1469	1493	1.8
1.9	428	542	637	718	793	859	922	979	1034	1087	1136	1186	1230	1275	1319	1359	1399	1439	1477	1514	1549	1575	1.9
2.0	450	570	670	756	834	904	970	1030	1088	1144	1196	1248	1294	1342	1388	1430	1472	1514	1554	1594	1632	1658	2.0
2.1	472	598	704	794	876	950	1020	1083	1144	1203	1258	1312	1361	1411	1460	1504	1548	1593	1635	1677	1717	1744	2.1
2.2	494	627	738	833	919	997	1070	1136	1200	1262	1320	1376	1428	1481	1532	1578	1625	1671	1715	1757	1801	1830	2.2
2.3	516	655	771	871	962	1043	1119	1190	1257	1321	1381	1441	1496	1550	1603	1652	1701	1750	1796	1842	1886	1915	2.3
2.4	538	684	805	910	1004	1090	1169	1243	1313	1380	1443	1505	1563	1620	1675	1726	1781	1828	1876	1924	1970	2001	2.4
2.5	560	712	839	948	1046	1136	1219	1296	1369	1439	1505	1569	1630	1689	1747	1800	1854	1907	1957	2007	2055	2087	2.5
2.6	582	740	873	986	1088	1182	1269	1349	1425	1498	1567	1633	1697	1758	1819	1874	1930	1986	2038	2090	2140	2173	2.6
2.7	604	769	907	1025	1131	1229	1319	1402	1481	1557	1629	1697	1764	1828	1891	1948	2007	2064	2118	2172	2224	2259	2.7
2.8	626	797	940	1063	1173	1275	1368	1456	1538	1616	1690	1762	1832	1897	1962	2022	2083	2143	2199	2255	2309	2344	2.8
2.9	648	826	974	1102	1216	1322	1418	1509	1594	1675	1752	1826	1899	1967	2034	2096	2160	2221	2279	2337	2393	2430	2.9
3.0	670	854	1008	1140	1258	1368	1468	1562	1650	1734	1814	1890	1966	2036	2106	2170	2236	2300	2360	2420	2478	2516	3.0
3.1	691	882	1041	1176	1300	1414	1517	1614	1705	1792	1875	1954	2032	2105	2177	2244	2312	2378	2440	2502	2562	2602	3.1
3.2	711	910	1074	1216	1342	1459	1566	1667	1761	1851	1936	2015	2099	2174	2252	2328	2408	2482	2550	2618	2687	2732	3.2
3.3	732	937	1107	1253	1383	1505	1616	1719	1816	1909	1998	2082	2165	2243	2320	2391	2464	2533	2600	2666	2730	2773	3.3
3.4	752	964	1140	1291	1425	1550	1665	1772	1872	1968	2059	2146	2232	2312	2391	2464	2540	2611	2680	2748	2814	2858	3.4
3.5	773	993	1173	1329	1467	1596	1714	1824	1927	2026	2120	2207	2298	2381	2462	2538	2616	2689	2760	2830	2898	2944	3.5
3.6	794	1021	1206	1367	1509	1642	1763	1876	1982	2084	2181	2271	2364	2450	2537	2612	2692	2767	2840	2912	2982	3030	3.6
3.7	814	1049	1239	1405	1551	1687	1812	1929	2038	2143	2242	2338	2431	2519	2604	2685	2768	2845	2920	2994	3066	3115	3.7
3.8	835	1076	1272	1442	1592	1733	1862	1981	2093	2201	2304	2402	2497	2588	2676	2759	2844	2922	3000	3076	3154	3201	3.8
3.9	855	1104	1305	1480	1634	1778	1911	2034	2149	2260	2365	2466	2564	2657	2747	2832	2920	3000	3080	3158	3244	3286	3.9
4.0	876	1132	1338	1518	1676	1824	1960	2086	2204	2318	2426	2530	2630	2726	2818	2906	2996	3078	3160	3248	3324	3372	4.0
4.1	897	1161	1373	1558	1721	1875	2013	2142	2264	2381	2492	2599	2701	2800	2895	2985	3077	3162	3246	3328	3409	3463	4.1
4.2	918	1198	1408	1598	1765	1927	2065	2198	2323	2444	2558	2667	2773	2874	2971	3065	3158	3246	3332	3417	3499	3554	4.2
4.3	939	1218	1446	1637	1810	1976	2118	2255	2383	2506	2623	2736	2844	2948	3048	3144	3240	3331	3419	3505	3588	3646	4.3
4.4	960	1246	1477	1671	1854	2027	2170	2311	2442	2569	2689	2804	2916	3022	3124	3224	3321	3415	3505	3594	3680	3737	4.4
4.5	981	1275	1512	1717	1909	2088	2233	2376	2508	2638	2759	2878	2997	3108	3214	3318	3424	3519	3618	3712	3804	3868	4.5
4.6	1002	1304	1547	1757	1954	2139	2287	2432	2566	2699	2821	2942	3058	3170	3278	3382	3483	3583	3682	3779	3878	3948	4.6
4.7	1023	1332	1582	1797	1998	2189	2340	2487	2621	2758	2887	3010	3130	3244	3354	3462	3564	3667	3763	3859	3958	4012	4.7
4.8	1044	1361	1616	1836	2033	2230	2381	2536	2671	2810	2947	3079	3201	3318	3431	3541	3646	3743	3840	3947	4043	4108	4.8
4.9	1065	1389	1651	1876	2077	2281	2433	2592	2730	2883	3018	3147	3273	3392	3507	3621	3727	3836	3936	4036	4133	4209	4.9
5.0	1086	1418	1686	1916	2122	2332	2486	2648	2800	2946	3084	3216	3344	3466	3584	3700	3808	3920	4024	4124	4224	4319	5.0
5.1	1106	1446	1720	1956	2167	2379	2539	2705	2860	3009	3151	3286	3416	3541	3662	3780	3891	4005	4110	4214	4316	4379	5.1
5.2	1125	1474	1755	1996	2212	2426	2592	2761	2920	3073	3217	3355	3489	3617	3740	3860	3974	4090	4198	4304	4408	4473	5.2
5.3	1145	1502	1789	2036	2256	2473	2645	2818	2981	3136	3284	3425	3561	3692	3818	3940	4057	4174	4285	4393	4501	4568	5.3
5.4	1164	1530	1824	2076	2301	2520	2698	2874	3041	3200	3350	3494	3634	3768	3896	4020	4140	4259	4373	4483	4593	4662	5.4
5.5	1184	1558	1858	2116	2346	2567	2751	2931	3101	3263	3417	3564	3706	3843	3974	4100	4223	4344	4461	4573	4685	4757	5.5
5.6	1204	1586	1892	2156	2391	2614	2804	2988	3161	3326	3484	3634	3778	3918	4058	4180	4300	4429	4549	4663	4777	4852	5.6
5.7	1223	1614	1921	2196	2436	2661	2857	3044	3221	3390	3550</												

TABLE 2
Climatological Summary
McKenzie Bridge Ranger Station
(Elevation 1478 feet)

Item and Description	Periods of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
		<u>Precipitation</u>												
Normal, inches	1931-1960	10.48	8.42	8.39	4.75	3.91	2.93	0.52	0.72	2.25	6.61	9.62	11.84	70.44
Percent of normal annual		15	12	12	7	5	4	1	1	3	9	14	17	100
Maximum, inches	1931-1965	23.62	19.07	18.12	10.97	9.39	7.74	2.31	2.73	6.74	18.28	22.54	26.94	26.94
Year of maximum		1953	1961	1932	1937	1960	1947	1947	1960	1959	1950	1942	1964	Dec. 1964
Minimum, inches	1931-1965	3.10	2.55	1.41	1.36	0.50	0	0	0	0	0.12	0.22	3.16	0
Year of minimum		1949	1964	1941	1939	1935	1951	1962	1955	1965	1936	1935	1944	Sep 1965
Greatest in 24 hours	1933-1965	3.83	4.38	2.90	3.21	2.35	2.14	0.90	1.41	2.81	3.20	4.80	5.28	5.28
Year of greatest 24 hours		1953	1961	1938	1937	1963	1933	1947	1953	1963	1934	1961	1945	Dec 1945
Avg. no. days with .01 or more	1933-1965	17	16	17	14	12	11	3	4	6	12	16	17	145
Average snowfall, inches	1933-1965	16.0	8.8	3.9	0.7	0	0	0	0	0	0	1.3	6.2	36.9
Maximum snowfall, inches	1933-1965	60.0	41.5	17.0	8.0	4.0	0	0	0	0	2.5	13.0	40.8	60.0
Year of maximum snowfall		1935	1939	1935	1961	1960	1965	1965	1965	1965	1946	1964	1948	Jan 1935
		<u>Temperature</u>												
Average °F	1933-1965	34.9	39.5	43.5	49.8	55.7	60.4	66.5	65.1	61.1	52.2	42.3	37.4	50.7
Average daily maximum, °F	1949-1965	42.9	49.8	53.4	62.6	69.8	75.8	85.4	84.0	80.7	66.7	53.8	41.9	63.9
Average daily minimum, °F	1949-1965	25.4	31.2	32.0	35.6	40.7	46.0	46.4	46.1	42.1	38.4	33.1	30.5	37.3
Absolute maximum, °F	1933-1965	66	71	83	91	97	108	108	105	108	98	79	66	108
Year of absolute maximum		1961	1965	1960	1957	1963	1961	1946	1960	1955	1952	1962	1962	Jan 1961
Absolute minimum, °F	1933-1965	-7	0	16	23	21	16	31	28	22	21	3	6	-7
Year of absolute minimum		1950	1933	1956	1964	1935	1952	1954	1957	1956	1946	1955	1948	Jan 1950

TABLE 2

TABLE 3

Climatological Summary
Eugene, Oregon
(Elevation 361 feet)

June 1966

Item and description	Period of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
		<u>Precipitation</u>												
Normal, inches	1931-60	6.33	4.97	4.32	2.38	2.14	1.42	0.27	0.40	1.27	3.83	5.62	6.68	39.56
Percent of normal annual		16	12	11	6	5	4	1	1	3	10	14	17	100
Maximum, inches	1891-1964	14.83	12.10	10.49	7.17	4.76	5.57	3.38	3.14	5.21	12.66	12.02	20.99	55.21
Year of maximum		1964	1904	1904	1937	1915	1937	1916	1899	1927	1950	1960	1964	1937
Minimum, inches	1891-1964	1.39	0.10	0.40	0.43	0.19	T	0.00	0.00	0.06	T	0.25	2.01	23.26
Year of minimum		1962	1920	1926	1909	1931	1951	1906+	1909+	1942+	1895	1890	1930	1944
Greatest in 24 hours, inches	1891-1961	3.78	4.17	2.44	1.79	1.79	2.36	1.59	1.54	1.74	3.85	4.53	4.82	4.82
Year of greatest 24 hours		1964	1961	1963	1907	1963	1952	1916	1896	1941	1955	1960	1955	Dec. 1955
Avg. No. days with .01" or more	1920-1964	18	16	18	13	11	7	2	4	5	12	16	19	140
Average snowfall, inches	1891-1964	4.2	0.4	0.9	T	0	0	0	0	0	T	0.4	0.9	6.8
Maximum snowfall, inches	1891-1964	36.1	22.7	15.7	2.0	0	0	0	0	0	1.0	6.0	10.2	44.9
Year of maximum snowfall		1950	1917	1916	1911	-	-	-	-	-	1935	1955	1964	1916
Greatest 24 hour snowfall, inches	1891-1964	7.3	10.1	10.7	2.0	0	0	0	0	0	1.0	5.0	6.5	10.7
Year of greatest 24 hour snowfall		1916	1917	1916	1911	-	-	-	-	-	1935	1955	1924	Mar. 1916
<u>Temperature</u>														
Normal, °F	1931-60	39.1	42.6	46.0	50.8	56.1	60.9	66.6	65.9	61.5	53.2	45.5	41.8	52.5
Normal daily maximum, °F	1931-60	45.3	50.2	55.1	61.9	68.1	73.6	82.2	81.6	76.2	64.2	52.6	47.3	63.3
Normal daily minimum, °F	1931-60	32.8	34.9	36.8	39.6	44.0	48.1	51.1	50.2	46.8	42.9	37.9	33.9	41.4
Absolute maximum, °F	1891-1964	69	78	80	89	92	100	105	100	101	91	75	67	105
Year of absolute maximum		1931	1932	1923	1926	1931	1925+	1946+	1932+	1944	1934	1908	1926+	July 1946+
Absolute minimum, °F	1891-1964	-4	-3	18	25	28	34	39	35	30	24	12	-4	-4
Year of absolute minimum		1957	1950	1913	1936	1954	1913+	1926+	1914	1926	1949	1896	1924	Dec. 1924+
<u>Miscellaneous Data</u>														
Average number of days clear	1943-64	2	3	3	4	6	8	17	14	13	5	2	1	78
Average number of days partly cloudy	1943-64	5	5	6	8	7	8	9	8	8	9	6	5	84
Average number of days cloudy	1943-64	18	16	18	13	11	7	2	4	5	17	22	25	203
Average number of days heavy fog	1943-64	7	6	3	2	1	1	*	1	6	11	9	10	58
Prevailing wind direction	1943-64	S	S	SW	NW	NW	NW	NW	NW	NW	NW	S	S	SW

+Later dates also.

*Less than one-half

STATION HISTORY

Location	Period
University of Oregon Campus	October 1890 to March 1912
533 East 10th Street	April 1912 to Aug. 13, 1915
Kincaid Park	Aug. 13, 1915 to Sept. 1917
Mill Race and Alder	Oct. 1917 to Nov. 1919
477 3rd Ave. East	Dec. 1919 to Jan. 1, 1925
Eugene Air Park	Jan. 1, 1925 to Dec. 12, 1942
Eugene Airport	Dec. 21, 1942 to 1964

TABLE 3

TABLE 4

Climatological Summary - Selected Stations

ITEM	Station, elevation, and period of record			
	Eugene 359 ft. 1891-1965	Leaburg 675 ft. 1934-65	Marcola 530 ft. 1940-65	McKenzie Bridge R.S. 1478 ft. 1931-65
		<u>Precipitation</u>		
Average annual precipitation, inches	39.56+	61.72	57.49	70.44+
Maximum annual precipitation, inches	57.95	84.15	77.49	93.29
Year of maximum annual precipitation	1964	1953	1953	1953
Minimum annual precipitation, inches	23.26	41.23	33.99	43.38
Year of minimum annual precipitation	1944	1944	1944	1935
Maximum Monthly Precipitation, inches	20.99	20.16	21.07	26.94
Month and year of maximum monthly precipitation	Dec. 1964	Dec. 1964	Dec. 1964	Dec. 1964
Maximum 1-day recorded precipitation, inches	4.82	4.41	4.99	5.28
Month and year of maximum 1-day precipitation	Dec. 1955	Feb. 1961	Feb. 1961	Dec. 1945
Greatest annual snowfall, inches	44.9	50.5		105.4
Season of greatest snowfall	1915-1916	1950		1948-1949
		<u>Temperature</u>		
Average annual temperature, °F.	52.5+	52.9		50.7
Average annual maximum temperature, °F	63.2+	63.3	No temperature data	63.9
Average annual minimum temperature, °F.	41.7+	42.0		73
Absolute maximum temperature, °F	105	105		108
Month and year of maximum temperature	July 1961	July 1961		June 1961
Absolute minimum temperature, °F.	-4	5		-7
Month and year of minimum temperature	Jan. 1957	Feb. 1950		Jan. 1950
January average temperature, °F	39.1+	39.6		34.9
July average temperature, °F	66.6+	67.0		66.5
Difference, July-January temperature, °F	27.5	27.4		31.6

+ Normals (1931-1960)

Jan 1967
JDH

TABLE 4

TABLE 5
SNOW SURVEY SUMMARY

Item	Dead Horse Grade 3800	Hogg Pass 4755	Lost Creek Ranch 1746	McKenzie 4800	McKenzie Bridge 1372	White Branch Slide 2800
January 1, data						
Length of record, years	15	25	13	14	14	15
Average snow depth, in.	27	53	3	52	0	13
Average water equiv., in.	7.2	15.7	0.9	16.7	0.0	2.6
Highest water equiv., in.	22.0	34.4	3.2	32.6	3.2	50
Year of highest	1950	1949	1965	1952	1965	1952
Lowest water equiv., in.	0.0	0.6	0.0	3.4	0.0	0.0
Year of lowest	1963*	1959	1963*	1959	1963*	1963*
February 1, data						
Length of record, years	17	29	15	23	18	18
Average snow depth, in.	38	78	11	73	0	10
Average water equiv., in.	13.2	26.0	3.7	27.2	0.0	5.7
Highest water equiv., in.	37.8	49.1	12.7	45.0	8.7	21.7
Year of highest	1950	1952	1957	1949	1950	1950
Lowest water equiv., in.	0.0	7.0	0.0	5.1	0.0	0.0
Year of lowest	1961*	1963	1963*	1940	1966*	1963*
March 1, data						
Length of record, years	16	25	12	17	15	16
Average snow depth, in.	49	94	7	101	0	18
Average water equiv., in.	17.1	35.9	2.6	40.0	0.0	5.9
Highest water equiv., in.	38.0	70.9	10.8	64.2	5.5	16.0
Year of highest	1950	1949	1956	1949	1952	1956
Lowest water equiv., in.	0.0	7.5	0.0	8.0	0.0	0.0
Year of lowest	1963	1963	1963*	1963	1965*	1963*
April 1, data						
Length of record, years	17	29	15	27	16	17
Average snow depth, in.	54	106	4	105	0	13
Average water equiv., in.	21.9	43.7	1.4	44.6	0.0	5.8
Highest water equiv., in.	43.3	73.5	6.4	70.5	0.0	16.4
Year of highest	1950	1956	1964	1956	1966*	1955
Lowest water equiv., in.	0.6	11.5	0.0	12.6	0.0	0.0
Year of lowest	1963	1963	1965*	1963	1966*	1963*
May 1, data						
Length of record, years	12	20	12	12	12	12
Average snow depth, in.	25	97	0	88	0	0
Average water equiv., in.	10.9	46.2	0.0	44.2	0.0	0.0
Highest water equiv., in.	37.8	65.3	0.0	66.0	0.0	16.8
Year of highest	1955	1949	1965*	1956	1966*	1955
Lowest water equiv., in.	0.0	22.4	0.0	19.1	0.0	0.0
Year of lowest	1959*	1959	1965*	1963	1966*	1966*

* Earlier years also

TABLE 5

Jan 1967
JDE

TABLE 6
Evaporation and Related Data

Item	Years Record ^{1/}	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
<u>FERN RIDGE RESERVOIR</u>														
Average wind speed (m.p.h.) ^{2/}	23	2.31	2.03	2.62	2.49	2.26	2.16	2.34	2.24	2.18	1.85	1.71	2.17	2.19
Mean air temperature	22	38.5	42.3	44.5	49.8	55.2	60.5	63.0	65.7	62.1	53.6	45.1	41.0	51.8
Class A pan evaporation	23	0.36	0.73	1.69	2.86	4.84	5.81	8.13	6.79	4.60	1.80	0.55	0.37	38.53
<u>BLUE RIVER RESERVOIR</u>														
Pan coefficient ^{3/}		1.1	0.9	0.7	0.6	0.6	0.6	0.6	0.6	0.8	1.2	1.3	1.2	
Evaporation inches ^{4/}		0.40	0.66	1.18	1.72	2.90	3.49	4.88	4.07	3.68	2.16	0.72	0.44	26.30
Evaporation acre-feet ^{4/}		4	16	58	116	218	267	293	131	65	30	8	5	1211

NOTES:

1. Record through 1965.
2. Wind speed 6" above evaporation pan.
3. Pan coefficients are based on studies made by Corps of Engineers at Lookout Point Reservoir.
4. Based on average pool elevations at Blue River. Taken from reservoir regulation study for period 1929-1955.

March 1967
SM

Gage Established _____
Datum m.s.l.

Stream Blue River
Station Blue River Dam Site
Drainage Area 88 sq.mi.

Date Sept. 20, 1957
By G.E.G.
CK. _____

Sheet 1 of 2

Water Year	Discharge in _____ c.f.s.													Extremes of Discharge						Annual Run-off					
	Mean Monthly												Mean Ann.	Max. Inst.			Max. Daily		Minimum *			Ac. Ft.	Inches		
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.		Date	Stage Ft.	Q c.f.s.	Date	Q c.f.s.	Date	Q c.f.s.					
1926	53	260	598	374	1114	428	282	184	52	27	22	29	285										206,300	43.96	
27	94	724	669	844	1185	634	534	592	410	87	46	77	491											355,500	75.75
28	375	1512	610	1280	310	880	762	366	83	56	28	26	524											380,400	81.06
29	53	109	261	311	231	645	621	585	322	68	22	14	267											193,300	41.19
1930	17	12	616	209	880	293	235	273	135	33	15	16	228											165,100	35.18
31	20	164	229	262	176	675	705	152	87	39	14	13	211											152,800	32.66
32	88	287	464	511	312	1455	768	610	322	89	35	19	413											299,800	63.88
33	43	586	610	740	408	699	751	692	891	176	52	49	475											343,900	73.28
34	89	141	1040	1080	274	446	364	137	88	40	21	14	311											225,200	47.99
1935	173	833	985	599	621	405	716	440	218	82	35	21	427											309,100	65.86
36	58	151	268	1542	525	601	648	465	232	81	36	37	387	1/4	6200	1/4	5210	11/3	18	280,900	59.86				
37	23	21	231	81	348	895	1277	956	626	130	50	36	389	4/14	5530	4/14	4870	11/27-12/2	16	281,600	60.00				
38	103	989	960	946	534	825	1098	865	156	56	29	26	524	1/22	6540	1/22	4700	9/27,28	15	379,400	80.84				
39	34	358	663	470	547	963	654	286	178	69	29	23	354	12/2	4870	12/2	2770	10/1,2	15	256,300	54.61				
1940	60	34	507	419	1153	813	354	206	59	31	21	33	307	2/28	2650	2/28	2350	8/30-9/2	17	222,900	47.50				
41	72	474	479	768	277	194	192	325	162	68	36	104	262	1/18	2900	1/18	2300	10/10-13,14	23	189,700	40.42				
42	127	604	1142	609	665	344	279	430	225	84	36	28	381	12/18	4860	12/19	4020	9/27-30	20	275,800	58.77				
43	43	1590	1940	897	974	620	916	341	387	112	54	35	659	12/31	9050	12/31	6950	10/7-9	19	477,100	101.66				
44	244	354	318	331	425	398	516	249	121	53	35	38	257	11/4	4400	11/4	2930	9/10-12	20	186,600	39.76				
1945	43	192	163	735	1220	595	865	767	180	57	30	30	406	2/8	5090	2/8	4040	9/18-20	20	293,900	62.63				
46	28	744	1396	1158	585	812	633	502	228	84	39	26	520	12/28	15,000	12/28	12,300	10/5,16	19	376,500	80.23				
47	228	1000	1360	628	616	628	630	144	272	94	46	45	474	12/14	8300	12/14	6960	10/15-17	28	343,200	73.13				
48	730	845	490	1252	890	521	760	771	314	89	42	58	563	1/7	9860	1/7	7170	9/12,13	21	408,700	87.09				
49	125	574	1000	183	974	860	893	960	197	68	36	32	492	12/12	7340	12/12	4910	9/4-6	23	356,200	75.90				
1950	95	372	401	613	1166	1215	945	914	648	136	54	40	550	2/24	6270	2/25	4600	10/2-4	24	398,200	84.85				
Total																									
Mean																									
Max.																									
Min.																									

Remarks: Mean monthly flows for period 1926-1935 incl. obtained from correlation with McKenzie River at McKenzie Bridge and at Vida. Correlation study made during 1957 by P.B.B. Period 1936-1955 from observed records for Blue River near Blue River, Oregon (D.A. = 75 sq. mi.) and adjusted to Blue River dam site (D.A. = 88 sq. mi.). Extremes of discharge from observed records at gaging station (D.A. = 75 sq. mi.) (continued on sheet 2)

TABLE 7

Gage Established _____
Datum m.s.l.

Stream Blue River
Station Blue River Dam
Drainage Area 88 sq.mi.

Date Sept. 20, 1957
By G.E.G.
CK _____

Sheet 2 of 2

Water Year	Discharge in _____ c.f.s.													Extremes of Discharge						Annual Run-off		
	Mean Monthly												Mean Ann.	Max. Inst.		Max. Daily		Minimum *		Ac. Ft.	Inches	
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.		Date	Stage Ft.	Q c.f.s.	Date	Q c.f.s.	Date			Q c.f.s.
1951	698	1012	1091	1139	1150	464	718	490	117	53	34	34	583	10/28		6650	10/29	5290	9/17	19	422,100	89.94
52	631	642	825	379	952	590	900	547	226	100	36	30	488	10/23		5210	10/23	3900	9/27-30	19	354,300	75.50
53	21	41	211	2120	1253	571	604	677	386	109	63	41	508	11/18		12,300	1/18	9800	10/5-7	16	367,800	78.37
54	75	906	1485	926	1120	529	695	245	294	88	62	89	543	11/22		10,600	11/22	8320	10/8-10	38	399,100	83.76
1955	148	255	463	470	545	502	734	896	621	161	55	53	409	12/31		4550	12/31	3530	9/12	32	296,100	69.09
56	336	1179	1882	1244	303	681	1020	823	314	84	45	32	662	12/21		10,220	12/21	9130	9/5-8 25-29	29	480,600	102.41
57	196	365	934	193	997	1198	573	308	130	55	39	28	418	12/11		11,280	12/11	6880	9/15-16 21-25	24	302,600	64.48
58	79	255	1419	1164	1312	367	706	233	182	63	33	34	487	12/20		9500	12/20	8630	9/8	25	352,600	75.13
59	47	888	631	1020	562	626	532	395	156	54	31	135	423	1/27		4980	1/27	3890	10/7	21	306,200	65.25
1960	345	318	194	281	920	1055	971	774	224	57	42	32	434	2/8		3340	2/8	2790	9/29-30	21	315,100	67.14
61	72	1008	546	517	1642	969	545	530	149	43	22	36	507	11/24		8870	2/10	7330	9/21-23	18	367,100	78.22
62	149	541	1063	543	444	685	933	450	157	50	38	36	424	11/22		6430	11/22	3990	10/7,5,6	19	307,000	65.41
63	249	635	642	188	1042	374	693	659	144	105	55	65	404	2/3		6310	2/3	4830	9/8	34	292,500	62.32
64	94	864	459	738	541	558	659	628	482	99	56	33	434	11/8		4920	11/8	4260	9/27-29	24	314,200	66.95
1965	29	477	2708											12/22		22,000						
Total	6158	21,839	29,245	27,763	29,193	26,013	26,681	19,497	10,175	3030	1474	1547	16,881								12,229,700	2605.93
Mean	158	560	750	712	749	667	684	500	261	78	38	40	433								313,600	66.82
Max.	730	1590	1940	2120	1642	1455	1277	960	891	176	63	104	662								480,600	102.41
Min.	17	12	163	81	176	194	192	137	52	27	14	13	211								152,800	32.56

Remarks: and adjusted to dam site (D.A. = 88 sq.mi.)

* Minimum mean daily

TABLE 8
 MAXIMUM ANNUAL INSTANTANEOUS DISCHARGES
 MCKENZIE RIVER BASIN

Water Year	Discharge in C. F. S.						Remarks		
	McKenzie River			Blue River					
	near Coburg ^{1/} D.A.=1337 sq.mi.			near Blue River D.A.=75 sq.mi.		Blue River D.S. ^{3/} D.A.=88 sq.mi.			
	Date	Discharge		Date	Discharge	Date		Discharge	
1936	Jan. 4	37,500		Jan. 4	5,500	Jan. 4	6,200	<u>1/</u> Flows at Coburg regulated by Cougar Reservoir since September 1963	
37	Apr. 14	38,500		Apr. 14	4,900	Apr. 14	5,530		
38	Jan. 22	48,000		Jan. 22	5,800	Jan. 22	6,540		
39	Dec. 2	23,500		Dec. 2	4,320	Dec. 2	4,870		
1940	Feb. 10	18,500		Feb. 28	2,350	Feb. 28	2,650		
41	Nov. 29	18,000	<u>2/</u>	Jan. 18	2,570	Jan. 18	2,900		<u>2/</u> Estimated from McKenzie River near Vida.
42	Nov. 15	36,000	<u>2/</u>	Dec. 18	4,310	Dec. 18	4,860		
43	Jan. 1	71,000	<u>2/</u>	Dec. 31	8,020	Dec. 31	9,050		
44	Nov. 4	32,000	<u>2/</u>	Nov. 4	3,900	Nov. 4	4,400		
1945	Feb. 14	37,900		Feb. 8	4,510	Feb. 8	5,090		<u>3/</u> Flows estimate from Blue River near Blue River D.A.=75 sq.mi.
46	Dec. 29	88,200		Dec. 28	13,300	Dec. 28	15,000		
47	Dec. 14	59,200		Dec. 14	7,360	Dec. 14	8,300		
48	Jan. 7	58,100		Jan. 7	8,740	Jan. 7	9,860		
49	Dec. 12	51,300		Dec. 12	6,510	Dec. 12	7,340		
1950	Feb. 25	37,600		Feb. 24	5,560	Feb. 24	6,270		
51	Oct. 29	52,100		Oct. 28	5,900	Oct. 28	6,650		
52	Feb. 4	29,600		Oct. 23	4,620	Oct. 23	5,210		
53	Jan. 19	78,500		Jan. 18	10,900	Jan. 18	12,300		
54	Nov. 23	68,200		Nov. 22	9,380	Nov. 22	10,600		
1955	Dec. 31	30,600		Dec. 31	4,030	Dec. 31	4,550		
56	Dec. 22	73,500		Dec. 22	9,500	Dec. 22	10,720		
57	Dec. 11	57,700		Dec. 11	10,000	Dec. 11	11,280		
58	Dec. 21	59,100		Dec. 20	8,400	Dec. 20	9,500		
59	Jan. 28	39,600		Jan. 27	4,390	Jan. 27	4,950		
1960	Feb. 8	23,000		Feb. 8	2,960	Feb. 8	3,340		
61	Feb. 10	76,600		Nov. 24	7,860	Nov. 24	8,870		
62	Dec. 20	40,100		Nov. 22	5,700	Nov. 22	6,430		
63	Feb. 3	28,800		Feb. 3	5,590	Feb. 3	6,310		
64	Jan. 20	35,900		Nov. 8	4,360	Nov. 8	4,920		
1965	Dec. 23	87,300		Dec. 22	19,600	Dec. 22	22,000		

TABLE 8

TABLE 9
 BLUE RIVER RESERVOIR
 ANNUAL FILLING SCHEDULE

Revised February 1970

Date	February		March		April		May	
	Elev. ft., msl	Storage ac.-ft.	Elev. ft., msl	Storage ac.-ft.	Elev. ft., msl	Storage ac.-ft.	Elev. ft., msl	Storage ac.-ft.
1	1180.00	3,970	1290.47	37,234	1319.86	57,136	1343.02	76,396
2	1188.40	5,158	1291.57	37,876	1320.70	57,778	1343.73	77,038
3	1195.96	6,346	1292.66	38,518	1321.53	58,420	1344.44	77,680
4	1202.83	7,534	1293.73	39,160	1322.36	59,062	1345.14	78,322
5	1209.10	8,722	1294.78	39,802	1323.18	59,704	1345.85	78,964
6	1214.88	9,910	1295.82	40,444	1324.00	60,346	1346.54	79,606
7	1220.26	11,098	1296.86	41,086	1324.81	60,988	1347.24	80,248
8	1225.29	12,286	1297.87	41,728	1325.62	61,630	1347.93	80,891
9	1230.05	13,474	1298.88	42,370	1326.42	62,272	1348.63	81,534
10	1234.56	14,662	1299.87	43,012	1327.22	62,914	1349.32	82,177
11	1238.85	15,850	1300.85	43,654	1328.01	63,556	1350.00	82,820
12	1242.93	17,038	1301.83	44,296	1328.80	64,198		
13	1246.80	18,226	1302.80	44,938	1329.59	64,840		
14	1250.48	19,414	1303.76	45,580	1330.37	65,482		
15	1253.98	20,602	1304.71	46,220	1331.14	66,124		
16	1257.34	21,790	1305.65	46,864	1331.92	66,766		
17	1260.56	22,978	1306.59	47,506	1332.68	67,408		
18	1263.62	24,166	1307.52	48,148	1333.45	68,050		
19	1266.55	25,354	1308.44	48,790	1334.21	68,692		
20	1269.35	26,542	1309.36	49,432	1334.96	69,334		
21	1272.04	27,730	1310.27	50,074	1335.71	69,976		
22	1274.62	28,918	1311.17	50,716	1336.46	70,618		
23	1277.10	30,106	1312.07	51,358	1337.20	71,260		
24	1279.50	31,294	1312.96	52,000	1337.94	71,902		
25	1281.82	32,482	1313.84	52,642	1338.68	72,544		
26	1284.08	33,670	1314.72	53,284	1339.41	73,186		
27	1286.27	34,858	1315.59	53,926	1340.14	73,828		
28	1288.40	36,046	1316.46	54,568	1340.86	74,470		
29			1317.32	55,210	1341.58	75,112		
30			1318.17	55,852	1342.30	75,754		
31			1319.02	56,494				

Notes:

1. Pool elevation and corresponding acre-feet applicable to the 0730 observation
2. In leap years, reservoir will be one day ahead of above schedule after 28 February.
3. Maximum conservation pool is elevation 1350.

TABLE 10

BLUE RIVER CAPACITY TABLE (1963)

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1100.0	0	0	0	0	0	0	0	0	0	0
1101.0	0	0	0	0	0	0	0	0	0	0
1102.0	0	0	0	0	0	0	0	0	0	0
1103.0	0	0	0	0	0	0	0	0	0	0
1104.0	0	0	0	0	0	0	0	1	1	1
1105.0	1	1	1	1	1	1	1	1	1	2
1106.0	2	2	2	2	2	2	3	3	3	3
1107.0	3	4	4	4	4	4	5	5	5	5
1108.0	6	6	6	7	7	7	8	8	8	9
1109.0	9	10	10	10	11	11	12	12	13	13
1110.0	14	14	15	15	16	16	17	18	18	19
1111.0	19	20	21	22	22	23	24	24	25	26
1112.0	27	28	28	29	30	31	32	33	34	35
1113.0	36	37	38	39	40	41	42	43	44	45
1114.0	46	47	49	50	51	52	54	55	56	57
1115.0	59	60	62	63	64	66	67	69	70	72
1116.0	73	75	77	78	80	82	83	85	87	88
1117.0	90	92	94	96	98	100	102	104	106	108
1118.0	110	112	114	116	118	120	122	125	127	129
1119.0	131	134	136	138	141	143	146	148	151	153
1120.0	156	159	161	164	166	169	172	174	177	180
1121.0	182	185	188	190	193	195	198	201	203	206
1122.0	209	212	214	217	220	222	225	228	230	233
1123.0	236	239	241	244	247	250	252	255	258	261
1124.0	263	266	269	272	274	277	280	283	286	288
1125.0	291	294	297	300	303	305	308	311	314	317
1126.0	320	322	325	328	331	334	337	340	343	345
1127.0	348	351	354	357	360	363	366	369	372	375
1128.0	378	381	384	386	389	392	395	398	401	404
1129.0	407	410	413	416	419	422	425	428	431	434

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1130.0	437	440	443	447	450	453	456	459	462	465
1131.0	468	471	474	477	480	483	486	490	493	496
1132.0	499	502	505	508	511	515	518	521	524	527
1133.0	530	534	537	540	543	546	550	553	556	559
1134.0	562	566	569	572	575	578	582	585	588	591
1135.0	595	598	601	605	608	611	614	618	621	624
1136.0	628	631	634	638	641	644	648	651	654	658
1137.0	661	664	668	671	674	678	681	685	688	691
1138.0	695	698	702	705	708	712	715	719	722	726
1139.0	729	732	736	739	743	746	750	753	757	760
1140.0	764	767	771	774	778	781	785	789	792	796
1141.0	800	803	807	811	815	818	822	826	830	833
1142.0	837	841	845	849	853	857	861	865	869	873
1143.0	877	881	885	889	893	897	902	906	910	914
1144.0	918	923	927	931	935	940	944	948	953	957
1145.0	962	966	971	975	980	984	989	993	998	1002
1146.0	1007	1012	1016	1021	1026	1030	1035	1040	1045	1050
1147.0	1054	1059	1064	1069	1074	1079	1084	1089	1094	1099
1148.0	1104	1109	1114	1119	1124	1129	1134	1140	1145	1150
1149.0	1155	1161	1166	1171	1177	1182	1187	1193	1198	1204
1150.0	1209	1215	1220	1226	1231	1237	1242	1248	1254	1259
1151.0	1265	1271	1276	1282	1288	1294	1300	1305	1311	1317
1152.0	1323	1329	1335	1341	1347	1353	1359	1365	1371	1377
1153.0	1384	1390	1396	1402	1408	1415	1421	1427	1434	1440
1154.0	1446	1453	1459	1466	1472	1479	1485	1492	1498	1505
1155.0	1511	1518	1525	1531	1538	1545	1552	1558	1565	1572
1156.0	1579	1586	1593	1600	1607	1614	1621	1628	1635	1642
1157.0	1649	1656	1663	1671	1678	1685	1692	1700	1707	1714
1158.0	1722	1729	1736	1744	1751	1759	1766	1774	1781	1789
1159.0	1797	1804	1812	1820	1827	1835	1843	1851	1859	1866

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1160.0	1874	1882	1890	1898	1906	1914	1922	1930	1938	1946
1161.0	1954	1963	1971	1979	1987	1995	2004	2012	2020	2029
1162.0	2037	2045	2054	2062	2071	2079	2088	2096	2105	2113
1163.0	2122	2131	2139	2148	2157	2165	2174	2183	2192	2201
1164.0	2209	2218	2227	2236	2245	2254	2263	2272	2281	2290
1165.0	2249	2309	2318	2327	2336	2345	2355	2364	2373	2383
1166.0	2392	2401	2411	2420	2430	2439	2449	2458	2468	2477
1167.0	2487	2497	2506	2516	2526	2535	2545	2555	2565	2575
1168.0	2585	2594	2604	2614	2624	2634	2644	2654	2664	2675
1169.0	2685	2695	2705	2715	2726	2736	2746	2757	2767	2777
1170.0	2788	2798	2809	2819	2830	2840	2851	2861	2872	2883
1171.0	2893	2904	2915	2925	2936	2947	2958	2969	2980	2991
1172.0	3002	3013	3024	3035	3046	3057	3068	3079	3090	3101
1173.0	3113	3124	3135	3147	3158	3169	3181	3192	3204	3215
1174.0	3227	3238	3250	3261	3273	3285	3296	3308	3320	3332
1175.0	3343	3355	3367	3379	3391	3403	3415	3427	3439	3451
1176.0	3463	3475	3487	3499	3512	3524	3536	3549	3561	3573
1177.0	3586	3598	3610	3623	3635	3648	3661	3673	3686	3698
1178.0	3711	3724	3737	3749	3762	3775	3788	3801	3814	3827
1179.0	3840	3853	3866	3879	3892	3905	3918	3931	3944	3958
1180.0	3971	3984	3998	4011	4024	4038	4051	4065	4078	4091
1181.0	4105	4118	4132	4146	4159	4173	4186	4200	4214	4227
1182.0	4241	4255	4268	4282	4296	4310	4323	4337	4351	4365
1183.0	4379	4393	4406	4420	4434	4448	4462	4476	4490	4504
1184.0	4518	4533	4547	4561	4575	4589	4603	4617	4632	4646
1185.0	4660	4674	4689	4703	4717	4732	4746	4761	4775	4789
1186.0	4804	4818	4833	4847	4862	4877	4891	4906	4920	4935
1187.0	4950	4964	4979	4994	5009	5023	5038	5053	5068	5083
1188.0	5097	5112	5127	5142	5157	5172	5187	5202	5217	5232
1189.0	5247	5262	5277	5292	5308	5323	5338	5353	5368	5384

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1190.0	5399	5414	5430	5445	5460	5476	5491	5506	5522	5537
1191.0	5553	5568	5584	5599	5615	5630	5646	5662	5677	5693
1192.0	5709	5724	5740	5756	5772	5787	5803	5819	5835	5851
1193.0	5867	5883	5899	5914	5930	5946	5962	5978	5995	6011
1194.0	6027	6043	6059	6075	6091	6108	6124	6140	6156	6173
1195.0	6189	6205	6222	6238	6254	6271	6287	6304	6320	6337
1196.0	6353	6370	6386	6403	6420	6436	6453	6469	6486	6503
1197.0	6520	6536	6553	6570	6587	6604	6621	6637	6654	6671
1198.0	6688	6705	6722	6739	6756	6773	6790	6808	6825	6842
1199.0	6859	6876	6893	6911	6928	6945	6962	6980	6997	7014
1200.0	7032	7049	7067	7084	7102	7119	7137	7154	7172	7189
1201.0	7207	7225	7242	7260	7278	7296	7313	7331	7349	7367
1202.0	7385	7403	7421	7439	7457	7475	7493	7511	7529	7547
1203.0	7565	7583	7602	7620	7638	7656	7675	7693	7711	7730
1204.0	7748	7767	7785	7804	7822	7841	7859	7878	7896	7915
1205.0	7934	7952	7971	7990	8009	8027	8046	8065	8084	8103
1206.0	8122	8141	8160	8179	8198	8217	8236	8255	8274	8293
1207.0	8313	8332	8351	8370	8390	8409	8428	8448	8467	8487
1208.0	8506	8525	8545	8565	8584	8604	8623	8643	8663	8682
1209.0	8702	8722	8742	8761	8781	8801	8821	8841	8861	8881
1210.0	8901	8921	8941	8961	8981	9001	9021	9042	9062	9082
1211.0	9102	9123	9143	9163	9184	9204	9224	9245	9265	9286
1212.0	9306	9327	9348	9368	9389	9409	9430	9451	9472	9492
1213.0	9513	9534	9555	9576	9597	9618	9639	9660	9681	9702
1214.0	9723	9744	9765	9786	9808	9829	9850	9871	9893	9914
1215.0	9935	9957	9978	10000	10021	10043	10064	10086	10107	10129
1216.0	10151	10172	10194	10216	10237	10259	10281	10303	10325	10347
1217.0	10369	10391	10413	10435	10457	10479	10501	10523	10545	10567
1218.0	10589	10612	10634	10656	10679	10701	10723	10746	10768	10791
1219.0	10813	10836	10858	10881	10903	10926	10949	10971	10994	11017

