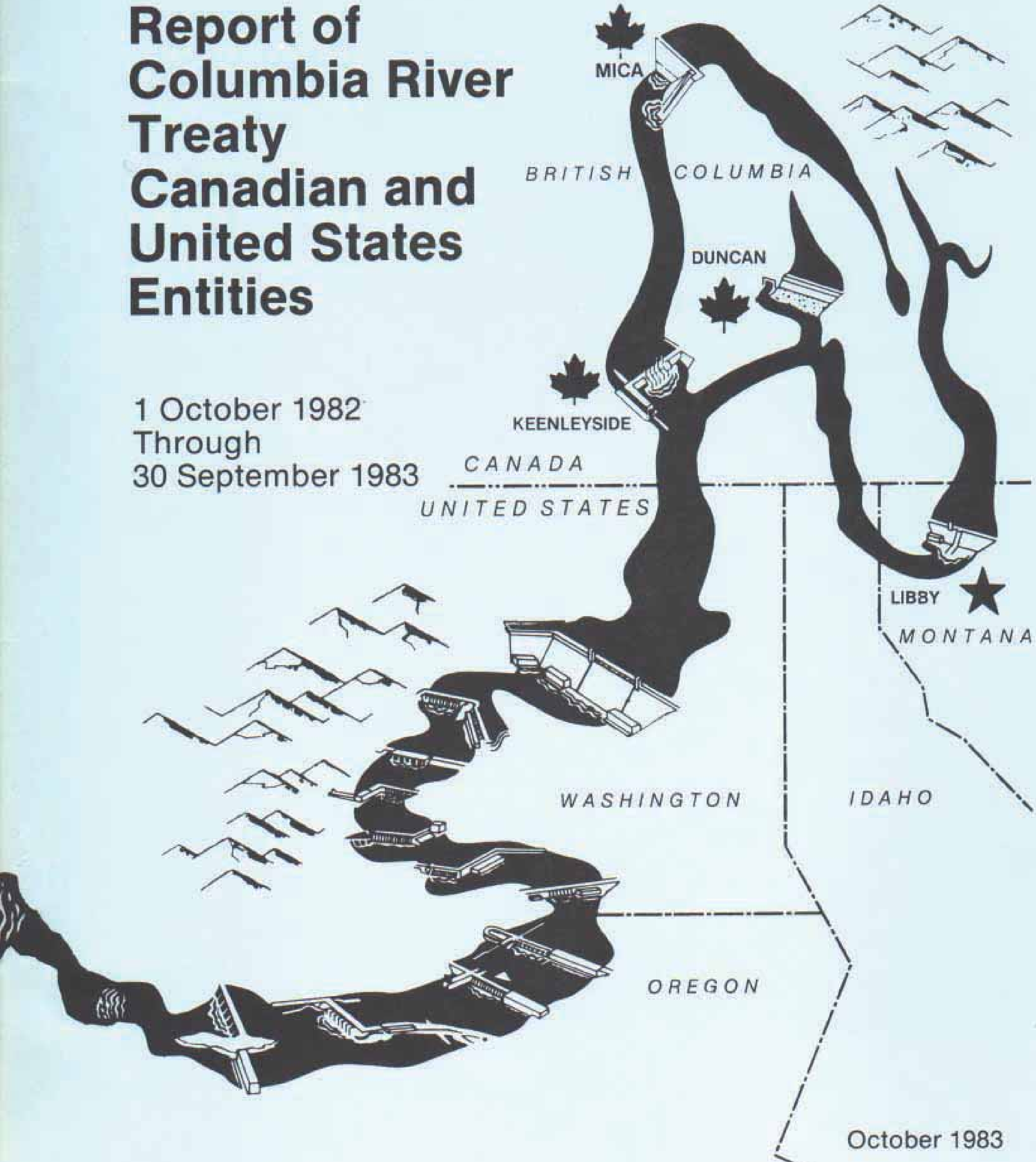
Report of Columbia River Treaty Canadian and United States Entities

1 October 1982
Through
30 September 1983



October 1983

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INTRODUCTION

This report describes the activities of the Canadian and United States Entities during the period 1 October 1982 through 30 September 1983 in discharging their responsibilities for formulating and carrying out operating arrangements necessary to implement the Columbia River Treaty. It is the seventeenth of a series covering the period since the ratification of the Columbia River Treaty in September 1964.

ORGANIZATION AND MEETINGS.

The names of the members and representatives of the two Entities during the reporting period are shown in Appendix A. There was one meeting of the Entities and one meeting of the Canadian Entity representative and U. S. Coordinators during the year.

The two international committees, listed in Appendix B, met as required throughout the reporting period to direct and coordinate Treaty storage operations and studies with the support of the staffs of B. C. Hydro, Bonneville Power Administration (BPA), and the U. S. Army Corps of Engineers, North Pacific Division (Corps).

COLUMBIA STORAGE OPERATION.

Operating Arrangements

During the period covered by this report, Duncan, Arrow, Mica, and Libby reservoirs were operated in accordance with the Columbia River Treaty for power and flood control.

The Canadian entitlement to downstream power benefits from Duncan, Arrow, and Mica for the 1982-83 operating year had been purchased in 1964 by the Columbia Storage Power Exchange. In accordance with the Canadian Entitlement Exchange Agreements dated 13 August 1964, the United States Entity delivered capacity and energy to the CSPE participants.

The operation of the storages was generally in accordance with:

(a) "Columbia River Treaty Hydroelectric Operating plan - Assured Operating Plan for Operating Year 1982-83," dated September 1977.

(b) "Detailed Operating Plan for Columbia River Treaty Storage - 1 August 1982 through 31 July 1983," dated September 1982.

(c) "Columbia River Treaty Flood Control Operating Plan," dated October 1972.

Consistent with all Detailed Operating Plans prepared since the installation of generation at Mica, the 1982-83 Detailed Operating Plan was designed to achieve optimum power generation at-site in Canada and downstream in Canada and the United States, in accordance with paragraph 7 of Annex A of the Treaty. The 1982-83 Assured Operating Plan prepared six years ago, was used as the basis for the preparation of the 1982-83 Detailed Operating Plan.

For each operating year, the determination of downstream power benefits is made five years in advance in conjunction with the Assured Operating Plan. For operating years 1982-83 and 1983-84, the estimates of benefits resulting from operating plans designed to achieve optimum operation in both countries were less than that which would have prevailed from an optimum operation in the United States only. The reduction in usable energy is 5.5 average annual megawatts of usable energy in 1982-83, 5.0 in 1983-84, and no reduction in dependable capacity in either year.

In accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement, the Entities agreed that the United States is entitled to receive 5.5 average megawatts of energy during the period 1 August 1982 through 31 March 1983 and five average megawatts of energy during the period from 1 April through 31 July 1983. Suitable arrangements have been made between the Bonneville Power Administration and B. C. Hydro for delivery of this energy.

Attached to this report in Appendix D is the "Report on Operation of Columbia River Treaty Projects - 1 August 1982 through 31 July 1983 dated October 1983." Appendix D reports in detail on the runoff conditions prevailing and on the operation of the Treaty storages for the first 10 months of the 12 month period of this report.

A brief summary follows of the Columbia River Treaty operation of the Mica, Arrow, Duncan, and Libby reservoirs during the period 1 October 1982 to 30 September 1983.

General

The Coordinated System reservoirs started the 1982-83 operating year with full reservoirs. Decreased load growth due to the economic recession gave BPA a firm power surplus. Above average streamflows from August through October allowed BPA to meet interruptible industrial loads and to market non-firm energy to the Pacific Southwest utilities from August through December.

A pattern of below average streamflow on the upper Columbia and Kootenay rivers began in November and was to continue through most of the operating year. Flows in the Columbia River at The Dalles were above average in all but two months of the year, with the August 1982 - July 1983 volume 16% above average. During this period BPA sold 17.1 billion kilowatt-hours of non-firm energy to the Pacific Southwest.

Canadian storage was on flood control operation during late February and March to assist in limiting river levels near Portland to just below flood stage.

Operation of U. S. reservoirs to meet minimum flows for the downstream migration of anadromous fish began April 22. Above average flows on the mid-Columbia and flows well above average on the Snake River enabled fishery goals to be met with minor impact on reservoir regulation.

Record high precipitation on the upper-Columbia during July helped bring the April through August runoff volume at Canadian reservoirs to slightly above average. All Coordinated System reservoirs were approximately full on 31 July 1983.

MICA RESERVOIR

Mica began the 1982-83 operating year with its Treaty storage full at elevation 2470.4 feet on 30 July 1982. The project continued to fill to elevation 2472.4 feet in early August to prevent the flow at Revelstoke from exceeding 75,000 cfs, which would cause problems at the Revelstoke Dam construction site. The reservoir was then gradually drawn down to its normal full pool elevation and on 30 September the reservoir was at elevation 2470.8 feet.

Inflow into Mica reservoir began to recede in October and storage draft commenced. By 15 December Mica had been drafted to elevation 2462.0 feet. Generation was curtailed from 16 December 1982 through 13 January 1983 due to reduced B.C. Hydro system load and higher generation at the Peace River plants due to ice problems. The project continued to draft from January through April 1983 and on 29 April it was at elevation 2415.0 feet, its lowest level for the year.

The project began to fill in May as Mica outflows were reduced to between zero and 15,000 cfs. The reservoir inflow peaked at 112,630 cfs on 12 July, slightly lower than the previous one-day record of 126,000 cfs which occurred in 1972. Project discharges were controlled to prevent overtopping of the cofferdam at the Revelstoke Dam construction site and to enable debris that had broken through an upstream boom to be removed from the diversion tunnel area.

During the period from 15 July to 24 July, 84,270 sfd was stored in the Mica reservoir pursuant to a storage agreement between B.C. Hydro and BPA. The Mica reservoir was filled to elevation 2472.0 feet on 25 July 1983 and remained between elevations 2472.0 feet and 2474.0 feet through August and September. On 30 September the reservoir was at 2472.0 feet.