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1220.0	11040	11063	11085	11108	11131	11154	11177	11200	11223	11246
1221.0	11269	11292	11315	11338	11362	11385	11408	11431	11455	11478
1222.0	11501	11525	11548	11572	11595	11618	11642	11666	11689	11713
1223.0	11736	11760	11784	11807	11831	11855	11879	11903	11926	11950
1224.0	11974	11998	12022	12046	12070	12094	12118	12142	12166	12191
1225.0	12215	12239	12263	12288	12312	12336	12361	12385	12409	12434
1226.0	12458	12483	12507	12532	12557	12581	12606	12631	12655	12680
1227.0	12705	12730	12754	12779	12804	12829	12854	12879	12904	12929
1228.0	12954	12979	13004	13030	13055	13080	13105	13130	13156	13181
1229.0	13206	13232	13257	13283	13308	13334	13359	13385	13410	13436
1230.0	13462	13487	13513	13539	13564	13590	13616	13642	13668	13694
1231.0	13720	13746	13772	13798	13824	13850	13876	13902	13928	13955
1232.0	13981	14007	14033	14060	14086	14112	14139	14165	14192	14218
1233.0	14245	14271	14298	14325	14351	14378	14405	14432	14458	14485
1234.0	14512	14539	14566	14593	14620	14647	14674	14701	14728	14755
1235.0	14782	14809	14836	14864	14891	14918	14946	14973	15000	15028
1236.0	15055	15083	15110	15138	15165	15193	15221	15248	15276	15304
1237.0	15331	15359	15387	15415	15443	15471	15499	15527	15555	15583
1238.0	15611	15639	15667	15695	15723	15751	15780	15808	15836	15865
1239.0	15893	15921	15950	15978	16007	16035	16064	16092	16121	16150
1240.0	16178	16207	16236	16265	16294	16322	16351	16380	16409	16438
1241.0	16467	16497	16526	16555	16584	16613	16643	16672	16702	16731
1242.0	16761	16790	16820	16849	16879	16909	16938	16968	16998	17028
1243.0	17058	17088	17118	17148	17178	17208	17238	17268	17299	17329
1244.0	17359	17390	17420	17450	17481	17511	17542	17573	17603	17634
1245.0	17665	17696	17726	17757	17788	17819	17850	17881	17912	17943
1246.0	17975	18006	18037	18068	18100	18131	18162	18194	18225	18257
1247.0	18289	18320	18352	18384	18415	18447	18479	18511	18543	18575
1248.0	18607	18639	18671	18703	18735	18768	18800	18832	18865	18897
1249.0	18929	18962	18995	19027	19060	19092	19125	19158	19191	19223

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1250.0	19256	19289	19322	19355	19388	19421	19455	19488	19521	19554
1251.0	19588	19621	19654	19688	19721	19755	19788	19822	19856	19889
1252.0	19923	19957	19991	20025	20059	20093	20127	20161	20195	20229
1253.0	20263	20297	20332	20366	20400	20435	20469	20504	20538	20573
1254.0	20608	20642	20677	20712	20747	20782	20817	20852	20886	20922
1255.0	20957	20992	21027	21062	21097	21133	21168	21204	21239	21275
1256.0	21310	21346	21381	21417	21453	21488	21524	21560	21596	21632
1257.0	21668	21704	21740	21776	21812	21849	21885	21921	21958	21994
1258.0	22030	22067	22104	22140	22177	22213	22250	22287	22324	22361
1259.0	22398	22435	22472	22509	22546	22583	22620	22657	22695	22732
1260.0	22769	22807	22844	22882	22919	22957	22995	23033	23070	23108
1261.0	23146	23184	23223	23261	23299	23337	23376	23414	23452	23491
1262.0	23530	23568	23607	23646	23685	23724	23763	23802	23841	23880
1263.0	23919	23958	23998	24037	24077	24116	24156	24196	24235	24275
1264.0	24315	24355	24395	24435	24475	24515	24555	24596	24636	24677
1265.0	24717	24758	24798	24839	24880	24921	24961	25002	25043	25085
1266.0	25126	25167	25208	25249	25291	25332	25374	25416	25457	25499
1267.0	25541	25583	25625	25666	25709	25751	25793	25835	25877	25920
1268.0	25962	26005	26047	26090	26133	26175	26218	26261	26304	26347
1269.0	26390	26433	26477	26520	26563	26607	26650	26694	26737	26781
1270.0	26825	26869	26913	26957	27001	27045	27089	27133	27177	27222
1271.0	27266	27311	27355	27400	27445	27489	27534	27579	27624	27669
1272.0	27714	27759	27805	27850	27895	27941	27986	28032	28077	28123
1273.0	28169	28215	28261	28307	28353	28399	28445	28491	28538	28584
1274.0	28631	28677	28724	28770	28817	28864	28911	28958	29005	29052
1275.0	29099	29146	29194	29241	29288	29336	29383	29431	29479	29526
1276.0	29574	29622	29670	29718	29766	29814	29863	29911	29960	30008
1277.0	30056	30105	30154	30203	30251	30300	30349	30398	30447	30497
1278.0	30546	30595	30645	30694	30744	30793	30843	30893	30942	30992
1279.0	31042	31092	31142	31192	31243	31293	31343	31394	31444	31495

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1280.0	31546	31596	31647	31698	31749	31800	31851	31902	31953	32005
1281.0	32056	32107	32159	32210	32262	32314	32365	32417	32469	32521
1282.0	32573	32625	32677	32730	32782	32834	32887	32939	32992	33044
1283.0	33097	33150	33203	33256	33309	33362	33415	33468	33521	33575
1284.0	33628	33682	33735	33789	33842	33896	33950	34004	34058	34112
1285.0	34166	34220	34274	34329	34383	34437	34492	34547	34601	34656
1286.0	34711	34766	34821	34875	34931	34986	35041	35096	35152	35207
1287.0	35262	35318	35374	35429	35485	35541	35597	35653	35709	35765
1288.0	35821	35878	35934	35990	36047	36104	36160	36217	36274	36331
1289.0	36387	36444	36502	36559	36616	36673	36730	36788	36845	36903
1290.0	36961	37018	37076	37134	37192	37250	37308	37366	37424	37483
1291.0	37541	37599	37658	37716	37775	37834	37893	37952	38010	38069
1292.0	38128	38188	38247	38306	38366	38425	38485	38544	38604	38664
1293.0	38723	38783	38843	38903	38963	39024	39084	39144	39205	39265
1294.0	39326	39386	39447	39508	39569	39629	39691	39752	39813	39874
1295.0	39935	39997	40058	40120	40181	40243	40305	40366	40428	40490
1296.0	40552	40614	40677	40739	40801	40864	40926	40989	41051	41114
1297.0	41177	41240	41303	41366	41429	41492	41555	41619	41682	41745
1298.0	41809	41872	41936	42000	42064	42128	42192	42256	42320	42384
1299.0	42448	42513	42577	42642	42706	42771	42836	42901	42966	43031
1300.0	43096	43161	43226	43291	43357	43422	43487	43553	43618	43684
1301.0	43749	43815	43881	43947	44013	44078	44144	44210	44276	44343
1302.0	44409	44475	44541	44608	44674	44740	44807	44874	44940	45007
1303.0	45073	45140	45207	45274	45341	45408	45475	45542	45609	45676
1304.0	45744	45811	45879	45946	46013	46081	46149	46216	46284	46352
1305.0	46420	46487	46556	46623	46692	46760	46828	46896	46964	47033
1306.0	47101	47169	47238	47307	47375	47444	47513	47581	47650	47719
1307.0	47788	47857	47926	47995	48065	48134	48203	48272	48342	48411
1308.0	48481	48550	48620	48690	48759	48829	48899	48969	49039	49109
1309.0	49179	49249	49319	49390	49460	49530	49601	49671	49742	49812

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1310.0	49883	49954	50025	50095	50166	50237	50308	50379	50450	50522
1311.0	50593	50664	50736	50807	50878	50950	51021	51093	51165	51236
1312.0	51308	51380	51452	51524	51596	51668	51740	51813	51885	51957
1313.0	52029	52102	52174	52247	52319	52392	52465	52538	52610	52683
1314.0	52756	52829	52902	52976	53049	53122	53195	53269	53342	53416
1315.0	53489	53563	53636	53710	53784	53858	53932	54006	54079	54154
1316.0	54228	54302	54376	54450	54525	54599	54674	54748	54823	54897
1317.0	54972	55047	55122	55196	55271	55346	55421	55497	55572	55647
1318.0	55722	55798	55873	55948	56024	56099	56175	56251	56327	56402
1319.0	56478	56554	56630	56706	56782	56859	56935	57011	57087	57164
1320.0	57240	57317	57394	57470	57547	57624	57700	57777	57854	57931
1321.0	58008	58085	58163	58240	58317	58394	58472	58549	58627	58704
1322.0	58782	58860	58937	59015	59093	59171	59249	59327	59405	59483
1323.0	59561	59639	59718	59796	59874	59953	60031	60110	60189	60267
1324.0	60346	60425	60504	60583	60662	60741	60820	60899	60978	61058
1325.0	61137	61216	61296	61375	61455	61534	61614	61694	61774	61854
1326.0	61934	62014	62094	62174	62254	62334	62414	62495	62575	62656
1327.0	62736	62817	62897	62978	63059	63139	63220	63301	63382	63463
1328.0	63544	63625	63707	63788	63869	63951	64032	64114	64195	64277
1329.0	64358	64440	64522	64604	64686	64768	64850	64932	65014	65096
1330.0	65178	65261	65343	65426	65508	65591	65673	65756	65839	65921
1331.0	66004	66087	66170	66253	66336	66419	66503	66586	66669	66753
1332.0	66836	66920	67003	67087	67171	67254	67338	67422	67506	67590
1333.0	67674	67758	67842	67926	68011	68095	68179	68264	68348	68433
1334.0	68518	68602	68687	68772	68857	68942	69027	69112	69197	69282
1335.0	69367	69453	69538	69623	69709	69794	69880	69966	70051	70137
1336.0	70223	70309	70395	70481	70567	70653	70739	70826	70912	70998
1337.0	71085	71171	71258	71344	71431	71518	71605	71692	71778	71866
1338.0	71952	72040	72127	72214	72301	72389	72476	72564	72651	72739
1339.0	72826	72914	73002	73090	73178	73266	73354	73442	73530	73618

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1340.0	73706	73795	73883	73972	74060	74149	74237	74326	74415	74504
1341.0	74592	74681	74770	74859	74948	75037	75126	75216	75305	75394
1342.0	75484	75573	75663	75752	75842	75931	76021	76111	76201	76291
1343.0	76381	76471	76561	76651	76741	76831	76922	77012	77103	77193
1344.0	77283	77374	77465	77555	77646	77737	77828	77919	78010	78101
1345.0	78192	78283	78374	78466	78557	78648	78740	78831	78923	79015
1346.0	79106	79198	79290	79381	79473	79565	79657	79750	79842	79934
1347.0	80026	80118	80211	80303	80396	80488	80581	80673	80766	80859
1348.0	80951	81044	81137	81230	81323	81416	81510	81603	81696	81790
1349.0	81883	81976	82070	82163	82257	82351	82444	82538	82632	82726
1350.0	82820	82914	83008	83102	83197	83291	83385	83480	83574	83668
1351.0	83763	83857	83952	84046	84141	84236	84331	84426	84520	84615
1352.0	84710	84805	84900	84995	85091	85186	85281	85376	85472	85567
1353.0	85662	85758	85854	85949	86045	86141	86236	86332	86428	86524
1354.0	86620	86716	86812	86908	87004	87101	87197	87293	87390	87486
1355.0	87582	87679	87776	87872	87969	88065	88162	88259	88356	88453
1356.0	88550	88647	88744	88841	88938	89035	89133	89230	89327	89425
1357.0	89522	89620	89718	89815	89913	90010	90108	90206	90304	90401
1358.0	90499	90597	90695	90793	90891	90989	91087	91185	91283	91381
1359.0	91479	91577	91676	91774	91872	91970	92069	92167	92265	92364
1360.0	92462	92561	92660	92759	92857	92956	93055	93154	93253	93352
1361.0	93451	93551	93650	93750	93849	93949	94048	94148	94248	94348
1362.0	94448	94548	94648	94748	94848	94948	95049	95149	95250	95350
1363.0	95450	95551	95652	95752	95853	95954	96055	96156	96256	96358
1364.0	96458	96560	96661	96762	96863	96964	97066	97167	97269	97370
1365.0	97472	97573	97675	97777	97879	97980	98082	98184	98286	98388
1366.0	98490	98592	98695	98797	98899	99001	99104	99206	99309	99411
1367.0	99514	99617	99720	99822	99925	100028	100131	100234	100337	100440
1368.0	100543	100646	100750	100853	100956	101060	101163	101267	101370	101474
1369.0	101578	101681	101785	101889	101993	102097	102201	102305	102409	102513

TABLE 10

BLUE RIVER CAPACITY TABLE

ELEV FEET	CAPACITY IN ACRE FEET									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1370.0	102617	102722	102826	102931	103035	103139	103244	103349	103453	103558
1371.0	103663	103768	103873	103977	104082	104187	104293	104398	104503	104608
1372.0	104713	104819	104924	105030	105135	105241	105346	105452	105558	105664
1373.0	105769	105875	105981	106087	106193	106299	106406	106512	106618	106725
1374.0	106831	106937	107044	107150	107257	107364	107470	107577	107684	107791
1375.0	107898	108005	108112	108219	108326	108433	108541	108648	108755	108863
1376.0	108970	109078	109185	109293	109401	109508	109616	109724	109832	109940
1377.0	110048	110156	110264	110372	110481	110589	110697	110806	110914	111023
1378.0	111131	111240	111349	111457	111566	111675	111784	111893	112002	112111
1379.0	112220	112329	112438	112548	112657	112766	112876	112985	113095	113205

TABLE 11

BLUE RIVER RESERVOIR

ANNUAL EVACUATION SCHEDULE

Revised Feb. 1970

Date	September		October		November	
	Elev. ft., msl	Storage ac.-ft.	Elev. ft.,msl	Storage ac.-ft.	Elev. ft., msl	Storage ac.-ft.
1	1350.00	82,820	1312.52	51,680	1250.82	19,527
2	1348.89	81,782	1311.07	50,642	1247.63	18,490
3	1347.78	80,744	1309.60	49,604	1244.31	17,453
4	1346.65	79,706	1308.12	48,566	1240.82	16,416
5	1345.52	78,668	1306.62	47,528	1237.17	15,379
6	1344.38	77,630	1305.11	46,490	1233.36	14,342
7	1343.23	76,592	1303.57	45,452	1229.39	13,305
8	1342.08	75,554	1302.01	44,415	1225.22	12,268
9	1340.91	74,516	1300.43	43,378	1220.84	11,231
10	1339.74	73,478	1298.83	42,341	1216.20	10,194
11	1338.56	72,440	1297.20	41,304	1211.27	9,157
12	1337.37	71,402	1295.54	40,267	1205.99	8,120
13	1336.16	70,364	1293.84	39,230	1200.30	7,083
14	1334.95	69,326	1292.11	38,193	1194.12	6,046
15	1333.73	68,288	1290.34	37,156	1187.40	5,008
16	1332.50	67,250	1288.53	36,119	1180.00	3,971
17	1331.25	66,212	1286.67	35,082		
18	1330.00	65,174	1284.78	34,045		
19	1328.73	64,136	1282.83	33,008		
20	1327.45	63,098	1280.84	31,971		
21	1326.16	62,060	1278.92 1287.78	30,934		
22	1324.86	61,022	1276.67	29,897		
23	1323.54	59,984	1274.49	28,860		
24	1322.21	58,946	1272.24	27,823		
25	1320.87	57,908	1269.91	26,786		
26	1319.52	56,870	1267.50	25,749		
27	1318.15	55,832	1264.99	24,712		
28	1316.76	54,794	1262.38	23,675		
29	1315.36	53,756	1259.65	22,638		
30	1313.95	52,718	1256.81	21,601		
31		51,680	1253.87	20,564		

Note: ~~Red elevations and corresponding storage values are to be applied to the evacuation schedule.~~

See the map of the reservoir for details. SDIA

TABLE 12

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

TABLE 12

Sta. No. 19161500

Table No. 08

Begin 70 01 18
YR. MO. D. HR.

Rating table for Lookout Creek near Blue River, Oreg.

from Jan. 18, 1970 to _____, from _____ to _____, from _____ to _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
2.00			4.00	360	50	6.00	1,800	120	8.00	4,960	180									
.10			.10	410		.10	1,920	130	.10	5,140		.10			.10			.10		
.20			.20	460		.20	2,050	130	.20	5,320	180	.20			.20			.20		
.30			.30	570		.30	2,180	130	.30	5,500	200	.30			.30			.30		
.40	6.8		.40	560	50	.40	2,310	150	.40	5,700		.40			.40			.40		
.50	10.9		.50	610	60	.50	2,460	160	.50	5,900		.50			.50			.50		
.60	16.2	7.6	.60	670		.60	2,620		.60	6,100		.60			.60			.60		
.70	23.8	9.2	.70	730	60	.70	2,780		.70	6,300		.70			.70			.70		
.80	33.0	11	.80	790	70	.80	2,940		.80	6,500		.80			.80			.80		
.90	44.0	14	.90	860		.90	3,100		.90	6,700	200	.90			.90			.90		
3.00	580	17	5.00	930		7.00	3,260		9.00	6,900										
.10	75	20	.10	1,000		.10	3,420		.10			.10			.10			.10		
.20	95	25	.20	1,070	70	.20	3,580		.20			.20			.20			.20		
.30	120	30	.30	1,140	80	.30	3,740		.30			.30			.30			.30		
.40	150		.40	1,220	80	.40	3,900	160	.40			.40			.40			.40		
.50	180		.50	1,300	100	.50	4,060	180	.50			.50			.50			.50		
.60	210	30	.60	1,400		.60	4,240		.60			.60			.60			.60		
.70	240	40	.70	1,500		.70	4,420		.70			.70			.70			.70		
.80	280		.80	1,600		.80	4,600		.80			.80			.80			.80		
.90	320	40	.90	1,700	100	.90	4,780	180	.90			.90			.90			.90		

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during 70-78

and is _____ well defined between _____ cfs and _____ cfs

Same as table 05 above 7.5'
sheet 2 of 2

Comp. by HDK date 2-3-71

Ckd. by JT date 2-8-71

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14-1611.00

TABLE 13

Rating table for Blue River below Tidbits Creek near Blue River, Oreg.
from Nov. 15, 1966 to _____ from _____ to _____ from _____ to _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	
Ft.	Cfs	Cfs	Ft.	Cfs	Cfs	Ft.	Cfs	Cfs	Ft.	Cfs	Cfs	Ft.	Cfs	Cfs	Ft.	Cfs	Cfs	Ft.	Cfs	Cfs	
2.00			4.00	295	30	6.00	1,350	80	8.00	3,250	110	10.00	5,500	1,200							
.10			.10	325	35	.10	1,430		.10	3,360		.10	6,700	1,300							
.20	8.3	3.7	.20	360		.20	1,510		.20	3,470		.20	8,000	1,300							
.30	12.0	4.5	.30	395	3.5	.30	1,590		.30	3,580		.30	9,300	1,300							
.40	16.5	6.0	.40	430	40	.40	1,670	80	.40	3,690		.40	10,600	1,400							
.50	22.5	7.0	.50	470	40	.50	1,750	90	.50	3,800		.50	12,000	1,400							
.60	27.5	8.0	.60	510	50	.60	1,840		.60	3,910		.60	13,400								
.70	37.5	9.5	.70	560		.70	1,930		.70	4,020		.70									
.80	47	11	.80	610		.80	2,020		.80	4,130		.80									
.90	58	12	.90	660		.90	2,110	90	.90	4,240		.90									
3.00	70	14	5.00	710	50	7.00	2,200	100	9.00	4,350											
.10	84	16	.10	760	60	.10	2,300		.10	4,460		.10									
.20	100	18	.20	820		.20	2,400		.20	4,570		.20									
.30	118	20	.30	880		.30	2,500		.30	4,680		.30									
.40	138	22	.40	940	60	.40	2,600	100	.40	4,790	110	.40									
.50	160	25	.50	1,000	70	.50	2,700	110	.50	4,900	120	.50									
.60	185		.60	1,070		.60	2,810		.60	5,020		.60									
.70	210	25	.70	1,140		.70	2,920		.70	5,140		.70									
.80	235	30	.80	1,210		.80	3,030		.80	5,260		.80									
.90	265	30	.90	1,280	70	.90	3,140	110	.90	5,380	120	.90									

TABLE 13

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during 32-39
and previous curve above 10.0 ft _____

Comp by W.D.P. date 10/30/67
Ckd by C.W.H. date 12/14/67
Table No. 5

TABLE 14

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 141622.00

TABLE 14

Table No. 09

Rating table for Blue River at Blue River, Oreg

Begin 700129
YR. MO. D. HR.

from Jan. 29, 1970 to _____, from _____ to _____, from _____ to _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	
1.00			3.00	128	20	5.00	860	60	7.00	2,200	140	9.00	5,820								
.10			.10	148	20	.10	920	60	.10	2,840		.10			.10			.10			
.20			.20	168	22	.20	980	70	.20	2,980		.20			.20			.20			
.30			.30	190	22	.30	1,050		.30	3,120		.30			.30			.30			
.40			.40	212	26	.40	1,120	70	.40	3,260		.40			.40			.40			
.50			.50	238		.50	1,190	80	.50	3,400		.50			.50			.50			
.60			.60	264	26	.60	1,270		.60	3,540		.60			.60			.60			
.70			.70	290	30	.70	1,350		.70	3,680		.70			.70			.70			
.80			.80	320	30	.80	1,430	80	.80	3,820		.80			.80			.80			
.90			.90	350	35	.90	1,510	90	.90	3,960	140	.90			.90			.90			
2.00	1.7	6	4.00	385	35	6.00	1,600	100	8.00	4,100	160										
.10	2.3	7	.10	420	40	.10	1,700		.10	4,260		.10			.10			.10			
.20	3.0	8	.20	460		.20	1,800		.20	4,420		.20			.20			.20			
.30	3.8	9	.30	500	40	.30	1,900		.30	4,580	160	.30			.30			.30			
.40	4.7	10	.40	540	50	.40	2,000	100	.40	4,740	180	.40			.40			.40			
.50	5.7	11	.50	590		.50	2,100	120	.50	4,920		.50			.50			.50			
.60	6.8	12	.60	640		.60	2,220		.60	5,100		.60			.60			.60			
.70	8.0	14	.70	690	50	.70	2,340		.70	5,280		.70			.70			.70			
.80	9.4	16	.80	740	60	.80	2,460		.80	5,460		.80			.80			.80			
.90	11.0	18	.90	800	60	.90	2,580	120	.90	5,640	180	.90			.90			.90			

This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during 54-61 and is _____ well defined between _____ cfs and _____ cfs.

Comp. by RT date 8-25-70

Ckd. by HDK date 12-23-70

Same as rating B above B A 11

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 14 16 5500

TABLE 15

Table No. 23

Rating table for McKenzie River near Coburg, Oreg.

Begin 70 01 29
YR. MO. D. HR.

from Jan 29, 1970 to _____, from _____ to _____, from _____ to _____

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
00			2 00	4,200	250	4 00	10,800	400	6 00	18,800	450	8 00	27,800	450	10 00	37,300		00		
10			10	4,450	250	10	11,200		10	19,250		10	28,250		10			10		
20			20	4,700	300	20	11,600		20	19,700		20	28,700		20			20		
30			30	5,000		30	12,000		30	20,150		30	29,150		30			30		
40			40	5,300		40	12,400		40	20,600		40	29,600		40			40		
50			50	5,600	300	50	12,800		50	21,050		50	30,050		50			50		
60			60	5,900	350	60	13,200		60	21,500		60	30,500		60			60		
70	1,800	140	70	6,250		70	13,600		70	21,950		70	30,950		70			70		
80	1,940	140	80	6,600		80	14,000		80	22,400		80	31,400		80			80		
90	2,080	160	90	6,950		90	14,400		90	22,850		90	31,850	450	90			90		
1 00	2,240		3 00	7,300		5 00	14,800		7 00	23,300		9 00	32,300	500	00			00		
10	2,400	160	10	7,650		10	15,200		10	23,750		10	32,800		10			10		
20	2,560	180	20	8,000		20	15,600		20	24,200		20	33,300		20			20		
30	2,740		30	8,350		30	16,000		30	24,650		30	33,800		30			30		
40	2,920	180	40	8,700		40	16,400		40	25,100		40	34,300		40			40		
50	3,100	200	50	9,050		50	16,800		50	25,550		50	34,800		50			50		
60	3,300		60	9,400		60	17,200		60	26,000		60	35,300		60			60		
70	3,500	200	70	9,750		70	17,600		70	26,450		70	35,800		70			70		
80	3,700	250	80	10,100		80	18,000		80	26,900		80	36,300		80			80		
90	3,950	250	90	10,450	350	90	18,400	400	90	27,350	450	90	36,800	500	90			90		

TABLE 15

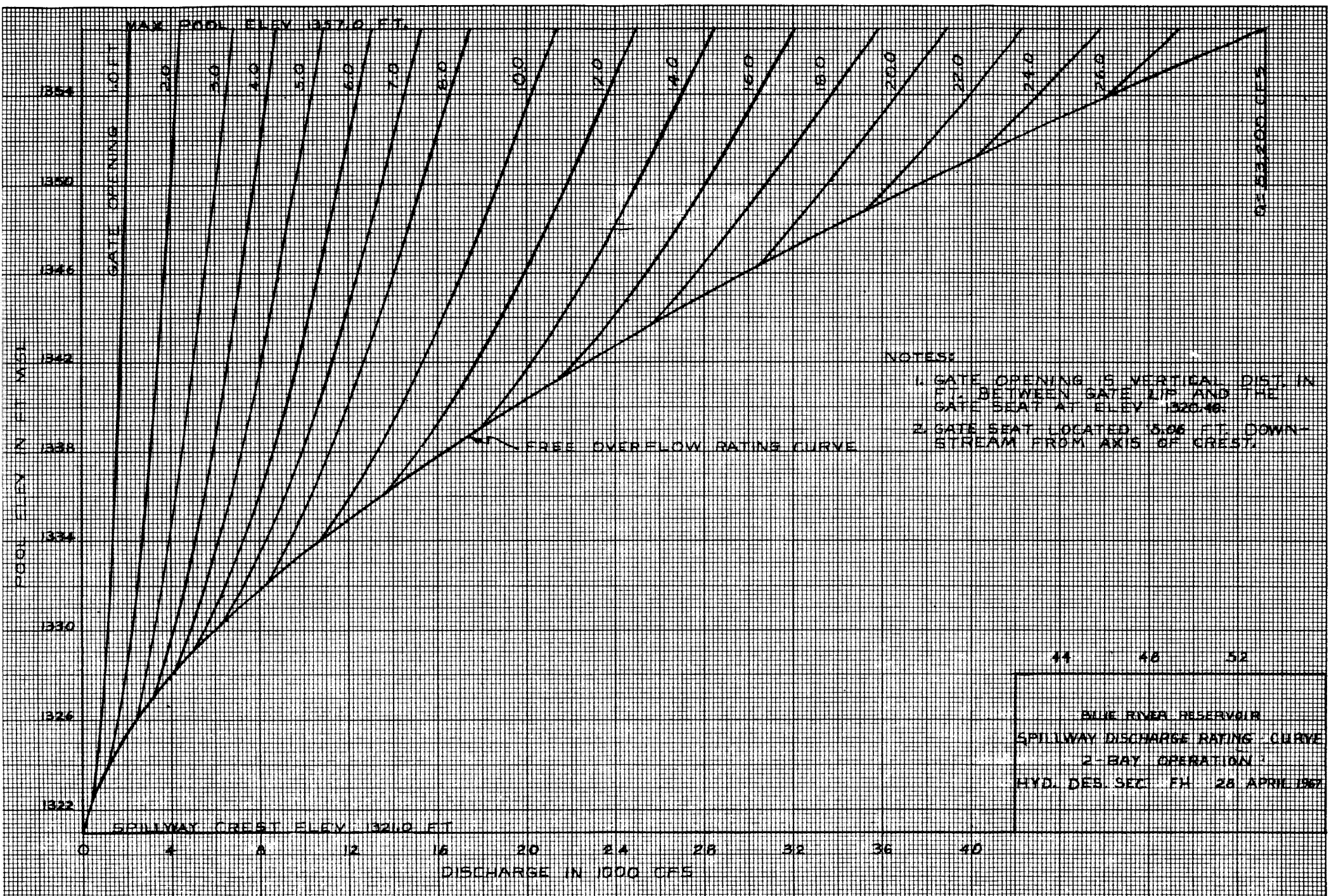
This table is applicable for open-channel conditions. It is based on _____ discharge measurements made during 265-273

_____ and is _____ well defined between _____ cfs and _____ cfs.
Extended from 0.80 to 0.70 ft. 2-5-71 RT
Rating 21 and 22 used provisionally only.

Comp. by RT date 11-3-70

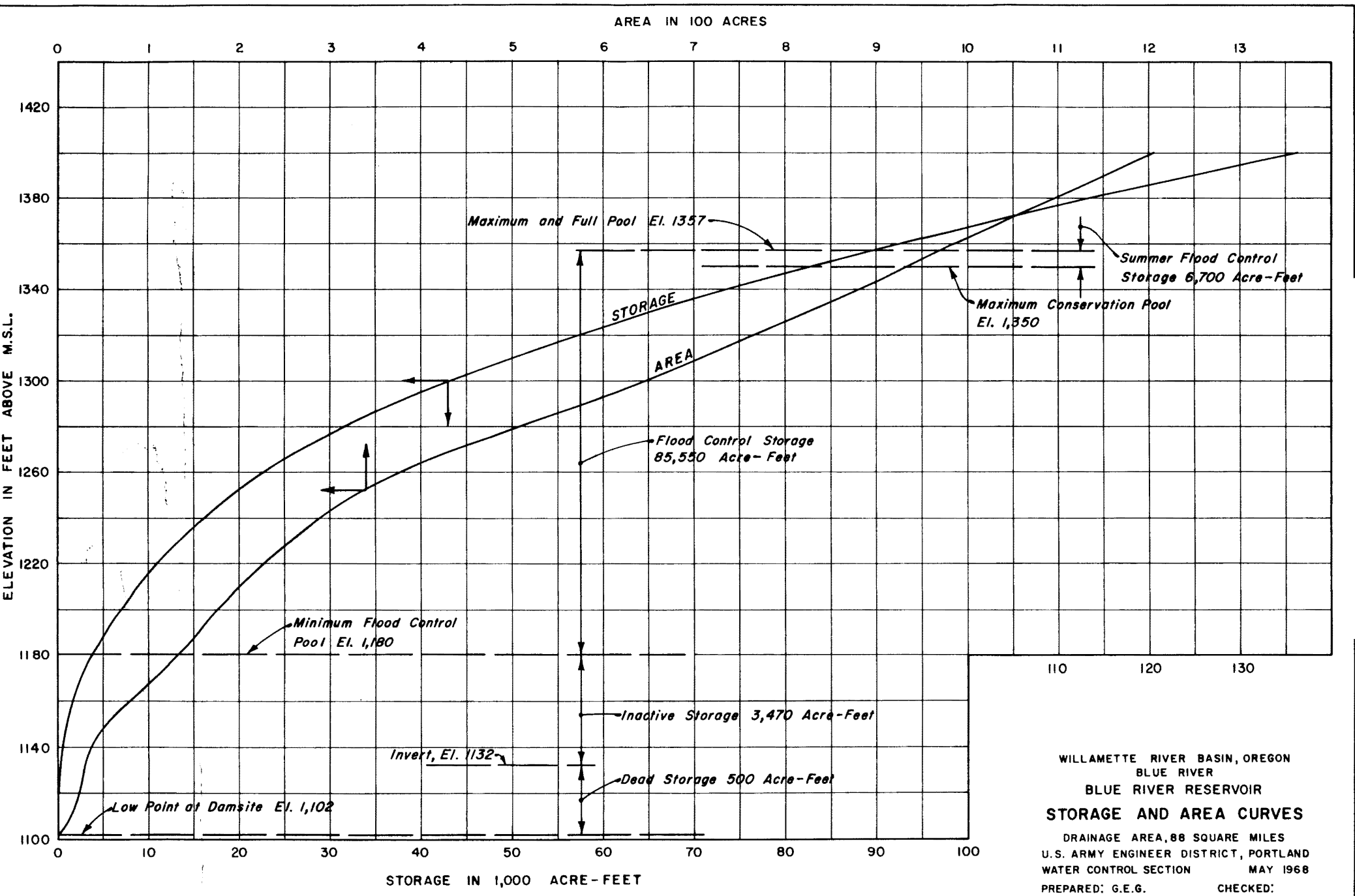
Ckd. by HDK date 11-3-70

Plates/charts



44 48 52

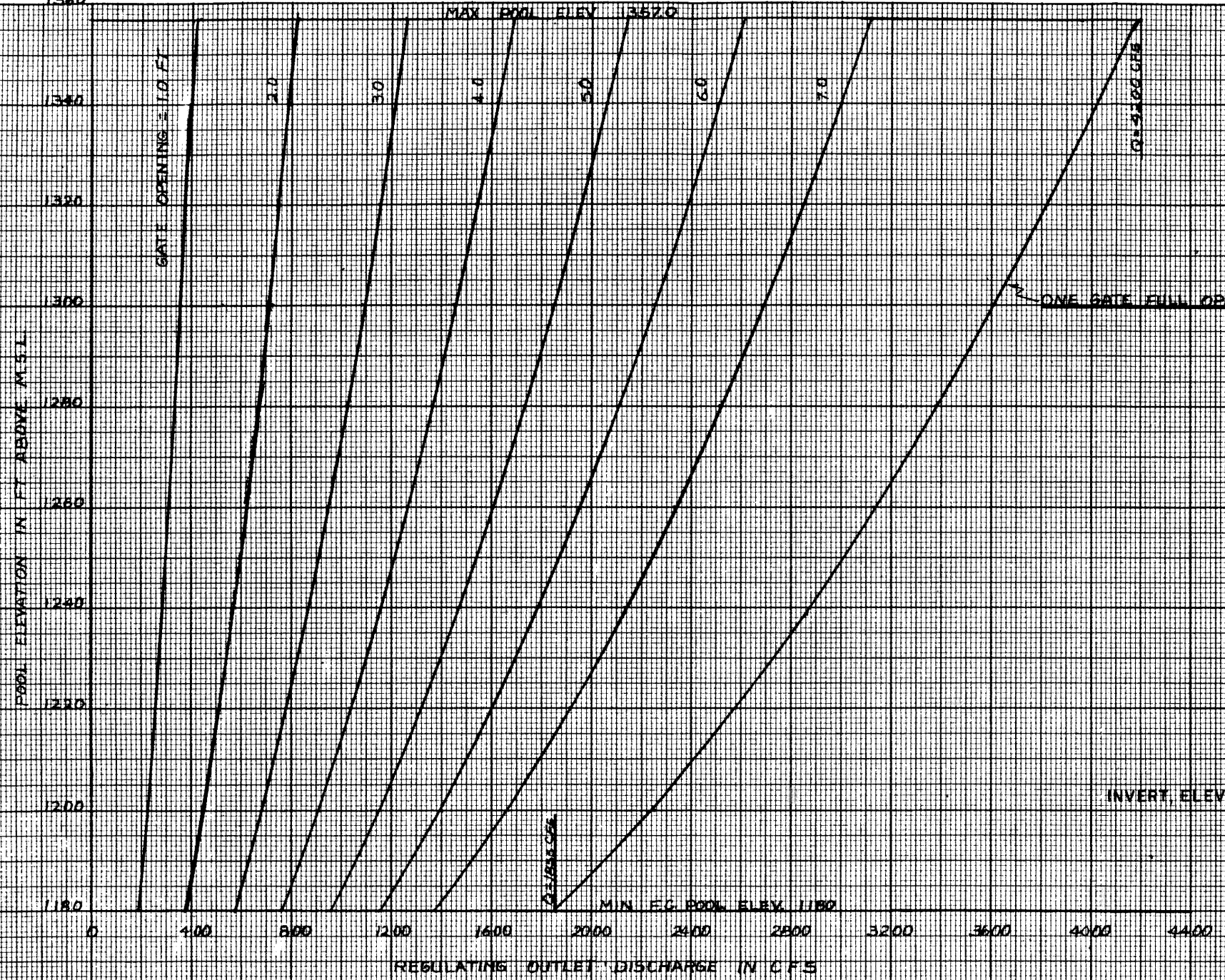
BLUE RIVER RESERVOIR
 SPILLWAY DISCHARGE RATING CURVE
 2-BAY OPERATION
 HYD. DES. SEC. FH 28 APRIL 1967



WILLAMETTE RIVER BASIN, OREGON
 BLUE RIVER
 BLUE RIVER RESERVOIR
STORAGE AND AREA CURVES
 DRAINAGE AREA, 88 SQUARE MILES
 U.S. ARMY ENGINEER DISTRICT, PORTLAND
 WATER CONTROL SECTION MAY 1968
 PREPARED: G.E.G. CHECKED:

1360

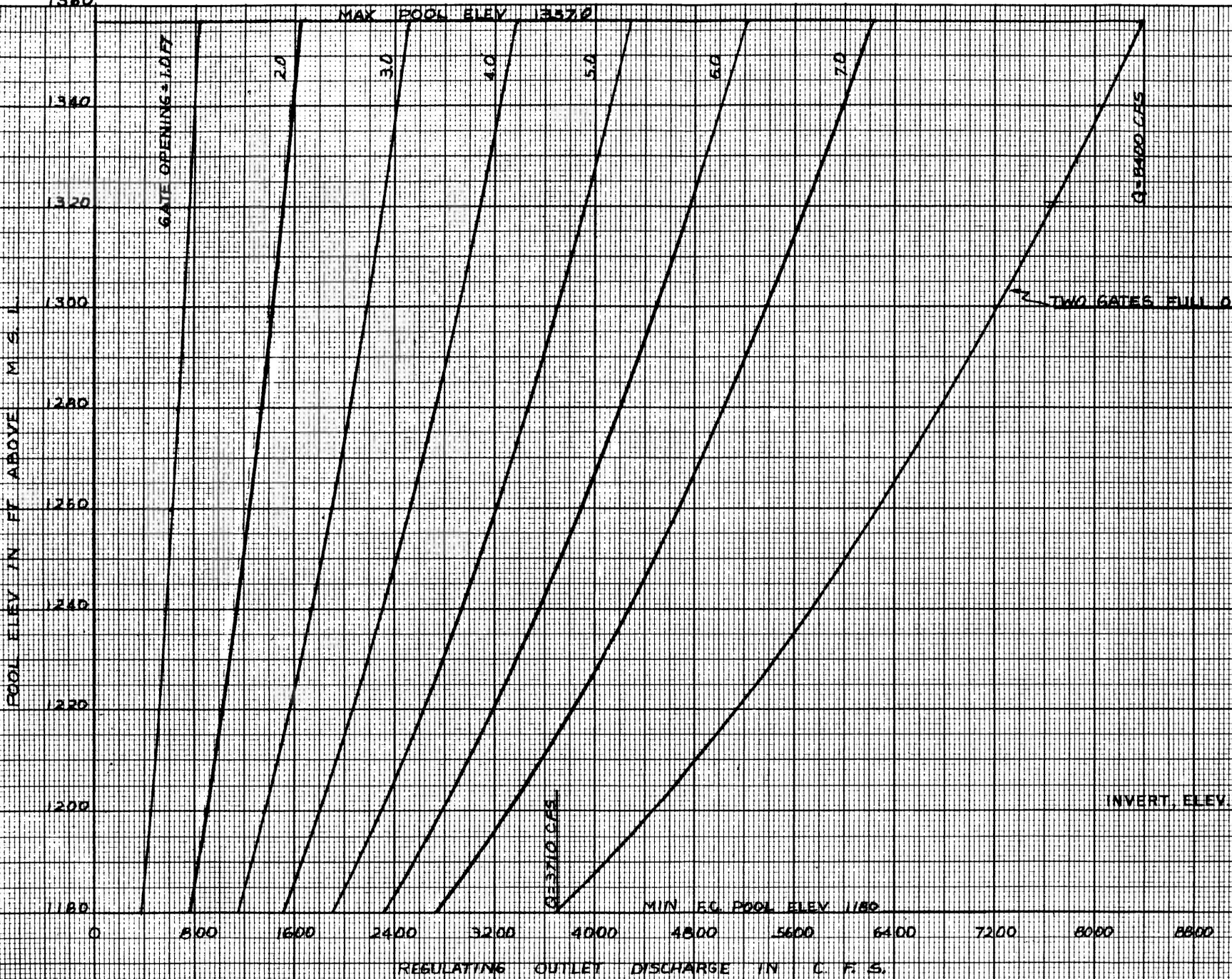
67



BLUE RIVER RESERVOIR
 REGULATING OUTLET
 DISCHARGE RATING CURVE
 SINGLE GATE OPERATION
 HYD. DES. SEC. FM 6 JUNE 1967

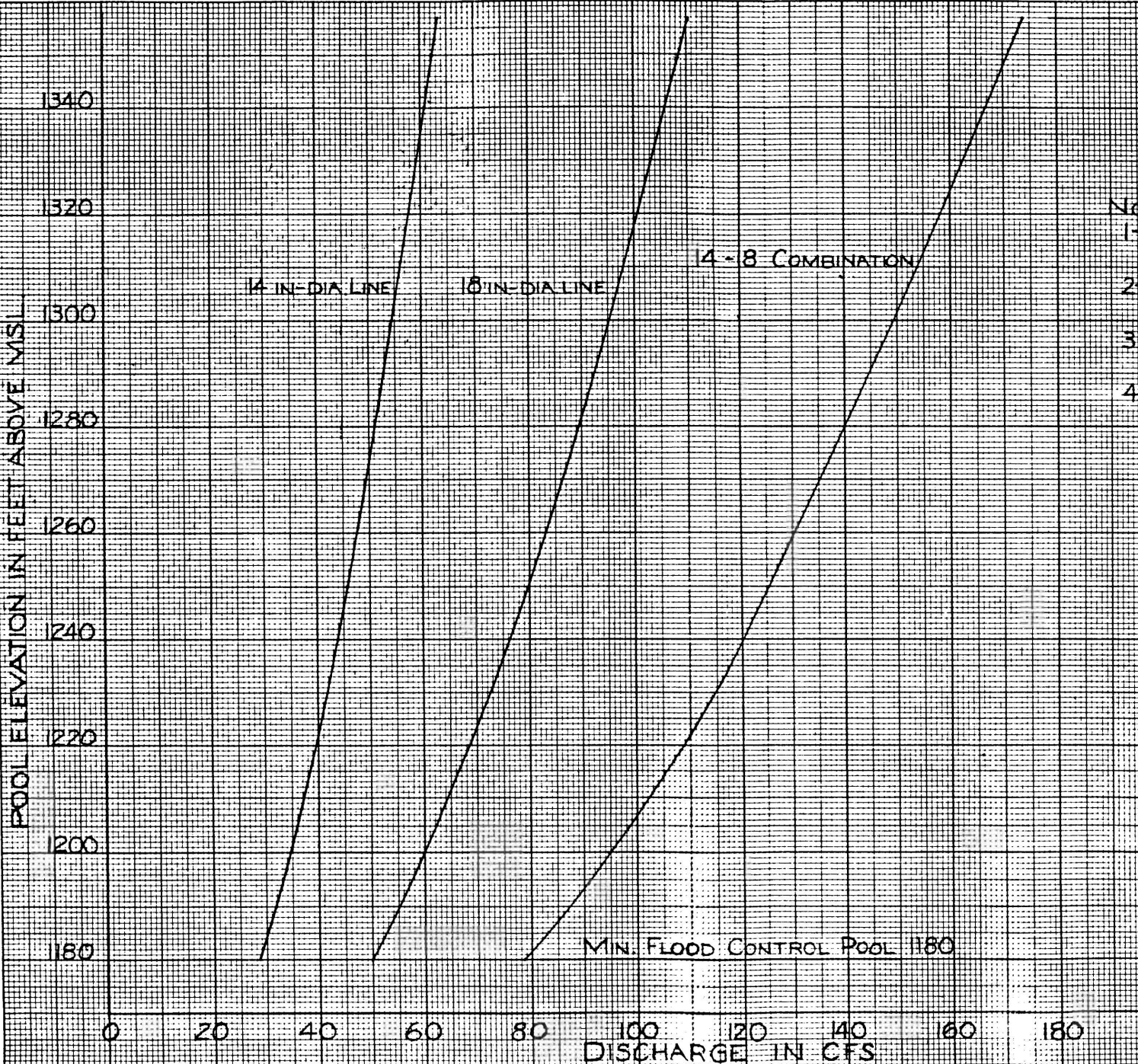
1360

77



BLUE RIVER RESERVOIR
 REGULATING OUTLET
 DISCHARGE RATING CURVE
 TWO GATE OPERATION
 HYD. DES. SEC. FEB. 6, 1966

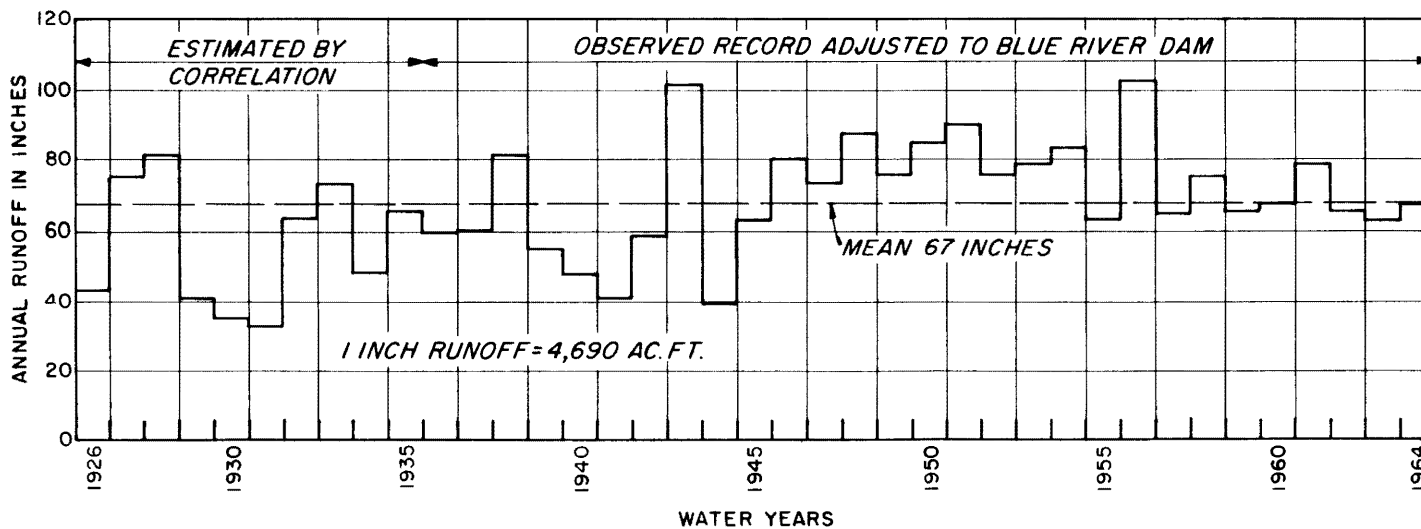
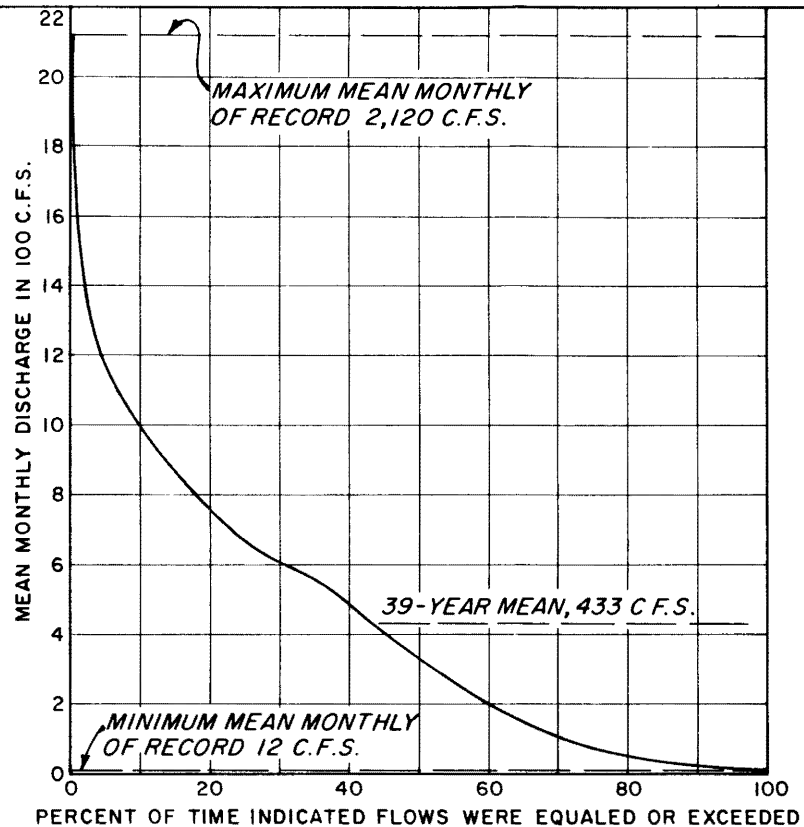
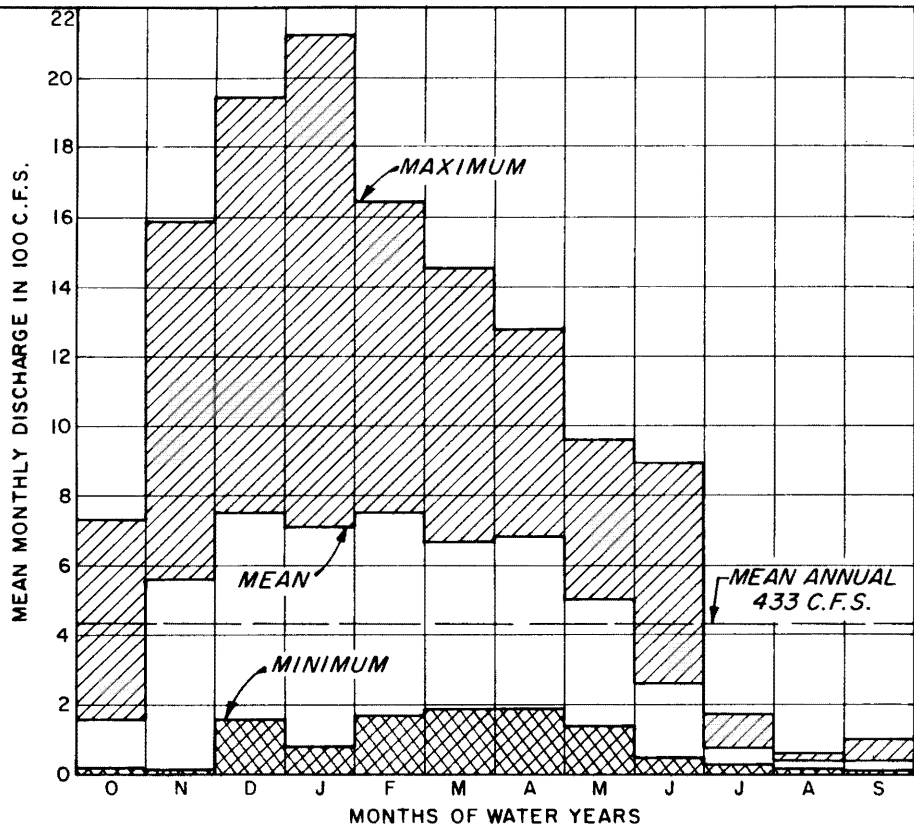
MAX. POOL 1357.0



NOTES:

- 1-THE 14 IN-DIA LINE IS TRANSITIONED TO A 18 IN BY 6 IN. EXIT.
- 2-THE 18 IN-DIA LINE IS TRANSITIONED TO A 30 IN BY 6 IN. EXIT.
- 3-EACH LINE CONTAINS A GATE VALVE AND A BALL VALVE.
- 4-ALL VALVES ARE FULL OPEN.

BLUE RIVER RESERVOIR
LOW-FLOW BY-PASS
RATING CURVES
HYDR. SECT. 27 OCT 1964



NOTE:
 RECORDS USED: PERIOD 1926 - 1935 INCL. ESTIMATED BY CORRELATION WITH MCKENZIE RIVER AT MCKENZIE BRIDGE AND AT VIDA.
 PERIOD 1936 - 1964 INCL. FROM OBSERVED DISCHARGE RECORDS BLUE RIVER NEAR BLUE RIVER, OREGON (D.A. 75 SQ.MI.) ADJUSTED TO BLUE RIVER DAM (D.A. 88 SQ.MI.).

WILLAMETTE RIVER BASIN, OREGON
 BLUE RIVER
 BLUE RIVER RESERVOIR
 RUNOFF SUMMARY

DRAINAGE AREA 88 SQUARE MILES
 U.S. ARMY ENGINEER DISTRICT, PORTLAND
 WATER CONTROL SECTION JANUARY 1967
 PREPARED: G.E.G. CHECKED:

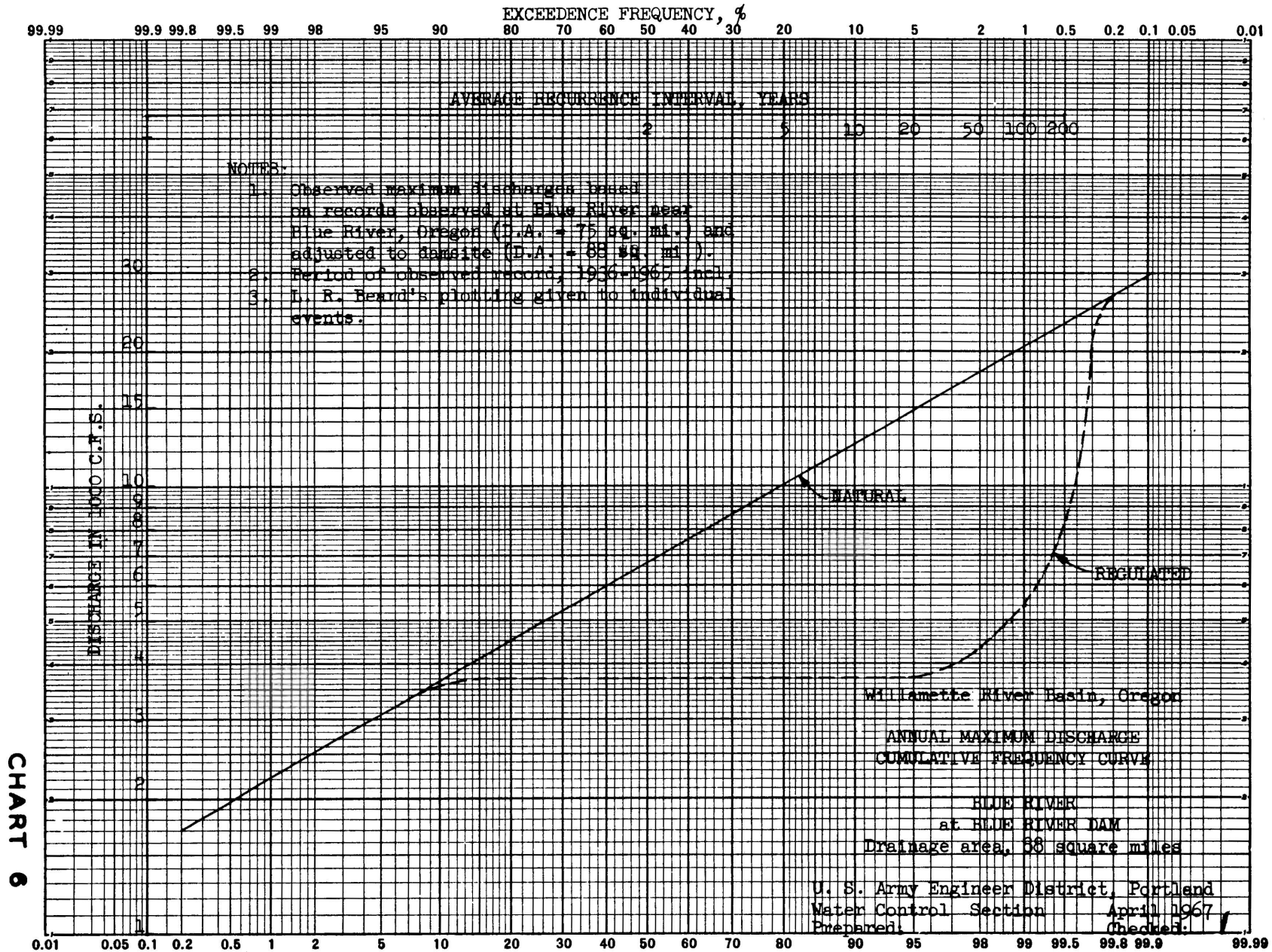
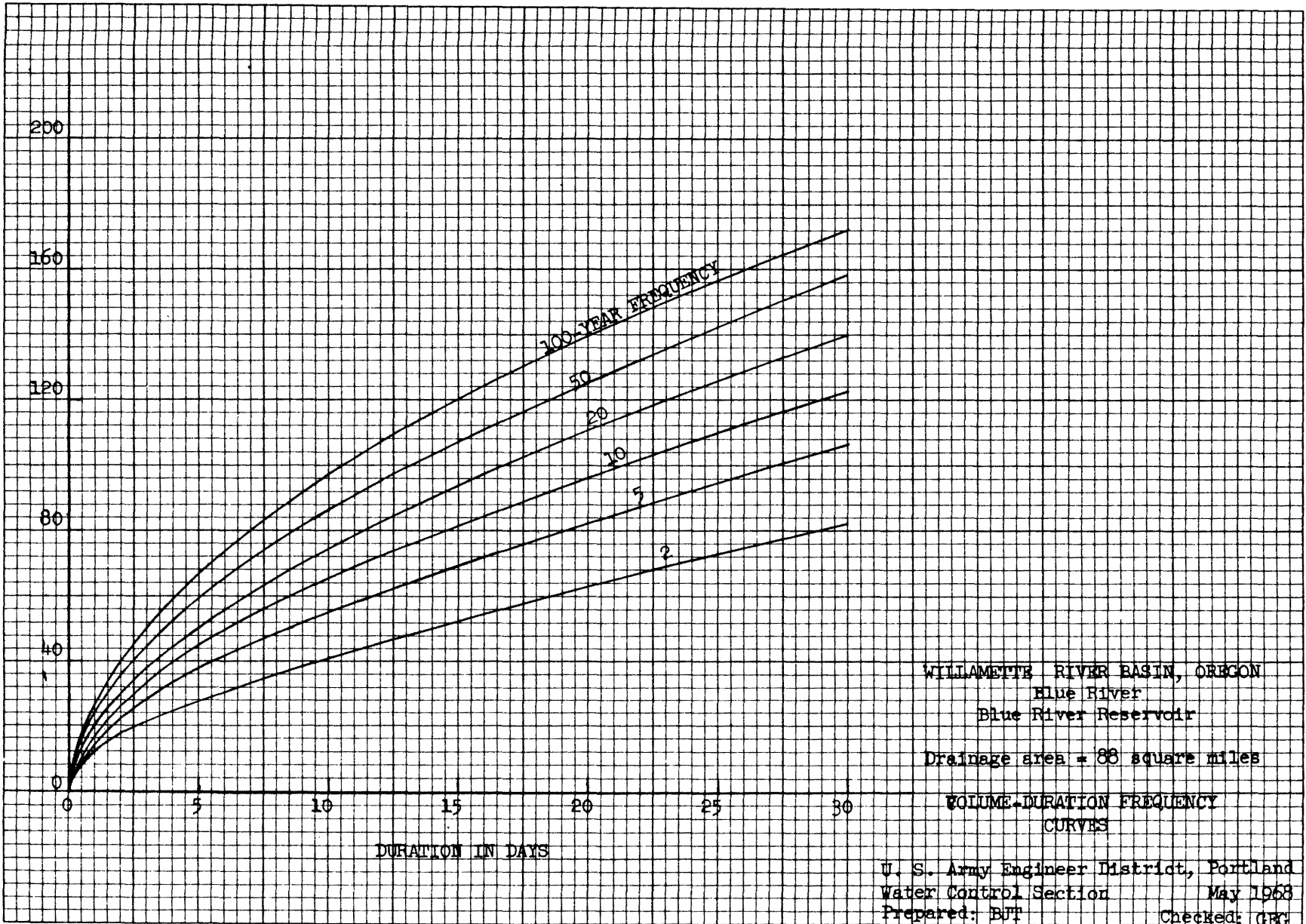


CHART 6

BL-20-27/6

CHART 7

RUNOFF IN 1000 ACRE-FEET



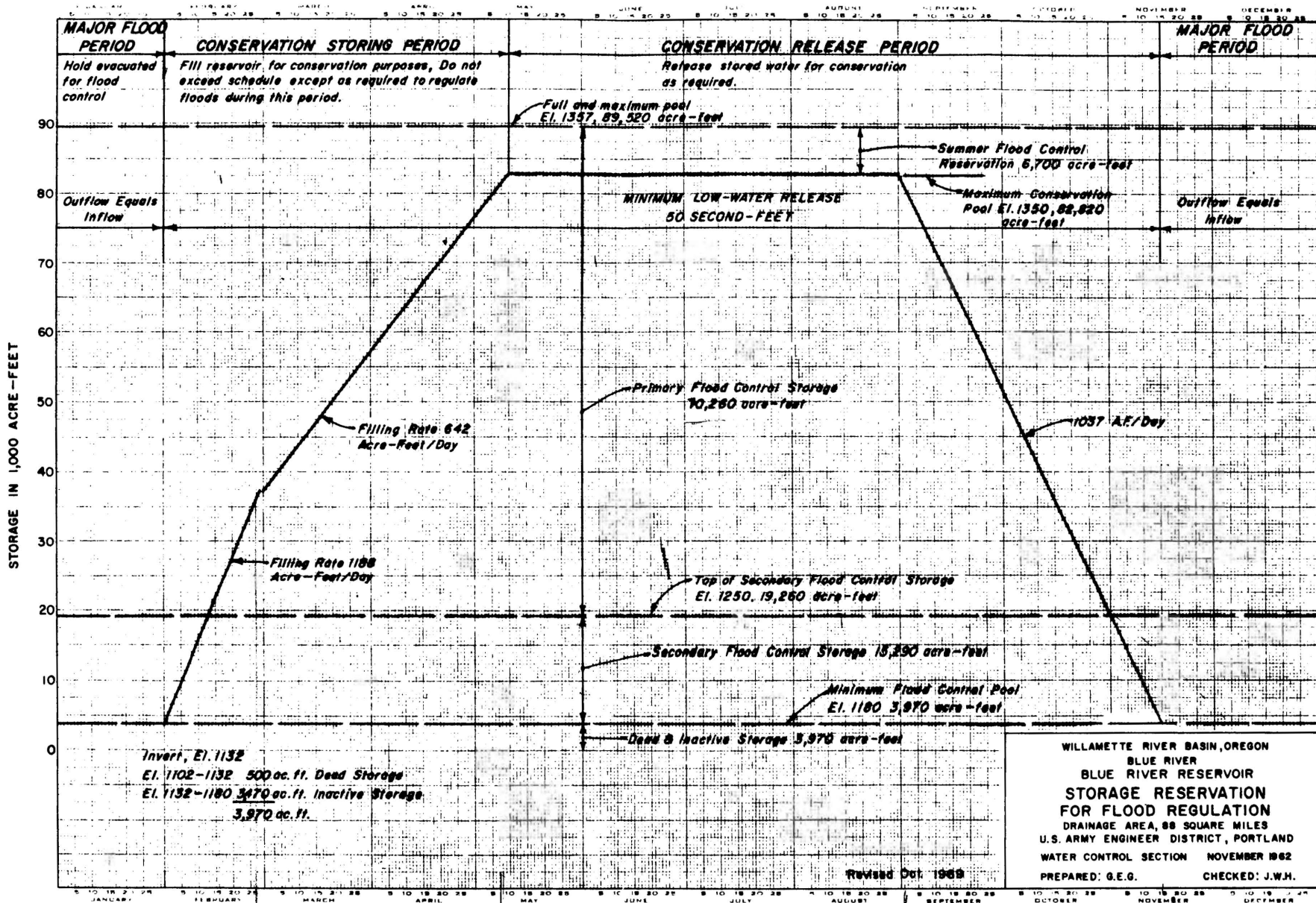
WILLAMETTE RIVER BASIN, OREGON
Blue River
Blue River Reservoir

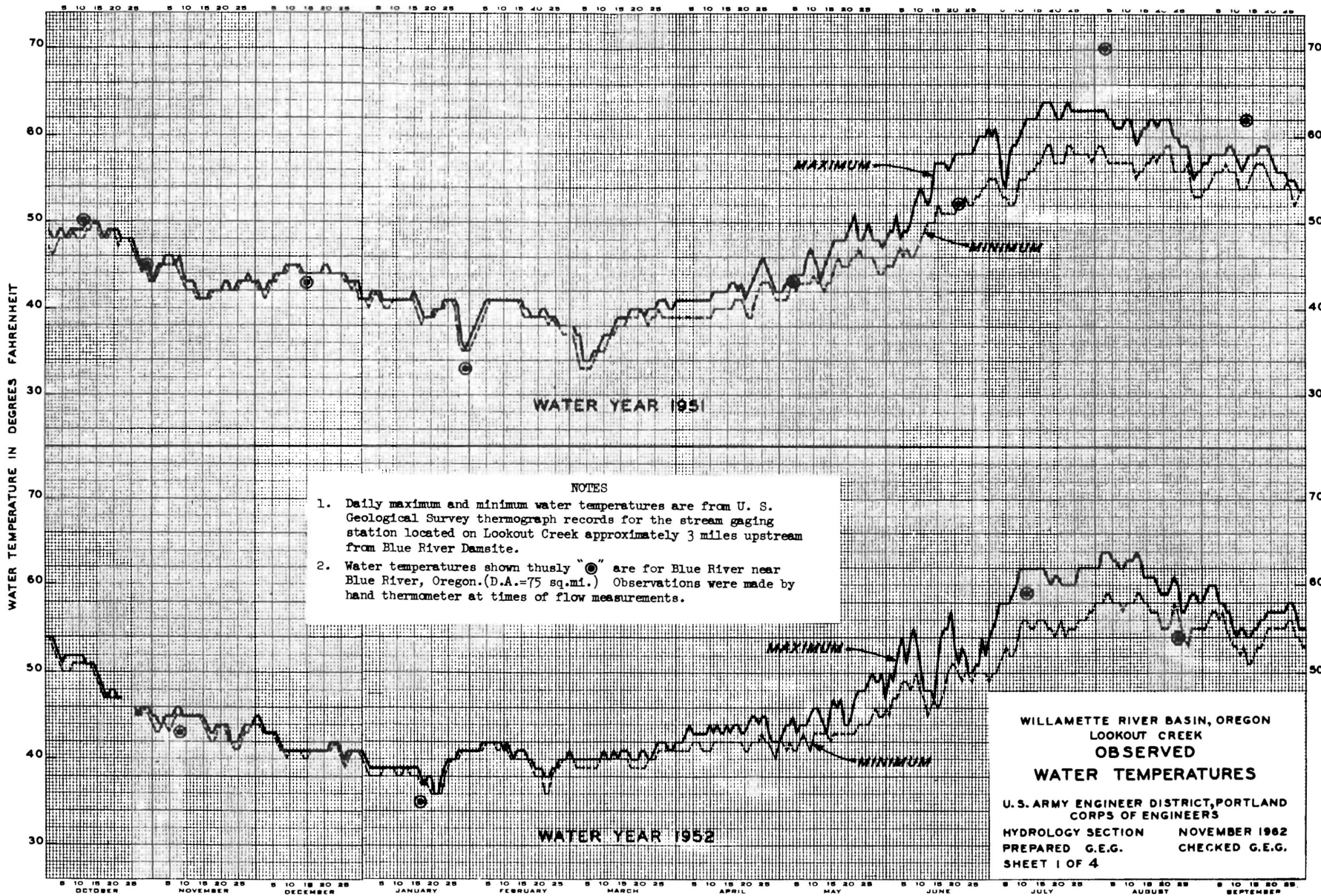
Drainage area = 88 square miles

VOLUME-DURATION FREQUENCY
CURVES

U. S. Army Engineer District, Portland
Water Control Section May 1968
Prepared: BJT Checked: gsc

BL-20-27/7





WATER YEAR 1951

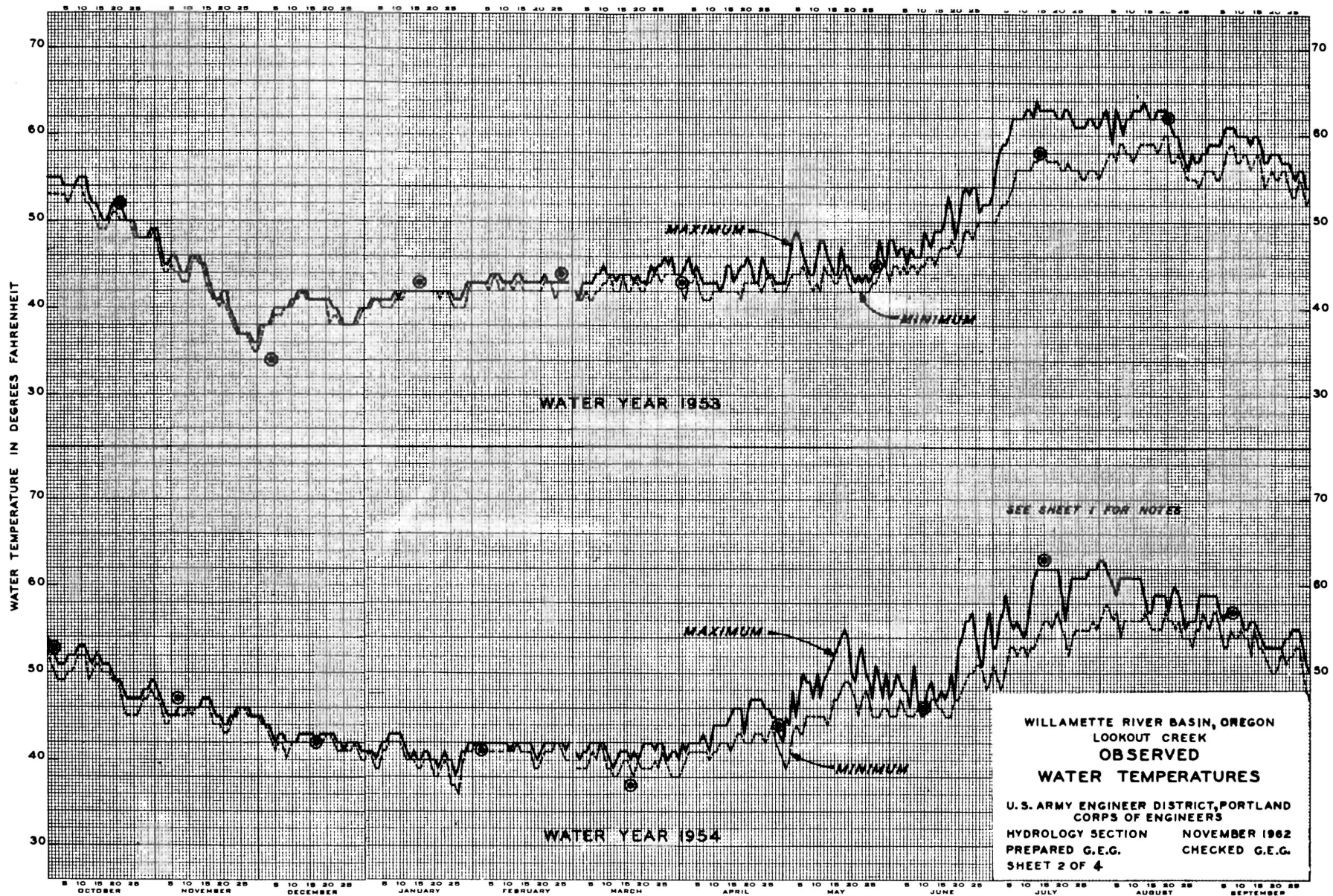
NOTES

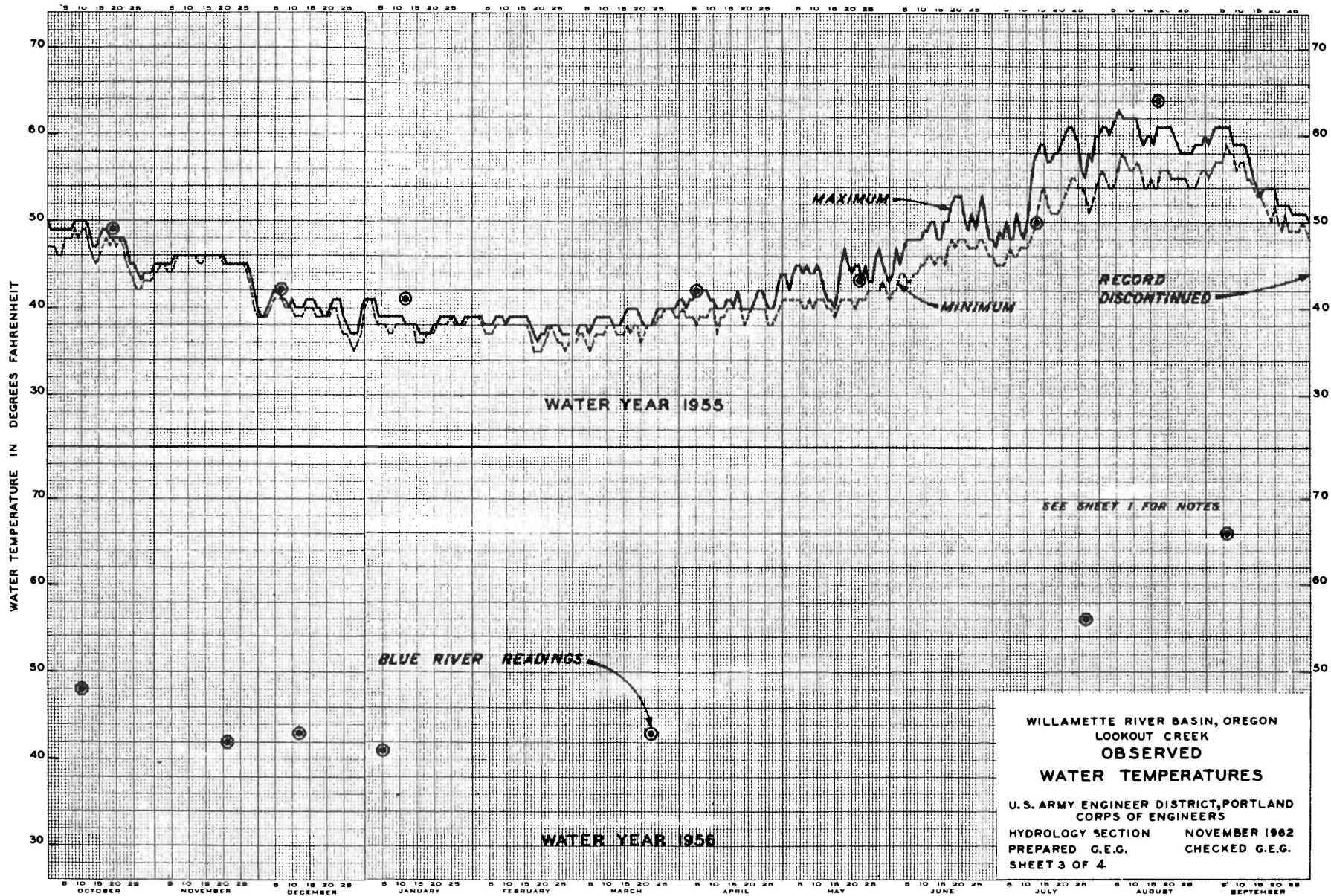
1. Daily maximum and minimum water temperatures are from U. S. Geological Survey thermograph records for the stream gaging station located on Lookout Creek approximately 3 miles upstream from Blue River Dam site.
2. Water temperatures shown thusly "⊙" are for Blue River near Blue River, Oregon. (D.A. = 75 sq. mi.) Observations were made by hand thermometer at times of flow measurements.

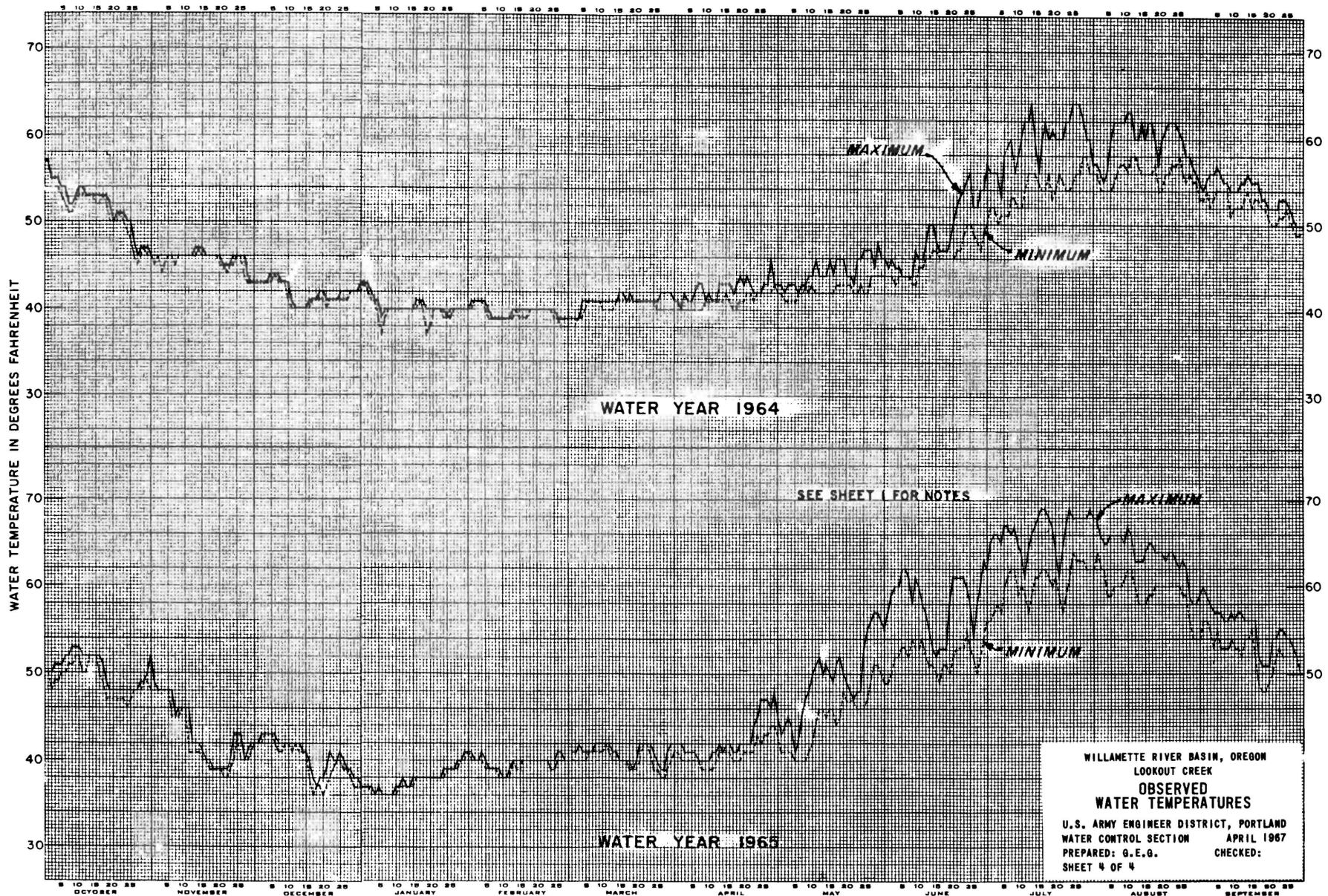
WATER YEAR 1952

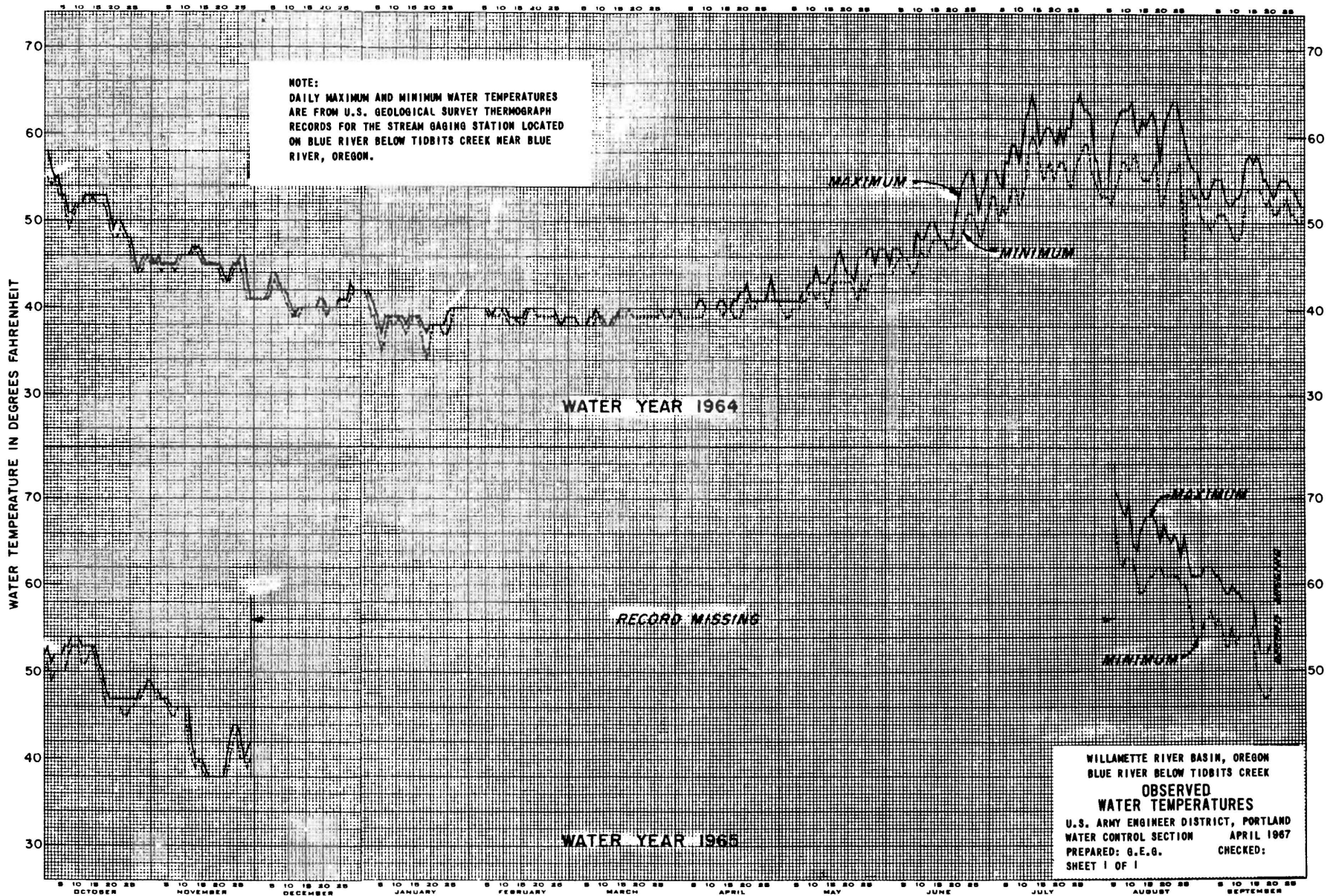
WILLAMETTE RIVER BASIN, OREGON
LOOKOUT CREEK
OBSERVED
WATER TEMPERATURES

U.S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS
HYDROLOGY SECTION NOVEMBER 1962
PREPARED G.E.G. CHECKED G.E.G.
SHEET 1 OF 4









NOTES:

1. Maintain scheduled pool elevations when flow at Coburg is below bankfull (22,000 c.f.s.). Use this schedule to prevent overbank stages at Coburg when rising flows are forecasted.
2. The uncontrolled flow at Coburg is the observed flow minus the summation of releases at Cougar and Blue River 12 hours earlier.
3. The combined allowable release is proportioned 35% from Blue River and 55% from Cougar.
4. Allowable minimum releases are 100 c.f.s. at Cougar and 50 c.f.s. at Blue River. Normal maximum releases are 6500 c.f.s. at Cougar and 3700 c.f.s. at Blue River.

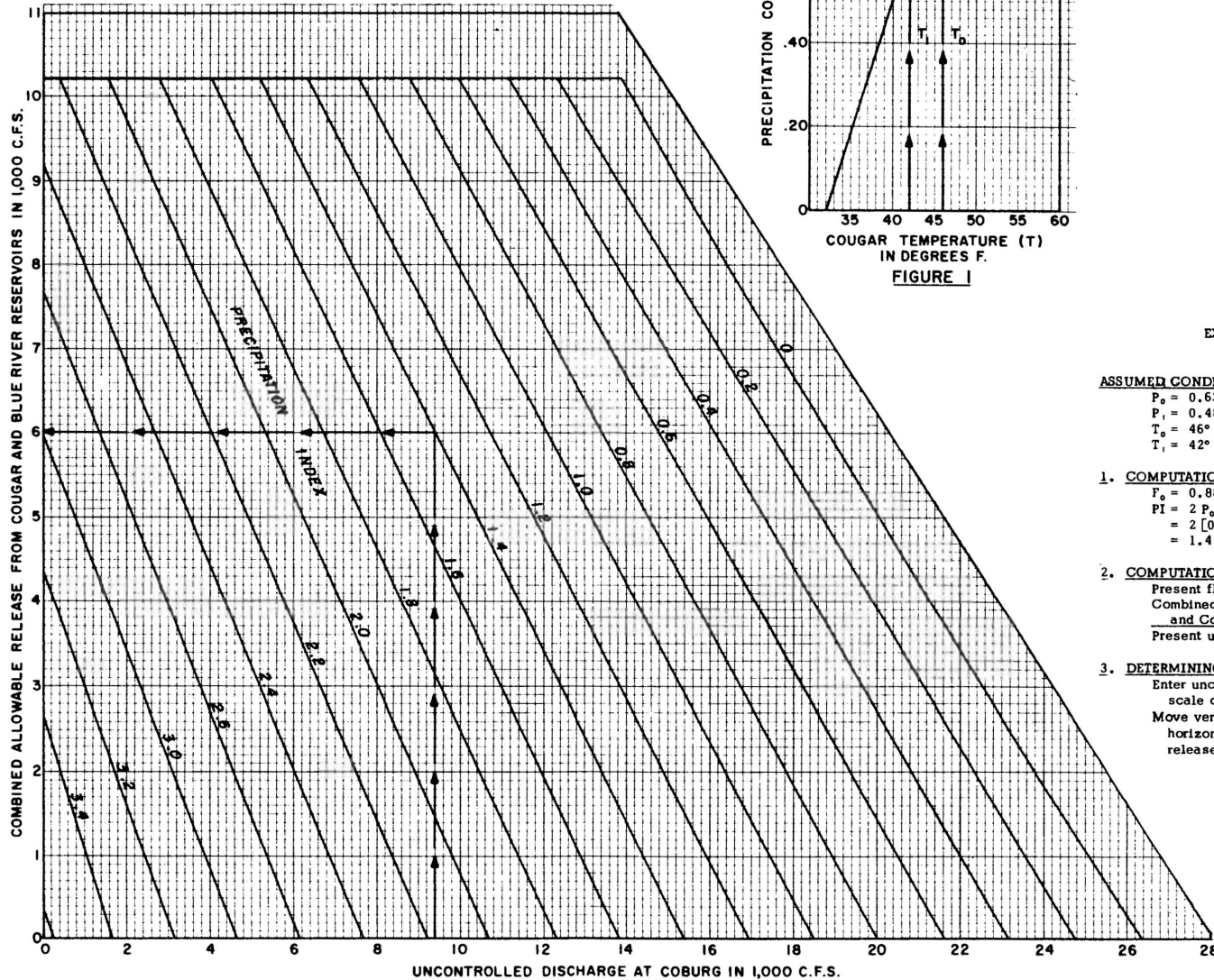


FIGURE 2

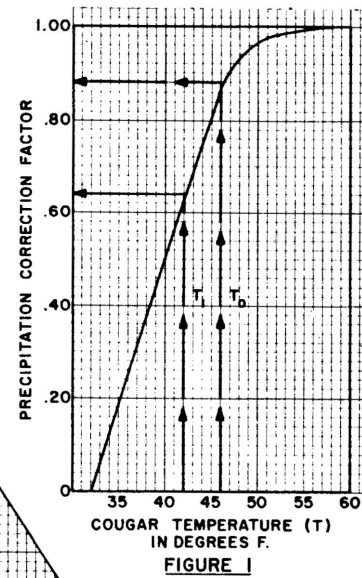


FIGURE 1

FORMULA FOR PRECIPITATION INDEX, (PI):

$$PI = 2 P_0 F_0 + P_1 F_1$$

WHERE:

- P_0 = Latest 6-hour precipitation at Cougar
- F_0 = Correction factor for present temperature at Cougar
- P_1 = Six-hour precipitation ending six hours ago at Cougar
- F_1 = Correction factor for temperature 6 hours ago at Cougar

EXAMPLE OF RESERVOIR OPERATION

ASSUMED CONDITIONS:

- $P_0 = 0.63$
- $P_1 = 0.48$
- $T_0 = 46^\circ \text{ F.}$
- $T_1 = 42^\circ \text{ F.}$

1. COMPUTATION OF PRECIPITATION INDEX (PI):

$$F_0 = 0.88; F_1 = 0.64 \text{ (From Figure 1)}$$

$$PI = 2 P_0 F_0 + P_1 F_1$$

$$= 2 [0.63 \times 0.88] + 0.48 \times 0.64$$

$$= 1.4$$

2. COMPUTATION OF UNCONTROLLED FLOW AT COBURG

- Present flow at Coburg = 16,900 c.f.s.
- Combined release from Blue River and Cougar Reservoirs 12-hours ago = 7,500 c.f.s.
- Present uncontrolled flow at Coburg = 9,400 c.f.s.