ARROW RESERVOIR

The Arrow reservoir began the operating year with full Treaty storage. During August 1982, as Mica reservoir was surcharged to elevation 2472 feet, Arrow reservoir was drafted to elevation 1442.7 feet. By 30 September the reservoir had been refilled to elevation 1443.7 feet.

Draft for flood control began in late October, and by 31 December the reservoir was at elevation 1432.2 feet. Due to reduced transmission capacity in the U.S. system and high winter runoff, B.C. Hydro provided temporary storage in non-Treaty storage space in Arrow reservoir during late 1982. By 31 December a total of 121,400 sfd had been retained and this storage was returned to BPA by 15 January 1983.

On 22 February the Corps initiated flood control operation for a short period due to high flows approaching flood stage in the lower Columbia River. The reservoir reached its lowest elevation of the year, 1400.0 feet on 18 April.

The reservoir was held at about elevation 1402 feet until mid-May, and by mid-June it was at elevation 1430 feet. The Treaty storage space at Arrow was full by 16 July 1983, and pursuant to a storage agreement between B.C. Hydro and BPA, water was stored to elevation 1446.0 feet by 19 July. The reservoir was held above elevation 1444.0 feet during the summer, and on 30 September was at elevation 1446.0 feet.

DUNCAN RESERVOIR

Duncan started the operating year with a full reservoir, and on 30 September it was still full at elevation 1892.0 feet.

The project remained full until 20 November. Discharges were then gradually increased to 6,000 cfs. These discharges continued through most of December and by 31 December the reservoir was drawn down to elevation 1868.1 feet.

With discharges of between 6,500 cfs and 10,000 cfs during January and February, Duncan continued to be drafted to meet flood control requirements. On 28 February, Duncan reservoir was near elevation 1817.0 feet, and it remained at about that elevation until 8 April. It was then drafted further and reached its lowest level of 1812.5 feet on 26 April.

The project outflow was reduced to 1,000 cfs on 15 May 1983 and the Duncan reservoir began to fill. The reservoir refilled to elevation 1892.0 feet by 24 July and remained close to full through August and September. On 30 September the reservoir was at 1891.6 feet.

LIBBY RESERVOIR

The Libby reservoir was full at the start of the operating year and was held full during August and September. On 30 September 1982 the reservoir was at elevation 2457.9 feet.

High reservoir releases resulted in a draft of Lake Koocanusa in October. The draft was accelerated in November and continued through January. The lowest elevation for the year was 2348.3 feet on 15 April.

Inflows began increasing in late April and the seasonal peak was reached on 31 May. The Libby reservoir reached elevation 2458.5 feet by 22 July and was full at elevation 2459.0 feet on 14 August. It remained at approximately this elevation through August and on 30 September 1983 was at 2453.2 feet.

COMMITTEE ACTIVITIES

HYDROMETEOROLOGICAL COMMITTEE

The Hydrometeorological Committee met twice during the year. The main topics discussed at the meetings were:

(i) status of data exchange and plans for developing a new data exchange agreement in light of newly automated hydromet facilities;

(ii) various operational problems such as reliability of snowpillow data, updating of hydromet data files, backwater effects on some Columbia River streamgauges in Canada, implementation of satellite telemetry and real-time reporting of major rainstorms;

(iii) finalization of Columbia River Treaty Hydrometeorological Committee Documents, reflecting automation of hydromet networks and data management and exchange systems;

(iv) verification of seasonal runoff volume forecasts for 1983 and change-over to a 20 year reference period in 1984.

Hydromet Communications and Data Management System

The Columbia Basin teletype network was upgraded during the year through use of solid state terminals and a higher transmission speed. The new network is used for real-time data exchange in the United States and it operates as an extension of the Columbia River Operational Hydromet System in Portland.

B.C. Hydro's distributed processor (VAX) at the System Control Center on Burnaby Mountain has been linked by a permanent two-way BPA/BCH microwave channel to the Columbia River Operational Hydromet System, permitting near real-time exchange of hydromet and operating data between the Entities.

Hydromet Network Automation.

The hydromet network in the Canadian portion of the Columbia River Basin is expected to be fully automated by October 1984. Manual station interrogation is being phased out, and replaced by automated microwave telemetry or satellite telemetry.

Hydrometeorological Committee Documents

The "Columbia River Treaty Hydrometeorological Committee Documents" have been updated and it is expected they will be issued in final form in October 1983. The United States Section will maintain the listing of hydromet network facilities in both countries and arrange for printing of the document. Details regarding exchange of data are included in the listing.

Seasonal Runoff Volume Forecasting

The 15 year reference period used in seasonal runoff volume forecasting will be changed to a 20 year reference period starting with the 1984 runoff season. The new period will use records from 1961 through 1980. The 1983 volume forecast was reviewed. The 1 April forecast of runoff at The Dalles was 121.0 maf, and the actual runoff was 118.7 maf.

OPERATING COMMITTEE

The Operating Committee coordinated the operation of the Treaty storage in accordance with the current hydroelectric and flood control operating plans. This aspect of the Committee's work is described in Appendix D, "Report on Operation of Columbia River Treaty Projects - 1 August 1982 through 31 July 1983."

The Committee prepared the Entity agreements listed in Appendix C and developed Operating Plans and Downstream Power Benefits for the subsequent operating years.

The Committee assured that the implementation of the two short term non-Treaty storage agreements, signed by the Entities on 9 June 1983 and 21 September 1983, were consistent with the Operating Plans.

The Committee began an analysis of the impact on Treaty Operating Plans and downstream benefits due to the proposed use of the Northwest Power Planning Council's Fish and Wildlife Program "water budget" flows.

COOPERATION WITH PERMANENT ENGINEERING BOARD.

The Entities continued their cooperation with the Permanent Engineering Board in the discharge of its functions and a joint meeting of the Permanent Engineering Board and the Entities was held on 3 December 1982 in Vancouver, B.C.

Copies of the agreements listed in Appendix C were sent to the Board.

APPENDIX A

COLUMBIA RIVER TREATY ENTITIES

CANADA

ROBERT W. BONNER

CHAIRMAN

Chairman

B. C. Hydro

Vancouver, B. C.

UNITED STATES OF AMERICA

PETER T. JOHNSON

CHAIRMAN

Administrator

Bonneville Power Administration

Department of Energy

Portland, Oregon

BRIGADIER GENERAL JAMES W. VAN LOBEN SELS

Division Engineer

North Pacific Division

U. S. Army Corps of Engineers

Portland, Oregon

Canadian Entity Representative

D. B. FORREST

Manager

Canadian Entity Services

B. C. Hydro

Vancouver, B. C.

United States Entity Coordinators

EDWARD W. SIENKIEWICZ, COORDINATOR

Asst. Administrator for Power & Resources Management

Bonneville Power Administration

Portland, Oregon

HERBERT H. KENNON, COORDINATOR

Chief, Engineering Division

North Pacific Division

U. S. Army Corps of Engineers

Portland, Oregon

JOHN M. HYDE, SECRETARY 1/

Bonneville Power Administration

Portland, Oregon

1/ Succeeded C. E. Cancilla 6 March 1983

APPENDIX B

COLUMBIA RIVER TREATY

OPERATING COMMITTEE

Canadian Section	United States Section
T. J. NEWTON Chairman	L. A. DEAN (BPA) Co-Chairman
R. D. LEGGE	N. A. DODGE, (USCE) Co-Chairman
K. R. SPAFFORD	J. M. HYDE (BPA) 1/
W. N. TIVY	G. G. GREEN (USCE)

HYDROMETEOROLOGICAL COMMITTEE

Canadian Section	United States Section
U. SPORNS Chairman	D. D. SPEERS (USCE) Co-Chairman
J. R. GORDON	R. G. HEARN (BPA) Co-Chairman

All Canadian committee members represent British Columbia Hydro. United States committee members represent either the United States Army Corps of Engineers, or Bonneville Power Administration.

1/ Succeeded C. E. Cancilla 6 March 1983.

APPENDIX C

COLUMBIA RIVER TREATY

OFFICIAL AGREEMENTS OF THE ENTITIES

Description	Date Agreement Signed by Entities
Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1987-88, dated September 1982.	12 November 1982
Determination of Downstream Power Benefits resulting from Canadian Storage for Operating Year 1987-88, dated September 1982.	12 November 1982
Detailed Operating Plan for Columbia River Treaty Storage, 1 August 1982 through 31 July 1983, dated September 1982.	12 November 1982
Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans, dated May 1983	29 September 1983