3. DETERMINING ALLOWABLE RESERVOIR RELEASE:

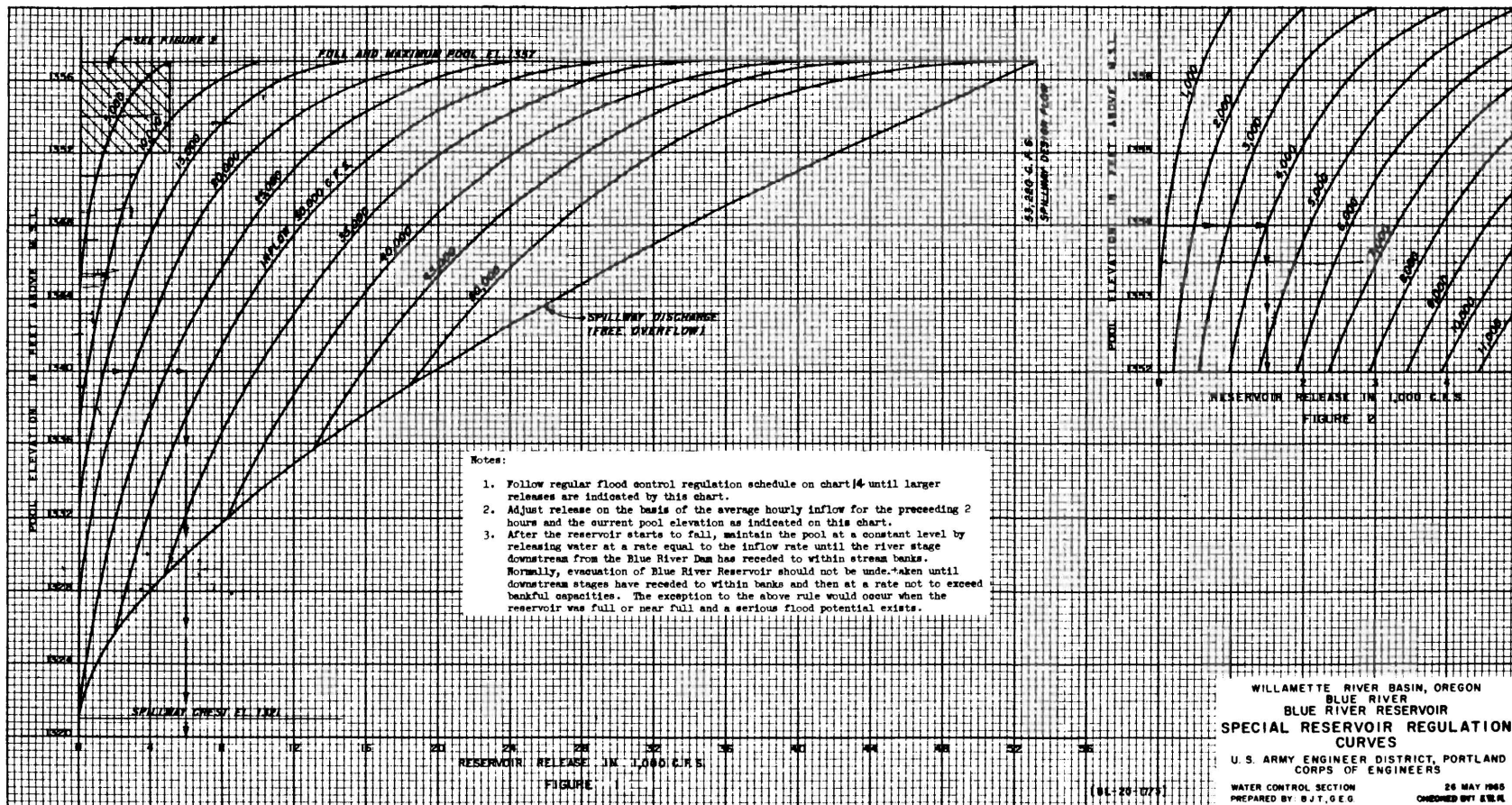
Enter uncontrolled flow (9,400 c.f.s.) on horizontal scale of Fig. II. Move vertically to precipitation index (1.4). Move horizontally to combined allowable reservoir release (6,000 c.f.s.).

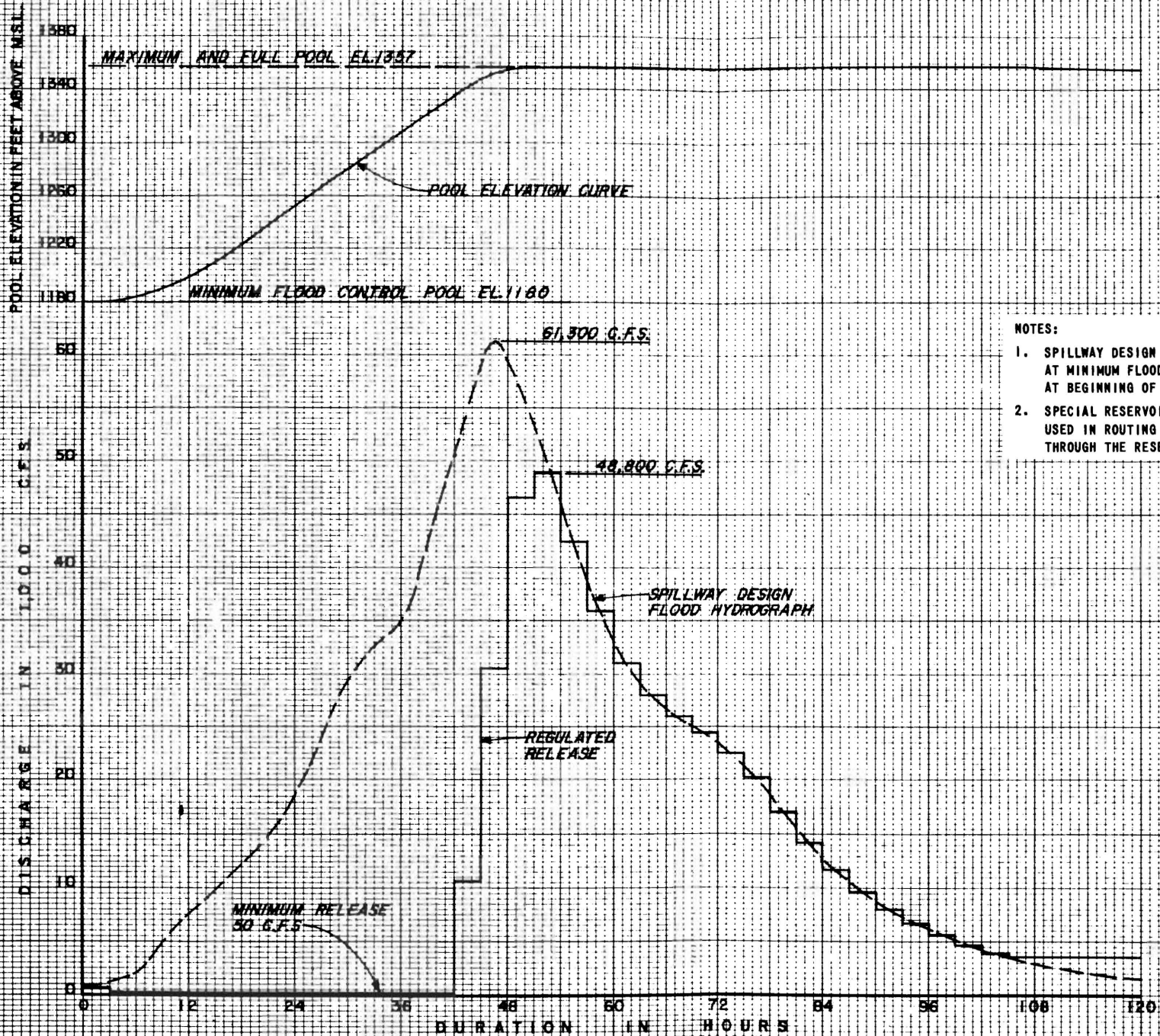
WILLAMETTE RIVER BASIN, OREGON
 BLUE RIVER
 BLUE RIVER RESERVOIR
 NORMAL FLOOD CONTROL
 REGULATION SCHEDULES
 U.S. ARMY ENGINEER DISTRICT, PORTLAND
 CORPS OF ENGINEERS
 WATER CONTROL SECTION
 MAY 1965

PREPARED: E.C.K.

CHECKED: S.M.

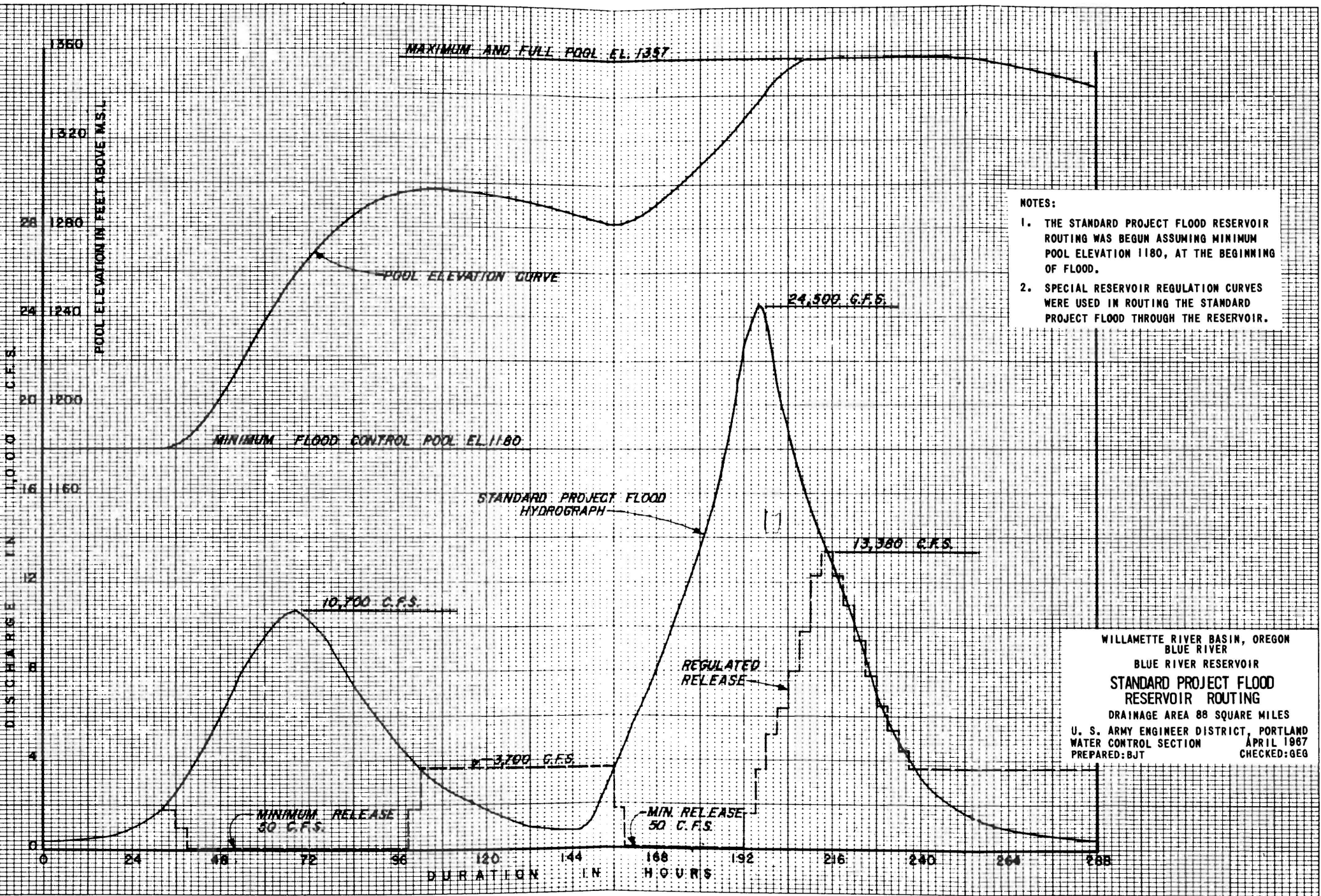
(BL-20-17/4)





- NOTES:
1. SPILLWAY DESIGN FLOOD ASSUMING POOL ELEVATION AT MINIMUM FLOOD CONTROL POOL, ELEVATION 1180, AT BEGINNING OF FLOOD.
 2. SPECIAL RESERVOIR REGULATION CURVES WERE USED IN ROUTING THE SPILLWAY DESIGN FLOOD THROUGH THE RESERVOIR.

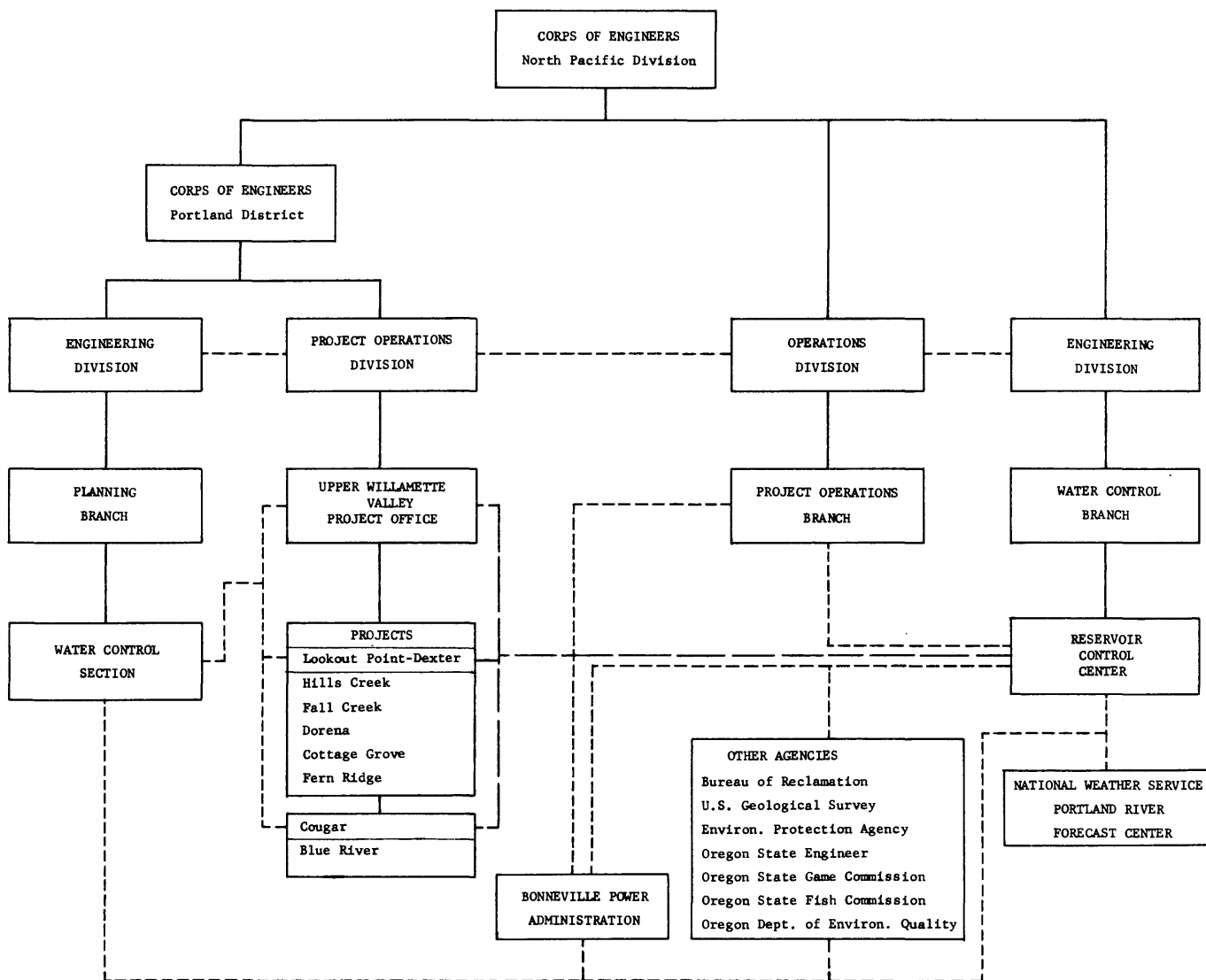
WILLAMETTE RIVER BASIN, OREGON
 BLUE RIVER
 BLUE RIVER RESERVOIR
 SPILLWAY DESIGN FLOOD
 RESERVOIR ROUTING
 DRAINAGE AREA 88 SQUARE MILES
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 WATER CONTROL SECTION APRIL 1957
 PREPARED: GEG CHECKED: GEG



- NOTES:
1. THE STANDARD PROJECT FLOOD RESERVOIR ROUTING WAS BEGUN ASSUMING MINIMUM POOL ELEVATION 1180, AT THE BEGINNING OF FLOOD.
 2. SPECIAL RESERVOIR REGULATION CURVES WERE USED IN ROUTING THE STANDARD PROJECT FLOOD THROUGH THE RESERVOIR.

WILLAMETTE RIVER BASIN, OREGON
 BLUE RIVER
 BLUE RIVER RESERVOIR
**STANDARD PROJECT FLOOD
 RESERVOIR ROUTING**
 DRAINAGE AREA 88 SQUARE MILES
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 WATER CONTROL SECTION APRIL 1967
 PREPARED:BJT CHECKED:GEG

FUNCTIONAL ORGANIZATION CHART
FOR
OPERATION OF UPPER WILLAMETTE BASIN PROJECTS



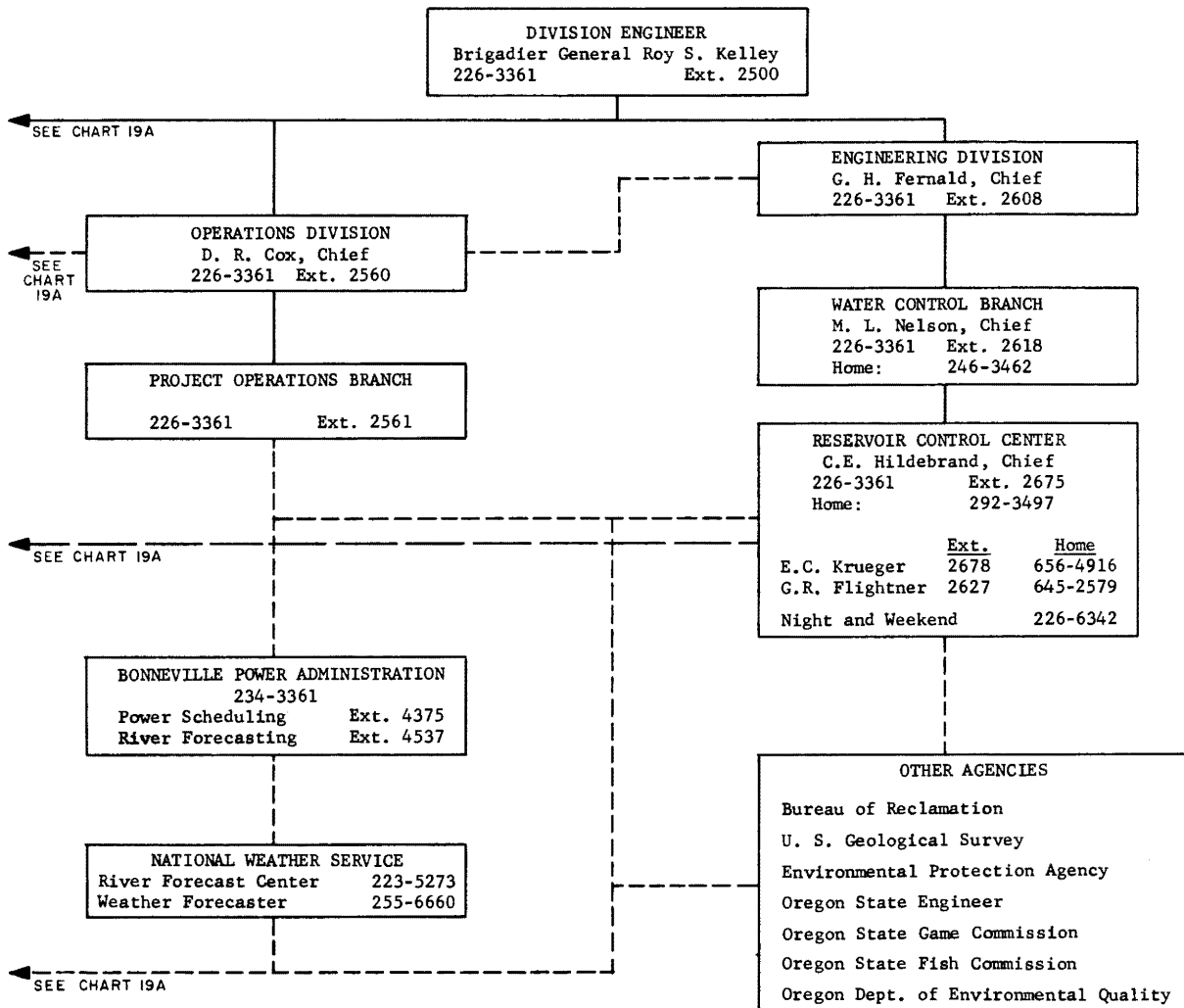
LEGEND

- SUPERVISORY AND ADMINISTRATIVE
- RESERVOIR REGULATION INSTRUCTIONS
- - - - COORDINATION AND LIAISON

APRIL 1971

CHART 19 A

NORTH PACIFIC DIVISION
FUNCTIONAL ORGANIZATION CHART



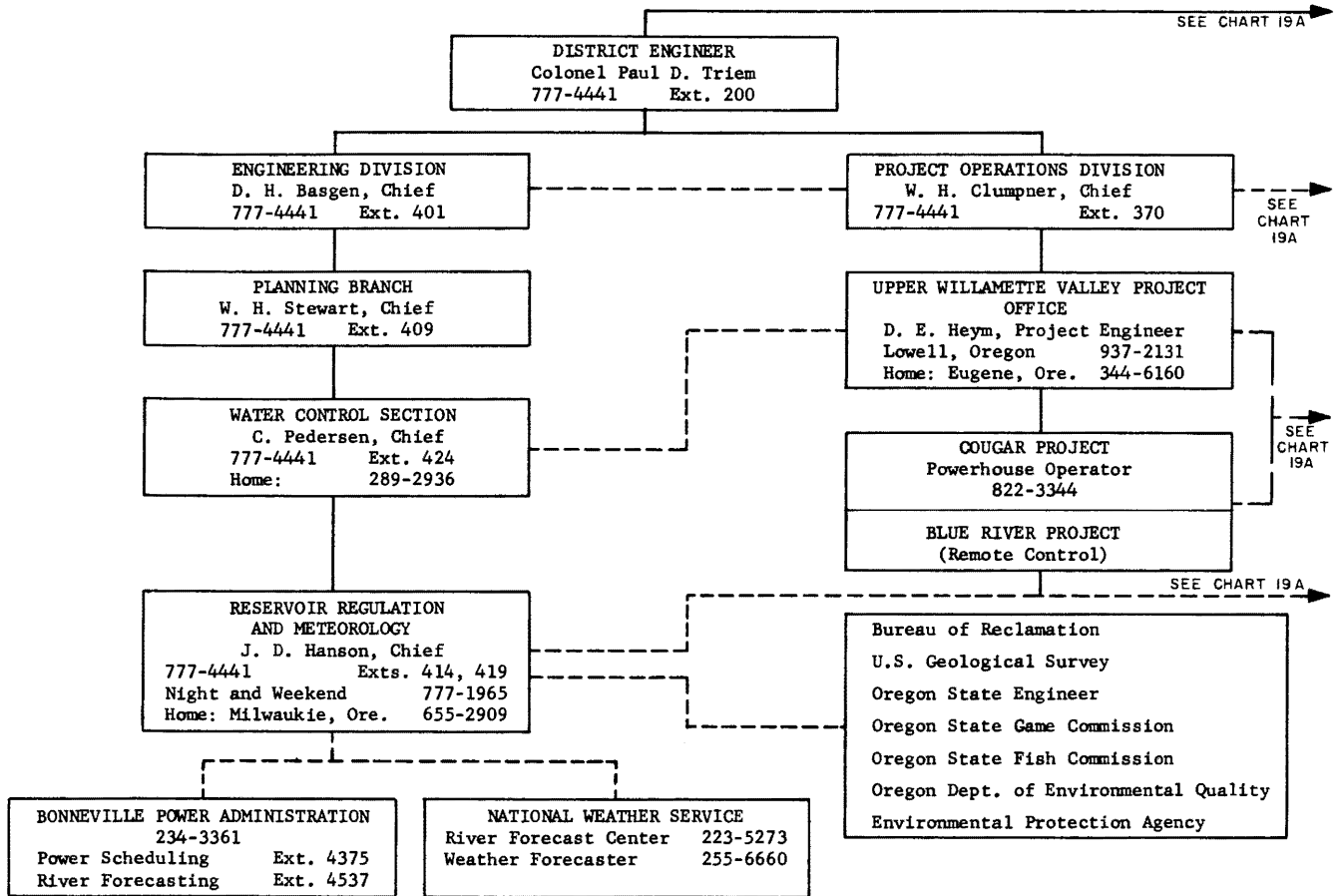
LEGEND

- SUPERVISORY AND ADMINISTRATIVE
- RESERVOIR REGULATION INSTRUCTIONS
- - - - - COORDINATION AND LIAISON

APRIL 1971

CHART 19 B

PORTLAND DISTRICT
FUNCTIONAL ORGANIZATION CHART
 COUGAR - BLUE RIVER PROJECTS



LEGEND

- SUPERVISORY AND ADMINISTRATIVE
- RESERVATION REGULATION INSTRUCTIONS
- - - - - COORDINATION AND LIAISON

APRIL 1971

CHART 19C

DAILY RESERVOIR DATA	DATE:
	TIME:

FALL CREEK RESERVOIR

STATION	STAGE FEET	CHANGE HR.	DISCHARGE C.F.S.	TENDENCY	CURRENT WEATHER			PREC. HR.
FALL CREEK (Above)					DAMSITE			
WINBERRY CREEK					AV. INFLOW	OUTFLOW	TIME	
FALL CREEK (Below)								
RESERVOIR	POOL ELEV. FEET	TEN'CY.	STORAGE AC. FT.	CHANGE HR.	AV. OUTFLOW			

COTTAGE GROVE RESERVOIR

STATION	STAGE FEET	CHANGE HR.	DISCHARGE C.F.S.	TENDENCY	CURRENT WEATHER			PREC. HR.
LONDON					LONDON			
COTTAGE GRV. (Below)					BLACK BUTTE			
					DAM SITE			
RESERVOIR	POOL ELEV. FEET	TEN'CY.	STORAGE AC. FT.	CHANGE HR.	AV. INFLOW	OUTFLOW	TIME	SUM
					AV. OUTFLOW			AVE.

DORENA RESERVOIR

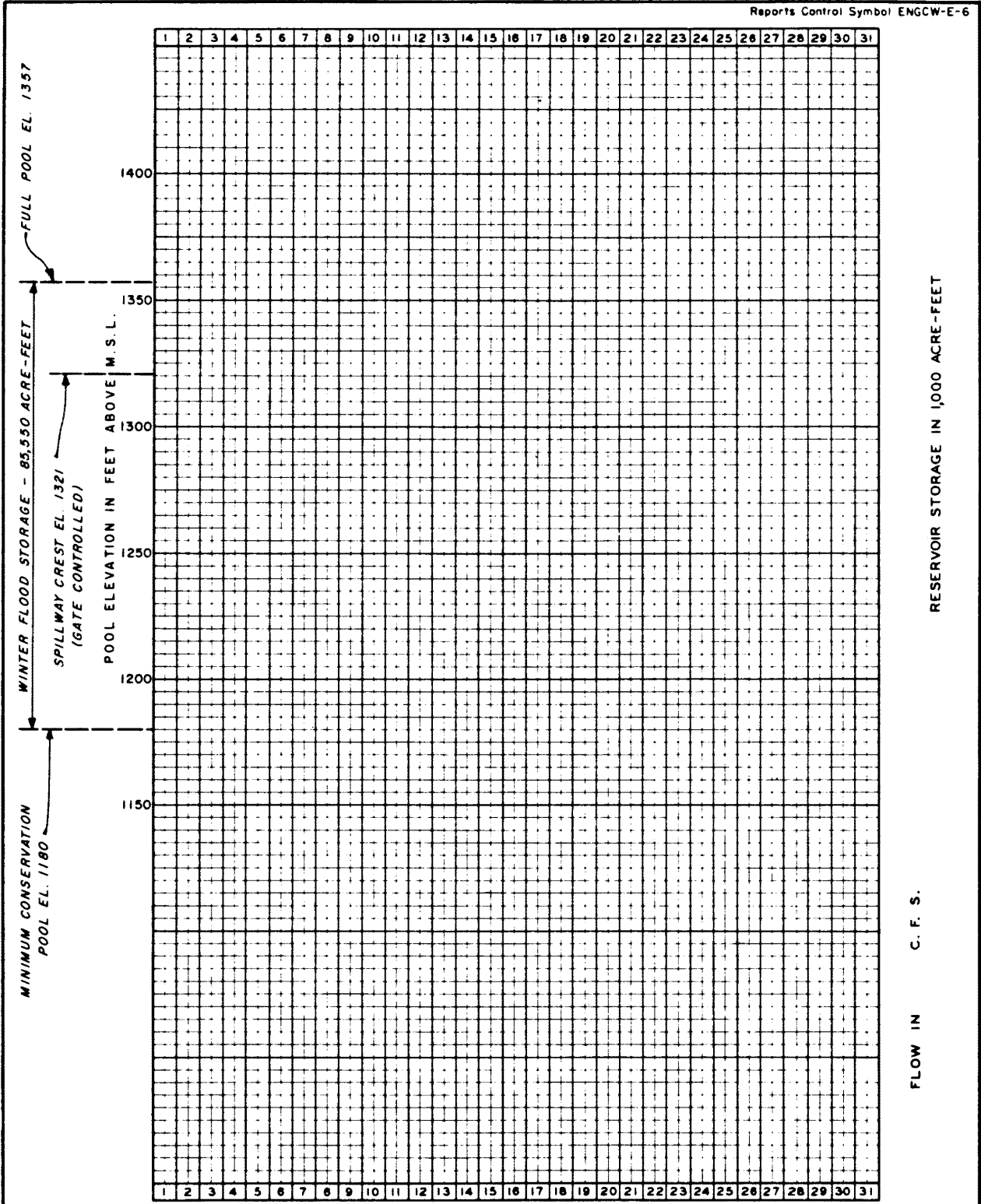
STATION	STAGE FEET	CHANGE HR.	DISCHARGE C.F.S.	TENDENCY	CURRENT WEATHER			PREC. HR.
ROW RIVER (Above Pitcher)					DAMSITE			
RESERVOIR	POOL ELEV. FEET	TEN'CY.	STORAGE AC. FT.	CHANGE HR.	AV. INFLOW	OUTFLOW	TIME	
					AV. OUTFLOW			

FERN RIDGE RESERVOIR

STATION	STAGE FEET	CHANGE HR.	DISCHARGE C.F.S.	TENDENCY	CURRENT WEATHER			PREC. HR.
NOTI (Near)								
CROW (Near)								
MONROE					FERN RIDGE (Below) +	DAM SITE		
RESERVOIR	POOL ELEV. FEET	TEN'CY.	STORAGE AC. FT.	CHANGE HR.	AV. INFLOW	OUTFLOW	TIME	SUM
					AV. OUTFLOW			AVE.

BLUE RIVER RESERVOIR

STATION	STAGE FEET	CHANGE HR.	DISCHARGE C.F.S.	TENDENCY	CURRENT WEATHER			PREC. HR.
BLUE RIVER (Above)					DAMSITE			
LOOKOUT CREEK					AV. INFLOW	OUTFLOW	TIME	
BLUE RIVER (Below)								
RESERVOIR	POOL ELEV. FEET	TEN'CY.	STORAGE AC. FT.	CHANGE HR.	AV. OUTFLOW			



MONTH OF 19

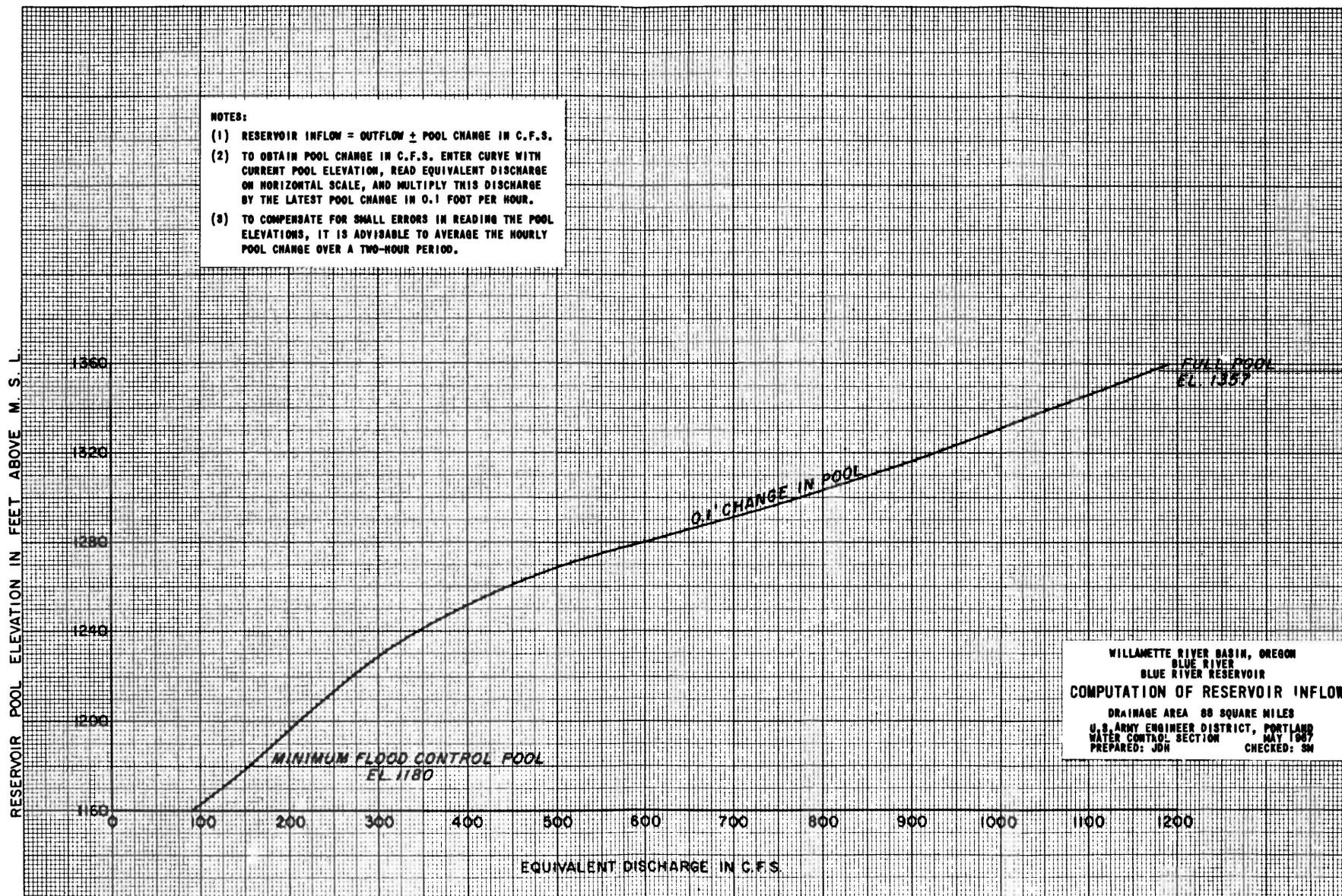
	EL. IN FEET ABOVE M. S. L.	GROSS STORAGE AC. FT.
MINIMUM CONSERVATION POOL	1180	3,970
MAXIMUM CONSERVATION POOL	1350	82,820
FULL POOL	1357	89,520

MAXIMUM PLANNED RELEASE 3,700 C.F.S.

**MONTHLY RESERVOIR REGULATION
BLUE RIVER RESERVOIR**

WILLAMETTE RIVER BASIN
DRAINAGE AREA ABOVE BLUE RIVER DAM 88 SQ. MI.