APPENDIX D

REPORT ON
OPERATION OF COLUMBIA RIVER
TREATY PROJECTS

1 AUGUST 1982 through 31 JULY 1983

REPORT ON
OPERATION OF COLUMBIA RIVER
TREATY PROJECTS

1 AUGUST 1982 through 31 JULY 1983

COLUMBIA RIVER TREATY OPERATING COMMITTEE

N. A. Dodge
Corps of Engineers
Co-Chairman, U. S. Section

L. A. Dean
Bonneville Power Administration
Co-Chairman, U. S. Section

G. G. Green
Corps of Engineers
Member, U. S. Section

J. M. Hyde
Bonneville Power Administration
Member, U. S. Section

T. J. Newton
B. C. Hydro and Power Authority
Chairman, Canadian Section

R. D. Legge
B. C. Hydro and Power Authority
Member, Canadian Section

K. R. Spafford
B. C. Hydro and Power Authority
Member, Canadian Section

W. N. Tivy
B. C. Hydro and Power Authority
Member, Canadian Section

REPORT ON

OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1982 THROUGH 31 JULY 1983

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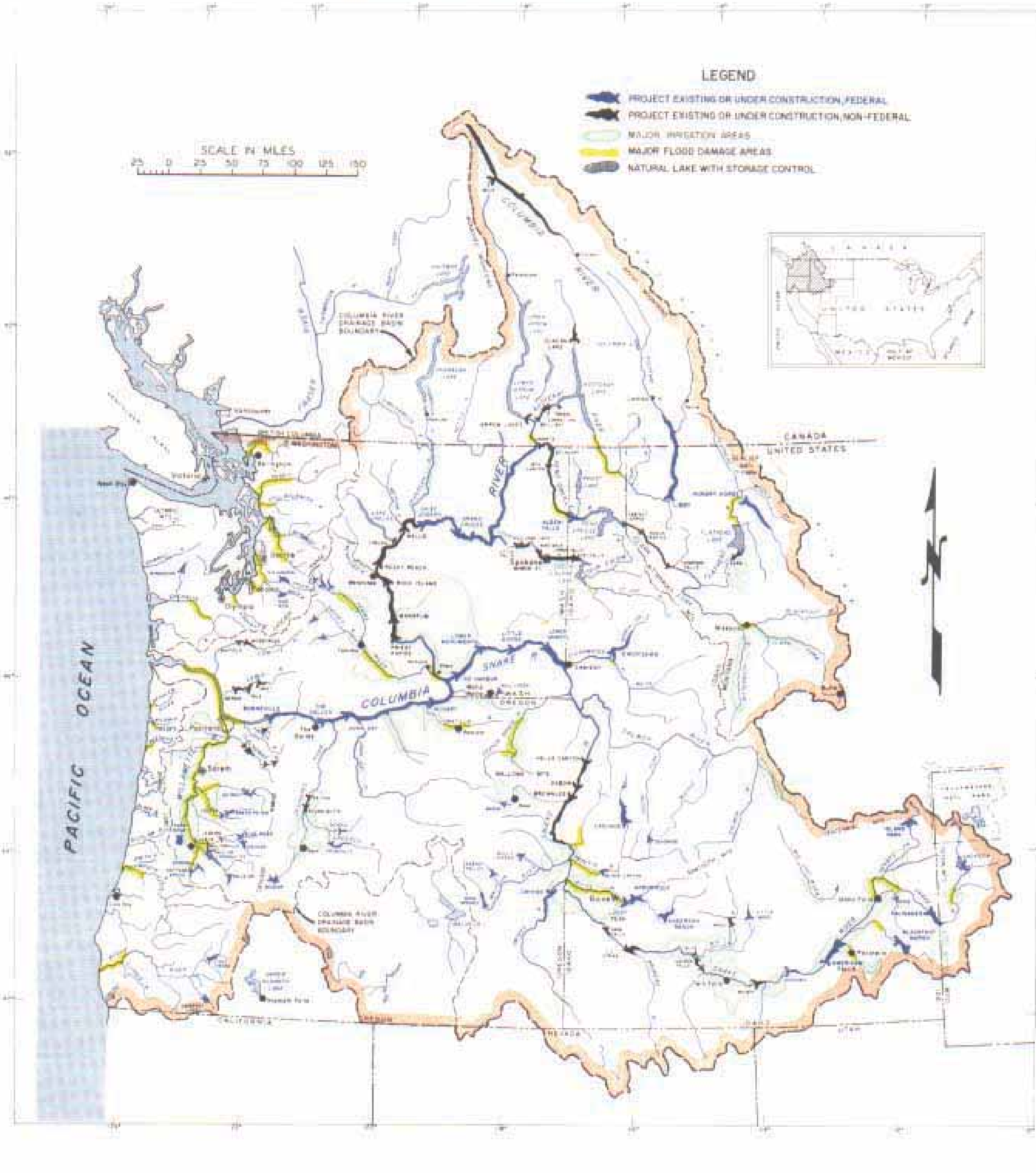
COLUMBIA RIVER AND COASTAL BASINS



REPORT ON

OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1982 THROUGH 31 JULY 1983

I. INTRODUCTION

A. AUTHORITY

Duncan, Arrow, and Mica reservoirs in Canada and Libby reservoir in the United States of America were constructed under the provisions of the Columbia River Treaty of January 1961. Treaty storage in Canada is required to be operated for the purpose of increasing hydroelectric power generation and flood control in the United States of America and in Canada. In 1964, the Canadian and United States governments each designated an Entity to formulate and carry out the operating arrangements necessary to implement the Treaty. The Canadian Entity is British Columbia Hydro and Power Authority (B. C. Hydro). The United States Entity is the Administrator, Bonneville Power Administration (BPA) and the Division Engineer, North Pacific Division, Corps of Engineers (USCE).

The Columbia River Treaty Operating Committee, established in September 1968 by the Entities, is responsible for preparing and implementing operating plans as required by the Columbia River Treaty. This report records and reviews the operation of Mica, Arrow, Duncan and Libby reservoirs for power and flood control during the period 1 August 1982 through 31 July 1983, including the major effects downstream in Canada and the United States.

B. OPERATING PROCEDURE

Throughout the period covered by this report, storage operations were implemented by the Operating Committee in accordance with the Detailed Operating Plan (DOP) for Columbia River Treaty Storage, dated September 1982. The regulation of the Canadian storage content was determined by the Operating Committee on a weekly basis during the operating year except when flood control operation required daily regulation.

II. WEATHER AND STREAMFLOW

A. WEATHER.

The August weather in the Columbia Basin was variable due to thunderstorm activity with the wettest region, the upper Columbia, having 150 percent of normal. The precipitation increased in September so that the monthly average for the basin above Grand Coulee was 129 percent of normal, and 147 percent for the entire basin above The Dalles. Among the wettest stations in September were Hope, B.C., 6.13 inches, and Bonneville Dam, OR., 7.31 inches. Although October precipitation in the Columbia Basin above The Dalles averaged 104 percent of normal, the basin above Grand Coulee received only 70 percent while the Snake River Basin received 147 percent of normal. November saw the cool dry weather spread throughout the basin with an average of 72 percent of normal above The Dalles and 74 percent above Grand Coulee. December saw a continuation of below normal precipitation in the basin above Grand Coulee, with 92 percent of normal precipitation and mean daily temperatures as much as 21 degrees below normal. The Snake River Basin, however, had above normal precipitation, an average of 120 percent for the region above Ice Harbor.

During January the weather patterns shifted so that the western portion of the Columbia Basin in British Columbia received above normal precipitation, although the eastern portion of the Kootenay Basin and the northernmost region of the Columbia Basin were less than 80 percent of normal. Although this dry region spread to include western Montana during February, most of the remainder of the Columbia Basin received much above normal precipitation with 160 percent of normal on the Snake River Plain and 91 percent above Grand Coulee. March saw a continuation of the previous months weather patterns with the exception that most basins had even heavier precipitation. The Columbia Basin above Castlegar had 94 percent of normal, the Okanagan 206 percent, and the Snake River Plain 245 percent.

With warmer temperatures in April, 1 to 3 degrees above normal, and highly variable precipitation, 42 to 209 percent, the snowmelt season began. The first two-thirds of May was cool and showery while the later third was unseasonably warm with daily temperatures ranging from 12 to 24 degrees above normal. June had near normal temperatures and above normal precipitation in the northern portion of the Columbia Basin. The region above Grand Coulee had 117 percent of normal precipitation while the basin above The Dalles had 105 percent. July weather was most unusual in that temperatures throughout,the basin averaged 3 to 6 degrees below normal and the precipitation averaged 325 percent of normal. An example of the heavy precipitation was the new record July precipitation of 10.04 inches set at Hope, B.C., surpassing the 46-year record of 5.65 inches.

The geographical distribution of the accumulated October through April precipitation for the basin, expressed as a percentage of the 15-year average, 1963-1977, is shown on chart 1. The October through April precipitation is shown as being well above normal for most of eastern Washington as well as the southern portion of Oregon and Idaho. In British Columbia the Columbia and Kootenay Basins varied from near normal to well below normal. Only the Kettle and Okanagan Basins had above average precipitation.

Chart 2 depicts the winter season precipitation and temperature sequences that occurred throughout the basin as measured by selected, weighted index stations in the Columbia River Basin above The Dalles, Oregon. Below normal amounts accumulating during each winter month yielded a 1 May basin wide snowpack that was 93 percent of normal.

The pattern of temperature and precipitation throughout the April-August snowmelt season is shown on charts 3 and 4. Chart 3 applies to the Columbia River Basin above The Dalles, Oregon, and chart 4 applies to the Upper Columbia and Kootenay River Basins in Canada. Since the major portion of the seasonal runoff is produced by snowmelt, the temperatures shown are of special significance to system regulation as they largely influence the pattern of streamflow. Except for the hot latter half of May, the cool June and July weather resulted in a protracted melt season this year.

B. STREAMFLOW

Streamflow during August was generally near normal throughout the Columbia River Basin with the exception of the upper Snake, Okanagan, and Kettle Basins which were above normal. September's streamflow was above normal throughout the Columbia Basin in British Columbia and in the upper Snake Basin while the Flathead Basin was below normal. During October streamflow was above normal throughout the entire basin. In November a pattern of streamflow developed that would persist throughout the year: above normal discharges in the Snake and below normal in the Flathead, Kootenay, and upper Columbia. This pattern continued virtually unchanged during December and January with the exception of normal streamflows occurring in the upper Columbia Basin.

During February the weather patterns shifted so that there was much above normal streamflow along the east slopes of the Cascade Mountains tapering to much below normal in the Flathead Basin. The upper Clark Fork and upper Kootenay Basins were near average during March while the remainder of the Columbia Basin was much above normal in streamflow, as illustrated by 210 percent of normal streamflow for the drainage above The Dalles.

The snowmelt season began in April with much below normal streamflow in the Clark Fork Basin and in the Okanagan, Similkameen, and Kettle Basins of British Columbia. May saw streamflows drop to much below normal in the Clark Fork and Flathead Basins, near normal in British Columbia Basins, and much above normal in the upper Snake Basin. Streamflows remained well above normal in the Snake Basin while the below normal areas expanded to include the Clark Fork, Flathead, Kootenai, and upper Columbia. Due to unseasonably high precipitation during July, streamflows were high throughout Oregon, southern Washington, most of Idaho, and British Columbia. Only the Wenatchee Basin in eastern Washington recorded below normal July streamflows.