U.S. ARMY ENGINEER DISTRICT, PORTLAND



STREAM GAGING STATIONS

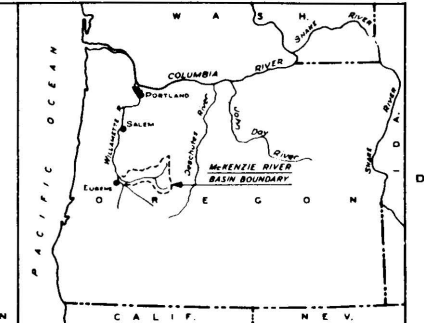
SNOW SURVEY COURSES

MAP NO.	MAP KEY	STATION	USGS NO.	AREA OF GAGE	DRAINAGE AREA SQ. MI.	PERIOD OF RECORDED WATER YEARS
101	C-2	MCKENZIE RIVER AT OUTLET CLEAR LAKE	1585	2803.82	82.8	1913-15, 1948 TO DATE
102	C-2	MCKENZIE RIVER NEAR BELENAP SPRINGS	1587	2802.96	146	1918 - 1962
103	C-2	SMITH RIVER ABOVE SMITH RIVER BRIDGE NEAR BELENAP SPRINGS	1887.9	2802.00	18.2	1961 TO DATE
104	C-2	MCKENZIE RIVER BELOW TRAIL BRIDGE NEAR BELENAP SPRINGS	1888.5	1900.00	194	1960 TO DATE
105	C-2	MCKENZIE RIVER AT MCKENZIE BRIDGE	1591	1619.04	348	1911 TO DATE
106	B-2	SOUTH FORK MCKENZIE RIVER ABOVE COUGAR RESERVOIR NEAR RAINBOW	1592	1278.51	180	1918 TO DATE
107	B-2	SOUTH FORK MCKENZIE RIVER NEAR RAINBOW	1595	1276.42	208	1948 TO DATE
108	C-2	MAHON CREEK NEAR MCKENZIE BRIDGE	1600	2491.1	5.12	1949 - 1951
109	C-2	WOLF CREEK NEAR MCKENZIE BRIDGE	1605	2491.1	2.1	1949 - 1952
110	C-2	BLUE RIVER ABOVE COSENTIN CREEK	1610	1960.1	11.5	1948 - 1955
111	C-2	LEARNING CREEK NEAR BLUE RIVER	1615	1377.83	24.1	1930-55, 1966 TO DATE
112	C-2	BLUE RIVER NEAR BLUE RIVER	1620	1231.82	75	1916 - 1964
113	B-2	MCKENZIE RIVER NEAR VIDA	1625	875.16	831	1925 TO DATE
114	B-2	GATE CREEK AT VIDA	1610	784.56	47.6	1897-97, 1967 TO DATE
115	B-4	MCKENZIE RIVER NEAR SPRINGFIELD	1650	442.47	177	1936-52, 1964 TO DATE
116	B-4	MCKENZIE RIVER NEAR COBURG	1655	182.12	1137	1945 TO DATE
117	C-2	BLUE R. BELOW TYBRITE CREEK NEAR BLUE RIVER	1611	1388.90	45.8	1964 TO DATE
118	C-2	BLUE RIVER AT BLUE RIVER	1622	1056.55	87.7	1961 TO DATE
120	C-4	WILLAMETTE RIVER AT HARRISBURG	1640	790.19	2	1945 TO DATE
121	C-3	HORSE CREEK NEAR MCKENZIE BRIDGE	1591	1428.17	169	1963 TO DATE
124	B-4	MCKENZIE RIVER NEAR SPRINGFIELD	1591	553.49	1058	1906 - 1914
124(1)	C-2	SMITH RIVER NEAR BELENAP SPRINGS	1588	2040.42	23.7	1958 - 1960

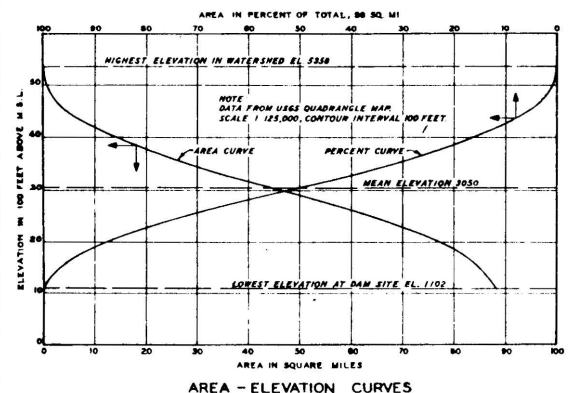
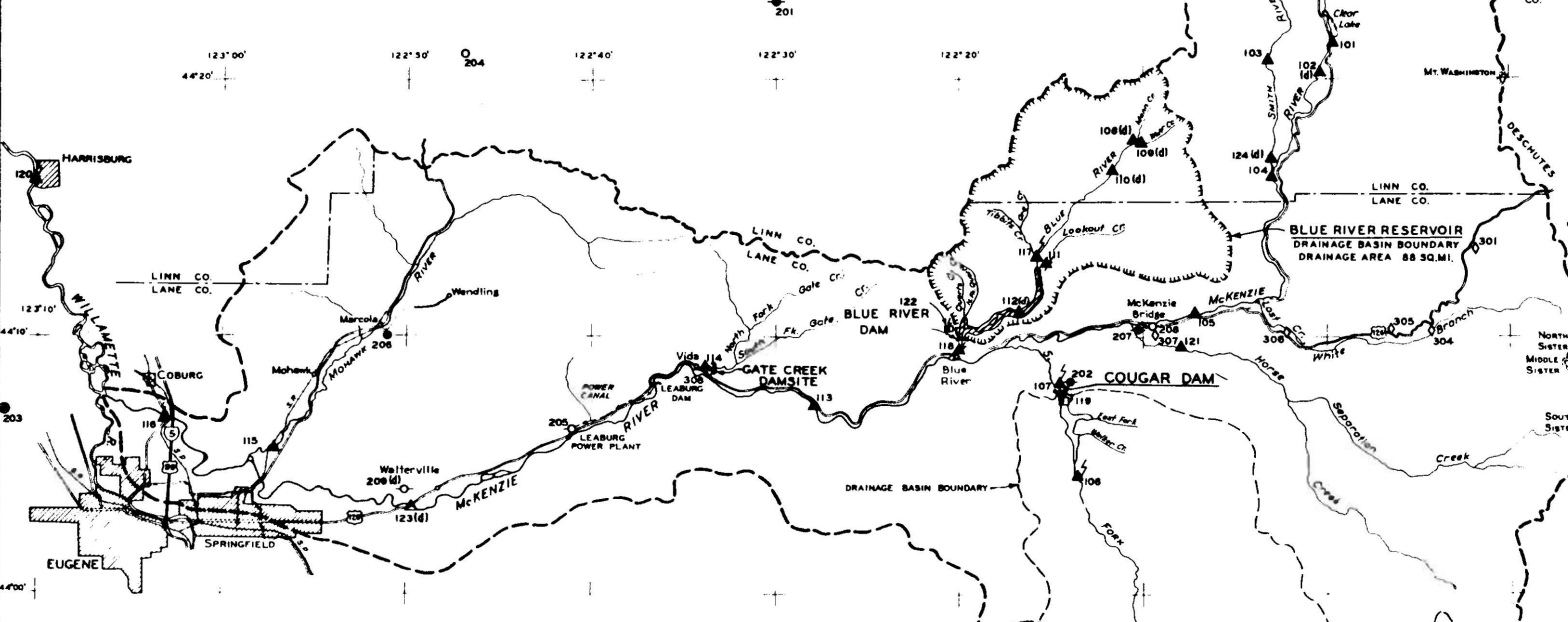
MAP NO.	MAP KEY	S.C.S. SNOW COURSE NAME	S.C.S. NO.	ELEV. M.S.L.	LOCATION	YEARS OF RECORD
101	C-1	MCKENZIE	2127	4800	25 155	1918 TO DATE
102	D-1	HOGG PASS	2126	4755	24 138	1918 -
103	D-2	SANTIAM JUNCTION	2125	3990	14 76	1961 -
104	C-2	DEAD HORSE GRADE	2128	3800	13 155	1960 -
105	-	WHITE BRANCH SLIDE	2129	2800	15 -	1950 -
106	-	LOST CREEK BANCH	2224	1954	24 -	1951 -
107	-	MCKENZIE BRIDGE	2225	1372	19 -	1951 -
108	B-3	VIDA	2226	800	28 -	1951 -

RESERVOIR WATER-LEVEL RECORDERS

MAP NO.	MAP KEY	STATION	USGS NO.	ELEV. ZERO OF GAGE	RECORDS
119	B-2	COUGAR DAM	1594	0	1963 -
122	C-2	BLUE RIVER	1594	0	1963 -



1 1929 ADJUSTMENT EXCEPT AS NOTED
2 1947 SUPPLEMENTARY ADJUSTMENT



CLIMATOLOGICAL STATIONS

MAP NO.	MAP KEY	USGS STATION NAME	USGS NO.	ELEV. M.S.L.	LOCATION	YEARS OF RECORD
201	D-3	CASCADE STATE PARK	1453	890	44°26' 122°39'	1908 TO DATE 1
202	B-2	COUGAR DAM	1914	1242	44°08' 122°15'	1957 - DATE
203	B-4	EUGENE AIRPORT	2709	344	44°07' 123°13'	1892 -
204	C-4	HOLLETT	3971	540	44°21' 122°47'	1960 - DATE 3
205	B-3	LEABURG 1 SW	4811	675	44°06' 122°41'	1934 - DATE
206	C-4	MARCOLA	5211	530	44°10' 122°51'	1941 - DATE 2
207	C-2	MCKENZIE BR. P. S.	1382	1375	- 122°10'	1902 - DATE 5
208	C-4	WALTERVILLE BRIDGE	1057	1370	44°11' 122°50'	1954 - DATE
209	B-4	WALTERVILLE P.W. (HENDRICKS BRIDGE)	9001	540	44°08' 122°50'	1947 - 1948(1945)

1 RECORDS NOT CONTINUOUS INCLUDES RECORD AT CASCADE STATE PARK
2 AT EUGENE AIRPORT AND AT SEVERAL OTHER LOCATIONS PRIOR TO 1943
3 PRECIPITATION RECORDS ONLY
5 RECORDS NOT CONTINUOUS

LEGEND

- HIGH-RECORDING PRECIPITATION STATION
- LOW-RECORDING PRECIPITATION STATION
- PRECIPITATION AND TEMPERATURE
- SNOW SURVEY COURSE
- COMPLETE METEOROLOGICAL STATION
- RESERVOIR OR LAKE GAGE
- RIVER GAGE, RATED
- WHEN USED IN COMBINATION WITH OTHER SYMBOLS AS INDICATES TELEPHONIC OR REMOTE WIRED RECORDER
- (d) DISCONTINUED

WILLAMETTE RIVER BASIN, OREGON
BLUE RIVER
BLUE RIVER RESERVOIR
BASIN MAP AND
HYDROLOGICAL STATIONS

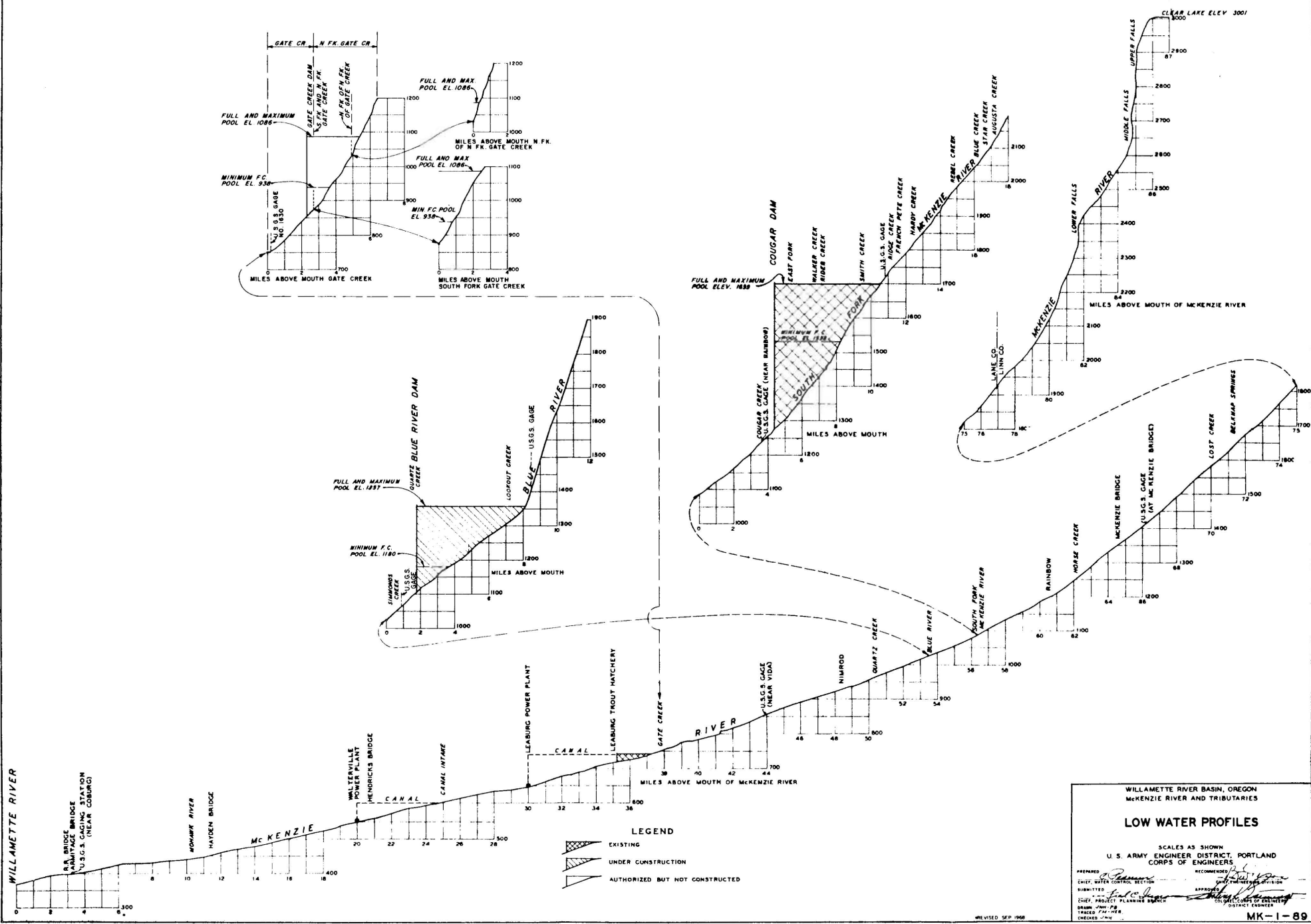
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

REVISOR: [Signature]
SUPERVISOR: [Signature]
CHECKED: [Signature]

REVISED FEB 1971

BL-20-19/1



WILLAMETTE RIVER BASIN, OREGON
 MCKENZIE RIVER AND TRIBUTARIES

LOW WATER PROFILES

SCALES AS SHOWN
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 CORPS OF ENGINEERS

PREPARED BY: *R. B. Brown*
 CHIEF, WATER CONTROL SECTION

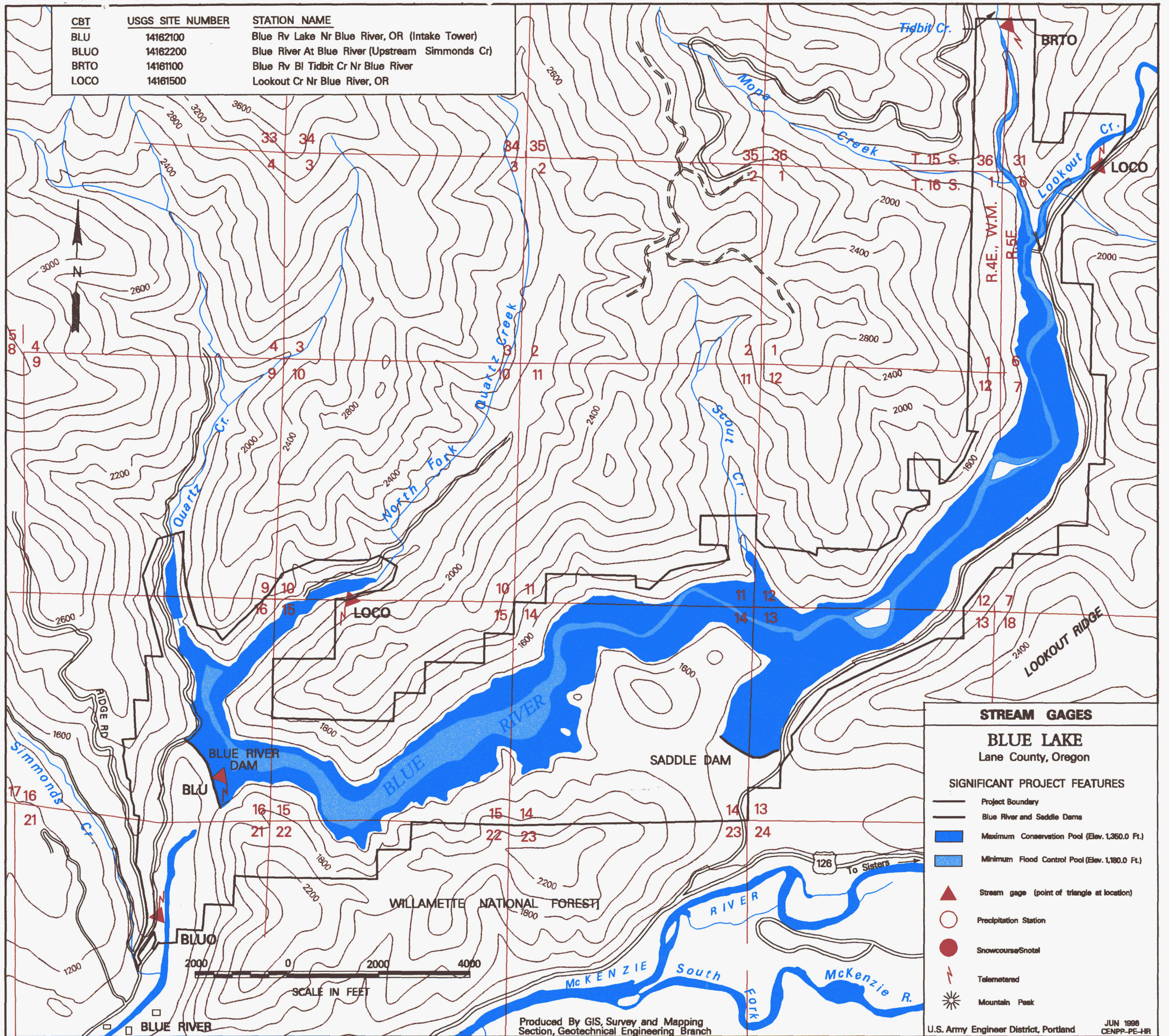
SUBMITTED BY: *Paul C. Jones*
 CHIEF, PROJECT PLANNING BRANCH

APPROVED BY: *[Signature]*
 DISTRICT ENGINEER

DRAWN BY: *[Signature]*
 TRACED BY: *[Signature]*
 CHECKED BY: *[Signature]*

48150 SEP 1968

CBT	USGS SITE NUMBER	STATION NAME
BLU	14162100	Blue Rv Lake Nr Blue River, OR (Intake Tower)
BLUO	14162200	Blue River At Blue River (Upstream Simmonds Cr)
BRTO	14161100	Blue Rv Bl Tidbit Cr Nr Blue River
LOCO	14161500	Lookout Cr Nr Blue River, OR



STREAM GAGES

BLUE LAKE
Lane County, Oregon

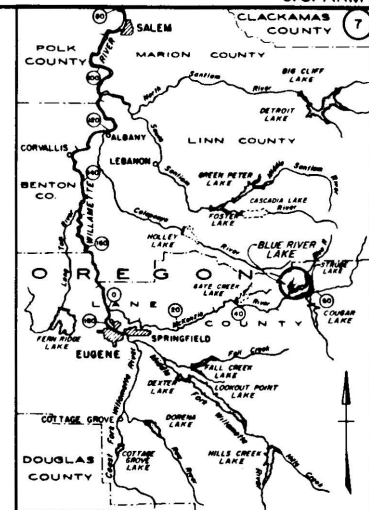
SIGNIFICANT PROJECT FEATURES

- Project Boundary
- Blue River and Saddle Dams
- Maximum Conservation Pool (Elev. 1,350.0 Ft.)
- Minimum Flood Control Pool (Elev. 1,180.0 Ft.)
- Stream gage (point of triangle at location)
- Precipitation Station
- Snowcourse/Snotel
- Telemetered
- Mountain Peak

Produced By GIS, Survey and Mapping
Section, Geotechnical Engineering Branch

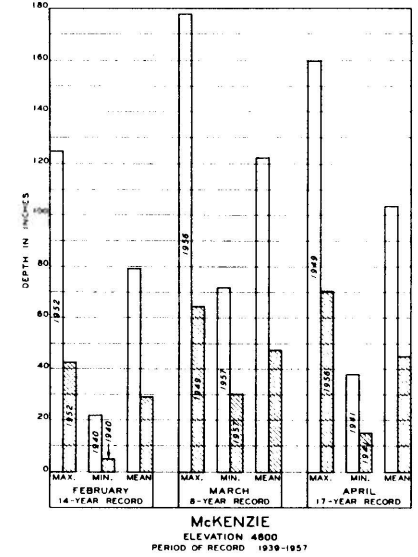
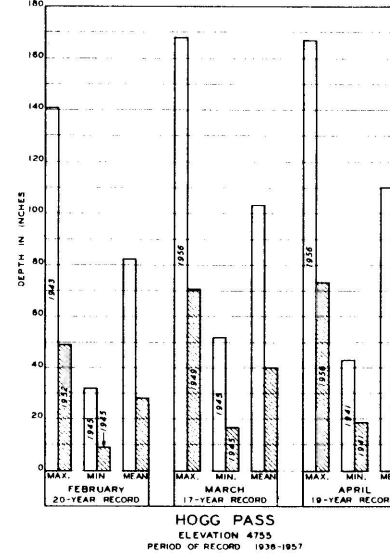
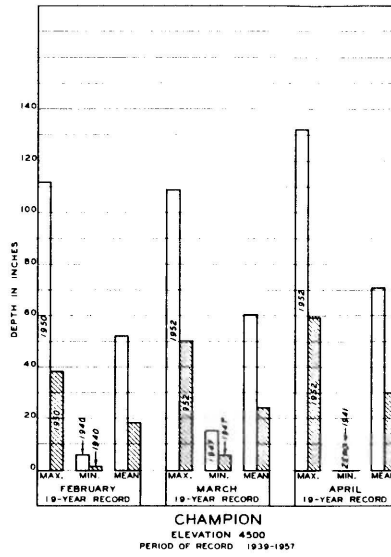
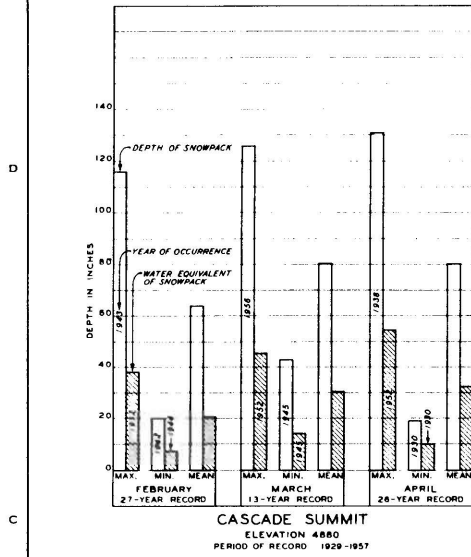
U.S. Army Engineer District, Portland

JUN 1996
CENPP-PE-HR

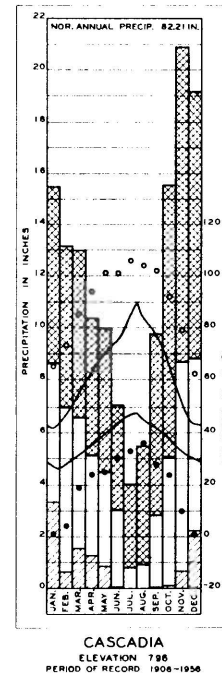
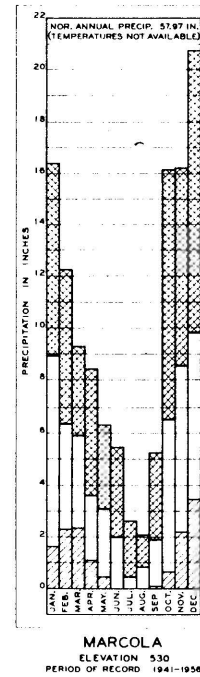
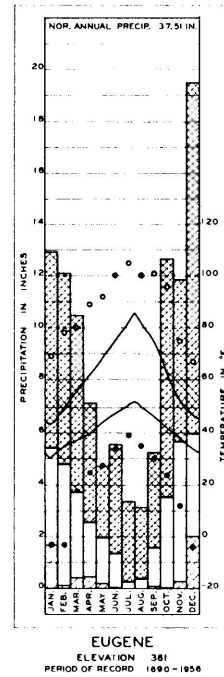
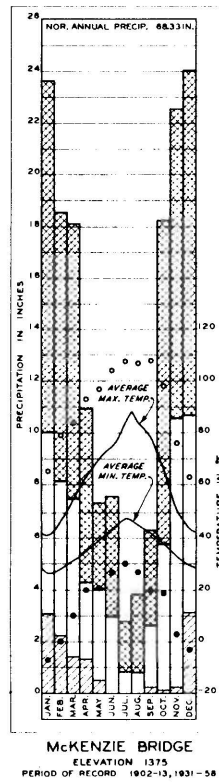
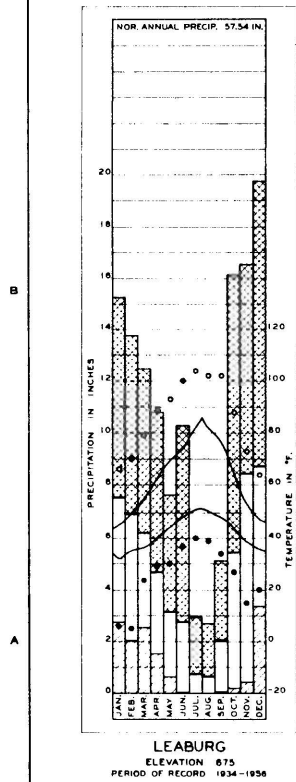


FLOOD CONTROL
 WILLAMETTE RIVER BASIN, OREGON
BLUE RIVER LAKE
 BLUE RIVER
 SCALES AS SHOWN
 U.S. ARMY ENGINEER DISTRICT, PORTLAND

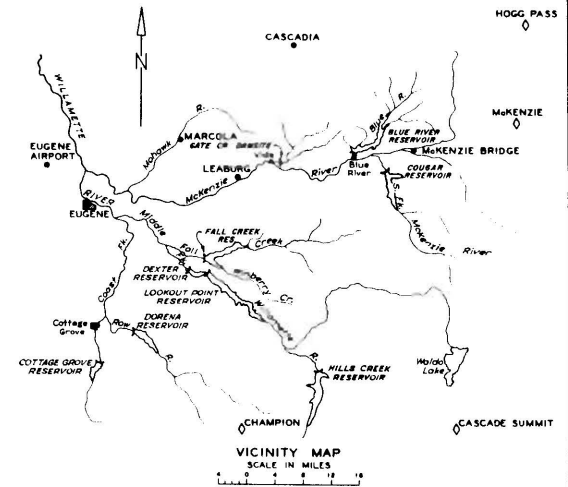
DRAWN BY: O.R.I. REVISED: FEB 1971



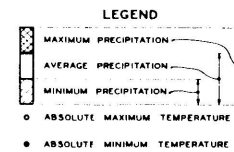
DEPTH AND WATER EQUIVALENT OF SNOWPACK



MONTHLY PRECIPITATION AND TEMPERATURE



- NOTE
1. SNOW DATA FROM U.S. SOIL CONSERVATION SERVICE.
 2. SNOW SURVEYS MADE ABOUT THE FIRST OF FEBRUARY, MARCH, AND APRIL.
 3. PRECIPITATION AND TEMPERATURE DATA FROM RECORDS OF U.S. WEATHER BUREAU.



WILLAMETTE RIVER BASIN, OREGON

WILLAMETTE RIVER AND TRIBUTARIES

CLIMATIC CHARACTERISTICS

SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, PORTLAND CORPS OF ENGINEERS

PREPARED BY: [Signature] RECOMMENDED BY: [Signature]

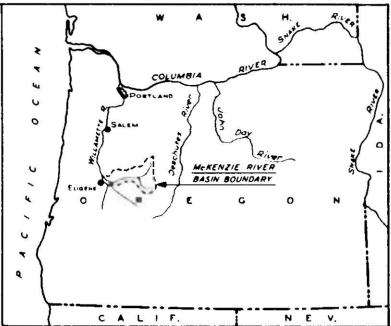
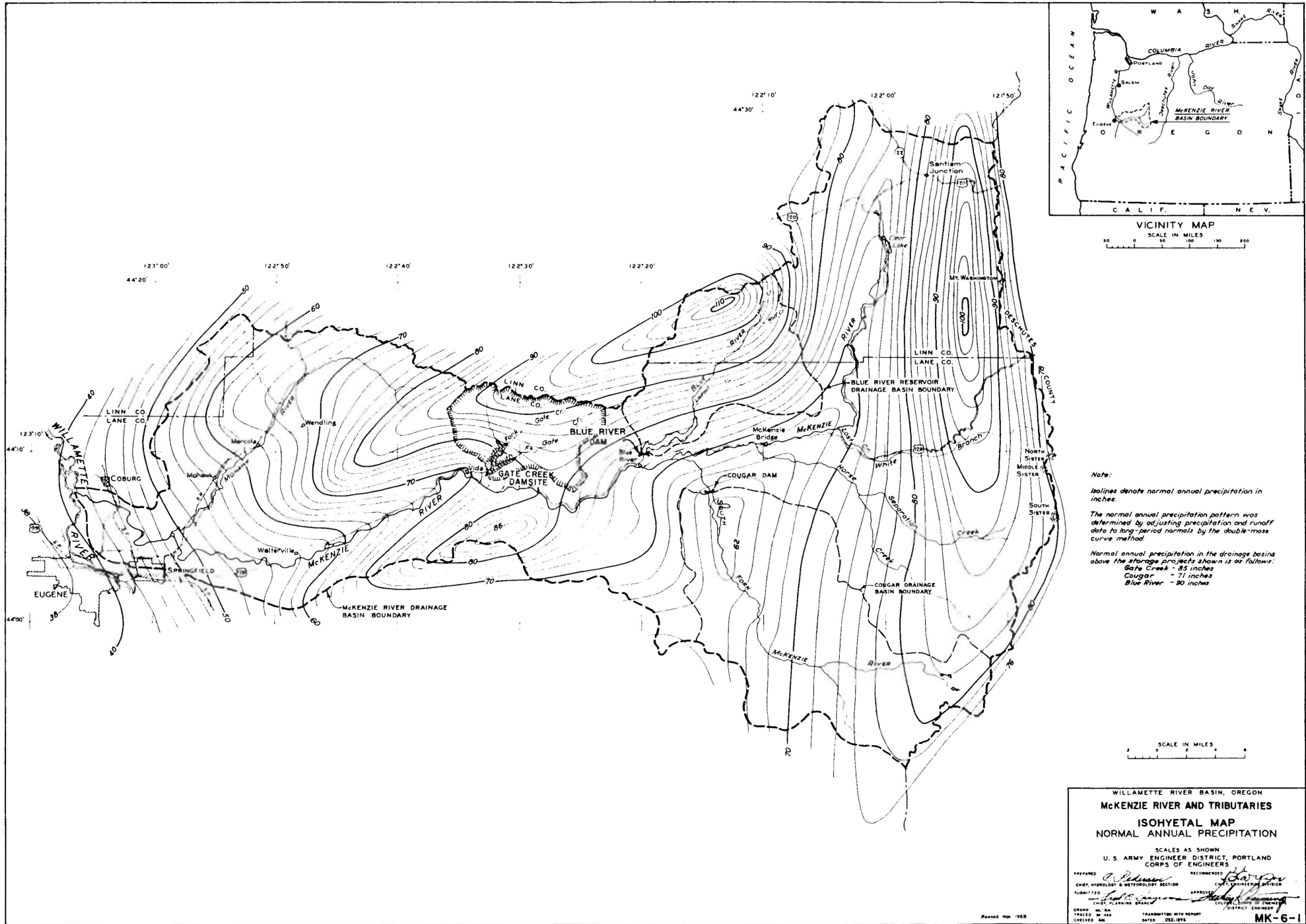
DATE: [Signature] CHECKED: [Signature]

APPROVED: [Signature]

BRON J.B. TRACER BY: [Signature] DATE: [Signature]

SEP 1960

WB-05-14



VICINITY MAP

SCALE IN MILES
0 50 100 200

Note:
 Isolines denote normal annual precipitation in inches.
 The normal annual precipitation pattern was determined by adjusting precipitation and runoff data to long-period normals by the double-mass curve method.
 Normal annual precipitation in the drainage basins above the storage projects shown is as follows:
 Gate Creek - 85 inches
 Cougar - 71 inches
 Blue River - 30 inches

SCALE IN MILES
0 2 4

WILLAMETTE RIVER BASIN, OREGON
McKENZIE RIVER AND TRIBUTARIES
ISOHYETAL MAP
NORMAL ANNUAL PRECIPITATION

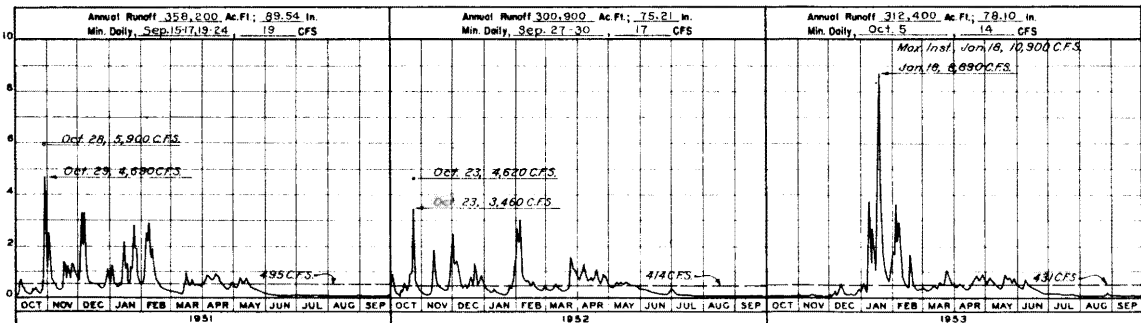
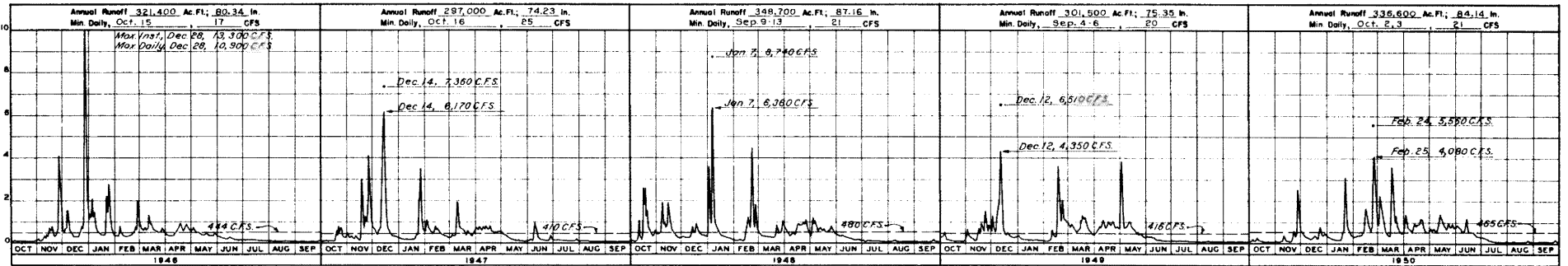
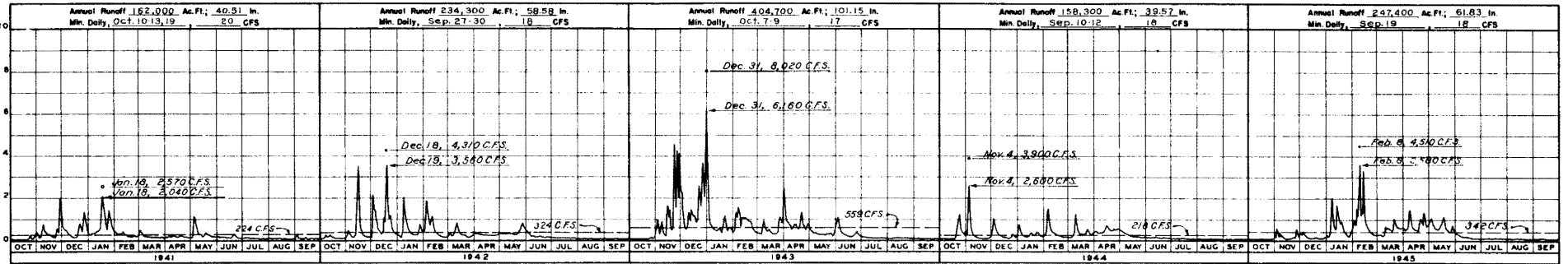
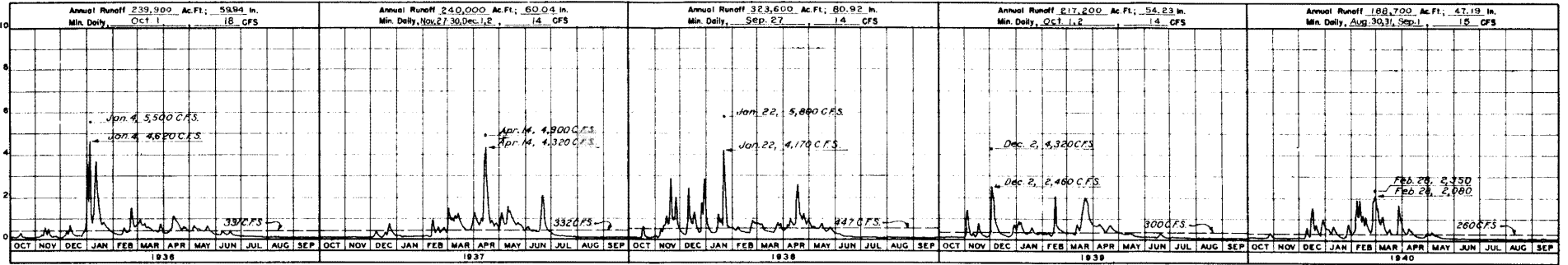
SCALES AS SHOWN
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 CORPS OF ENGINEERS

PREPARED BY: <i>A. Peterson</i>	RECOMMENDED BY: <i>A. Peterson</i>
CHEF, HYDROLOGY & METEOROLOGY SECTION	CHIEF, ENGINEERING DIVISION
SUBMITTED: <i>[Signature]</i>	APPROVED: <i>[Signature]</i>
CHIEF, PLANNING BRANCH	DISTRICT ENGINEER

DRAPP. IN. 84
 TRACED BY: *[Signature]*
 CHECKED: *[Signature]* DATED: 05-1955

Revised Nov 1958

MK-6-1



Station	Dr Area Sq Miles	Records Available	Character	Type of Gage	Location	Datum MSL
Blue River near Blue River, Ore.	7.5	Sep. 1885 - Continuous	Records	Between Sec 124 Sec 14, T16S, R4E	122.5	

LEGEND

- * MAXIMUM INSTANTANEOUS DISCHARGE
- MAXIMUM DAILY DISCHARGE
- MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON

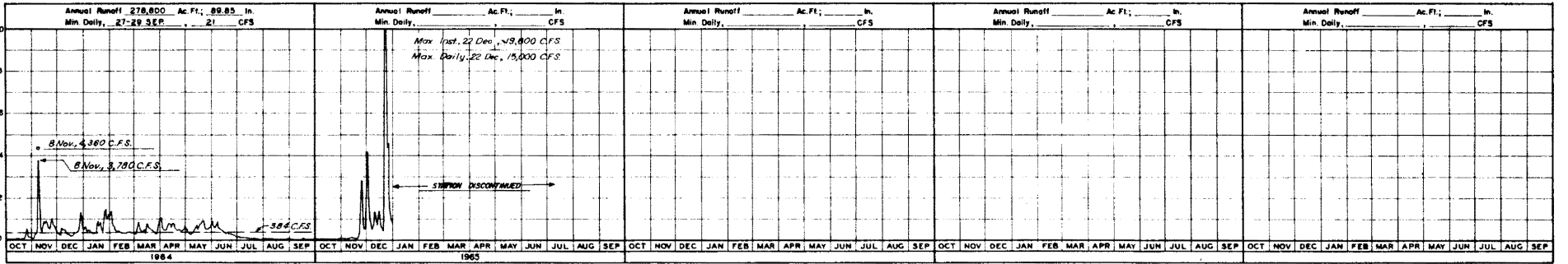
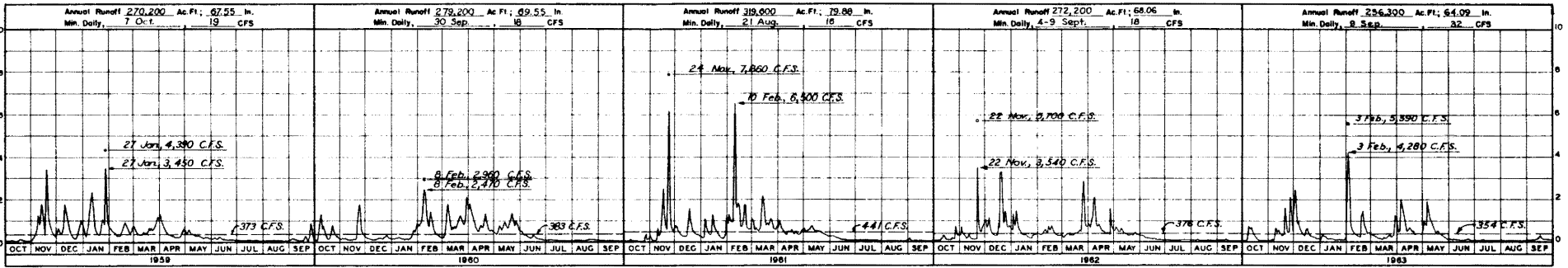
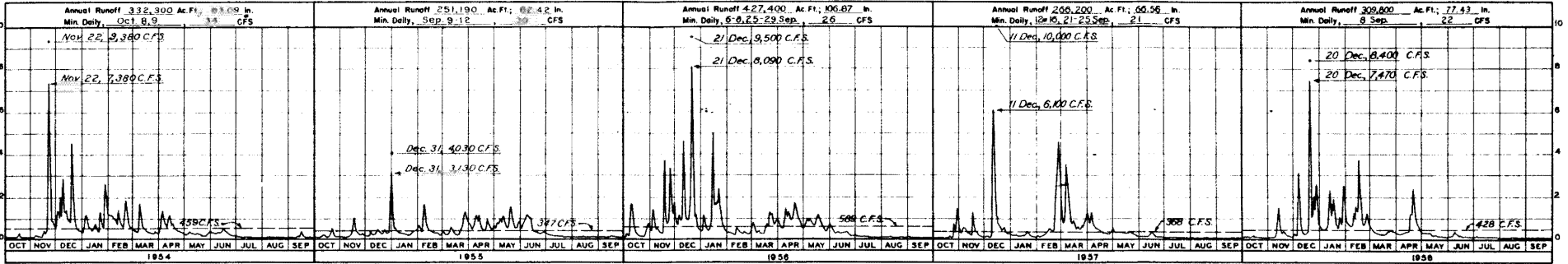
DAILY DISCHARGE HYDROGRAPH

BLUE RIVER NEAR BLUE RIVER, OREGON

IN 2 SHEETS SHEET NO. 1
U. S. ARMY / ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

DATE: 1953
DRAWN BY: G. E. O.
CHECKED BY: [Signature]
APPROVED BY: [Signature]
DISTRICT ENGINEER

PD-25-32/1



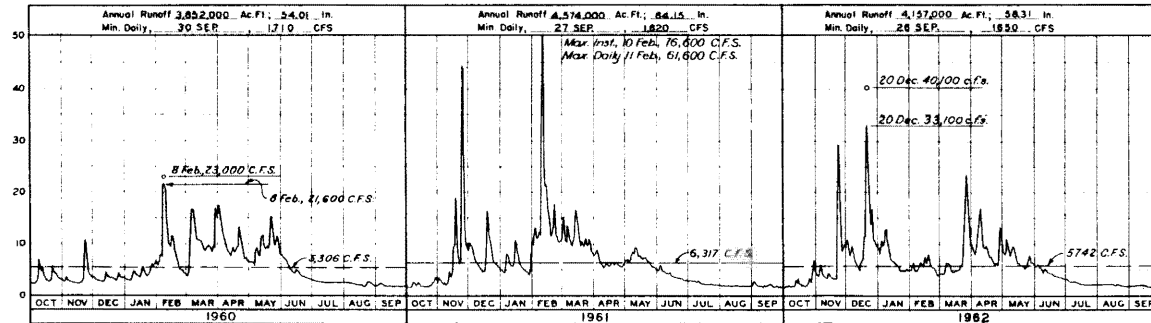
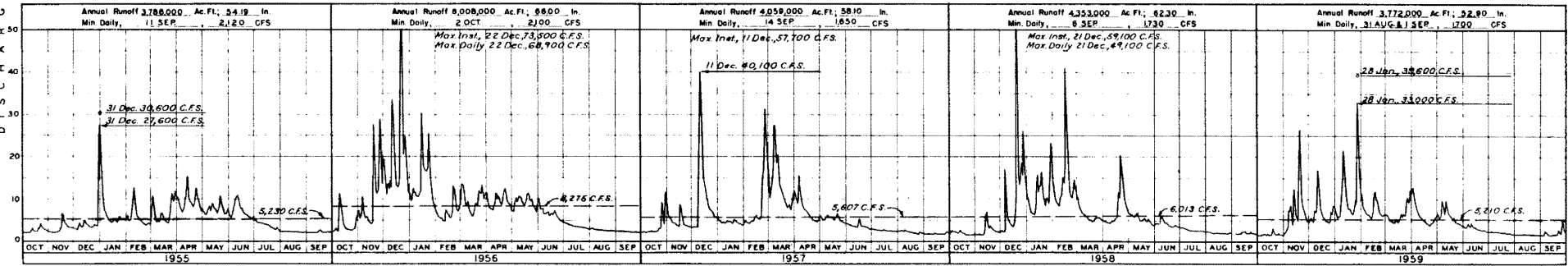
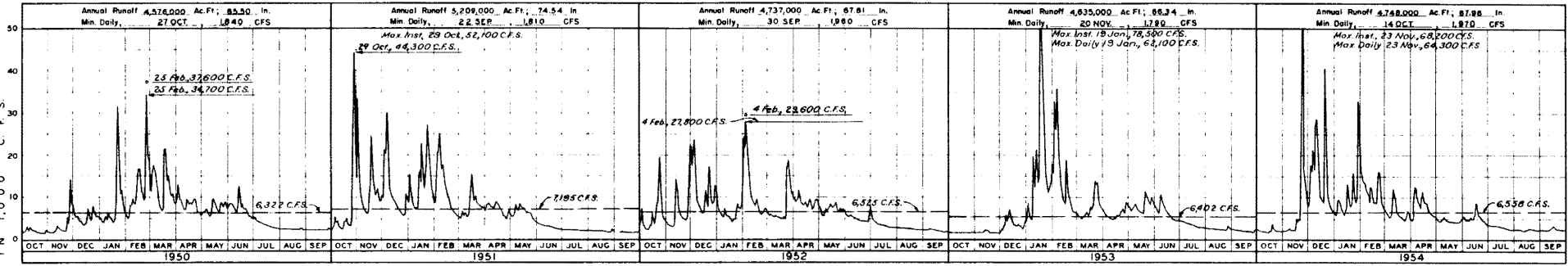
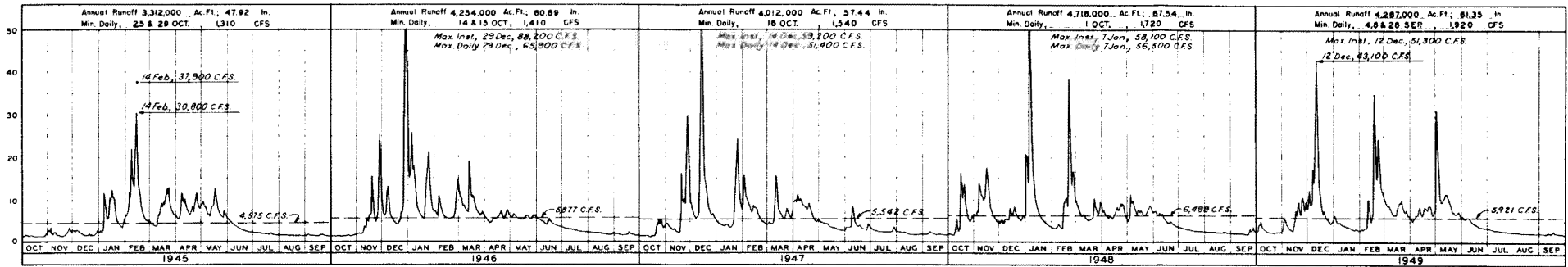
Annual Runoff	Ac. Ft.	Min. Daily	Annual Runoff	Ac. Ft.	Min. Daily	Annual Runoff	Ac. Ft.	Min. Daily
_____	_____	_____	_____	_____	_____	_____	_____	_____