The 1982-1983 monthly modified streamflows and average monthly flows for the 1926-1982 period are shown in the following table for the Columbia River at Grand Coulee and at The Dalles. These modified flows are corrected for storage in lakes and reservoirs to exclude the effects of regulation, and are adjusted to the 1970 level of development for irrigation.

Mean Monthly Modified Streamflow, in CFS

Month	Columbia River at Grand Coulee Year 1982-1983	Columbia River at Grand Coulee Average 1926-1982	Columbia River at The Dalles Year 1982-1983	Columbia River at The Dalles Average 1926-1982
AUG	115,200	97,690	156,200	133,480
SEP	77,880	60,250	115,200	92,580
OCT	54,480	51,080	100,500	88,260
NOV	41,720	46,420	90,210	90,750
DEC	41,700	43,620	104,500	95,530
JAN	48,020	38,650	125,700	91,700
FEB	55,860	42,050	147,700	105,150
MAR	92,000	48,660	235,600	119,660
APR	116,100	114,510	243,000	217,320
MAY	252,200	266,400	448,300	417,670
JUN	280,100	314,990	466,000	469,030
JUL	211,300	187,300	294,200	253,640
YEAR	115,890	109,300	210,910	181,230

The maximum mean monthly modified streamflow for the Columbia River at Grand Coulee occurred as usual in June this year and was 89 percent of the long-term average. The maximum value for the Columbia River at The Dalles also occurred during the usual maximum month of June and was 99 percent of the long-term average.

Maximum observed mean daily inflows during the 1982-83 operating year were 112,630 cfs at Mica on 12 July, 137,740 cfs at Arrow on 12 July, 31,500 cfs at Duncan on 12 July, and 61,700 cfs at Libby on 31 May. The maximum observed mean daily flow in the Columbia River at The Dalles was 402,400 cfs on 2 June. The observed streamflow patterns for the year are shown on the inflow hydrographs for the Treaty reservoirs, charts 5, 6, 7 and 8. Observed and computed unregulated hydrographs for Kootenay Lake, and the Columbia River at Birchbank, Grand Coulee, and The Dalles are shown on charts 9, 10, 11, and 12, respectively.

C. SEASONAL RUNOFF VOLUMES

The volume and distribution of runoff during the snowmelt season are of great importance because the reservoir regulation plans are determined in part by the expected runoff volume. In 1983, the runoff volume forecasts, based on precipitation and snowpack data, were prepared for a large number of locations in the Columbia River Basin and updated each month as the season advanced. Table 1 lists the seasonal volume inflow forecasts for Mica, Arrow, Duncan, and Libby projects and for the unregulated runoff for the Columbia River at The Dalles. The forecasts for Mica, Arrow, and Duncan inflows were prepared by B.C. Hydro and those for the lower

Columbia River and Libby inflows were prepared by the United States Columbia River Forecasting Service. Also shown in table 1 are the actual volumes for these five locations. Note that actual spring runoff for all basins was greater than the April forecasts due to above normal summer precipitation.

Observed 1983 April-August runoff volumes, adjusted to exclude the effects of regulation of upstream storage, are listed for eight locations in the following tabulation:

(Revision to page 25 of the Columbia River Treaty Entities Report)

Streamflow and Location	April - August Runoff (1983)	
	Thousands of Acre-Feet	Percent of 1963-77 Average
Libby Reservoir Inflow	5979	87
Duncan Reservoir Inflow	2080	100
Mica Reservoir Inflow	11220	95
Arrow Reservoir Inflow	22939	97
Columbia River at Birchbank	40339	95
Grand Coulee Reservoir Inflow	59984	94
Snake River at Lower Granite Dam	27287	111
Columbia River at The Dalles	97857	101

Storage Evacuation Period. As shown in chart 5, Kinbasket Lake (Mica Reservoir) was filled to elevation 2470.4 feet on 29 July 1982. The project continued to fill to elevation 2472.0 feet as the outflow was curtailed to prevent the flow at Revelstoke from exceeding 75,000 cfs. The project released inflow thru mid-September and then the reservoir was gradually drawn down to near its normal full pool elev. 2470.4 feet by the end of the month.

Inflow into Mica Reservoir began to recede in October 1982 below the release target for the month. Actual discharge from the project was below the target, therefore creating a Treaty storage imbalance between Mica and Arrow. Treaty storage release began in October and the project was drafted to elevation 2470.0 feet, by 31 October.

Storage drafts continued in November through mid-December with the project outflows varying between 10,000 cfs and 25,000 cfs as necessary to deliver Treaty storage to the U.S., and to meet B.C. Hydro's system load requirements. Mica drafted to elevation 2462.0 feet by 15 December.

Generation at Mica was curtailed from 16 December 1982 thru 13 January 1983 due to reduced B.C. Hydro system loads and to maintain sufficient flow on the Peace River to mitigate an ice problem there. The Mica outflow was subsequently increased above the Detailed Operating Plan target releases up to hydraulic capacity of the powerhouse to restore balance in the Treaty storage between Mica and Arrow.

The project continued to draft from January through April 1983. On 29 April, the reservoir was drawn down to elevation 2415.0 feet, its lowest level for the year.

Refill Period. The project began to fill in May 1983 as Mica outflow was reduced to between zero and 15,000 cfs. Mica Reservoir was at elevation 2427.4 feet on 31 May. Reservoir inflow peaked at 112,630 cfs on 12 July, slightly lower than the previous one-day record of 126,000 cfs which occurred in 1972. During this period of high flow the project discharge was first reduced to prevent overtopping of the cofferdam at Revelstoke Dam construction site and later controlled to maintain a relatively steady water level behind Revelstoke to remove debris brought down by heavy rain. This operation continued until 19 July. Mica began spilling on 15 July as the required outflow exceeded B.C. Hydro's load requirements. During the period from 15 July to 24 July, pursuant to the storage agreement between B.C. Hydro and BPA (Contract DE-M79-83BP91290) 84,270 sfd of storage, which would otherwise be released from Mica, was retained at Mica Reservoir and equally shared between two new special storage accounts.

Mica Reservoir was filled to elevation 2472.0 feet on 25 July 1983 and thereafter the project discharged inflow to maintain the reservoir level near this elevation through the rest of the month.

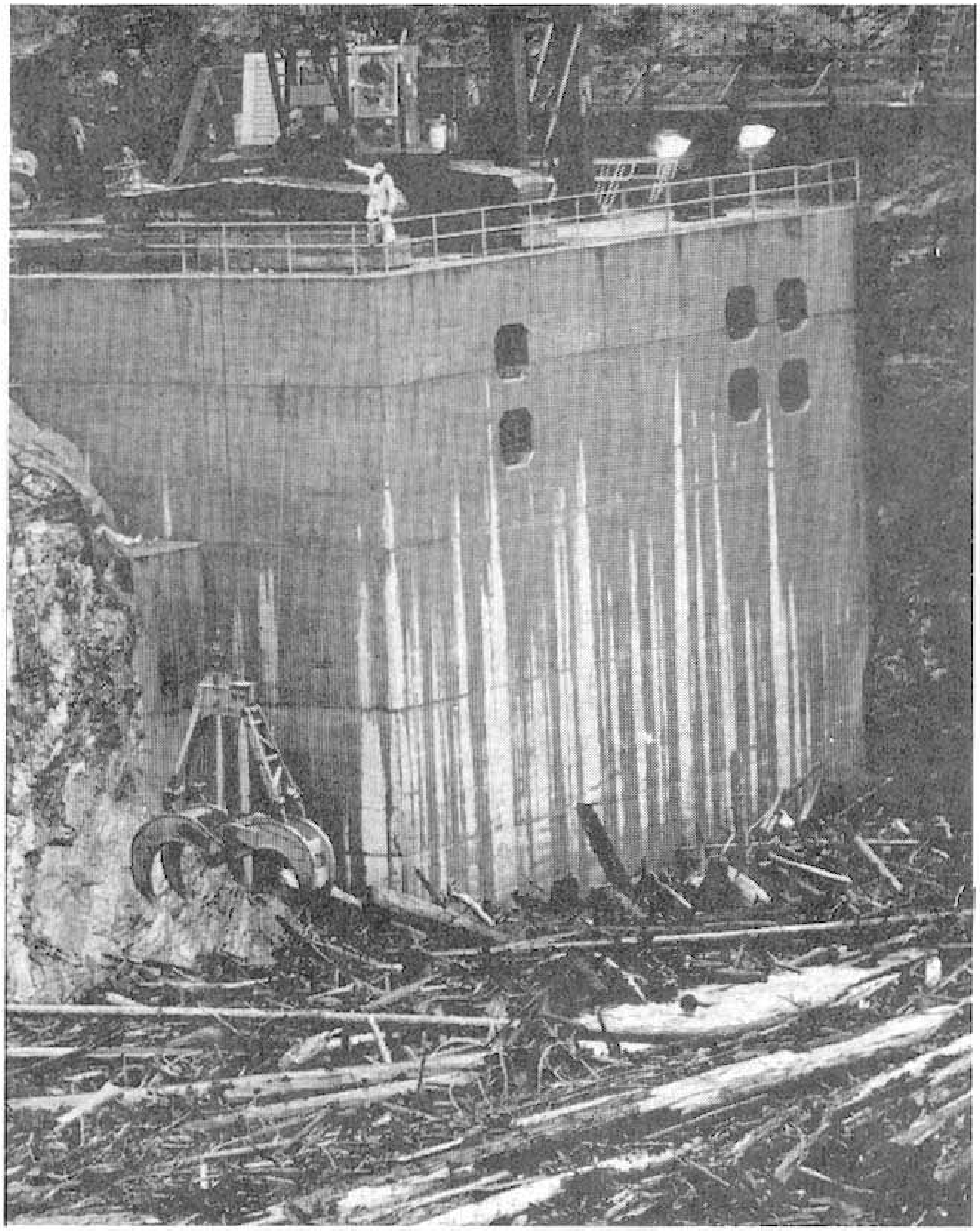
B. ARROW RESERVOIR

Storage Evacuation Period. As shown in chart 6, Arrow Reservoir was filled to elevation 1444.0 feet on 22 July 1982.