Station	Dr Area Sq Miles	Records Available	Type of Gauge	Location	Datum MSL

LEGEND
 * MAXIMUM INSTANTANEOUS DISCHARGE
 — MAXIMUM DAILY DISCHARGE
 - - - - - MEAN DISCHARGE

SEE SHEET 1 FOR STATION DESCRIPTION

WILLAMETTE RIVER BASIN, OREGON
DAILY DISCHARGE HYDROGRAPH
 BLUE RIVER NEAR BLUE RIVER, OREGON
 IN 2 SHEETS SHEET NO 2
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 CORPS OF ENGINEERS
 SUPERVISOR: [Signature]
 DRAWN BY: [Signature]
 CHECKED BY: [Signature]
 DATE: [Date]
 SCALE: [Scale]
 PD-25-32/2
 PLATE 8



Station	Dr Area Sq Miles	STATION DESCRIPTION			Datum MSL
		Records Available	Type of Character	Location	
Mckenzie River near Coburg, Oregon	1337	Oct 1944	Continuous Recorder	In NE 1/4 Sec 9, T15N, R18E, on left bank of the wide arm of the river	396.32 (74) equip (47)

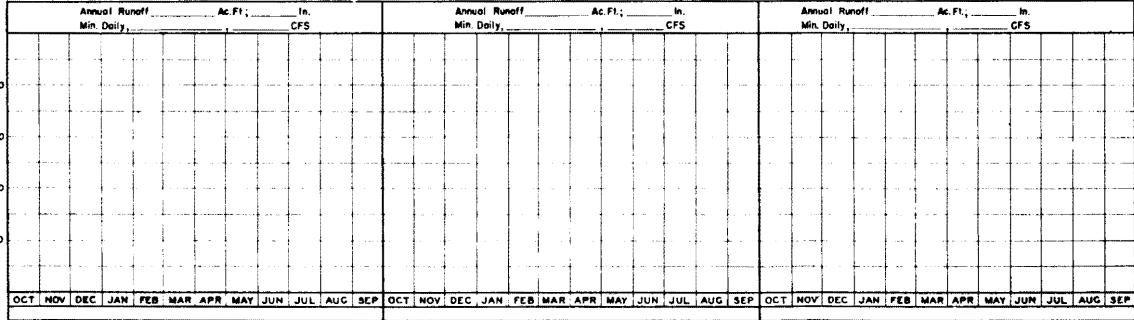
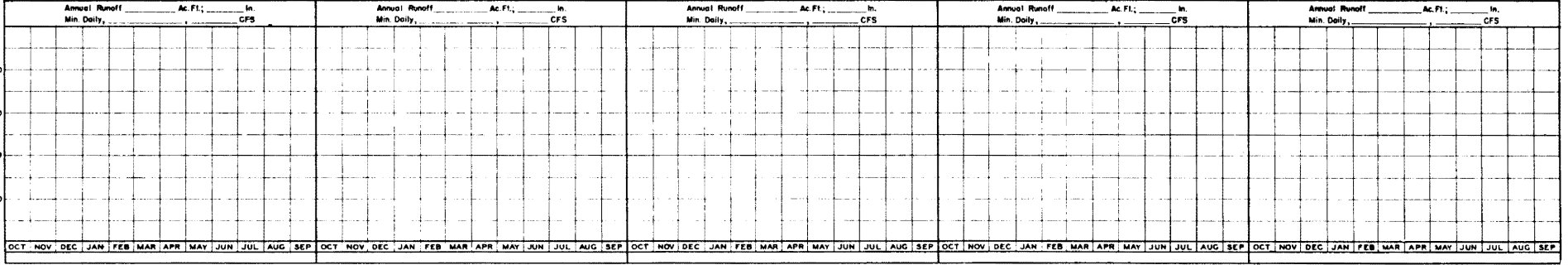
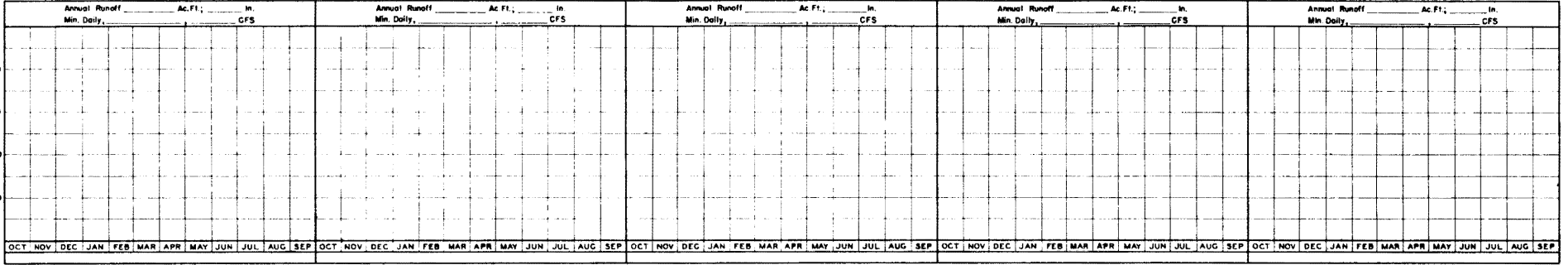
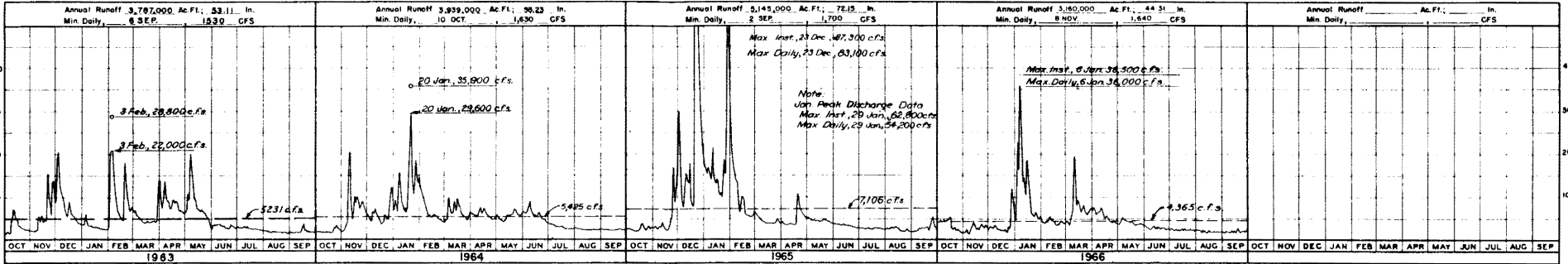
LEGEND
 * MAXIMUM INSTANTANEOUS DISCHARGE
 ← MAXIMUM DAILY DISCHARGE
 - - - - - MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON
DAILY DISCHARGE HYDROGRAPH
 MCKENZIE RIVER NEAR COBURG, OREGON
 IN 2 SHEETS SHEET NO. 1
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 CORPS OF ENGINEERS

APPROVED: [Signature]
 CHIEF, HYDROLOGICAL DISTRICT
 DATED: [Date]
 DRAWN: J.W.H. M.C.L.
 CHECKED: [Signature]

RECORDED: [Signature]
 INDEXED: [Signature]

PD-25-23/1



Station	Dr Area Sq. Miles	Records		Type of Gauge	Location	Datum MSL
		Available	Character			

LEGEND
 * MAXIMUM INSTANTANEOUS DISCHARGE
 — MAXIMUM DAILY DISCHARGE
 - - - - - MEAN DISCHARGE

WILLAMETTE RIVER BASIN, OREGON
DAILY DISCHARGE HYDROGRAPH

McKENZIE RIVER NEAR COBURG, OREGON

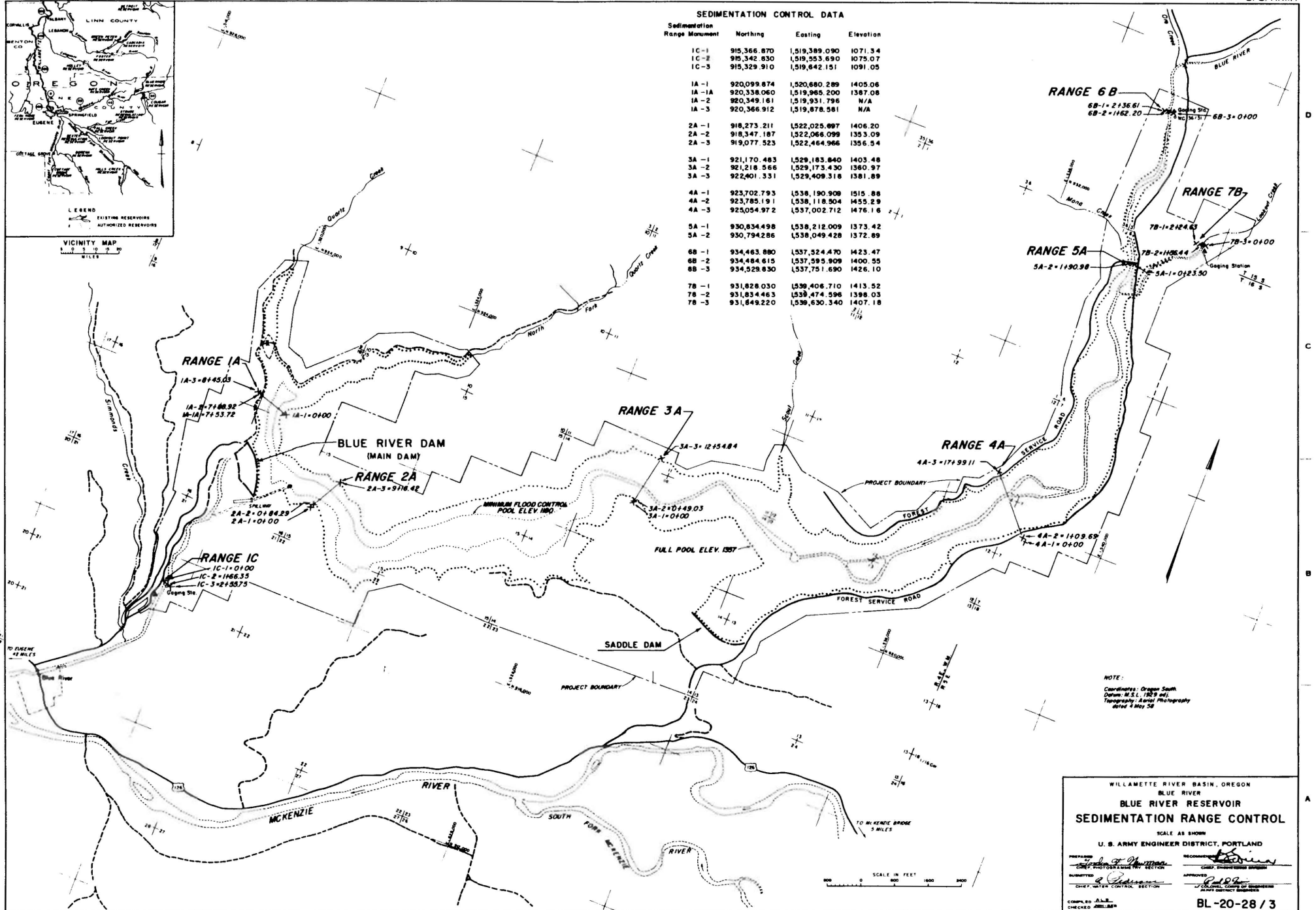
IN 2 SHEETS SHEET NO. 2
 U. S. ARMY ENGINEER DISTRICT, PORTLAND
 CORPS OF ENGINEERS

SUPERVISED BY: *[Signature]* RECORDED BY: *[Signature]*
 CHECKED BY: *[Signature]* CORRECTED BY: *[Signature]*
 DRAWN BY: *[Signature]* PLOTTED BY: *[Signature]*
 TITLE: DAILY DISCHARGE HYDROGRAPH
 DATE: *[Date]*

SEE SHEET NO. 1 FOR STATION DESCRIPTION

SEDIMENTATION CONTROL DATA

Sedimentation Range Monument	Northing	Easting	Elevation
IC-1	915,366.870	1,519,389.090	1071.34
IC-2	915,342.830	1,519,553.690	1075.07
IC-3	915,329.910	1,519,642.151	1091.05
IA-1	920,099.874	1,520,680.289	1405.06
IA-1A	920,338.060	1,519,965.200	1387.08
IA-2	920,349.161	1,519,931.796	N/A
IA-3	920,366.912	1,519,878.581	N/A
2A-1	918,273.211	1,522,025.897	1406.20
2A-2	918,347.187	1,522,066.099	1353.09
2A-3	919,077.523	1,522,464.966	1356.54
3A-1	921,170.483	1,529,183.840	1403.48
3A-2	921,218.566	1,529,173.430	1360.97
3A-3	922,401.331	1,529,409.318	1381.89
4A-1	923,702.793	1,538,190.908	1515.88
4A-2	923,785.191	1,538,118.504	1459.29
4A-3	923,054.972	1,537,002.712	1476.16
5A-1	930,834.498	1,538,212.009	1373.42
5A-2	930,794.286	1,538,049.428	1372.89
6B-1	934,463.880	1,537,524.470	1423.47
6B-2	934,484.615	1,537,595.909	1400.55
6B-3	934,329.830	1,537,751.690	1426.10
7B-1	931,828.030	1,539,408.710	1413.52
7B-2	931,834.463	1,539,474.596	1398.03
7B-3	931,649.220	1,539,630.340	1407.18



NOTE:
 Coordinates - Oregon South
 Datum - M.S.L. 1929 adj.
 Topography - Aerial Photography dated 4 May 58

WILLAMETTE RIVER BASIN, OREGON
 BLUE RIVER
 BLUE RIVER RESERVOIR
 SEDIMENTATION RANGE CONTROL

SCALE AS SHOWN

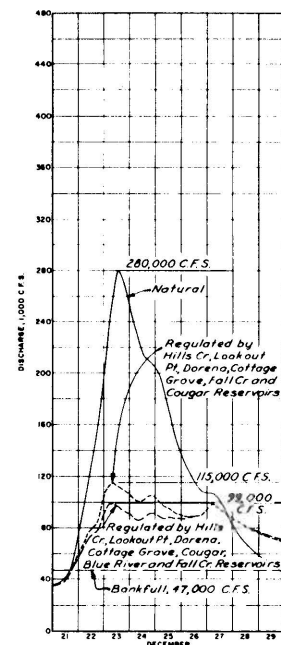
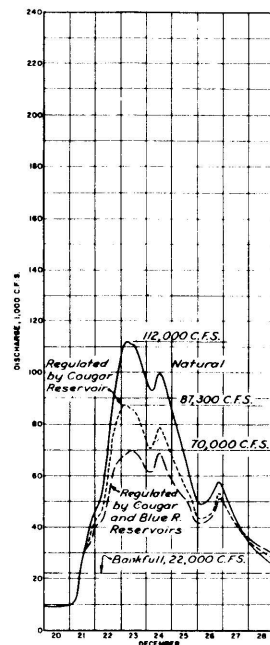
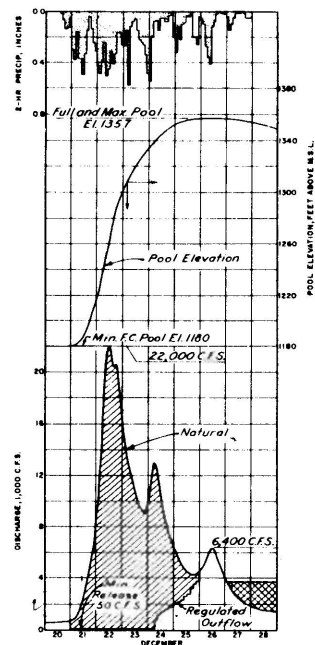
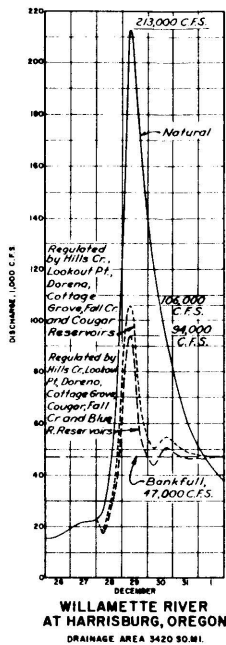
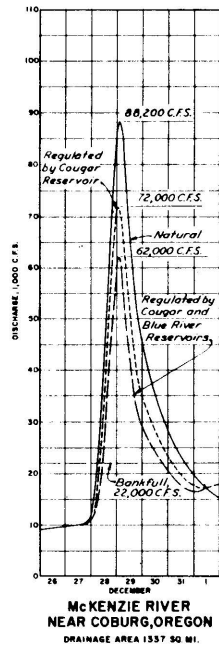
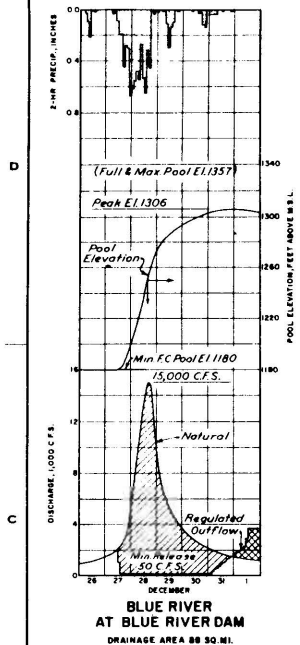
U. S. ARMY ENGINEER DISTRICT, PORTLAND

PREPARED BY: *[Signature]*
 CHECKED BY: *[Signature]*
 SUBMITTED BY: *[Signature]*
 APPROVED BY: *[Signature]*

CHIEF, WATER CONTROL SECTION

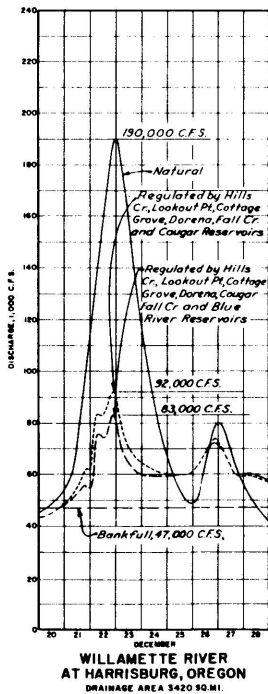
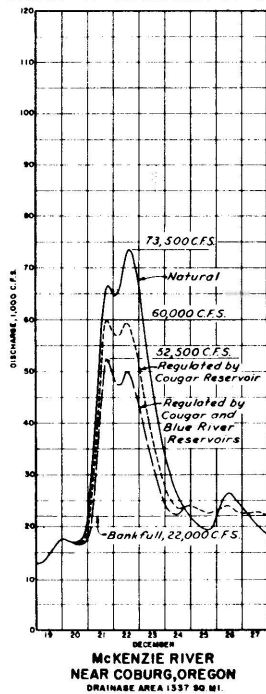
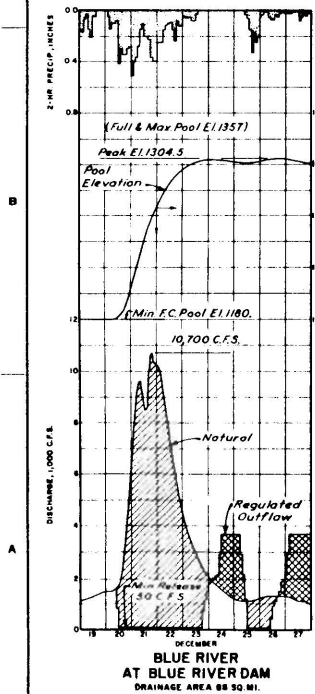
COMPILED BY: A.H.B.
 CHECKED BY: J.M.L.B.

BL-20-28 / 3

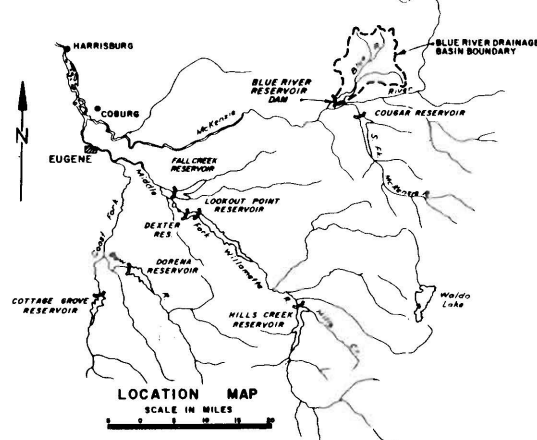


FLOOD OF DECEMBER 1945

FLOOD OF DECEMBER 1964



FLOOD OF DECEMBER 1955



- LEGEND**
- HYDROGRAPH OF NATURAL DISCHARGE
 - - - HYDROGRAPH OF REGULATED FLOW WITH EXISTING STORAGE
 - · - · - HYDROGRAPH OF REGULATED FLOW WITH EXISTING STORAGE PLUS BLUE RIVER
 - HYDROGRAPH OF REGULATED FLOW AT DAM
 - ▨ WATER STORED IN RESERVOIR
 - WATER IN EXCESS OF INFLOW RELEASED FROM RESERVOIR

FLOOD CONTROL STORAGE RESERVOIRS ABOVE HARRISBURG	
RESERVOIR	FLOOD CONTROL STORAGE ACRES- FEET
COTTABE GROVE	30,000
DORENA	70,000
LOOKOUT POINT	337,000
HILLS CREEK	200,000
FALL CREEK	115,000
COUGAR	155,000
BLUE RIVER	85,550
TOTAL	992,000

■ EXISTING RESERVOIR
● UNDER CONSTRUCTION

WILLAMETTE RIVER BASIN, OREGON
BLUE RIVER RESERVOIR
EXAMPLES OF REGULATION

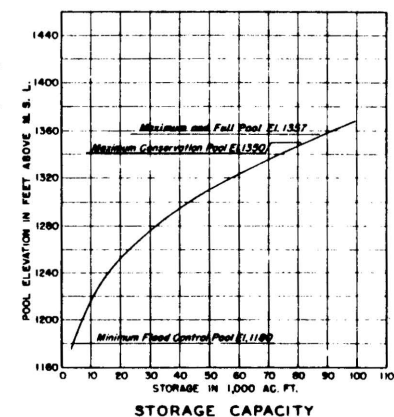
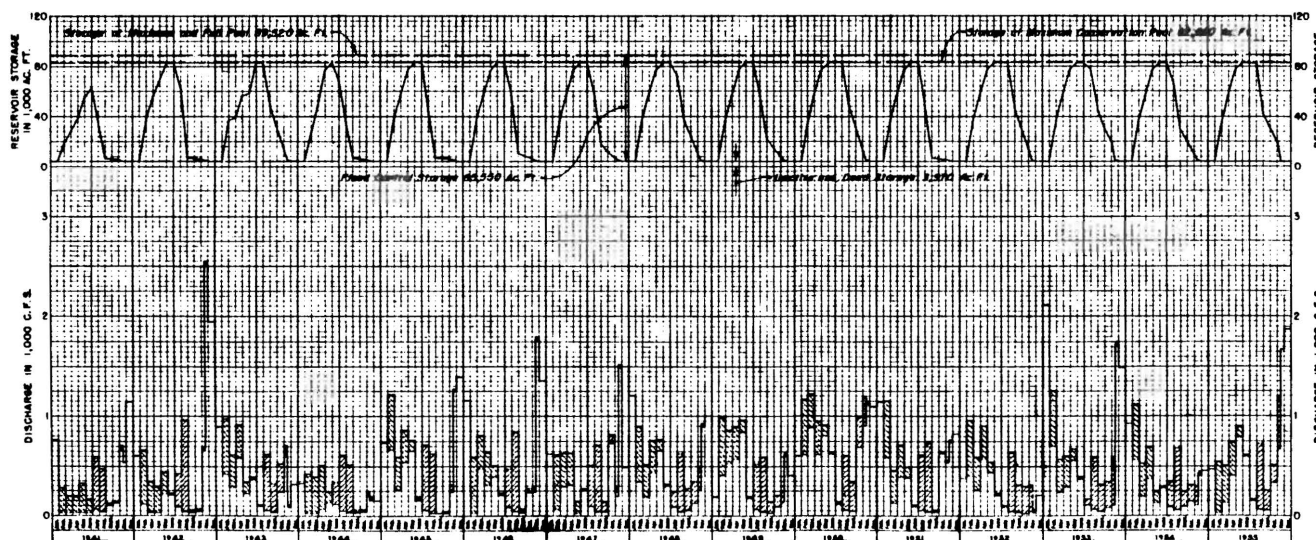
SCALE AS SHOWN
U. S. ARMY ENGINEER DISTRICT, PORTLAND

CHIEF, WATER CONTROL SECTION
DISTRICT ENGINEER

DATE: 1-1-55
PROJECT: 2-12
CHECKED BY: [Signature]
DESIGNED BY: [Signature]

TRANSMITTED WITH REPORT
DATE: [Signature]

BL-20-25



- LEGEND**
- NATURAL INFLOW
 - REGULATED OUTFLOW
 - WATER STORED IN RESERVOIR
 - WATER RELEASED FROM RESERVOIR (IN EXCESS OF NATURAL INFLOW)

- NOTES**
1. THIS PLATE ILLUSTRATES AT THE BLUE RIVER RESERVOIR SITE FOR THE PERIOD 1926-1955, THE INFLOW, OUTFLOW AND RESERVOIR CONTENTS AS AFFECTED BY A PLAN TO DEVELOP THE ULTIMATE WATER RESOURCES OF THE WILLAMETTE BASIN.
 2. BLUE RIVER IS ONE UNIT OF A SYSTEM OF FOURTEEN MULTI-PURPOSE RESERVOIRS AUTHORIZED FOR THE WILLAMETTE BASIN.
 3. EXAMPLES OF FLOOD CONTROL REGULATION ARE ILLUSTRATED ON PLATE 12.
 4. SEE TEXT FOR EXPLANATION OF SEASONAL RESERVOIR REGULATION.

WILLAMETTE RIVER BASIN, OREGON
BLUE RIVER
BLUE RIVER RESERVOIR
SEASONAL RESERVOIR REGULATION
1926 - 1955

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, PORTLAND,
CORPS OF ENGINEERS

PREPARED BY: *[Signature]*
 CHECKED BY: *[Signature]*
 APPROVED BY: *[Signature]*

REV APRIL 1968
(BL-20-17/2)

BL-20-19/2



US Army Corps
of Engineers®
Portland District

EXHIBIT A

DROUGHT CONTINGENCY PLAN FOR THE WILLAMETTE VALLEY PROJECT



Detroit reservoir at minimum power pool, after the 2015 Drought (Oct 17, 2015)

Drought Contingency Plan for the Willamette Valley Project

Table of Contents

	<u>Page</u>
1.0 Introduction.....	1
1-01. Purpose	1
1-02. Requirements	1
1-03. Background.....	1
1-04. Responsibilities.....	1
2.0 Authorities.....	1
3.0 Droughts.....	3
3-01. Definition of Drought	3
3-02. Historical Oregon Droughts.....	3
3-03. Drought Signals and Indicators	5
3-04. Drought Monitoring and Climate Forecasts	6
a. USDA Drought Monitor	6
b. Natural Resources Conservation Service Oregon.....	6
c. Drought Severity	7
3-05. Drought in the Context of Climate Change.....	7
a. Drought Contingency Planning for Climate Change	8
b. Climate and Streamflow Projections	8
c. Implications for Water Management	9
4.0 Basin Description.....	9
4-01. Willamette Basin Description.....	9
4-02. Willamette Reservoir System	9
4-03. USACE Projects in the Willamette Valley Project	11
5.0 Water Uses and Availability	11
5-01. Water Uses.....	11
a. Irrigation.....	11
b. Fishery Enhancement.....	14
c. Recreation	14
d. Hydropower	14
e. Environmental.....	14
f. Municipal and Industrial Water Supply.....	14
g. Navigation.....	15
h. Water Quality.....	15
i. Effects on Cultural Resources.....	15
5-02. Available Storage	16
a. Quantity of Inactive Storage	16
b. Ability to Use Inactive Storage.....	16
c. Ability to Use Power Pool Storage	17
d. Quantity of Uncontracted Water Supply Storage	18
e. Ability to use Uncontracted Water and Procedures to Obtain Water	18
f. Use of Surplus Water.....	18
6.0 Oregon Water Rights	18

	<u>Page</u>
6-01 Appropriation Doctrine.....	18
6-02 Instream Water Rights.....	19
6-03 Irrigation Contracts.....	19
7.0 Flow Management	19
7-01. Reservoir Regulation Seasons	19
7-02. Willamette Conservation Plan.....	20
7-03. Forecasts	20
7-04. Methods and Tools	21
7-05. Project Minimum Flows	21
7-06. System Minimum Flow Objectives	22
7-07. Adaptive Management.....	24
8.0. Drought Management	25
8-01. Reservoir Regulation in Drought Conditions	25
8-02. Flow Objectives in Past Drought Years	25
8-03. Reservoir Regulations in Past Drought Years	26
a. Reducing Minimum Winter Flow	26
b. Winter Steelhead in the Santiam Basin.....	26
c. Chinook Spawning in the Santiam Basin.....	26
d. Mainstem Flows.....	27
8-04. Determination of Interim Draft Limits	27
8-05. Priorities.....	27
9.0 USACE’s Emergency Navigation.....	28
10.0 State of Oregon Drought Management	28
10-01. Authorities	28
10-02. Declaration of Drought.....	28
a. Drought Readiness Council.....	29
b. Water Supply Availability Committee.....	29
10-03. Drought Strategies	30
11.0 Coordination	30
11-01. USACE	30
11-02. Regional.....	30
11-03. State of Oregon.....	31
11-04. County Emergency Managers	31
12.0 Internal and External Communication	31
12-01. Congressional Briefs and Public Officials.....	31
12-02. Public Communication	31
12-03. Internet.....	32
13.0 Emergency Assistance for Drought	31
REFERENCES	33
WEBLINKS	34

<u>Tables</u>	<u>Page</u>
Table 4-1. List of Willamette Valley Project Water Control Manuals	11
Table 5-1. Willamette System Irrigation Contract Data	12
Table 5-2. Inactive Storage Volume by Project.....	17
Table 5-3. Powerpool Storage Volume by Project	17
Table 7-1. 2008 Biological Opinion and Congressional Minimum Reservoir Outflow.....	23
Table 7-2. Evaluation of Spring Runoff and Conservation Operation	24
Table 7-3. Minimum Mainstem Threshold Flows for Albany and Salem.....	24
Table 8-1. Past Drought Year Interagency Minimum Flow Objectives, Albany	25
Table 8-2. Past Drought Year Interagency Minimum Flow Objectives, Salem	26

<u>Figures</u>	<u>Page</u>
Figure 3-1. Willamette Basin Monthly Precipitation.....	4
Figure 3-2. Peak Annual Oregon Snowpack 1981-2015	5
Figure 3-3. Oregon River Basins to Evaluate Drought Conditions	7
Figure 4-1. Willamette Valley Project Map.....	10
Figure 5-1. Water Service Contracts Reach Map	13
Figure 10-1. Standard Drought Declaration Process	29

Attachment 1. USACE-City Agreement Template, Temporary Withdrawal of Water

BLANK PAGE

1.0 Introduction.

1-01. Purpose. The purpose of this document is to provide a drought contingency plan (DCP) for USACE reservoirs in the Willamette Valley Project.

1-02. Requirements. This DCP for the Willamette Valley Project meets the requirements of ER 1110-2-1941, *Development of Drought Contingency Plans*, dated 15 September, 1981. Engineering Regulation (ER) 1110-2-240, *Water Control Management*, dated 30 May 2016, Section 2-3.i, states that water control management policies and procedures, including project regulation, shall be evaluated for adaptation to climate change. A vulnerability assessment by the USACE, summarized in two reports, the 2011 and 2012 *USACE Climate Change Adaptation Plans and Report*, dated September 2011, and June 2012, respectively, identified drought as a source of continuing vulnerability in the future. Updated policy and guidance regarding DCP updates to account for climate change is planned as stated in the CWTS¹ Report 15-15, *USACE Drought Contingency Planning in the Context of Climate Change, U.S. Army Corps of Engineers: Washington DC*, dated September 2015 (Pinson et al., 2015).

1-03. Background. This 2017 DCP update provides a description of historical droughts, drought signals and indicators, drought trends in the context of climate change, water uses and availability, flow and drought management for the Willamette Valley Project, and addresses coordination and communications to take place during a drought situation. This DCP will be included as an exhibit to the Willamette Master Manual and the individual water control manuals upon approval. As of 2017, the Willamette Master Manual draft, dated March 2015, is awaiting the updated NEPA documentation on the operations and maintenance of the Willamette Valley Project.

1-04. Responsibilities. The Portland District Reservoir Regulation & Water Quality Section (CENWP-EC-HR) is responsible for preparation, revision, and implementation of the DCP. The Northwestern Division Water Management, Columbia Basin (CENWD-PDW) is responsible for oversight and approval of this DCP.

2.0 Authorities

The following list of authorities is pertinent to the preparation of drought contingency plans and drought related activities:

- Section 6 of the Flood Control Act of 1944, 33 U.S.C. § 708, provides authority for the Secretary of the Army to enter into agreements for surplus water with states, municipalities, private concerns, or individuals at such prices and on such terms as he may deem reasonable for domestic, municipal, and industrial uses (but not for crop irrigation), for surface water that may be available at any reservoir under the control of the Department of the Army, and provides adequate authority to permit temporary withdrawal of water from USACE projects to supplement normal supplies.

¹ “CWTS” is Civil Works Technical Series

- Flood Control Act of 1941, Pub. L. No. 84-99, 33 U.S.C. § 701n, as amended by Section 82 of the Water Resources Development Act of 1974, Pub. L. No. 93-251, grants the Chief of Engineers discretionary authority to provide emergency supplies of clean water. Work under this authority requires a request from the governor of the affected state. This law authorizes an emergency fund to be expended in preparation for emergency response to natural disasters, including drought, and authorizes the Chief of Engineers to perform emergency work and to provide emergency supplies of clean water on such terms as he determines to be advisable as a result of drought.
- Pub. L. No. 95-51, Disaster Relief Act of 1974 Appropriations Act, amended the Flood Control Act of 1941 to provide for disaster relief, and authorized the Secretary of the Army to construct wells and transport water to farmers, ranchers, and political subdivisions within areas determined to be drought distressed.
- The National Drought Policy Act of 1998, Pub. L. No. 105-199, established the National Drought Policy Commission to provide advice and recommendations on creation of an integrated coordinated Federal policy designed to prepare for and respond to serious drought emergencies.
- ER 1110-2-1941, *Development of Drought Contingency Plans*, dated 15 September 1981, provides policy and guidance for the preparation of drought contingency plans as part of the USACE over-all water management activities.
- ER 1110-2-240, *Water Control Management*, dated 30 May 2016, 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.
- ER 500-1-1, *Emergency Employment of Army and Other Resources*, dated 30 September 2001, prescribes policies for the Civil Emergency Management Program of the USACE under the Flood Control Act of 1941. Section II of this ER describes the policy for the USACE to provide assistance during drought, the level of assistance authorized in providing emergency water, and funding procedures for emergency water activities.
- 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.
- EM 1110-2-3600, *Management of Water Control Systems*, 30 November 1987 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.

The USACE Institute for Water Resources, *Water Supply Handbook, Report 96-PS-4*, dated December 1998, Chapter 2, provides the authorities, policies and procedures for the different types of water during a drought. This includes storage costs, restrictions, disaster relief, emergency water supply planning and other water uses during a state of emergency, including drought conditions.

3.0 Droughts

3-01. Definition of Drought. The CWTS report 15-15 (referred to in Section 1-02), classifies three types of drought: meteorological, agricultural, and hydrologic. Socioeconomic and ecological droughts are other types described by the National Drought Mitigation Center. These types of droughts are described follows:

- **Meteorological** drought is a period of months to years in which precipitation is below normal. It can be accompanied by above-normal temperatures and other factors. It can precede and cause the other types of drought.
- **Agricultural or soil-moisture** drought is a period with dry soils which can reduce crop production and plant growth. Soil-moisture drought can result from below-normal precipitation, above-normal evaporation, or intense but less-frequent precipitation events. Susceptibility to soil-moisture drought can depend on crop or vegetation type.
- **Hydrologic** drought refers to a period when river streamflow and water storages in aquifers, lakes and reservoirs fall below long-term mean levels. It can develop slowly as stored water is used but not replenished.
- **Socioeconomic** droughts occur when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. The supply of economic goods, such as water, forage, food grains, fish and hydropower depends on weather. Because of the natural variability of climate, water supply is ample in some years, but not able to meet human and environmental needs in other years.
- **Ecological** drought is a prolonged and widespread deficit in naturally available water supplies, which include changes in natural and managed hydrology and create multiple stresses across ecosystems.

3-02. Historical Oregon Droughts. Droughts in Oregon occur in all parts of the state and in both winter and summer months. The region east of the Cascade Mountain Range is the most vulnerable to drought with localized risks statewide where climate is influenced by local topographical features. Water is often in short supply in much of Oregon during the low flow months of July through September. Figure 3-1 is reproduced from the draft Willamette Master Manual, dated March 2015, which shows the low precipitation during the summer months compared to the rest of the year. This condition has been described as Oregon's seasonal "drought". Droughts appear to be cyclic and can have an effect on the economy, particularly on the hydropower and agricultural sectors. Environmental consequences include insect infestations in forests and reduced water availability for endangered fish. Severe drought conditions have preceded major forest fires. Water allocation continues to be controversial.

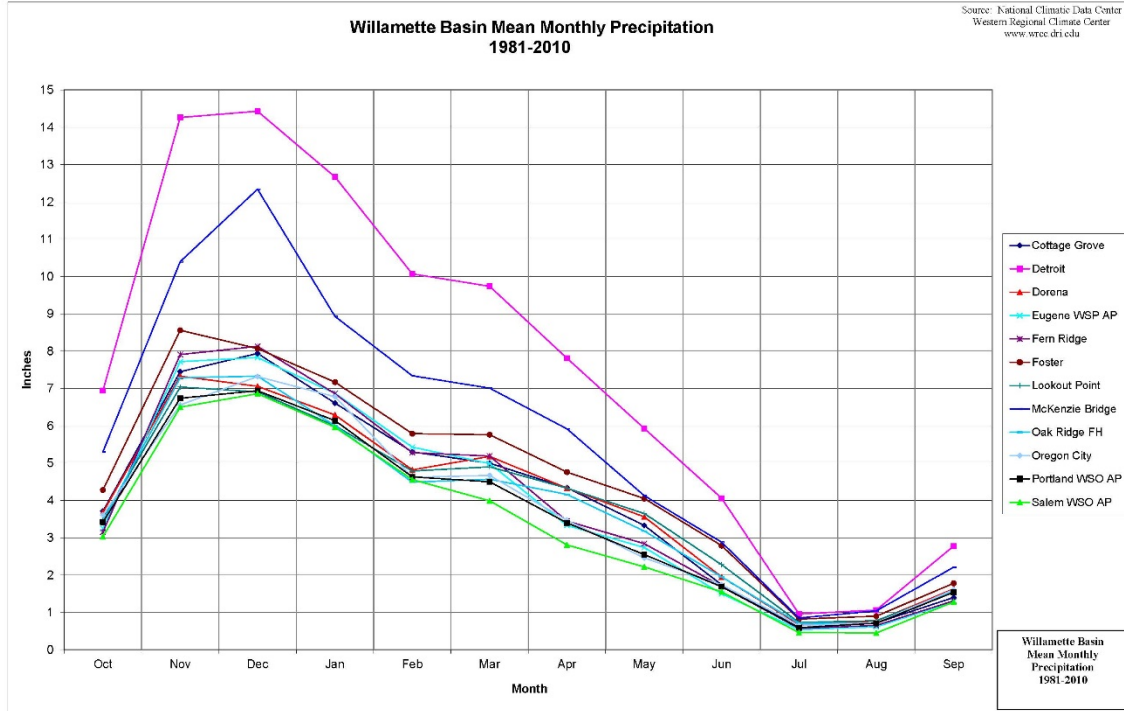


Figure 3-1. Willamette Basin Monthly Precipitation

Eight significant hydrologic drought periods have occurred in Oregon since 1900 (*Oregon Emergency Management Plan, Natural Hazards Mitigation Plan, Drought Chapter, February 2012, and the 2015 Drought After Action Report for Portland District Reservoir Operations.*).

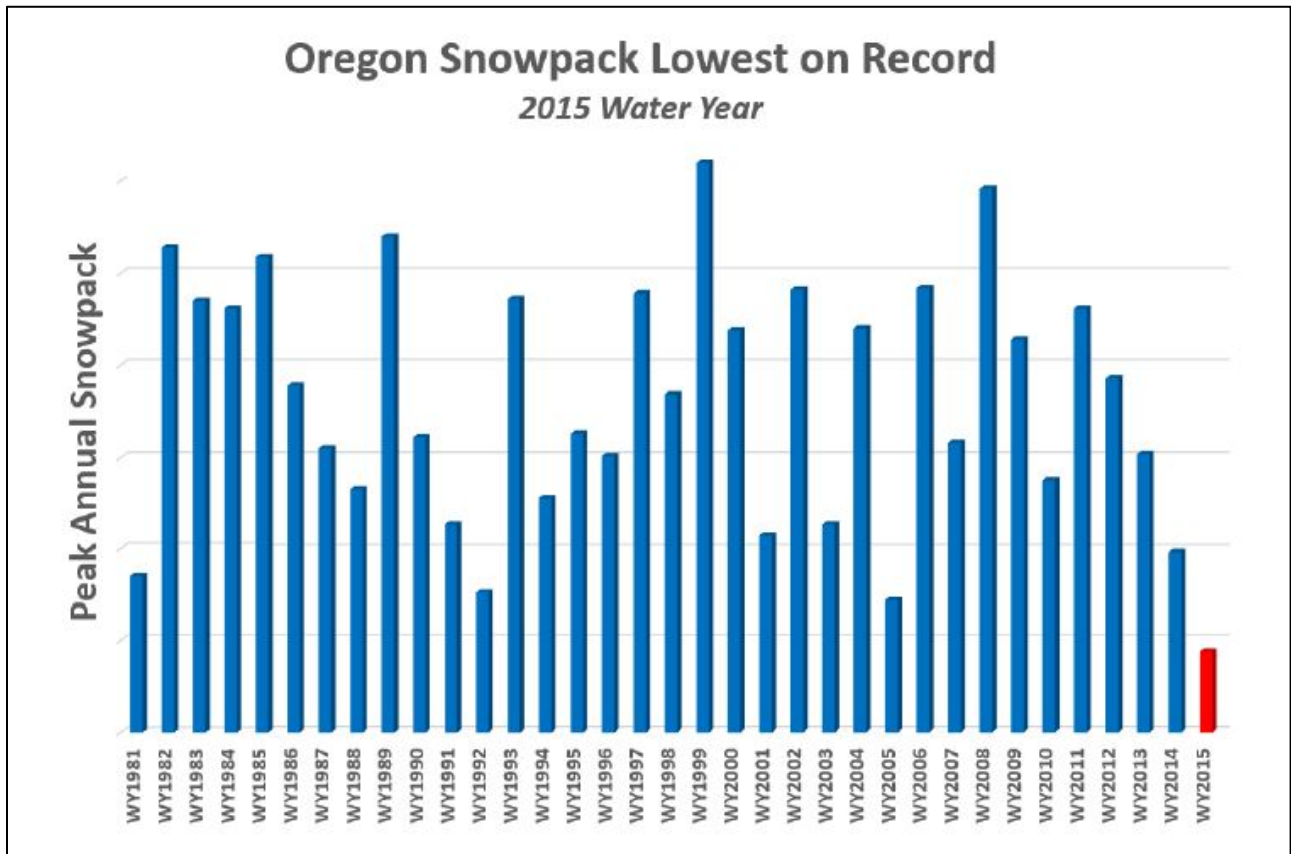
- 1904-1905: Drought period of about 18 months
- 1917-1931: Very dry period punctuated by brief wet spells (1920-21, 1927)
- 1939-1941: Three year intense drought
- 1976-1977: Brief, but intense statewide drought
- 1985-1994: Generally dry period, with statewide droughts in 1992 and 1994
- 2001-2002: Second most intense drought in Oregon's history
- 2005: Drought affected at least eleven of Oregon's thirty-six counties
- 2015: El Niño brought dry and very warm conditions from February thru October

The most recent drought year occurred in water year 2015, and was a low water year for the history books with record low snowpack and streamflows along with record high temperatures that combined to create drought conditions across Oregon.