During August 1982, as Mica Reservoir was surcharged to elevation 2472.0 feet, Arrow Reservoir was drafted to elevation 1442.7 feet, maintaining full Treaty storage in Mica and Arrow. Draft for flood control began in October and by 31 October Arrow Reservoir was drawn down to elevation 1441.7 feet.

Arrow Reservoir continued to draft in November and December. On 23 December, due to reduced transmission capacity and high winter runoff, BPA requested temporary storage into the non-Treaty storage space at Arrow Reservoir. This was accomplished by reducing the Arrow discharge below what is normally required. A total of 121,400 sfd storage was retained in the Arrow non-Treaty storage space by 31 December. This storage was returned to BPA between 2 and 15 January.

The project continued to draft through February to provide flood control storage. On 22 February, the Corps of Engineers initiated flood control operation due to high flows approaching flood stage in the lower Columbia River. Arrow Reservoir discharge was reduced and adjusted on a day to day basis as requested by the Corps. This operation caused the reservoir level to exceed the Flood Control Rule Curve in March by as much as nine feet.



Heavy rain in mid July 1983 caused debris problems at the Revelstoke project site. A crane grapple is shown removing debris from the diversion tunnel forebay. Special releases were made from Mica for several days to maintain a constant forebay elevation at Revelstoke until the debris could be removed. The heavy rain also washed out construction roads and culverts in the project area and a part of Trans-Canada Highway No. 1 east of the town of Revelstoke as well as causing other problems. (B.C. Hydro photograph).

The project was able to draft again as the reservoir outflow was increased near the end of March. On 7 and 8 April, discharge at Arrow project was reduced to 5,000 cfs for approximately 36 hours to facilitate removal of sunken logs at the project and water level measurements of the Columbia River near Murphy Creek. This measurement would provide important data for the hydraulic modeling of the proposed Murphy Creek project.

Refill Period. Arrow Reservoir began refilling in the last ten days of April. By 30 April, the reservoir was filled to elevation 1402.3 feet, approximately 24 feet above the Operating Rule Curve. In the following three weeks, Arrow Reservoir operated near elevation 1402.5 feet.

Arrow outflow was reduced to below inflow to resume filling the project on 30 May. Capturing the snowmelt runoff, the project quickly filled to elevation 1430.3 feet by 19 June. In order to help fill the Grand Coulee project, Arrow Reservoir discharge was increased to between 40,000 cfs and 50,000 cfs, maintaining the reservoir level near elevation 1430.5 feet for the period 22 to 30 June.

Arrow Reservoir resumed filling in July. On 11 July, a heavy rainstorm increased the inflow into the reservoir, peaking at 137,740 cfs on 12 July. The Treaty storage space at Arrow was full on 13 July and pursuant to the storage agreement between B.C. Hydro and BPA (Contract DE-M79-83BP91290), Arrow continued to store water into the non-Treaty storage space between elevations 1444.0 feet and 1444.6 feet by reducing the project outflow below what otherwise is normally required to maintain full pool. Arrow Reservoir was filled to elevation 1446.0 feet on 19 July after which day the project outflow was increased to discharge inflow.

C. DUNCAN RESERVOIR

Storage Evacuation Period. As shown in chart 7, Duncan Reservoir was filled to full pool elevation 1892.0 feet on 28 July 1982. The project then discharged inflow to maintain full pool to November. On 22 November, Duncan discharge was increased to 6,000 cfs. This continued through most of December and by 31 December the reservoir was drawn down to elevation 1868.1 feet, slightly below the Flood Control Rule Curve. On 2 January 1983 the outflow was increased to 8,300 cfs to accelerate the drawndown.

Discharging between 6,500 cfs and 10,000 cfs, Duncan continued to be operated to meet the flood control drawdown requirement during January and February 1983.

Duncan Reservoir was drafted to near elevation 1817.0 feet by 28 February 1983, approximately ten feet above its Flood Control Rule Curve for the year, and held at this elevation until 8 April. The project resumed drafting on 9 April and continued thru 21 April when releases were decreased to reduce the inflow to Kootenay Lake. The reservoir was maintained near elevation 1812.5 feet through 15 May.

Refill Period. The project outflow was reduced to 1,000 cfs on 15 May 1983 and Duncan Reservoir began to fill. On 26 May, the project outflow was further reduced to 100 cfs. Capturing the snowmelt runoff, Duncan was filled to elevation 1833.0 feet by 31 May. The reservoir inflow peaked at 31,500 cfs on 12 July. Release from Duncan was increased from 100 cfs in several steps to 8,000 cfs by 15 July to reduce the rate of filling. The project continued to fill and reached full pool elevation 1892.0 feet on 24 July, after which the project outflow was increased to pass inflow.

D. LIBBY RESERVOIR

Storage Evacuation Period. On 1 August 1982, Lake Koocanusa was at elevation 2459.0 as shown on chart 8. Water supply for the basin above Libby was near average in 1982, therefore, there was no problem filling the reservoir.

Higher reservoir releases resulted in a draft of Lake Koocanusa in September through November to meet U. S. power requirements. Draft accelerated in December, January and the first half of February as releases were at full powerhouse capacity, approximately 20,000 cfs. The lake drafted to elevation 2407.3 feet by 1 January, about three feet below the 1 January flood control requirement.

Libby continued to draft for power and flood control from January through early March 1983. The lake was at its lowest level at elevation 2348.3 feet on 15 April, about 7 feet above its Variable Refill Curve. However, draft did not continue as it would have resulted in Kootenay Lake exceeding its IJC Rule Curve.

Refill Period. Inflows to Libby began increasing early in April 1983. The seasonal peak was reached on 31 May with a daily average inflow of 61,700 cfs. Inflows gradually receded to near 20,000 cfs by mid-July.

Libby outflow was held at approximately inflow until late April 1983. Inflows increased above 4,000 cfs by 25 May and the lake filled about 42 feet in May reaching elevation 2401.8 feet by 31 May. Lake Koocanusa continued to fill through June reaching elevation 2442.9 by 30 June. During June, Libby average outflow was 4,000 cfs. Libby continued to fill through July reaching elevation 2458.5 feet by 22 July. Lake Koocanusa was full at elevation 2459.0 feet on 14 August. At site spill was not needed during the refill period as the project was able to release the inflow with three generating units that were available out of the four.

E. KOOTENAY LAKE.

Storage Evacuation Period. Kootenay Lake was at elevation 1744.9 feet on 31 July 1982 as shown in chart 9. The lake continued to draft through August with an average discharge for the month of 26,900 cfs. Kootenay Lake reached elevation 1743.2 feet on 31 August.

Between 1 September and 23 September 1982, Kootenay Lake outflow was maintained near 18,000 cfs. This reduction in discharge and the higher releases from Duncan Reservoir filled Kootenay Lake to elevation 1745.1 feet by 23 September. From October through early December, Kootenay Lake discharged inflow to maintain its level near elevation 1745.0 feet. During this period, discharge from Kootenay Lake varied between 15,000 cfs and 35,000 cfs.

In anticipation of a reduction in B.C. Hydro's system load during the holidays, Kootenay Lake was drafted to elevation 1743.9 feet by 23 December. The lake was subsequently refilled to 1745.2 feet by 5 January.

Following the IJC Rule Curve, Kootenay Lake was drafted in January to elevation 1743.8 feet by 31 January. Beginning 8 February, Kootenay Lake went on free flow. During February and March, Kootenay Lake inflow was controlled by upstream projects to below the free flow capability at Grohman Narrows. This enabled Kootenay Lake to draft through March to early April, reaching its lowest level at elevation 1738.8 feet on 7 April. Kootenay Lake then discharged inflow, maintaining its level near elevation 1739.0 feet.

Refill Period. Kootenay Lake began to fill gradually in late April 1983 as inflow exceeded the free flow capability at Grohman Narrows. The inflow increased in May and Kootenay Lake filled quickly to elevation 1748.6 feet by 3 June.

The inflow receded in early June, allowing Kootenay Lake to be drafted to elevation 1744.3 feet by 10 July. Kootenay Lake level increased again in the latter part of July, reaching elevation 1745.9 feet on 27 July. During this period, Kootenay Lake discharge averaged 36,000 cfs, and the lake was at elevation 1745.3 by 31 July.

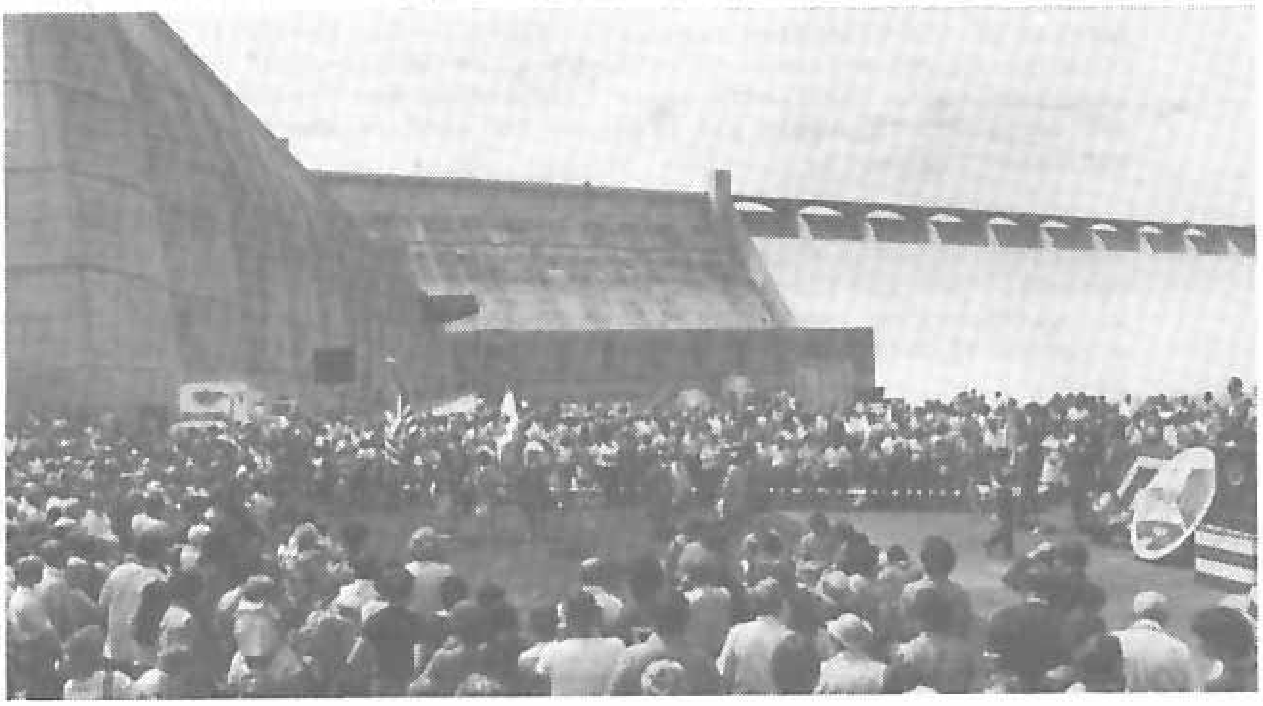
IV. DOWNSTREAM EFFECTS OF STORAGE OPERATION

A. POWER

General. During the period covered by this report, the Treaty storage was operated in accordance with the 1982-83 Detailed Operating Plan designed to achieve optimum power generation in Canada and in the United States of America in accordance with paragraph 7, Annex A of the Treaty. In 1964, the Canadian Entitlement to downstream power benefits for the 1982-83 Operating Year was purchased by Columbia Storage Power Exchange (CSPE) and exchanged with BPA for specified amounts of power and energy. Deliveries of power and energy specified under the Canadian Entitlement Exchange Agreements and attributable to Arrow, Duncan, and Mica under the provisions of these agreements were made to the CSPE participants during the 1982-83 Operating Year.

The generation at downstream projects in the United States, delivered under the Canadian Entitlement Exchange Agreement was 520 average megawatts at rates up to 1,254 megawatts from 1 August 1982, through

The dedication ceremony for the Grand Coulee third powerhouse was held on 16 July 1983, in honor of the 50th anniversary of the start of initial project construction. (U.S. Bureau of Reclamation photographs).



31 March 1983, and 495 average megawatts at rates up to 1,216 megawatts from 1 April 1982, through 31 July 1983. During the period of 1 April 1982, through 31 March 1983, the CSPE participants assigned 63 average megawatts at rates up to 150 megawatts to Pacific Southwest utilities. Beginning 1 April 1983, all CSPE power was used to meet Pacific Northwest loads.

Review of 1982-83 Power Operations.

All coordinated system reservoirs were full on 31 July 1982. The system remained essentially full on 31 August as above normal precipitation in the upper portion of the Columbia River Basin held streamflows well above median-month levels. Northwest energy sales to California established a new all-time record in August when a total of 3,119,289 megawatthours was sold for a monthly average of 4,193 megawatts. Hanford returned to service 3 August and Certralia units 1 and 2 returned to service 4 August and 1 August, respectively. Trojan returned to service 24 August.

Above normal precipitation during September and October caused natural streamflows to exceed median-month levels. Total northwest energy sales to California in September and October set new records for both months. The last unit at the Bonneville Dam second powerhouse was declared commercially available on 13 October, raising the total project installed capacity to 1,220 megawatts. Below normal precipitation in November caused streamflows to recede, but they still averaged slightly above median for the month. BPA continued to make nonfirm energy available to northwest utilities during the entire month of November but supplied nonfirm energy to southwest utilities from 3 to 7 November only. However, non-federal intertie sales totaled nearly 2.5-billion kilowatt-hours during November, loading the intertie to 98.8 percent of its available capacity. Above normal precipitation during December helped maintain streamflows above median-month levels. Northwest energy sales to California again established new records for December and BPA continued to supply all requests for nonfirm energy to Pacific Northwest customers.

For the 1982 calendar year, the a-c line was loaded to 91.8 percent of its available capacity while the d-c line was loaded to a remarkable 99.0 percent. BPA and northwest utilities sold more than 33.5-billion kilowatthours to the California utilities during the year with BPA selling a record 17.1-billion kilowatthours equal to 51 percent of the total sales.

Precipitation in January 1983 was below normal but high freezing levels caused streamflows to rise and average well above median-month levels. During 8 to 31 January, BPA offered spill rate nonfirm energy sufficient to load the interties. On 22 January the Trojan nuclear plant was shut down for economy reasons and it remained down until 17 July 1983. As a result of above normal volume runoff forecasts, coordinated system reservoirs were 11.1-billion kilowatthours above variable energy content curves (assured refill curves) on 31 January 1983.

Above normal precipitation and mild temperatures during the second half of February caused streamflows to rise sharply. On 22 February the Corps of Engineers began specifying daily reservoir operation for flood control purposes and continued that through 8 July. BPA and northwest utilities marketed 2.4-billion kilowatthours of nonfirm energy to the California utilities during February. Continuation of above normal precipitation along with mild temperatures during March caused streamflows to average 200 percent of median for the month. BPA sold 1.3-billion kilowatthours of nonfirm energy to northwest utilities during March and in addition, intertie sales by BPA totaled 2.0-billion kilowatthours and sales by northwest utilities exceeded 0.4-billion kilowatthours. On 31 March 1983, the Pacific Northwest-Southwest Intertie completed its 15th year of operation during which time sales by BPA and northwest utilities have exceeded 176-billion kilowatthours.

Although the Columbia Basin experienced below normal precipitation during April, mild temperatures caused streamflows to average slightly above median-month levels. Dworshak discharge was increased on 22 April, coincidental with the first request from the fishery management agencies for flow augmentation. During April, BPA sold 1.2-billion kilowatthours of nonfirm energy to northwest utilities. Nonfirm sales on the intertie totaled 2.6-billion kilowatthours of which BPA sold in excess of 2.2-billion kilowatthours. Hanford was shut down from 28 April to 25 June for refueling and its annual maintenance outage. Below normal precipitation and cool temperatures during the first half of May held streamflows below median. Streamflows rose sharply during the last half of the month due to much above normal temperatures throughout the basin. Reservoirs continued to fill dictated by flood control requirements and federal reservoirs spilled 2.7-billion kilowatthours past unloaded turbines. BPA sold nearly one-billion kilowatthours of nonfirm energy during May to northwest utilities. Intertie sales during May exceeded 2.4-billion kilowatthours of which 95.7 percent was made by BPA.

Flows available for the 1983 spring juvenile fish outmigration during the mid-April to mid-June period were well above optimum levels in the mid-Columbia. However, in the lower Snake River flows were below fishery optimum but well above minimum levels during this period until early June when flows well above optimum occurred there also. There were large amounts of spill in the U.S. portion of the reservoir system from 20 February until the end of July 1983. This included significant amounts of spill past unloaded turbines. Extensive use of spill priorities were used to control this spill at mainstem U.S. projects both to facilitate down-stream juvenile fish passage and to reduce gas (nitrogen) supersaturation problems for fishery. BPA also made special arrangements to transfer excessive spill from the mainstem projects to help reduce supersaturation levels. During June BPA sold 0.9-billion kilowatthours of nonfirm energy to northwest utilities while total intertie sales were near 2.8-billion kilowatthours of which 2.5-billion was from the federal system.

Precipitation averaged three times normal during July and while streamflows receded during the month they still averaged well above median-month levels. Intertie sales exceeded 3.1-billion kilowatthours during July and net deliveries to the California utilities averaged 3,904 megawatts. All reservoirs were again virtually full on 31 July 1983, the end of the operating year for treaty purposes.