Based on the Oregon Surface Water Supply Index (SWSI) (see section 3-04.c), water year 2014 began quite dry, became normal in June and July, and then became dry again in September, resulting in an extremely dry start to water year 2015. The 2015 statewide snowpack set new record lows, replacing the previous low-snow years of 1977, 1981, 1992 and 2005. Many snow sites set records for the lowest peak snowpack and earliest melt-out date since measurements

began. Figure 3-2 shows the relative, state-wide peak annual snowpack for each water year, 1981 through 2015, showing that 2015 was the lowest for this period.

For the period May 2015 through July 2015, Oregon recorded the warmest average temperatures since 1895 when record keeping began. By 1 September 2015, the SWSI for the entire state ranged from -1.65 to -3.78 (recalibrated as of September 2016), with the Willamette Basin at 3.78. By the end of September, the U.S. Drought Monitor showed the Willamette Basin to be in a D2 Severe Drought condition and 25 of Oregon’s 36 counties had requested and received drought declarations from the Governor. Reservoirs fell to unprecedented levels, irrigators stopped irrigation early in the season, and some cities implemented water restrictions.



Source: Drought Annex, State of Oregon Emergency Operations Plan, January 2016

Figure 3-2. Peak Annual Oregon Snowpack 1981-2015

3-03. Drought Signals and Indicators. A key to understanding the impacts of a drought is to evaluate the specific components of the hydrologic cycle. Precipitation and snow can be considered the carrier of the drought signal, while hydrologic processes such as snowpack accumulation and melt, runoff, evaporation rates, soil moisture, streamflow magnitudes, and groundwater content and flow can be viewed as the indicators revealing the drought presence.

The El Niño Southern Oscillation Index (ENSO) refers to the cyclical conditions that occur across the equatorial Pacific Ocean due to natural interactions between the ocean and atmosphere. El Niño is the warm phase of the ENSO cycle and the La Niña, is the cool phase. A major El Niño event generally occurs every 3 to 7 years and tends to bring drier winters to the Pacific Northwest which could signal a potential drought. La Niña conditions in the Pacific Northwest 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.

There does not appear to be a viable connection with ENSO for short term or sustained drought for Western Oregon. The overall warm signal for the Pacific Northwest during ENSO is marginal for Western Oregon at best. El Niño warmth may suggest higher snow levels, producing a less reliable snowmelt in the spring, which could be a factor for refill of the reservoirs. The La Niña (ENSO) phase, does lean wetter for the Willamette and might be considered to not produce a drought situation; however, caution should be used when considering the use of ENSO, as the resolution in climate models is low, there are lots of uncertainty, and the opposite of what might be expected in a La Niña or El Niño year does occur.

A discussion of the up-to-date ENSO status is issued monthly by NOAA's Climate Prediction Center and the International Research Institute for Climate and Society. The discussions and data can be accessed at the Climate Prediction Center's website provided in the Weblinks section of this document.

3-04. Drought Monitoring and Climate Forecasts. The United States Department of Agriculture (USDA) and the Natural Resources Conservation Service (NRCS) provide climate forecasts that include indicators of drought. Regulators monitor and use these to aid in making water management decisions.

a. USDA Drought Monitor. The USDA provide maps, data, and forecasts related to drought through the Drought Monitor website. The U.S. Drought Monitor is a weekly product that provides a general summary of current drought conditions. Various indices, outlooks, field reports, and news accounts are reviewed and synthesized. Policymakers and the media use the information in discussions of drought and in allocating drought relief. The Drought Monitor provides a color coded map of the U.S. that shows levels of drought intensities by region. The Drought Monitor Update Report for Oregon can be accessed at the weblink provided in the Weblinks section of this document.

b. Natural Resources Conservation Service Oregon. The NRCS Oregon provides snow and precipitation data for current water year, water supply outlook reports, climate, and soil moisture/temperature data for their SNOTEL sites. Snow survey products and water supply outlook reports for Oregon are provided through maps and graphs, and can be accessed at the weblink provided in the Weblinks section of this document.

The water supply outlook reports include the Oregon Basin Outlook Report, streamflow forecast tables and maps, daily water supply forecasts, reservoir reports, and the Surface Water Supply Index. The Oregon Basin Outlook Report provides a monthly update (January through June) of

the water supply for select basins across Oregon and includes the current status of the snowpack and long term water supply forecasts.

c. Drought Severity. Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. NOAA uses the Palmer Drought Severity Index that provides data back to 1900. Most federal agencies use the Palmer Method. This method uses precipitation, runoff, evaporation, and soil moisture as variables. Because the method does not use snowpack as a variable, the Palmer index does not provide an accurate indication of drought in the Pacific Northwest and Oregon; however, it can be useful because of its long term historical record of wet and dry conditions back to 1900.

The Oregon Water Resources Department uses the Surface Water Supply Index (SWSI) to help assess drought conditions. The SWSI is developed by the NRCS. 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 extremely dry conditions. The SWSI calculations use different equations for each month, all available data, an objective method to determine coefficients, and a 5-month running average to smooth the effects between months. Figure 3-3 shows the 14 river basins within Oregon used to evaluate state-wide drought conditions. The up-to-date and historic SWSI values can be accessed at the weblink provided in the Weblinks section of this document.

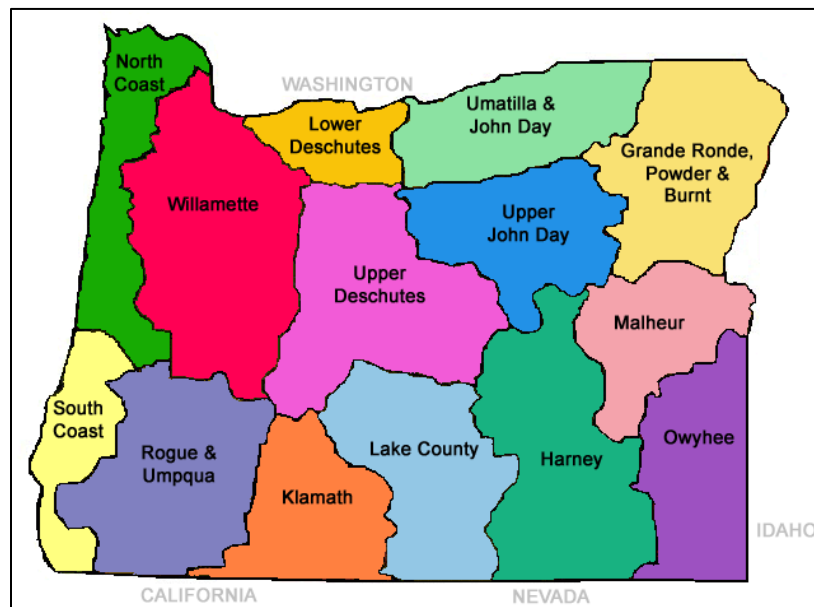


Figure 3-3. Oregon River Basins to Evaluate Drought Conditions

3-05. Drought in the Context of Climate Change. Drought contingency plans are a critical element of flexible water management when combined with water control manuals and the

operation deviation process. The following describes efforts to include climate change in DCPs, climate and streamflow projections in Oregon, and implications to future operations of the Willamette Valley Project.

a. Drought Contingency Planning for Climate Change. The CTWS Report 15-15, contains an overview of climate change and drought in the U.S. to aid in planning for current and future droughts at USACE projects. As of 2017, the report may be accessed at the weblink provided in the Weblinks section of this document. Table 1 of the CTWS Report 15-15, shows that the prediction for the Northwest is for a possible increase in summer drought conditions, and increased hydrologic drought due to changes in mountain snowpack. Appendix B of the report provides a summary of the climate change impacts for six regions in the U.S., including the Northwest.

b. Climate and Streamflow Projections. The report prepared for the CENWP by the Oregon Climate Change Research Institute, *Historical Trends and Future Projections of Climate and Streamflow in the Willamette Valley and Rogue River Basins*, dated June 2015 and revised March 3, 2016, examines observed changes in temperature, precipitation, snowpack, and streamflow in the Willamette and Rogue River Basins, provides projections of the future changes of these variables based on global climate model (GCM) simulations, and addresses implications to water management. The following is a summary of the findings of this study. Refer to the report for details.

1) Temperature. The temperature trend analysis shows, that the minimum and maximum temperatures are projected to increase year-round with greater warming in June through August periods. There is a high degree of confidence in the temperature increases because all models agree with the trend.

2) Precipitation. Some model predictions show an increase and some show a decrease in precipitation. The average multi-model projection change is small in each season, with slightly more precipitation in the winter and less in the summer. While the average multi-model projection change is small, the range of plausible outcomes should be considered.

3) Snowpack. Snow water equivalent as a portion of cumulative precipitation is expected to decline across the region. The North Santiam sub-basins which historically receive the most snow, show a projected December through February decline. The Middle Willamette sub-basin generally receives less snow compared to the other basins and future trend is to receive even less snow. In addition, the small increases in total winter precipitation are projected to potentially equate to very little snow in the future due to the increase in winter temperatures.

4) Streamflow. Changes in streamflow are primarily driven by decreases in snow accumulation, and secondarily by seasonal variation in precipitation change. Models show that mean winter flows will increase and summer flows will decrease, with the magnitude of change mainly determined by the basin's sensitivity to a decline in snow accumulation. The North Santiam is considered sensitive to the snowpack. In this basin, the mean flow is projected to increase significantly during the winter and decrease in the spring and summer, whereas, in the

Middle Fork, the winter flows are projected to increase slightly with small changes during the rest of the year.

Annual peak flows are projected to increase in the future with the peak flows with lower return periods to increase more than those with higher return periods. For rain driven basins, annual peak flows are of short duration (1 to 5 days), and are projected to occur up to 5 days earlier in the water year. For basins with a larger snowmelt component such as in the North Santiam, peaks are expected to occur up to 2 weeks earlier.

c. Implications for Water Management. The probability of drought is projected to increase under future climate change if drought were defined as prolonged periods of demand exceeding supply. As of 2017, it is not clear if current operations provide enough flexibility to manage hydrological changes.

4.0 Basin Description

4-01. Willamette Basin Description. The Willamette Basin is an 11,200 square mile watershed that is a major tributary to the Columbia River and is located entirely within the state of Oregon. The basin has a maximum north-south length of about 150 miles, averages about 75 miles in width, and encompasses 12 percent of the state. The basin is bound by three mountain ranges: the Cascade Range to the east, the Coast Range to the west, and the Calapooya Mountains to the south. Maximum elevations exceed 10,000 feet in the Cascade Range, 4,000 feet in the Coast Range, and 6,000 feet in the Calapooya Mountains. Thirteen of Oregon's thirty-six counties intersect or lie within the boundary of the basin and nearly seventy percent of Oregon's population lives within the basin.

Principal tributaries of the Willamette River originate in the Cascade Range and have headwater elevations generally around 6,000 feet (see figure 4-1). In the upper reaches, these tributaries flow in narrow valleys with steep gradients. The major Cascade Range tributaries include the Santiam, McKenzie, Middle Fork of the Willamette, Molalla, and Clackamas Rivers. The Willamette River is also fed by major tributaries from the Coast Range, including the Long Tom, Marys, Luckiamute, Yamhill, and Tualatin rivers. At the south end of the basin, the Coast Fork of the Willamette River emerges from the Calapooya Mountains and joins the mainstem Willamette River near the City of Springfield (near Eugene).

Precipitation ranges from 40 to 200 inches in the Willamette Basin. Based on computations from USGS data, the average annual flow at Salem (river mile 84, drainage area of 7,280 square miles) for the water years 1910-2015 is 23,300 cfs, or about 16.9 million acre-feet per year. The minimum daily flow at Salem was 2,480 cfs on 27 August 1940. This flow occurred before the USACE dams were completed and operational. The minimum regulated flow for the period 1970-2016 after all of the USACE dams in the Willamette Basin became operational, was 4,140 cfs which occurred on February 20th, 1977.

4-02. Willamette Reservoir System. The USACE operates 13 dams in the Willamette Basin. The system of 13 dams is referred to as the Willamette Valley Project. Eleven of the USACE dams are operated as multiple purpose storage projects and two are strictly reregulating dams for

hydropower production. The locations of the individual dams are shown on figure 4-1. The USACE' reservoirs in the Willamette Valley Project can store up to approximately 1.6 million acre-feet of usable water. This represents about 9 percent of the average annual runoff of the Willamette River at Salem. The 13 USACE dams manage about 27 percent of the entire drainage area above Portland and 42 percent of the drainage area above Salem.

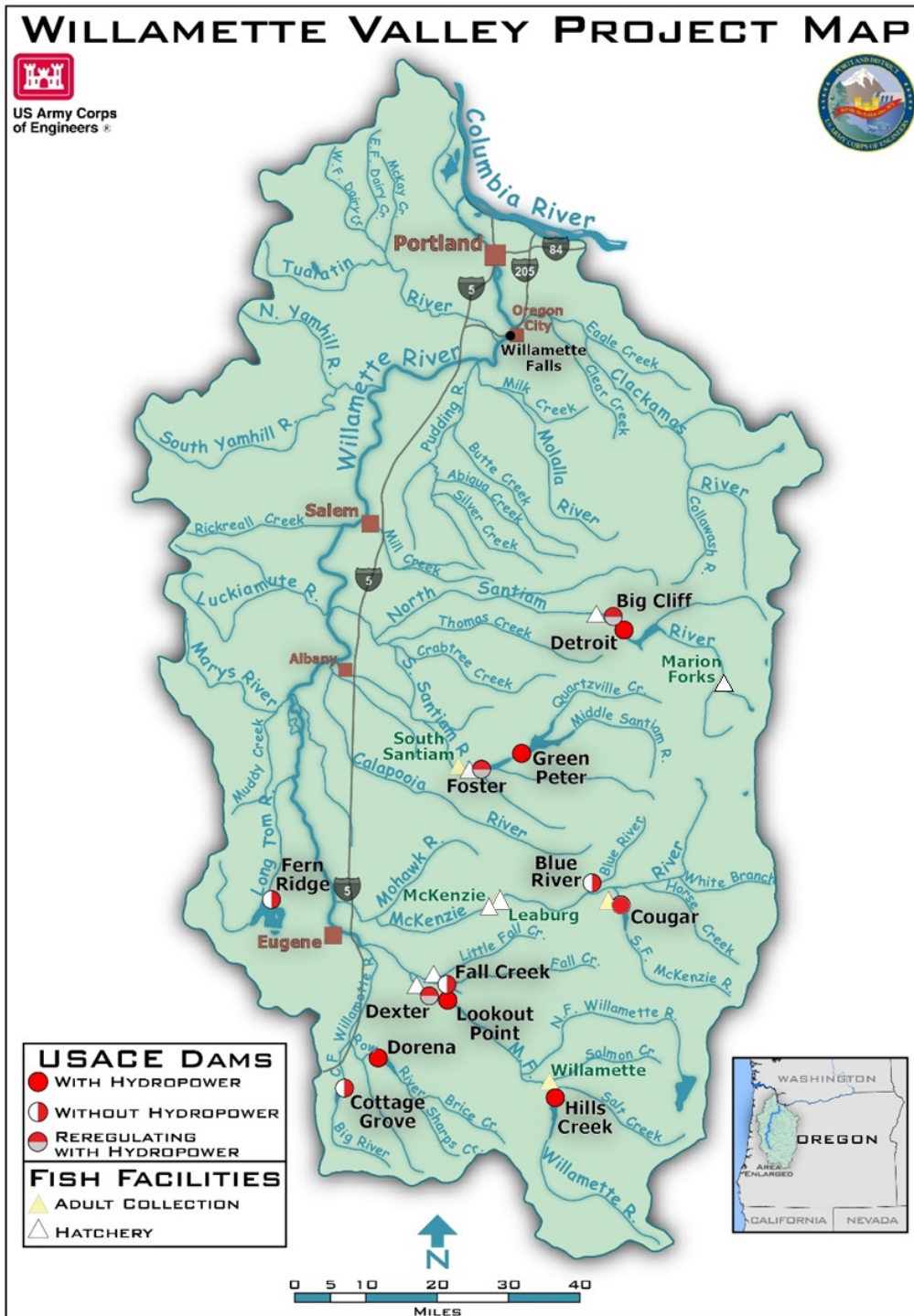


Figure 4-1. Willamette Valley Project Map

4-03. USACE Projects in the Willamette Valley Project. The list of 13 USACE projects in the Willamette Basin are shown on table 4-1. Each water control manual is an appendix to the draft

Willamette Master Manual. As of 2017, the Willamette Master Manual is in draft form while awaiting updated NEPA documentation on the operations and maintenance of the Willamette Valley Project, which is required for approval of the Master Manual. The location of each project is shown on Figure 4-1. A description of each project can be found in their respective water control manuals. Three projects have reregulation dams downstream of them; Big Cliff is the reregulation dam for Detroit; Dexter is the reregulation dam for Lookout Point; and Foster is the reregulation dam for Green Peter, but also has storage capability.

Table 4-1. List of Willamette Valley Project Water Control Manuals

Appendix	Project
--	Willamette Master Manual
1-A	Blue River Lake
1-B	Cottage Grove Lake
1-C	Cougar Lake
1-D	Detroit and Big Cliff Lakes
1-E	Dorena Lake
1-F	Fall Creek lake
1-G	Fern Ridge Lake
1-H	Foster Lake
1-I	Green Peter Lake
1-J	Hills Creek Lake
1-K	Lookout Point and Dexter Project

5.0 Water Uses and Availability

5-01. Water Uses. Water that is stored in the Willamette Valley Project is currently (2017) used for irrigation, fishery enhancement, recreation, hydropower, and environmental flows. Future water storage allocations may include municipal and industrial water supply. It is increasingly important to plan for providing adequate flows for multiple water uses. Informed decision making is accomplished through coordination of the Willamette Conservation Plan (see Section 7-02). The following is a brief description of water use in the Willamette Basin. In addition the effect on cultural resources as a result of low pool levels is provided.

a. Irrigation. According to House Document (HD) 531 that provides authorization for the Willamette Valley Project, irrigation was anticipated to be a significant use of water stored in the Project reservoirs. The U.S. Bureau of Reclamation (Reclamation) administers water service contracts for irrigators within 15 water service contract reaches. Irrigation use in the Willamette Basin has not occurred as initially projected and is not expected to occur in the future at levels near the scope and scale originally envisioned. As of February 2017, nearly 75,000 acre-feet of water (less than 5% of the conservation storage) is contracted for irrigation. Table 5-1 shows the

number of contracts within each reach, volume of water contracted, and the acres served for each reach in the Willamette Basin. Figure 5-1 shows the reach locations.

Table 5-1. Willamette System Irrigation Contract Data

	Reach	Reservoirs Providing Water	Number of Contracts	Acre-Foot Contracted	Acres Served
1	Willamette River	All Reservoirs	45	22,825	11,289
2	Santiam River	All Reservoirs on North and South Santiam Rivers	3	242	323
3	North Santiam River	Big Cliff, Detroit	29	11,375	6,584
4	South Santiam River	Foster, Green Peter	13	914	492
5	Willamette River	All Reservoirs Except Santiam Reservoirs	28	15,603	11,015
6	Long Tom River	Fern Ridge	55	19,715	8,379
7	Willamette River	All Reservoirs Except Santiam and Fern Ridge	9	749	458
8	McKenzie River	Blue River, Cougar	31	1,772	911
10	Middle Fork Willamette River	Fall Creek, Dexter, Lookout Point, Hills Creek	2	911	472
11	Middle Fork Willamette River	Dexter, Lookout Point, Hills Creek	2	92	37
12	Fall Creek	Fall Creek	3	11	5
13	Coast Fork Willamette River and Row River	Dorena, Cottage Grove	6	581	233
14	Row River	Dorena	1	51	20
15	Coast Fork Willamette River	Cottage Grove	1	56	45
Total			228	74,899	40,262

Source: Reclamation, as of February, 2017

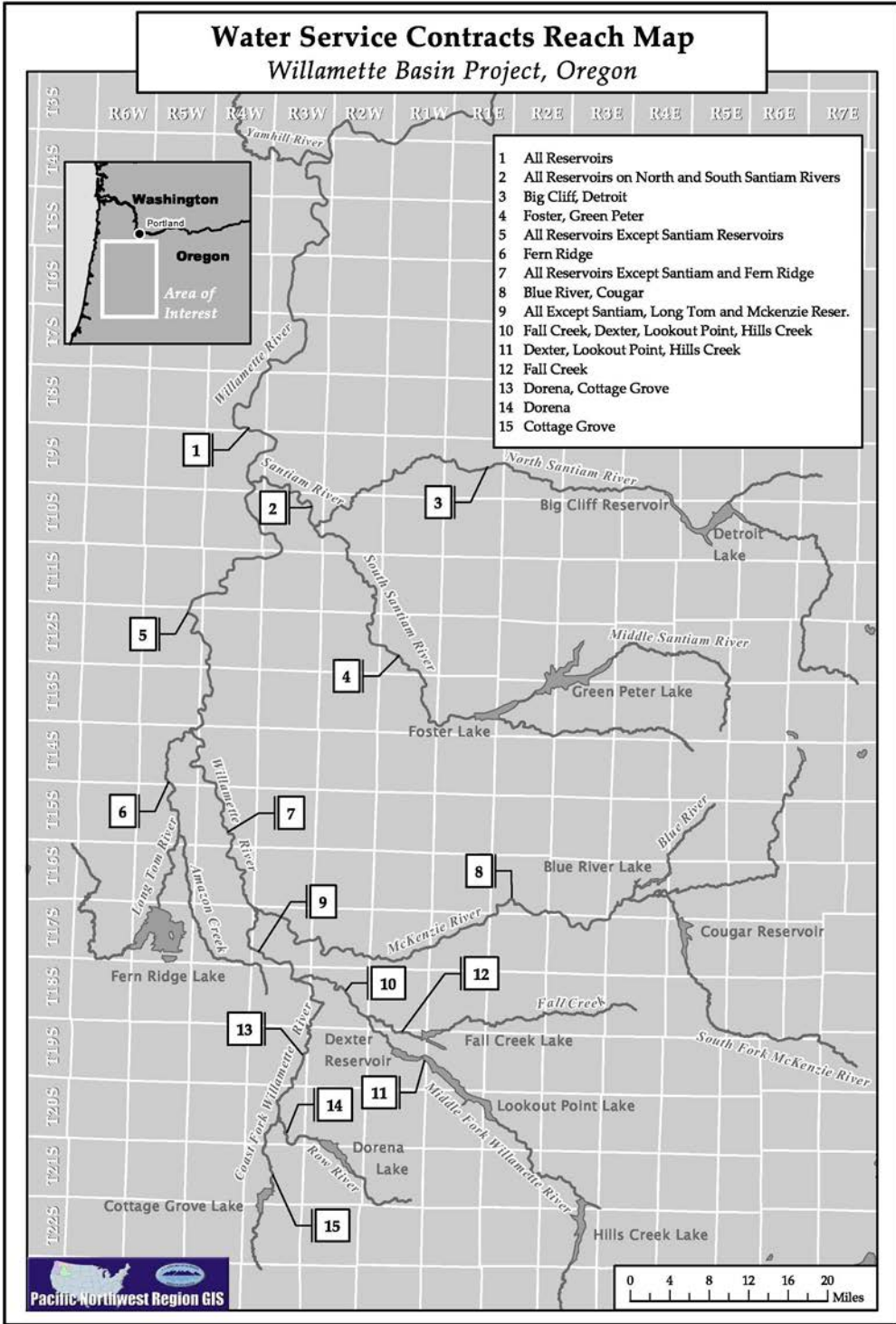


Figure 5-1. Water Service Contracts Reach Map

b. Fishery Enhancement. State and federal fishery resource agencies have identified a number of fish species in the Willamette Basin that are of regional or national significance. Upper Willamette River (UWR) winter steelhead, UWR Spring Chinook salmon, and bull trout are listed as “threatened” under the national Endangered Species Act. Oregon chub was listed as threatened but was delisted in 2015. As habitat degradation and water quality problems, including temperature, affect fish populations, it will be increasingly important to provide for adequate flows in the Willamette Basin.

c. Recreation. Reservoir recreation such as boating and water skiing are major revenue sources for many basin communities. Peak demand for these activities often coincides with the driest point of the summer season, when water for irrigation and in-stream needs is most critical. In some years as early as July, some reservoirs may be drawn down to levels too low to allow use of boat ramps; however, these same summer releases may provide flows for fishing, kayaking, and other recreation on rivers like the McKenzie and North Santiam. The reservoirs are not operated to meet recreation needs during a drought.

d. Hydropower. Eight of the Willamette Valley Project dams have a federal hydropower facility. These dams provide enough power to service 300,000 homes. Generation from the peaking projects are often based upon load throughout the day or week and are subject to frequent fluctuations. The reregulation reservoirs are used to absorb the fluctuations in flows from their upstream peaking projects and release flows at a more uniform level. The generation at the baseload projects provides uniform generation supply. Monthly generation can change drastically from year to year depending on the amount of runoff which occurs in the basin. A non-federal hydropower facility was added to Dorena Dam in 2014. The Dorena water control plan has not been altered due to installation of the hydropower facility. All flow releases from Dorena Dam are as determined by CENWP-EC-HR and reservoir regulations are documented in the Dorena Water Control Manual.

e. Environmental. A set of environmental flow recommendations (e-flows) were developed through the Sustainable Rivers Project, a USACE and The Nature Conservancy partnership. The purpose and benefits of the e-flows are to improve habitats on the flood plain margins, re-establish some river dynamism such as increasing river sediment transport, thereby encouraging re-formation of pools and riffles, re-establishing extant flood plain connection and smoothing the flow transitions after winter high flow events to facilitate lateral movement between refugia, seed dispersal, and birdnesting, etc. These operations are targeted for winter and spring months and use water that would need to be released to stay within the rule curve elevations. The e-flow operations provide ecological benefits while affecting minimal change to flood risk reduction, water quality, hydropower and meeting biological opinion flow objectives. E-flow targets are for the Middle Fork Willamette River at Jasper (outflows from Fall Creek and Dexter), South Fork McKenzie outflows from Cougar, and the North Santiam at Mehama (outflows from Big Cliff) and have been incorporated into the respective water control manuals.

f. Municipal and Industrial Water Supply. Some of the largest cities in the Willamette Basin rely on the Willamette River and its tributaries for drinking water. As population increases throughout the valley, and as environmental and financing issues reduce the likelihood that

municipalities will build new reservoirs for drinking water, river flow and existing reservoirs will continue to be an important water source.

Throughout the basin, employers such as pulp and paper mills use river water directly without purchasing through a municipal provider. In addition, high-tech industries have grown and have a significant demand for water. Although most of the high-tech industries receive their water through a municipal system, it is important to include all industry needs when planning for dry season uses of reservoir water.

As of 2017, the Willamette River Basin Review Feasibility Study is assessing the feasibility of reallocating storage in the Willamette Valley Project reservoirs from general joint-use to specific originally authorized purposes, including municipal and industrial (M&I) water supply, irrigation, and fish and wildlife. Any reallocation plan will require approval from Congress as the volume of storage exceeds the limits for local approval. Once the storage is reallocated and state issued water rights are modified, storage will be available for M&I use. The amount of storage and water expected to be needed for M&I is higher than listed in HD 531, but still much less than irrigation.

g. Navigation. Navigation is an authorized purpose of the Willamette Valley Project, but the project flows are no longer regulated for navigation use above the Willamette Falls Lock at Oregon City. Project authorizing documents (HD 544, 75th Congress, third session, March 16, 1938) stipulated a minimum flow of 5,000 cfs between Albany and the Santiam River, and 6,500 cfs downstream to Salem to provide navigation depths of 6 feet and 5 feet, respectively, above Willamette Falls. These minimum flows have been adopted for water quality purposes (see section 5-01.h). Over the years, the ODEQ has issued wastewater discharge permits based on a 7Q10 flow (the EPA definition: the lowest 7-day regulated average flow that occurs on average once every 10 years), which is approximately 5,500 cfs near Salem. The USACE continues to attempt to meet these flows to aid in water quality and fisheries enhancement in compliance with the 2008 Biological Opinion.

h. Water Quality. The minimum congressional flows of 5,000 cfs at Albany and 6,500 cfs at Salem were established for the purposes of navigation, but have become base flows used to maintain water quality standards in the mainstem Willamette. Both water quantity and quality were of great concern, particularly in watersheds with salmon and other fish species listed as endangered or threatened under the Endangered Species Act. Many streams in Oregon do not meet water quality standards during the summer due to high water temperatures, but release of water from reservoirs provide some aid in reducing water temperatures downstream of the dams. Water quality standards are also limited due to inadequate riparian zones and increasing problems associated with agriculture and forestry chemicals.

i. Effects on Cultural Resources. The USACE Willamette Valley Projects Dams lies within the traditional lands for four federally recognized Native American Tribes, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of the Siletz Indians, the Cow Creek Tribes of Umpqua Indians, and the Confederated Tribes of the Warm Springs Reservation of Oregon. The tributaries that the dams block are used traditionally by these tribes (historically and today) for the gathering of plants for food and fiber, fish, and

other wildlife associated with the watershed. The projects also have inundated hundreds of historic and Native American archaeological sites. Drought situations where water levels are altered, such as being lower for longer periods of time, might affect the archaeological resources due to exposure, wave action, recreational uses, and vandalism / looting. It also has the potential to have an additional negative effect on subsistence fishing utilized by the Tribes. The USACE has a responsibility to the protection of these resources, archaeological and historic under the National Historic Preservation Act. Tribal traditional cultural properties are included under the NHPA, as well as the consultation and coordination under the Executive Order 13175, Department of Defense (DoD) American Indian and Alaska Native Policy, 2004; Department of the Army American Indian and Alaska Native Policy, 24 Oct 2012; Tribal Consultation, Presidential Memorandum, 5 Nov 2009; USACE Memorandum, Sovereignty and Government-to-Government Relations with American Indian and Alaska Native Tribal Governments: USACE Tribal Policy Principles, 10 May 2010; and USACE Tribal Consultation Policy, 1 Nov 2012.

5-02. Available Storage. The storage of water in the Willamette Valley Project is based on seasonal regulation schedules established according to each project's rule curve. The Willamette Valley Project can store up to approximately 1.6 million acre-feet of water within the conservation pool. The ability to use water from inactive storage, power pool storage, and uncontracted stored water is described below.

a. Quantity of Inactive Storage. For projects with hydropower that have regulating outlets (Hills Creek, Lookout Point, Cougar, Green Peter, and Detroit), the inactive storage is the reservoir capacity between the minimum power pool and the lowest regulating outlet invert elevation. For projects without USACE operated hydropower (Fall Creek, Cottage Grove, Dorena, Fern Ridge, and Blue River), the inactive storage is the reservoir capacity between the minimum flood pool and lowest regulating outlet invert elevations. For reregulation projects (Dexter, Foster, and Big Cliff), the inactive storage is the reservoir capacity between the minimum power pool and the spillway crest. The total inactive storage for the Willamette Valley Project reservoirs is approximately 359,999 acre-feet. Table 5-2 shows the percent of inactive storage by project.

b. Ability to Use Inactive Storage. Under no circumstances should the inactive storage be used for power generation, as operating to the low heads could cause damage to the turbines. In 2015, most of the Willamette Valley Project reservoirs dipped into inactive storage to meet minimum flow with little impact. The impact of drafting into the inactive storage is an increased risk of not refilling the reservoir. Fall Creek Project uses 9,505 acre-feet of inactive storage in winter for a maximum of two weeks to pass predatory fish in order to reduce predation on salmonids in the reservoir.

Table 5-2. Inactive Storage Volume by Project¹

Project	Inactive Storage Volume (Acre-Feet)	Inactive Storage (Percent)
Hills Creek	6,600	1.8%
Lookout Point	19,194	5.3%
Dexter	97,644	27.1%
Fall Creek	9,505	2.6%
Cottage Grove	3,139	0.9%
Dorena	7,355	2.0%
Fern Ridge	2,802	0.8%
Cougar	16,700	4.6%
Blue River	3,430	1.0%
Green Peter	71,220	19.8%
Foster	10,980	3.1%
Detroit	109,700	30.5%
Big Cliff	1,730	0.5%
Total	359,999	100.0%

¹Volumes derived based on reservoir storage capacity tables located on the CENWP-EC-HR weblink, as of June 2017.

c. Ability to Use Power Pool Storage. The power pool is the reservoir capacity between the minimum flood pool and the minimum power pool. Table 5-3 shows the powerpool storage by project (Dexter and Big Cliff do not have flood pools, therefore they are not shown). Under project authorities, the power pool is reserved exclusively for power generation. Infrequent, limited (or modest) drafting into the power pool on a case-by-case basis may be accomplished pursuant to project authorities. This decision must be coordinated with the Bonneville Power Administration to ensure that any decision to use the power pool has taken into consideration power requirements. The decision should also consider how critical the need is to draft (e.g., biological need to provide minimum flows at the time).

If reservoirs draft to the minimum power pool level, generation will be stopped to avoid damage to the generating units. Station service will be supplied to the plants from the transmission grid. Regulating outlets will be used to maintain streamflow.

Table 5-3. Powerpool Storage Volume by Project¹

Project	Powerpool Storage Volume (Acre-Feet)	Powerpool Storage (Percent)
Hills Creek	48,800	28.5%
Lookout Point	11,377	6.6%
Cougar	8,700	5.1%
Green Peter	62,600	36.5%
Foster	3,600	2.1%
Detroit	36,375	21.2%
Total	171,452	100.0%

¹Volumes derived based on reservoir storage capacity tables located on the CENWP-EC-HR weblink, as of June 2017.

d. Quantity of Uncontracted Water Supply Storage. The Reclamation holds two water rights with the State of Oregon to store 1.64 million acre-ft (applications filed in 1954 and 1968) of water in the Willamette Valley Project reservoirs for irrigation use only. As of February 2017, there are only 74,899 acre-feet of water actually contracted, therefore the uncontracted storage is about 95% of the water rights storage. It is important to note that the entirety of the conservation storage volume remains in the joint-use purpose. As of 2017, the conservation storage volume in the Willamette Valley Project is 1.6 million acre-ft. See section 6-03 for more information on irrigation contracts.

e. Ability to Use Uncontracted Water and Procedures to Obtain Water. The withdrawal of water from streams, lakes, and reservoirs, is regulated by the OWRD under the state water law. An applicant must file for a water right with the 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 USACE).

f. Use of Surplus Water. Section 6 of the Flood Control Act of 1944 (Public Law 78-534) authorized the Secretary of the Army to enter into agreements for use of surplus water for temporary drought relief, and for purposes other than crop irrigation. Surplus water will only be declared available when the use would not significantly affect other authorized purposes. When stored water is in excess of meeting the authorized project purposes it can be identified as surplus water available for use on a temporary (5 years, with the ability for one 5-year extension). Surplus water withdrawn from the streams below USACE projects will require a signed agreement accompanied by a brief letter report documenting how and why stored water is determined to be available as surplus. The level of detail will be commensurate with the amount of water to be used, time of use, and economic and environmental effects. Authority to sign these agreements by the District Commander requires approval from USACE Headquarters. As of December 2016, the price of the available water is based on the updated cost of storage (highest of four cost methods for the Willamette Valley Project), as required for reallocated storage, though draft rule making issued in December 2016 may change this methodology. A template for a surplus water agreement for use of water from USACE reservoirs is provided in Attachment 1.

6.0 Oregon Water Rights

6-01. Appropriation Doctrine. Water rights in Oregon are managed by the OWRD. Refer to the *Water Rights in Oregon, An Introduction to Oregon's Water Laws*, by the OWRD, dated November 2013. In Oregon, the prior appropriation doctrine has been law since February 24, 1909 when the first unified water code introduced state control over the right to use water. The principle of prior appropriation means the first person to obtain a water right on a stream is the last to be shut off in times of low streamflows. Before 1909, water users had to depend on themselves or local courts to defend their rights to water. 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 537.1 0) 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 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.

6-02. Instream Water Rights. An instream water right law was enacted in Oregon via Senate Bill 140 during 1987. The Oregon legislation recognized that public uses are beneficial uses, as defined by the appropriation doctrine. The act allows the Departments of Fish and Wildlife, Environmental Quality, and Parks and Recreation to request instream water rights from the Department. The law gives instream water rights the same status as other water rights, except that municipal uses may have priority over these rights. In a Governor declared drought, Oregon law allows the Department to give preference to human consumption and livestock watering over other uses. Unlike minimum perennial 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. In the Willamette Basin, the majority of the minimum perennial streamflows established in 1964 have not been converted to instream water rights. Once converted the instream water rights will have a priority date of 1964.

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 water right for use of stored water.

6-03. Irrigation Contracts. The Reclamation implements and manages the sale of irrigation water for the Federal government. The Reclamation filed applications for water rights in 1954 and 1968 on behalf of the federal government. Subsequent state water right certificates have been issued to the Reclamation authorizing all of the 1.64 million acre-feet of system conservation pool storage for irrigation uses (Certificates 72755 and 72756). Currently, irrigators have contracted for less than five percent of the 1.64 million acre-feet; however, agricultural needs may increase in the future. To use the stored water, a contract holder with the Reclamation must obtain a state permit to withdraw the water from an Oregon stream, referred to as a secondary water right.

The storage of water in the Willamette Valley Project is based on the seasonal regulation schedules established according to the rule curve for each dam. The USACE coordinates with the multiple federal and state agencies when releasing stored water at projects to meet secondary project purposes.

7.0 Flow Management

7-01. Reservoir Regulation Seasons. Reservoir regulation activities occur over three regulation seasons; major flood, conservation storage, and conservation release. The major flood season is from mid-November through January. During the major flood season, reservoirs are kept at their minimum flood pool to capture high inflows in order to reduce the risk of downstream flooding. The conservation storage season is from February through about mid-May. During this period, the reservoirs fill to their maximum conservation pool level to store

water for the conservation release season. During the conservation release season from mid-May through mid-November, water stored within the conservation pool is released for multiple uses, including hydropower, fisheries enhancement, water quality, environmental purposes, recreation, and consumptive use for irrigation.

7-02. Willamette Conservation Plan. The Willamette Conservation Plan (WCP) is the annual water management plan for the Willamette Valley Project and identifies flow and storage needs for each tributary and reservoir in the Willamette Valley Project. Forecasts in April, of runoff volume and system-wide volume storage in the Willamette Valley Project by mid-May are used to set minimum flow objectives for April through October on the mainstem Willamette River, which is central to the WCP. The WCP includes estimates of mainstem flows and reservoir storage volumes likely to occur over the conservation season based on forecasts, system operational alternatives, and constraints through modeling. Reservoir modeling considers the likelihood of meeting the tributary flow objectives in table 7-1 and the mainstem flow objectives in table 7-3. Adaptive management (see section 7-07) may be used to adjust operations within authorized project purposes due to changing conditions and with new knowledge that is gained from ongoing operating experience or studies. Refer to the most recent WCP for the up-to-date minimum flow objectives, as they vary from year-to-year depending on water availability. The WCP may be obtained from the CENWP-EC-HR.

The WCP is coordinated to meet the ESA and all other purposes of the Willamette Valley Project. The Willamette Action Team for Ecosystem Restoration (WATER) is a forum of the Action Agencies (USACE, Reclamation, and BPA), Services (USFWS and NOAA Fisheries), state agencies, and tribes, responsible for planning and implementing flow management in the Willamette Basin. The Flow Management Committee is the technical committee under WATER to coordinate the development of and implement the WCP. The WCP is updated annually during the conservation storage season based on the April forecast made in early April, and anticipated total system storage in mid-May. The plan is fine-tuned in early June after spring refill.

7-03. Forecasts. Forecasts are required during the conservation storage period to assess the timing and capability of refilling to the desired maximum conservation storage elevation of individual projects. The benefits of an accurate forecast are twofold: (1) minimum flow requirements less than normal minimum releases can be requested through the OWRD if insufficient inflows are forecasted and (2) probability of lake refill and timing can be estimated in order to inform lake users. Projections of lake levels during the summer and fall periods are also useful for the same reasons. Adaptive management (see section 7-07) allows for adjustments in reservoir operations if unexpected hydrologic changes were to occur.

NOAA's Climate Prediction Center Seasonal Drought Outlook or the Department of Agriculture's drought indices can be used as an indicator of a short-term drought in consideration of planning for operations in meeting minimum flow objectives without much base-flow or rain. If rainfall and runoff forecasts show that the Willamette Valley Project reservoirs may not fill to the maximum conservation pool levels, a potential drought

situation may be indicated. Drought forecasting in the Willamette Basin is most useful in preparing for and during the conservation release season.

Beginning in January, the USACE uses NRCS's April-September water supply volume forecasts issued monthly, and may use Ensemble Streamflow Prediction (ESP) forecasts issued by the Northwest River Forecast Center of the National Weather Service, as input in modeling of the reservoir system. The ESP forecasts use historical meteorological data to represent possible future conditions for probabilistic analyses. These forecasts help estimate how full the reservoirs may be in May and June and how much stored water may be available for release during the conservation season.

7-04. Methods and Tools. Methods and tools are discussed in individual project water control manuals or as described in the *Standard Procedures for Regulation of the Willamette Basin Projects* (contact CENWP-EC-HR for the most up-to-date version). The tools assist in developing estimates of reservoir refill during the conservation filling period.

For long-term planning (greater than 6 months) and for use in the Willamette Conservation Plan, the CENWP-EC-HR runs the USACE's Hydrologic Engineering Center (HEC), reservoir simulation model, HEC-ResSim, to evaluate the water supply forecasts. Water supply volumes are input to the ResSim model to estimate how full the reservoirs may be in May and how much stored water will be available for the release season.

For shorter-term planning, as of 2017, the USACE and Northwest River Forecast Center (NWRFC) use the Community Hydrologic Prediction System (CHPS) reservoir system simulation model, a product of the NWRFC. The USACE provides reservoir regulation information as input to the model while the NWRFC provides weather sequences of given probabilities, soil moisture and ground water conditions. Model runs are made with these parameters and assumptions, and the output are forecasts of lake inflows, streamflows, and lake elevations. The model is used to inform project operational decisions.

During the summer and during drought situations, the CHPS model is run twice a week to ensure the summer flow objectives are met. In addition, the water travel time during the summer is longer due to lower flows, and the CHPS forecast model runs help ensure the flow objectives are met with proper timing.