B. FLOOD CONTROL

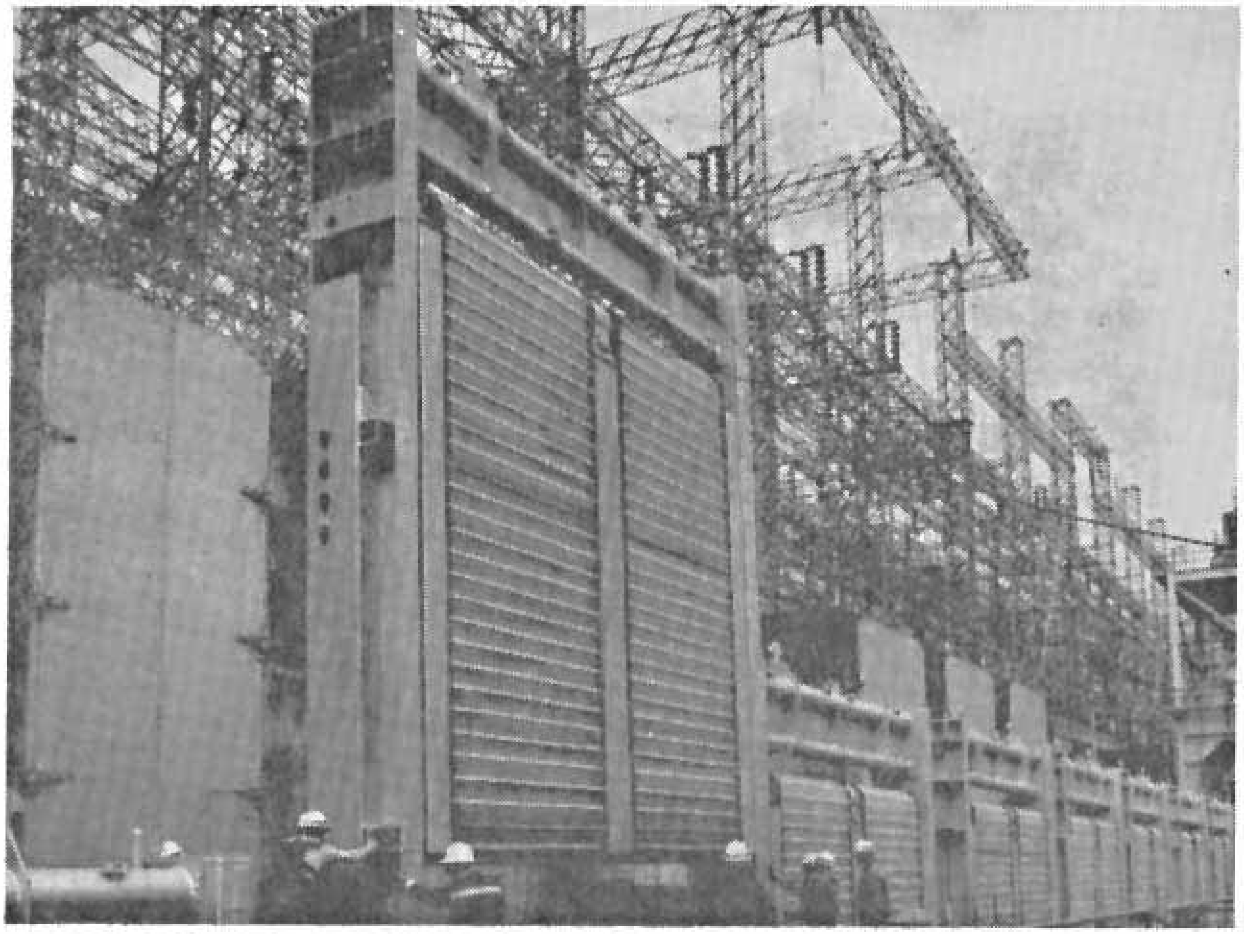
Heavy rains in late-February 1983 caused high flows in the mid and lower Columbia River and other rivers of the Pacific Northwest. The Treaty Projects began operating for flood control on 22 February. Arrow outflow was reduced from 58,000 cfs to 28,000 cfs on 4 March and to 15,000 cfs by 11 March. Arrow outflow reductions were made to reduce the lower Columbia River stage. Approximately 2.5 feet of storage was used in Arrow Lake for flood control regulation. Treaty project operations were scheduled on a daily basis from 4 March through 25 March to reduce flooding and for post-flood evacuation of space filled during the flood operations. Columbia River stage at Vancouver, Washington peaked at 15.6 feet on 11 March. The unregulated peak stage would have been 19.6 feet, flood stage is 16.0 feet. After the flow in the lower river had receded, the Arrow outflow was increased and reached a high of 84,000 cfs on 25 March.

V. OPERATING CRITERIA

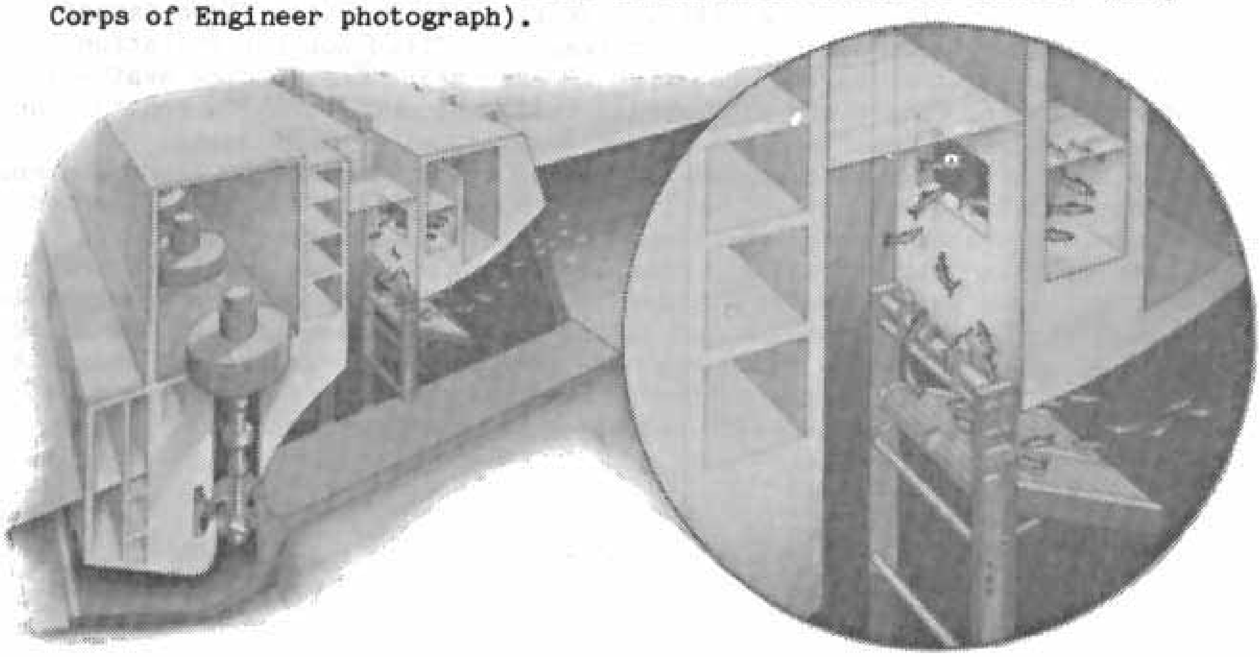
A. GENERAL

The Columbia River Treaty requires that the reservoirs constructed in Canada be operated pursuant to flood control and hydroelectric operating plans developed thereunder. Annex A of the Treaty stipulates that the United States Entity will submit flood control operating plans and that the Canadian Entity will operate in accordance with flood control storage diagrams or any variation which the Entities agree will not be adverse to the desired aim of the flood control plan. Annex A also provides for the development of hydroelectric operating plans five years in advance to furnish the Entities with an Assured Operating Plan for Canadian storage. In addition, Article XIV.2.k of the Treaty provides that a Detailed Operating Plan may be developed to produce more advantageous results through use of current estimates of loads and resources. The Protocol to the Treaty provides further detail and clarification of the principles and requirements of Annex A. The Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans dated May 1979, together with the Columbia River Treaty Flood Control Operating Plan dated October 1972, establish the general criteria of operations.

The Assured Operating Plan dated September 1977 established Operating Rule Curves for Duncan, Arrow and Mica during the 1982-83 operating year. The Operating Rule Curves provided guidelines for refill levels as well as drawdown levels. They were derived from Critical Rule Curves, Assured



In the above photograph juvenile fish screens are shown raised onto the Bonneville powerhouse forebay deck for inspection. Below is a typical powerhouse cross-section schematic showing conceptually a fish screen in its operating position in a turbine intake. These rotating wire mesh screens are officially known as submersible traveling screens (STS) and are used each spring and summer during the juvenile downstream migration season. The first such screens were used operationally at Little Goose in 1971 and by 1983 fish screens were in operation at Lower Granite, McNary, and both powerhouses at Bonneville Dam as well as Little Goose. (Army Corps of Engineer photograph).



Refill Curves, Upper Rule Curves, and Variable Refill Curves, consistent with flood control requirements, as described in the Principles and Procedures. The Flood Control Storage Reservation Curves were established to conform to the Flood Control Operating Plan.

The Detailed Operating Plan dated September 1982 established data and criteria for determining the Operating Rule Curves for use in actual operations. At the request of the U. S. Entity, these criteria included the Critical Rule Curves for Duncan, Arrow, and Mica from the 1982-83 Pacific Northwest Coordination Agreement final regulation. The Variable Refill Curves and flood control requirements subsequent to 1 January 1983 will be determined on the basis of seasonal volume runoff forecasts during actual operation.

B. POWER OPERATION

Consistent with all Detailed Operating Plans prepared since the installation of generation at Mica, the 1982-83 Detailed Operating Plan was designed to achieve optimum power generation at-site in Canada and downstream in Canada and the United States, consistent with project operating limits and flood control requirements.

The power facilities in the United States which are downstream from the Treaty storage projects are all operated under the Pacific Northwest Coordination Agreement dated September 1964. Optimum generation in the United States and Canada was assured by the adoption, in the Assured and Detailed Operating Plans, of criteria and operating guides designed to coordinate the operation of Treaty projects with the projects operating under the Agreement. Optimum operation of Treaty reservoirs was accomplished, for the actual water condition experienced, by operating with reference to the Critical Rule Curves, Assured Refill Curves, Variable Refill Curves, Flood Control Storage Reservation Curves and related criteria determined in accordance with the Detailed Operating Plan.

C. FLOOD CONTROL OPERATION

The Flood Control Operating Plan was designed to minimize flood damage both in Canada and in the United States. The flood control operation during the drawdown period consisted of evacuating and holding available storage space, consistent with refill criteria, sufficient to control the flood that could occur under forecast conditions. Runoff volume forecasts determined the volume of storage space required. Flood control operation of the Columbia River Treaty projects during the refill period was controlled in part by the computed Initial Controlled Flow of the Columbia River at The Dalles. Other operating rules and local criteria were utilized to prepare day-to-day streamflow forecasts for key points in Canada and the United States and to establish the operations of the flood control storage. These forecasts were prepared daily during the snowmelt season by the U. S. Columbia River Forecasting Service for periods of 30 to 45 days using both moderate and severe snowmelt sequences.