7-05. Project Minimum Flows. Throughout the year, water is passed through the dams to meet or exceed the congressionally authorized minimum flows. Due to developments in the basin to meet Endangered Species Act needs, a set of minimum flow objectives were recommended by the NOAA's National Marine Fisheries Service Biological Opinion, *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation, Consultation on the "Willamette River Basin Flood Control Project,"* dated 11 July 2008. The Congressional minimum flows as stated in House Document 531, Volume V (Appendix J) and the biological opinion objective flows are provided in table 7-1.

The operational flow objectives and the associated flow management guidelines are intended to balance the risks to listed fish species under low water year conditions with the risks to other uses authorized by Congress for the Willamette Valley Project. Key among these authorized uses are those significant to human health and safety, including flood risk management, hydropower production, and summer and fall low flow augmentation for maintenance of water quality.

7-06. System Minimum Flow Objectives. In addition to the project minimum flows discussed in section 7-05, the 2008 Biological Opinion provides Willamette River mainstem minimum flow objectives at Salem and Albany. Because the water supply in the Willamette can vary significantly from year to year, the 2008 Biological Opinion allows for adaptive management (see section 7-07) of the reservoir system dependent upon predicted system water availability by mid-May. The 2008 Biological Opinion designates four levels of water availability, in terms of forecasted volume of storage in the Willamette Valley Project reservoirs by mid-May. The designation of a conservation season runoff forecast as “abundant”, “adequate”, “insufficient”, or “deficit” will lead to differing management approaches.

Table 7-2 summarizes the designation of Willamette Basin runoff observed over a 64-year period of record. Table 7-3 shows the minimum flow objectives for Salem in “deficit” years (column 6), and for “abundant” and “adequate” years (column 5). Minimum flow objectives for insufficient years are based on a sliding scale between columns 5 and 6. The minimum flow objective for Albany is the same for all years. The flow objectives for April through June are flow objectives for fish while the summer and fall flows at Albany help maintain water quality. For years designated as “abundant” or “adequate”, minimum flow objectives during spring, summer, and fall would be expected to be met or exceeded whenever possible (e.g., considering factors such as the accuracy of weather forecasts, constraints in the accuracy of operational adjustments at dams, and delayed system response time between the points of storage release and Salem), therefore these years would not be considered drought years. For years designated as “insufficient” or “deficit”, the minimum flow objectives are not expected to be met, and these would be considered drought years. The mainstem spring flow objectives may be temporary actions and are subject to review and revision in accordance with results of appropriate monitoring and evaluation.

Table 7-1. 2008 Biological Opinion and Congressional Minimum Reservoir Outflow

Location	2008 NMFS Biological Opinion			Water Control Manual		House Document No. 531 Volume V	
	Date	Minimum Flow (cfs)	Remarks	Date	Minimum Flow (cfs)	Date	Minimum Flow for Fish ¹
Detroit/Big Cliff	1 Feb - 15 Mar	1000	Rearing/adult migration	Feb-Jun	1,000	Feb-Jun	1,000
	16 Mar - 31 May	1500	steelhead spawning	Jul-Nov	750	Jul - Nov	750
	1 Jun - 15 Jul	1200	steelhead incubation				
	16 Jul - 31 Aug	1000	rearing				
	1 Sep - 15 Oct	1500	chinook spawning				
	16 Oct - 31 Jan	1200	chinook incubation				
Blue River	1 Feb - 31 Aug	50	rearing	Jul-Nov	50	Feb-Jun	30
	1 Sep - 15 Oct	50	chinook spawning			Jul - Nov	30
	16 Oct - 31 Jan	50	chinook incubation				
Cottage Grove	1 Feb - 30 Jun	75		Feb-Jun	75	Feb-Jun	75
	1 Jul - 31 Oct	50		Jul-Oct	50	Jul - Nov	50
	1 Nov - 31 Jan	inflow					
Cougar	1 Feb - 31 May	300	rearing	Feb-Jun	300	Feb-Jun	300
	1 Jun - 30 Jun	400	rearing adult migration			Jul - Nov	200
	1 Jul - 31 Aug	300	rearing				
	1 Sep - 15 Oct	300	chinook spawning				
	16 Oct - 31 Jan	300	chinook incubation				
Dorena	1 Feb - 30 Jun	190		Feb-Jun	190	Feb-Jun	190
	1 Jul - 31 Oct	100		Jul-Oct	100	Jul - Nov	100
	1 Nov - 31 Jan	inflow					
Fall Creek	1 Feb - 31 Mar	50	rearing	1 Feb - 15 Nov	30	Feb-Jun	30
	1 Apr - 31 Aug	80	rearing, adult migration (Jun)			Jul - Nov	30
	1 Sep - 15 Oct	200	chinook spawning				
	16 Oct - 31 Jan	50	chinook incubation				
Fern Ridge	1 Feb - 30 Jun	50		Dec-Jun	50	Feb-Jun	50
	1 Jul - 31 Oct	30		Jul-Nov	30	Jul - Nov	30
	1 Nov - 31 Jan	inflow					
Green Peter/Foster	1 Feb - 15 Mar	800	Rearing/adult migration	Feb-Arp	800	Feb-Apr	500
	16 Mar - 15 May	1500	steelhead spawning	May	750	May	450
	16 May - 30 Jun	1100	steelhead incubation	1 Jul - 15 Nov	400	Jun	300
	1 Jul - 31 Aug	800	rearing			Jul - Nov	300
	1 Sep - Oct 15	1500	chinook spawning				
	16 Oct - 31 Jan	1100	chinook incubation				
Hills Creek	1 Feb - 31 Aug	400	rearing	Feb-Nov	100	Feb-Jun	100
	1 Sep - 31 Jan	400	migration and rearing			Jul - Nov	100
Lookout Point/Dexter	1 Feb - 31 Aug	1200	rearing	Feb-Jun	1,200	Feb-Jun	1,200
	1 Sep - 15 Oct	1200	chinook spawning	1 Jul - 15 Nov	1,000	Jul - Nov	1,000
	16 Oct - 31 Jan	1200	chinook incubation				

¹ House Document 531, Review Report on Columbia River and Tributaries, Appendix J, Willamette River Basin, Table III-1. Minimum flows were adopted for the preservation of fish. At the power reservoirs (Hills Creek, Cougar, Green Peter, and Detroit) the releases during the power season (October - March, inclusive) are substantially greater than the minimum regulated flows shown.

Table 7-2. Evaluation of Spring Runoff and Conservation Operation

Volume in Storage by 10-20 May (MAF)	Designation	Occurrences (years) ¹	Percent of Years
< 0.9	Deficit	10	16
0.9 – 1.19	Insufficient	6	9
1.20 – 1.48	Adequate	11	17
> 1.48	Abundant	37	58
1.59	Maximum ²	---	---

¹ Period of record 1936-1999 using flow objectives in columns 2, 4, and 5 in Table 7-3

² Maximum usable conservation storage.

Table 7-3. Minimum Mainstem Threshold Flows for Albany and Salem (cfs)

1	Albany		Salem			7
	2	3	4	5	6	
Period	Minimum Average Flow ¹	HD 531 ²	Minimum Instantaneous Flow ³	Minimum Weekly Flow Threshold Abundant and Adequate ⁴	Minimum Weekly Flow Threshold Deficit Years ⁴	HD 531 ²
April	--	5,000	14,300	17,800 ³	15,000	6,500
May	--		12,000	15,000 ³	15,000	
1 – 15 June	4,500		10,500	13,000 ³	11,000	
16 – 30 June	4,500		7,000	8,700 ³	5,500	
July	4,500		--	6,000 ¹	5,000	
1 – 15 August	5,000		--	6,000 ¹	5,000	
16 – 31 August	5,000		--	6,500 ¹	5,000	
September	5,000		--	7,000 ¹	5,000	
October	5,000		--	7,000 ¹	5,000	

¹ 2008 Biological Opinion Appendix D, Table D-2.

² Congressional minimum flows from House Document (HD) 531, Volume 5, paragraph 88.

³ 2008 Biological Opinion Appendix D, Table D-1, biologically based minimum flow objectives.

⁴ 2008 Biological Opinion Appendix D, Table D-4. Flows in Column 5 are for “Abundant”, and “Adequate” years. Flows for “Insufficient” years are based on a sliding scale between Columns 5 and 6.

7-07. Adaptive Management. Adaptive management of flow objectives involve making adjustments to reservoir operations and flow releases based on changing conditions and changing forecasted hydrologic conditions. Current volume forecast methods do not differentiate between the significant contribution of snowmelt and the highly variable rainfall contribution which makes it difficult to forecast runoff volumes. It is not possible to foresee, describe, and model all of the possible management scenarios and contingencies. In

a rain-driven system like the Willamette Basin the best available hydrologic modeling early in the season may result in forecasts that differ significantly from actual conditions later in the conservation season. Since the plan calls for setting operational flow objectives at Salem beginning on 1 April based on a storage forecast for mid-May, flow objectives may need to be adjusted throughout the conservation release season. The availability of water will be re-assessed monthly (or as necessary) and related changes in management strategy will be made.

Adaptive management allows for spreading the risk of insufficient water among all authorized project purposes. Adaptive management is especially important during low water years to balance needs for flows during spring that support spawning and incubation of ESA-listed winter steelhead, needs for storage that provide flows during summer for water quality, and for fall spawning and incubation of ESA-listed Spring Chinook salmon.

8.0 Drought Management

8-01. Reservoir Regulation in Drought Conditions. Drought-related water management work is integrated within the overall USACE water management responsibilities and associated activities, which play a major role in characterizing drought conditions in the Willamette Basin. The Willamette Conservation Plan, consistent with the 2008 Biological Opinion, is the vehicle that sets the operational flow objectives in all water year conditions, including drought years. As drought conditions and priorities may vary from year to year, reservoir operational agreements will be made dependent upon the WCP and agreements made under the WATER forum and Flow Management Committee coordination, therefore a prescriptive procedure is not provided in this document. Operations in past drought years may provide an indication for operational strategies for future drought years. Operations used in past years is provided in the following paragraphs.

8-02. Flow Objectives in Past Drought Years. In previous years of extreme drought, interagency agreements resulted in minimum flow objectives at Salem that were less than the Congressional minimum flows at Albany and Salem of 6,500 cfs and 5,000 cfs, respectively. Tables 8-1 and 8-2 show the minimum flow objectives for Albany and Salem, respectively, in various drought years.

Table 8-1. Past Drought Year Interagency Minimum Flow Objectives, Albany

Period	Drought Years				
	1977	1987	1988-91	1992	2015
June	4,000	4,000	4,500	4,000	3,500
July 1-15	4,000	4,000	4,500	4,000	3,500
July 16-31	4,000	4,500	4,500	4,000	3,500
August 1-15	4,000	4,500	5,000	4,500	3,500
August 16-31	5,000	4,500	5,000	4,500	3,500
September	5,000	4,800	5,000	4,500	3,500

Table 8-2. Past Drought Year Interagency Minimum Flow Objectives, Salem

Period	Drought Years					
	1977	1987	1988-91	1992	2001	2015
June 1-15	5,000	5,000	6,000	5,500	11,000	5,000
June 16-30	5,000	5,000	6,000	5,500	5,500	5,000
July 1-15	5,000	5,000	6,000	5,500	5,000	5,000
July 16-31	5,000	5,500	6,000	5,500	5,000	5,000
August 1-15	5,000	5,500	6,000	5,500	5,000	5,000
August 16-31	6,000	5,500	6,500	5,500	5,000	5,000
September	7,000	7,000	7,000	6,000	5,000	5,000

8-03. Reservoir Regulations in Past Drought Years. The following is a description of reservoir operations and coordination used in recent low water years in the Willamette Basin in drought years.

a. Reducing Minimum Winter Flow. Refill of the reservoirs begins on 1 February. When the observed elevation was below an individual project’s rule curve and the forecast was for dry weather, the USACE requested a reduced minimum flow from NOAA Fisheries.

b. Winter Steelhead in the Santiam Basin. In the Santiam Basin, Big Cliff and Foster Dams released minimum flows of 1,500 cfs for winter steelhead spawning. The release periods are from 16 March through 15 May for Foster and from 16 March through 31 May for Big Cliff. During low water years (drought), discussions with NOAA Fisheries took place as modeling showed reservoir levels well below the rule curve. In past years, NOAA Fisheries has agreed to reduce spawning flows to about 1,200 cfs below Big Cliff and 1,100 cfs below Foster.

After steelhead spawning, the steelhead incubation period occurs. This incubation period occurs from 16 May through 30 June at Foster, and from 1 June through 15 July for Big Cliff. In the past, NOAA Fisheries had agreed to reduce incubation flows to be equal to the reduced spawning flows minus 200 cfs.

Rearing flows are maintained during the dry season. Past operations have met the minimum biological opinion rearing flows or released higher flows in order to meet mainstem flows. The ODFW and the NOAA Fisheries have supported steady tributary flows that draft the projects to minimum conservation pool by 1 October without maintaining the mainstem minimum flows.

c. Chinook Spawning in the Santiam Basin. Chinook spawning occurs from 1 September – 15 October. For Big Cliff and Foster Dams, even when pool levels were low, the fisheries agencies preferred to release spawning flows. Although the preference is to provide the spawning flow (1,500 cfs), flows have been reduced by 200-300 cfs, have begun later, or have been stepped-up from the summer flow to the spawning flow over a week.

By the end of spawning, in years of little precipitation and when projects were near or at minimum conservation pool, NOAA Fisheries had expressed a need to use power pool storage

and inactive pool storage to provide water for fish. Under this condition, major impacts could occur. Any use of power pool water must be discussed and agreed upon by the BPA.

d. Mainstem Flows. Projects outside of the Santiam Basin have operated to minimum flows. Fisheries agencies have agreed to reduce mainstem flows slightly after April 1. When the observed elevation was below an individual project's rule curve and the forecast was for dry weather, the USACE requested a reduced mainstem flow from NOAA Fisheries. NOAA Fisheries has agreed to lower flows in April and May for the Willamette River at Salem as well as a fixed release from the projects and the elimination of minimum flows for the months of June thru September. The amount that NOAA Fisheries has reduced the mainstem flow requirement has varied from year-to-year based on the extent to which the reservoirs have drafted below rule curve.

8-04. Determination of Interim Draft Limits. Reservoir-specific interim draft limits will be used to avoid over-draft of stored water during the early part of the flow management season. The interim draft limits conserve water in order to meet minimum tributary and mainstem flows later in the summer and early fall. Beginning in May, regulators can use a spreadsheet to back calculate, from October to May, the required storage in the reservoirs at month-end throughout the spring and summer to meet the 2008 Biological Opinion flow objectives at Salem and Albany through 31 October. Modeling may include the use of 90% exceedance inflows from the Period of Record data; however, users can test different levels of inflow and outflow to see resulting reservoir levels within the spreadsheet for a risk assessment.

8-05. Priorities. In both "insufficient" and "deficit" year cases, recreational use would be considered a low priority. Hydropower generation, irrigation, and other authorized uses will be met to the fullest extent possible through both discharges of reservoir inflows during spring and release of storage during summer and fall to meet mainstem flow management objectives. Priority will be given to those flow needs directly related to human health and safety. Reservoir inflow in excess of that needed to meet the mainstem operational flow objectives during spring will be stored in a manner that maximizes the likelihood of being able to meet minimum discharge rates, mainstem Willamette River flow objectives at Albany and Salem during June through October, and Willamette Basin hydropower production needs.

As of 2017, due to low level of use for water service contracts, the USACE does not make special operational adjustments, such as increasing flow releases, to meet contract requirements at most projects with the exception of Fern Ridge and Detroit. However, in "deficit" water years, the National Marine Fisheries Service's (NOAA Fisheries) Reasonable and Prudent Alternative (RPA) requires the Reclamation to curtail water contract diversions. In other years, the RPA requires the USACE to release more than minimum flow to ensure the contract users do not take water intended for fish purposes from Fern Ridge and Detroit. In "deficit" water years, a partial water supply or no water supply may be available to satisfy irrigation contracts. Water deliveries may be ceased or curtailed under these conditions, per RPA 3.4.

9.0. USACE's Emergency Navigation

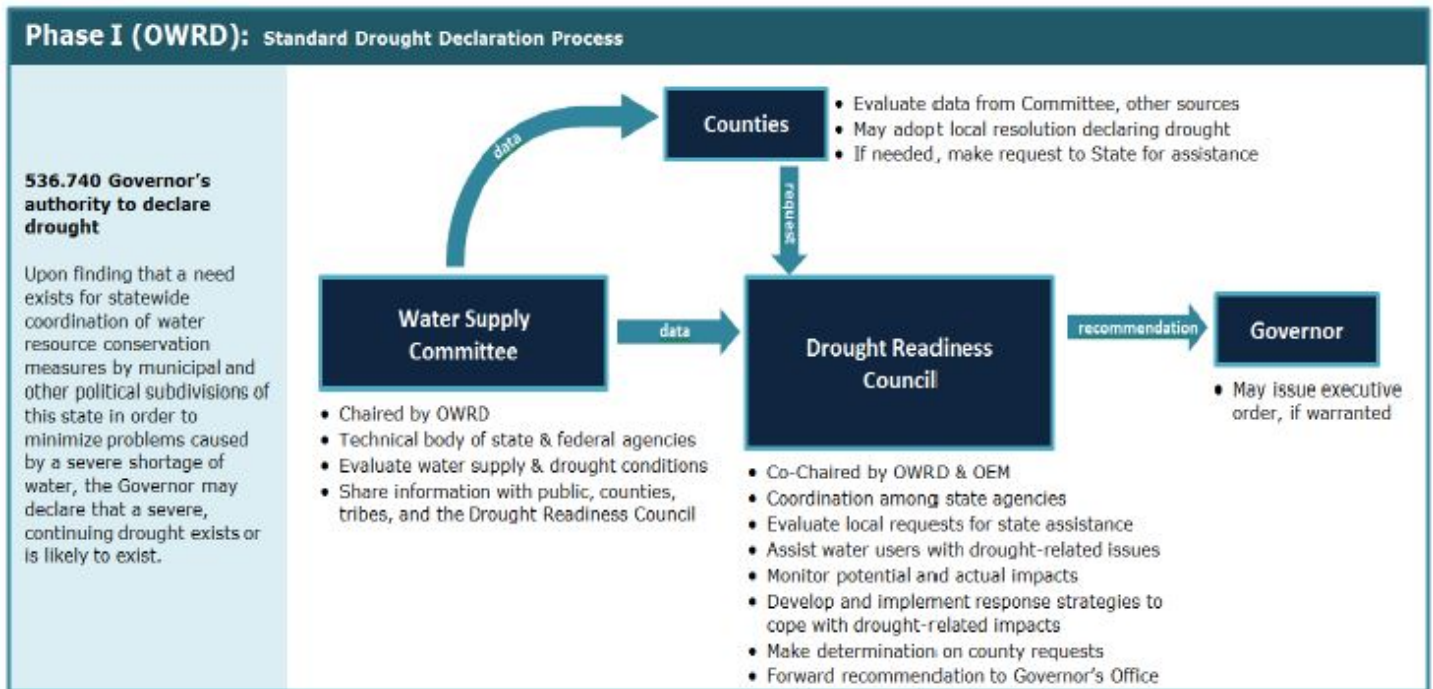
Although there is authorization for navigation in the mainstem Willamette River, there is currently little to no actual navigation for commercial purposes. There is no opportunity to move boats around the Willamette Falls at Oregon City except by trailer. Navigation did not seem to be an issue during the drought of 2001 or 2015. In December of 2011, the Willamette Falls Locks were placed in a non-operational status because of safety issues.

10.0 State of Oregon Drought Management

10-01. Authorities. The legal authorities for the State of Oregon's drought mitigation and response functions are found in ORS 536.700 - 536.780 and Oregon Administrative Rules (OAR) Chapter 690, Division 19. The Governor, through the request of a local jurisdiction, can declare an emergency under ORS 401.165. Under ORS 536.740, the Governor has authority to declare that a severe, continuing drought exists, or may exist, in any (or all) of the drainage basins in Oregon. Based on that declaration, the Governor or the Oregon Water Resources Commission can also direct state agencies and political subdivisions to implement a water conservation plan or water curtailment plan. Additionally, ORS 536.750 states that a drought declaration by the Governor allows the Water Resources Department to provide existing water right holders with access to temporary water management tools, described in OAR 690-019.

The Water Resources Commission is made up of seven members who represent different areas of the state. The commission is a citizen body that sets state water policy and oversees activities of the Water Resources Department. WRC meetings are held regularly at different locations around the state and is open to the public. The region areas in the Willamette Valley are the Northwest Region and the West Central Region.

10-02. Declaration of Drought. The declaration of drought in Oregon is performed by the Governor on a county-by-county or on a state-wide basis. The Governor's technical advisory group is the Oregon Drought Readiness Council (DRC) (see 10-02.a), and the interagency Water Supply Availability Committee (WSAC) (see 10-02.b) reports to the DRC. The two interagency groups evaluate water supply conditions and help assess and communicate potential drought related impacts. The State of Oregon's drought declaration process is shown on figure 10-1. A description of the DRC and WSAC and their activities are provided in the following sections, along with the State's drought strategy. The USACE does not make a declaration of drought conditions associated with its reservoirs in the Willamette Basin.



Source: Drought Annex, State of Oregon Emergency Operations Plan, January 2016.

Figure 10-1. Standard Drought Declaration Process

a. Drought Readiness Council. The DRC relies on information from the WSAC to assess how conditions may affect various sectors across the state, including instream and out-of-stream uses. The DRC reviews local requests for assistance and makes recommendations to the Governor regarding the need for state drought declarations. The DRC is responsible for ensuring coordination among state agencies and help water users access drought related information and assistance programs. The DRC consists of nine state agencies with natural resources management, public health, or emergency services expertise. Co-chairs of the Drought Readiness Council is the Administrator, Technical Services Division of the OWRD, and the Section Manager of the Office of Emergency Management.

b. Water Supply Availability Committee. The WSAC consists of ten state and federal science and emergency preparedness agencies that meet throughout the year to evaluate the potential for drought conditions. If drought is likely, monthly meetings occur shortly after release of the NRCS Water Supply Outlook reports to assess conditions. The WSAC communicates through the OWRD, the status of drought conditions to local, state, and tribal agencies. The WSAC is responsible for providing updates and reports on conditions to the Drought Readiness Council. As of 2016, the chair of the Water Supply Availability Committee is the Surface Water Hydrology Manager of the OWRD. The Chief of CENWP-EC-HR or designee represents the USACE on this committee.

10-03. Drought Strategies. Because of the 2015 drought, the Governor signed Executive Order 15-09, to direct state agencies to plan for resiliency to drought to meet the challenge that a changing climate brings. The document, *Report to the Governor Kate Brown, Implementation of Executive Order No. 15-09 Directing State Agencies to Plan for Resiliency to Drought*, dated 1 November 2015 (Report to the Governor) is in response to the Executive Order, and contains an overview of activities that Oregon's agencies, boards, and commissions are to do to prepare for and respond to drought now and in the future. The weblink for the Executive Order is provided in the Weblinks section of this document.

The Executive Order also directed the Office of Emergency Management and the Oregon Water Resources Department (OWRD) to update the *Drought Annex* to the State's *Emergency Operations Plan*. The *Drought Annex*, dated January 2016, was prepared by the Oregon Office of Emergency Management, OWRD. The purpose of the annex is to coordinate state and federal agency response to drought emergencies and to provide emergency water supplies for human consumption under conditions of inadequate supply. The annex outlines steps and lists responsibilities of various federal, state, and local jurisdictions. It also includes a description of federal drought assistance programs and guidelines for water curtailment planning and program development. The *Emergency Operations Plan* and the *Drought Annex* are provided in the Weblinks section of the document.

Two other state of Oregon strategies support the Drought Annex. The first, is the 2015 *Natural Hazards Mitigation Plan*, dated September 2015, which contains an up-to-date description of Oregon's natural hazards and their probability, the state's vulnerabilities, and its mitigation strategies and implementation capability. Cities and counties can use this information when preparing local natural hazard mitigation plans. The second, is the *Oregon's 2012 Integrated Water Resources Strategy*, dated August 2012. The purpose of the document is to describe the water needs of Oregon and to provide a strategy to meet those needs. The intent of the strategy is to provide a blueprint for future actions.

11.0 Coordination

11-01. USACE. The Chief, CENWP-EC-HR updates the Corporate Board (District Commander, Deputy District Engineer, and other CENWP Chiefs) of the drought situation, typically on a monthly basis. The reservoir regulation team, along with CENWD water management will meet at least weekly to discuss the drought situation, decisions to be made and the possible impacts of those decisions. Reports of the drought situation are prepared by the CENWP-EC-HR, and may be provided to USACE Headquarters (CECW-EC), through the CENWD. CENWP-EC-HR also reports to the Portland District Readiness Section (CENWP-OD-SE), who coordinates with the CENWD Regional Contingency Office (CENWD-RCO), for upward reporting to Head Quarters Emergency Management. The CENWP-EC-HR also coordinates with Portland District Public Affairs (CENWP-PA) to develop talking points for news releases and public inquiries (see section 12.0).

11-02. Regional. The USACE coordinates with the region on reservoir operations to meet the ESA and all other purposes of the Willamette Valley Project through the WATER

forum. WATER works as a collaborative regional forum among the sovereign governments (federal/state/tribal) with responsibility for assisting the federal Action Agencies (USACE, BPA, and Reclamation) in the coordinated implementation of the ESA and related measures. WATER is also responsible for making recommendations to the Action Agencies in implementing the Willamette Biological Opinions' RPA.

11-03. State of Oregon. The WSAC meets nearly monthly and discuss the status of water supply conditions across the state. The members of the WSAC are: NOAA, NRCS, Oregon Climate Change Research Institute, Oregon Department of Agriculture, Oregon Department of Forestry, Oregon Office of Emergency Management, Oregon Water Resources Department, USACE (CENWP-EC-HR), Reclamation, and the U.S. Geological Survey. The CENWP-EC-HR provides the status of the reservoirs and an assurance that project outflow will not be zero cfs, that in fact the rivers below USACE dams will still contain water. The Chief, CENWP-EC-HR coordinates with the State Engineer for the OWRD.

11-04. County Emergency Managers. The WSAC provides data to the counties and other sources. The counties may adopt a local resolution declaring a drought. If needed, counties make a request to the Drought Readiness Council for assistance. The Drought Readiness Council evaluates the local requests for assistance, and makes recommendations to the Governor, who in turn may make a request to the USACE for assistance.

12.0 Internal and External Communication

12-01. Congressional Briefs and Public Officials. The Deputy District Engineer for Program and Project Management (DDEPPM) meets with congressional representatives when requested. The Chiefs of CENWP-EC-H and CENWP-HR support the DDEPPM by providing technical information on specific questions they may have. Senior Management will maintain open communication with local officials and staff as needed, including the city and county commissioners and selected officials from the governor's office.

12-02. Public Communication. The CENWP-EC-HR coordinates with the CENWP-PA to provide the news media and the general public with water resources information related to the Willamette Valley Project, using a positive approach to deal with drought distress situations. The Willamette Valley Project staff and CENWP-EC-HR staff should attend watershed council meetings, chambers of commerce, and City Council meetings and civic organizations to help reinforce understanding of competing demands of authorized purposes on reservoirs. The CENWP-PA may attend public meetings and provide support to the Willamette Valley Project staff and CENWP-EC-HR by disseminating information through social media and by printing flyers and other materials. As required, news releases containing updated water resources facts concerning the drought, as they relate to USACE reservoir conditions, will be prepared and distributed by the CENWP-PA.

12-03. Internet. Reservoir levels, recreation updates, current issues, and other information will be posted on the District internet site. The internet is one of the District's most comprehensive public resources for information on USACE activities. The weblink for this information is provided in the Weblinks section of this document. In a drought year, the CENWP will create a public web page to share drought related information. Drought information include forecasts and impacts, current reservoir data, information on emergency water assistance, and links to State of Oregon and other federal agency websites. Current conditions related to drought is provided in the weblink in the Weblinks section of this document.

13.0 Emergency Assistance for Drought

The USACE authority for Drought Assistance is contained in section 6-5, Policy – Emergency Water Assistance Due to Drought, of Engineering Regulation 500-1-1, *Emergency Employment of Army and Other Resources, Civil Emergency Management Program*, dated 30 September, 2001. The Portland District, Business Operations Branch, Readiness Section (CENWP-OD-SE), is the point of contact for drought assistance.

The USACE is authorized to transport emergency supplies of clean drinking water for human consumption to any locality designated as a drought distressed area, and to construct wells in such drought distressed areas. Assistance will only be to meet minimum public health and welfare requirements. Assistance may be in the form of emergency supply of clean drinking water for human consumption, and construction of wells (at state/local expense) if not commercially possible. Water normally provided by tank trucks or small diameter pipelines. Beneficiaries are any locality faced with a threat to public health and welfare from a drought situation affecting the water system.

Application for program assistance to the CENWP must be initiated by the Governor or his/her authorized representative, but assistance is subject to approval at a higher level. The impacted area must be designated as a “drought distressed” area by Assistant Secretary of the Army for Civil Works. For other details on obtaining assistance during a drought, contact CENWP-OD-SE.

REFERENCES

NOAA's National Marine Fisheries Service, *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation, Consultation on the "Willamette River Basin Flood Control Project,"* 11 July 2008.

Oregon Office of Emergency Management, Oregon Water Resources Department, *Drought Annex, State of Oregon Emergency Operations Plan,* January 2016,

Oregon Partnership for Disaster Resilience for the State of Oregon, Oregon Emergency Management, *Natural Hazards Mitigation Plan, Drought Chapter,* February 2012,

Oregon Water Resources Department, *Water Rights in Oregon, An Introduction to Oregon's Water Laws,* November 2013.

Oregon Climate Change Research Institute, *Historical Trends and Future Projections of Climate and Streamflow in the Willamette Valley and Rogue River Basins,* June 2015 and revised March 3, 2016.

Pinson, A., A. Jordan, B. Baker, K. D. White, R. Vermeeren, and K. Fagot (2015), *USACE Drought Contingency Planning in the Context of Climate Change,* Civil Works Technical Report, CWTS 15-15, US Army Corps of Engineers: Washington, DC, September 2015.

U.S. Army Corps of Engineers, *2011 USACE Climate Change Adaptation Plans and Report,* dated September 2011.

U.S. Army Corps of Engineers, *2012 USACE Climate Change Adaptation Plans and Report,* dated June 2012.

U.S. Fish and Wildlife Service and Oregon Fish and Wildlife Office, *Final Biological Opinion on the Willamette River Basin Flood Control Project, Biological Opinion on the Continued Operation and Maintenance of the Willamette Basin River Project and Effects to Oregon Chub, Bull Trout and Bull Trout Critical Habitat Designated Under the Endangered Species Act,* 11 July 2008.

WEBLINKS (as of May 2017)

NOAA's Climate Prediction Center ENSO status:

http://www.cpc.ncep.noaa.gov/products/expert_assessment/ENSO_DD_archive.shtml

Drought Monitor Update Report for Oregon:

<http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?OR>

NRCS Oregon Snow Survey Reports: <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/snow/>

Oregon Water Supply Outlook Reports:

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/snow/waterproducts/?cid=nrcs142p2_048083

Oregon Surface Water Supply Index (SWSI):

<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/snow/waterproducts/?cid=stelprdb1244919>

CWTS Report 15-15: <http://www.corpsclimate.us/ccaupddr.cfm>.

The State of Oregon's Governor Executive Order:

http://www.oregon.gov/owrd/pages/wr/drought.aspx#Implementing_the_Drought_Executive_Order.

State of Oregon's Emergency Operations Plan and the Drought Annex:

http://www.oregon.gov/OMD/OEM/Pages/plans_train/EOP.aspx.

Portland District internet site: <http://www.nwp.usace.army.mil/>

Portland District current conditions related to drought:

<http://www.nwp.usace.army.mil/Missions/Water/Drought>.

Reservoir storage capacity tables:

<http://wmlocal.nwd.usace.army.mil/nwp/ratings/www/index.html>

Attachment 1

USACE-City Agreement Template Temporary Withdrawal of Water

AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
[CITY]
FOR
TEMPORARY WITHDRAWAL OF WATER
FROM
[RESERVOIR], [STATE]
PURSUANT TO
SECTION 6 OF THE FLOOD CONTROL ACT OF 1944

THIS AGREEMENT, entered into this ____ day of MONTH, YEAR, by and between the DEPARTMENT OF THE ARMY (hereinafter called the "Government") represented by the District Engineer executing this Agreement, and CITY, (hereinafter called the "User"*);

WITNESSETH THAT:

WHEREAS, pursuant to the Flood Control Acts of 1938 (Public Law 75-761) and 1950 (Public Law 81-516), the Government has constructed and is operating [Project] on the [waterway], (hereinafter called the "Project"); and

WHEREAS, Section 6 of the Flood Control Act of 1944 (Public Law 78-534), as amended (33 U.S.C. 708), provides that the Secretary of the Army is authorized to enter into agreements with states, municipalities, private concerns, or individuals, at such prices and on such terms as the Secretary may deem reasonable, for domestic and industrial uses for surplus water that may be available at any reservoir under the Secretary's control provided that no agreements for such water shall adversely affect the existing lawful uses of such water; and

WHEREAS, pursuant to Section 6 of the Flood Control Act of 1944, as amended, the Government has determined that up to [volume] acre-feet of storage, as described in the [supporting document] (hereinafter called the "Report"), approved [date], is available at the Project as surplus water for municipal and industrial use, as the withdrawal of such amount will not interfere with Project purposes, nor adversely affect the existing lawful uses of water from the Project; and

WHEREAS, the User desires to enter into an agreement with the Government for the withdrawal of up to [volume] acre-feet of surplus water downstream from the Project for municipal purposes; and

WHEREAS, the User, as shown in Exhibit "A", attached to and made a part of this Agreement, is empowered to enter into an agreement with the Government and is vested with all necessary powers of accomplishment of the purposes of this Agreement.

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

ARTICLE 1 - Withdrawal of Surplus Water

a. The Government grants the User the right to withdraw water from the Project, or request releases to be made by the Government through the outlet works of the Project, for municipal use, subject to the User's compliance with its responsibility for water rights as set out in Article 3 of this Agreement.

The rate of such withdrawal shall not exceed [rate], and the volume shall not to exceed [volume] acre-feet per year, during the term of this Agreement as specified in Article 5 hereof.

b. The User's rights under this Agreement are subject to the Government's control and use of any or all storage in the Project to fulfill the authorized purposes of the Project. In the event that the Government determines that withdrawals of any or all of the surplus water identified in the Report are resulting in unexpected adverse impacts to other Project purposes or operations, the User shall immediately suspend withdrawals.

c. The Government further reserves the right to take such measures as it determines in its sole discretion to be necessary to inspect, operate, maintain, and repair the Project, including taking any and all measures necessary to protect life and property.

d. The water which may be available for withdrawal by the User pursuant to this Agreement is raw water only. The Government makes no representation with respect to the quality of water which may be available and assumes no responsibility therefore, or for treatment of the water.

e. The Government makes no guarantee with respect to the availability of 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 Agreement shall not be construed as giving the User any rights to have the water level maintained at any elevation.

ARTICLE 2 – Metering and Recordkeeping

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 District Engineer, without cost to the Government. Such devices shall be available for inspection by Government representatives at all reasonable times. The User agrees to furnish to the District Engineer: (i) advance estimates of need; and (ii) records of the quantity of water actually withdrawn as requested by the District Engineer, but in any event no less frequently than once a year.

ARTICLE 3 - Regulation of and Right to the Use of Water

The regulation of the use of water withdrawn or released from the storage space under this Agreement shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with applicable law, and if necessary to establish or defend, any and all water rights needed for the water withdrawn or released from the Project under this Agreement. 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 4 - Consideration and Payment

a. In consideration of the right to withdraw [volume] acre-feet between [timeframe] per year for a period not to exceed five (5) years from the Project for municipal and industrial water supply purposes, the User shall pay the Government \$[capital cost] per year in capital costs, the first of which shall be due and payable within thirty (30) days of the effective date of the Agreement as set forth in Article 5 herein. In addition to the annual capital cost payment, the User shall be responsible for a share of the Operations and Maintenance (O&M) costs of the Project. The first payment will be for \$[O&M cost] and is due within thirty (30) days of the effective date of the Agreement. Future capital and O&M payments thereafter will be due and payable on the anniversary date the first payment is due.

b. The repayment amount shown in Article 4(a) is based upon joint use and specific water supply construction costs updated to [month year] price levels using appropriate indices and the Fiscal Year [FY] water supply interest rate of [interest rate] 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 Agreement within thirty (30) days of the date due, the delinquent payment shall be charged interest at the Current Value of Funds Rate, as determined by the Secretary of the Treasury that is applicable on the date that the payment became delinquent, with such penalty interest as may be required by Federal law or regulation. 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 Agreement for default.

ARTICLE 5 - Duration of Agreement

This agreement shall become effective upon the date it is signed by the Government, and shall continue in full force and effect under the conditions set forth herein for a period of not to exceed five (5) years from the said date of approval. Upon expiration, this agreement may be extended by mutual agreement for additional periods of not to exceed five (5) years each. All such agreement extensions shall be subject to recalculation of reimbursement. Nothing in this agreement, nor in any extension thereto, shall imply a permanent right to utilize the storage space.

ARTICLE 6 - Termination of Agreement

a. The User may terminate the Agreement upon fourteen (14) days written notice.

b. The Government may terminate this Agreement upon thirty (30) days written notice in the event the Government determines that withdrawals of any or all of the surplus water identified in the Report are resulting in unexpected adverse impacts to other Project purposes or operations.

c. The Government may terminate this Agreement and the User's right to withdraw water upon thirty (30) days written notice if the User shall default in performance of any obligation of this Agreement. Upon such a termination, the User shall continue to be liable to the Government for any monies owed and for any costs incurred by the Government as a result of the default.

d. In the event of any termination pursuant to this Article or Article 5, User shall, upon request of the Government, promptly remove, at User's expense, any facilities constructed on Project land for water withdrawal and restore premises around the removed facilities to a condition satisfactory to the Government.

e. Not later than ten (10) calendar days from the date of the written notice to terminate, the Government shall commence a final accounting of the financial obligations of the User under Article 4.a. of this Agreement. The results of the final accounting will be furnished by written notice to the User.

(i) Should the final accounting show that the User owes the Government further payment under this Agreement, the User, not later than ninety (90) calendar days after receipt of the written notice from the Government, shall provide the Government with the full amount by delivering a check payable to "FAO. USAED, Portland" to the District Engineer, or by providing an Electronic Funds Transfer of the required funds in accordance with procedures established by the Government.

(ii) Should the final accounting show that the amount of funds provided by the User exceeds its financial obligations under this Agreement, the Government, subject to the availability of funds, shall refund the excess amount to the User within ninety (90) calendar days of the date of completion of the final accounting, or if funds are not available, shall seek such appropriations as are necessary to make the refund.

ARTICLE 7 - Rights-of-Way

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.

ARTICLE 8 - Release of Claims

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 pursuant to the terms of the Agreement, 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.

ARTICLE 9 - Transfer or Assignment

The User shall not transfer or assign this Agreement nor any rights acquired thereunder, nor grant any interest, privilege or license whatsoever in connection with this Agreement, without the approval of the Secretary of the Army or his duly authorized representative, provided that this restriction shall not be construed to apply to any water withdrawn or obtained from the Project and furnished by the User to any third party or parties, or to the rates charged therefor.

ARTICLE 10 - Officials Not to Benefit

No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this Agreement if made with a corporation for its general benefit.

ARTICLE 11 - Covenant Against Contingent Fees

The User warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies 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 Agreement without liability, or in its discretion, to add to the Agreement price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 12 - 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 13 - Civil Rights Assurance and Certification Regarding Lobbying

a. The User furnishes, as part of the Agreement, an assurance (Exhibit C) that it 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 195 of Title 32, Code of Federal Regulations.

b. The user furnishes, as part of this Agreement, a certification (Exhibit D) that no appropriated funds have been paid or will be paid to an officer or employee of a Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the execution of this Agreement; and that any funds other than appropriated funds that have been paid or will be paid to such persons will be disclosed on the appropriate form.

ARTICLE 14 - Approval of Agreement

This Agreement 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 Agreement as of the day and year first above written.

FOR THE DEPARTMENT OF THE ARMY

FOR THE [CITY]

By _____

[Commander]
Colonel, U.S. Army
District Engineer
U.S. Army Engineer District
Portland, Oregon

By _____

[name of signatory]
[position or title]

DATE: _____

DATE: _____

EXHIBIT A: CERTIFICATION

I _____, Attorney for the [ENTITY], have reviewed the foregoing agreement executed by _____ and, as principal legal officer for the [ENTITY], certify that the [ENTITY] is legally and financially capable of entering into the contractual obligations contained in the foregoing agreement and that, upon acceptance by the Department of the Army, it will be legally enforceable.

Given under my hand, this _____ day of _____ [YEAR].

Attorney for [ENTITY]

EXHIBIT B

The cost charged to the user for [volume] acre-feet of storage for five years is \$[total cost], plus an annual O&M fee. For a surplus water supply agreement, the user will pay the annual fees as listed in the table below.

**TOTAL ANNUAL COST TO USER
FOR SURPLUS WATER SUPPLY STORAGE**

Item	Type of Use	Computation	Cost
Interest and amortization	Annual cost of storage space	\$[cost per acre-foot] x [acre-feet], (based on 30 year repayment plan) and 5 payments at interest rate of [interest rate]%. []% ² x \$[total joint-use O&M for previous FY]	\$[total cost]
Operation and maintenance ¹	Joint-use actual for FY [previous FY]		\$[share of O&M]
Repair, rehabilitation and replacement ³	Joint-use actual for FY [previous FY]		\$[share of RR&R]

Notes:

1 Payment due and payable on the date specified in Article 4(a).

2 Percent of Users share of the Usable storage space in the project.

3 Repair, rehabilitation and replacement costs are payable only when incurred as specified in Article 5(b).

EXHIBIT C: ASSURANCE OF COMPLIANCE

ASSURANCE OF COMPLIANCE WITH THE DEPARTMENT OF DEFENSE DIRECTIVE UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964, AS AMENDED; THE AGE DISCRIMINATION ACT OF 1975; AND THE REHABILITATION ACT OF 1973, AS AMENDED

The party executing this assurance, being the applicant recipient of Federal financial assistance under the instrument to which this assurance is attached hereby agrees that, as a part of its obligations under the aforesaid instrument, it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), as amended (42 U.S.C. 2000d), and all requirements imposed by or pursuant to the Directive of the Department of Defense (32 CFR Part 195), issued as Department of Defense Directive 5500.11 pursuant to that title; The Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), to the end that in accordance with the aforementioned Title, Directive and Acts, no person in the United States shall on the ground of race, color, age, sex, religion, handicap or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant-Recipient receives Federal financial assistance from the Department of the Army and gives assurances that it will immediately take any measures necessary to effectuate this agreement.

If any personal property or real property, or interest therein, or structure thereon is provided or improved with the aid of Federal financial assistance extended to the applicant-recipient by the Department of the Army, or if such assistance is in the form of personal property or real property, or interest therein or structure thereon, then this assurance shall obligate the applicant-recipient or in the case of any transfer of such property, any transferee, for the period during which the property is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits, or for the period during which it retains ownership or possession of the property whichever is longer. In all other cases, this assurance shall obligate the applicant-recipient for the period during which the Federal financial assistance is extended to it by the Department of the Army. The Department of the Army representatives will be allowed to visit the recipient's facilities. They will inspect the facilities to ensure that there are no barriers to impede the handicap's accessibility in either programs or activities.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the applicant-recipient by the Department of the Army, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The applicant-recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the applicant-recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the applicant.

Date _____

By _____

[position/title]

[entity]

Mailing Address:

[]

EXHIBIT D: CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

[position/title]
[entity]

DATE: _____