Table 1
Unregulated Runoff Volume Forecasts
Millions of Acre-Feet
1983

Forecast Date - 1st of	DUNCAN Most Probable 1 Apr - 31 Aug	ARROW Most Probable 1 Apr - 31 Aug	MICA Most Probable 1 Apr - 31 Aug	LIBBY Most Probable 1 Apr - 31 Aug	UNREGULATED RUNOFF COLUMBIA RIVER AT THE DALLES, OREGON Most Probable 1 Apr - 31 Jul
January	1.9	21.1	10.7	6.6	97.9
February	2.0	22.1	10.8	6.5	95.1
March	2.1	22.9	11.0	6.3	98.7
April	2.0	23.4	11.0	6.3	100.0
May	2.0	23.8	10.9	6.7	100.0
June	1.9	21.3	9.5	6.5	98.2
July	2.0	21.9	9.7	7.3	100.0
Actual	2.1	22.9	11.2	6.2	97.9

NOTE: These data are used in actual operations. Subsequent revisions have been made in some cases.

Table 2
95 percent Confidence Forecast and Variable Energy Content Curve
Mica 1983

		INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1	PROBABLE FEB 1 - JUL 31 INFLOW, KSFD 1/		4400.0	4471.6	4578.6	4610.0	4583.5	4125.0
2	95% FORECAST ERROR, KSFD		718.3	536.6	495.2	482.4	472.0	469.8
3	95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD 2/		3681.7	3935.0	4083.4	4127.6	4111.5	3655.2
4	OBSERVED FEB 1 - DATE INFLOW, KSFD				126.4	281.3	540.7	1370.1
5	RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD 3/		3681.7	3935.0	3957.0	3846.3	3570.8	2285.1
	ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
	ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 4/		3681.7					
	MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		2255.0					
	MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/		2102.5					
	MIN. JAN 31 RESERVOIR ELEVATION, FT 6/		2442.2					
	JAN 31 ECC, FT 7/		2438.9					
	BASE ECC, FT	2443.9						
	LOWER LIMIT, FT	2426.2						
	ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		97.8	97.8				
	ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 4/		3600.7	3848.4				
	MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		1835.0	1835.0				
	MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/		1763.5	1515.8				
	MIN. FEB 28 RESERVOIR ELEVATION, FT 6/		2435.1	2429.7				
	FEB 28 ECC, FT 7/		2426.8	2426.8				
	BASE ECC, FT	2432.5						
	LOWER LIMIT, FT	2410.6						
	ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		95.4	95.4	97.6			
	ASSUMED APR 1 - JUL 31 INFLOW, KSFD 4/		3512.3	3754.0	3862.0			
	MIN. APR 1 - JUL 31 OUTFLOW, KSFD		1370.0	1370.0	1370.0			
	MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/		1386.9	1145.2	1037.2			
	MIN. MAR 31 RESERVOIR ELEVATION, FT 6/		2426.9	2421.6	2419.2			
	MAR 31 ECC, FT 7/		2415.1	2415.1	2415.1			
	BASE ECC, FT	2421.2						
	LOWER LIMIT, FT	2402.0						
	ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		91.0	91.0	93.1	95.4		
	ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 4/		3350.3	3580.8	3684.0	3669.4		
	MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		920.0	920.0	920.0	920.0		
	MIN. APR 30 RESERVOIR CONTENT, KSFD 5/		1098.9	868.3	765.2	779.8		
	MIN. APR 30 RESERVOIR ELEVATION, FT 6/		2420.5	2415.3	2412.9	2413.3		
	APR 30 ECC, FT 7/		2405.5	2405.5	2405.5	2405.5		
	BASE ECC, FT	2411.8						
	LOWER LIMIT, FT	2400.7						
	ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		74.1	74.1	75.8	77.7	81.5	
	ASSUMED JUN 1 - JUL 31 INFLOW, KSFD 4/		2728.1	2915.8	2999.4	2988.6	2910.2	
	MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		610.0	610.0	610.0	610.0	610.0	
	MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/		1411.1	1223.4	1139.8	1150.6	1229.0	
	MIN. MAY 31 RESERVOIR ELEVATION, FT 6/		2427.5	2423.3	2421.5	2421.7	2423.4	
	MAY 31 ECC, FT 7/		2416.9	2416.9	2416.9	2416.9	2416.9	
	BASE ECC, FT	2422.9						
	LOWER LIMIT, FT	2400.7						
	ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		36.9	36.9	37.8	38.7	40.6	49.8
	ASSUMED JUL 1 - JUL 31 INFLOW, KSFD 4/		1358.5	1452.0	1495.7	1488.5	1449.7	1138.0
	MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		310.0	310.0	310.0	310.0	310.0	310.0
	MIN. JUN 30 RESERVOIR CONTENT, KSFD 5/		2480.7	2387.2	2343.5	2350.7	2389.5	2701.2
	MIN. JUN 30 RESERVOIR ELEVATION, FT 6/		2449.6	2448.0	2447.1	2447.3	2448.1	2454.3
	JUN 30 ECC, FT 7/		2446.6	2446.6	2446.6	2446.6	2446.6	2446.6
	BASE ECC, FT	2451.2						
	LOWER LIMIT, FT	2400.7						
	JUL 31 ECC, FT		2470.4	2470.4	2470.4	2470.4	2470.4	2470.4

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ FULL CONTENT (3529.2 KSFD) PLUS PRECEDING LINE LESS LINE PRECEDING THAT (USABLE STORAGE)
6/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE DATED FEB. 21, 1973.
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR.

Table 3
95 Percent Confidence Forecast and Variable Energy Content Curve
Arrow 1983

		INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1	PROBABLE FEB 1 - JUL 31 INFLOW, KSFD 1/		4753.6	5151.1	5542.0	6023.70	6271.5	5957.4
2	95% FORECAST ERROR, KSFD		978.0	813.8	733.0	564.0	517.1	482.9
3	95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD 2/		3775.6	4337.3	4809.0	5459.7	5754.4	5474.5
4	OBSERVED FEB 1 - DATE INFLOW, KSFD				267.5	680.8	1297.4	2706.1
5	RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD 3/		3775.6	4337.3	4541.5	4778.9	4457.0	2768.4
	ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
	ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 4/		3775.6					
	MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		1454.0					
	MICA REFILL REQUIREMENTS, KSFD 8/		2255.0					
	MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/		-997.0					
	MIN. JAN 31 RESERVOIR ELEVATION, FT 6/		1377.9					
	JAN 31 ECC, FT 7/		1392.0					
	BASE ECC, FT	1408.5						
	LOWER LIMIT, FT	1392.0						
	ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		97.3	97.3				
	ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 4/		3673.7	4220.2				
	MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		1314.0	1314.0				
	MICA REFILL REQUIREMENTS, KSFD 8/		1835.0	1835.0				
	MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/		-615.1	-1161.6				
	MIN. FEB 28 RESERVOIR ELEVATION, FT 6/		1377.9	1377.9				
	FEB 28 ECC, FT 7/		1385.3	1385.3				
	BASE ECC, FT	1399.5						
	LOWER LIMIT, FT	1385.3						
	ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		94.1	94.1	96.8			
	ASSUMED APR 1 - JUL 31 INFLOW, KSFD 4/		3552.8	4081.4	4396.2			
	MIN. APR 1 - JUL 31 OUTFLOW, KSFD		1159.0	1159.0	1159.0			
	MICA REFILL REQUIREMENTS, KSFD 8/		1370.0	1370.0	1370.0			
	MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/		-184.2	-712.8	-1027.6			
	MIN. MAR 31 RESERVOIR ELEVATION, FT 6/		1377.9	1377.9	1377.9			
	MAR 31 ECC, FT 7/		1385.0	1385.0	1385.0			
	BASE ECC, FT	1411.1						
	LOWER LIMIT, FT	1385.0						
	ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		87.2	87.2	89.7	92.7		
	ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 4/		3292.3	3782.1	4037.7	4430.0		
	MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		1009.0	1009.0	1009.0	1009.0		
	MICA REFILL REQUIREMENTS, KSFD 8/		920.0	920.0	920.0	920.0		
	MIN. APR 30 RESERVOIR CONTENT, KSFD 5/		376.3	-113.5	-405.1	-761.4		
	MIN. APR 30 RESERVOIR ELEVATION, FT 6/		1386.8	1377.9	1377.9	1377.9		
	APR 30 ECC, FT 7/		1386.8	1377.9	1377.9	1377.9		
	BASE ECC, FT	1414.9						
	LOWER LIMIT, FT	1377.9						
	ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		63.9	63.9	65.7	67.9	73.3	
	ASSUMED JUN 1 - JUL 31 INFLOW, KSFD 4/		2412.6	2771.5	2983.8	3244.9	3267.0	
	MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		854.0	854.0	854.0	854.0	854.0	
	MICA REFILL REQUIREMENTS, KSFD 8/		610.0	610.0	610.0	610.0	610.0	
	MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/		1411.0	1052.1	839.8	578.7	556.6	
	MIN. MAY 31 RESERVOIR ELEVATION, FT 6/		1407.6	1400.8	1396.5	1391.2	1390.7	
	MAY 31 ECC, FEET 7/		1407.6	1400.8	1396.5	1391.2	1390.7	
	BASE ECC, FT	1426.1						
	LOWER LIMIT, FT	1377.9						
	ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		27.5	27.5	28.2	29.2	31.5	43.0
	ASSUMED JUL 1 - JUL 31 INFLOW, KSFD 4/		1038.3	1192.8	1280.7	1395.4	1404.0	1190.4
	MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		434.0	434.0	434.0	434.0	434.0	434.0
	MICA REFILL REQUIREMENTS, KSFD 8/		310.0	310.0	310.0	310.0	310.0	310.0
	MIN. JUN 30 RESERVOIR CONTENT, KSFD 5/		2665.3	2510.8	2422.9	2308.2	2299.6	2513.2
	MIN. JUN 30, RESERVOIR ELEVATION, FT 6/		1429.6	1427.0	1425.5	1423.6	1423.5	1427.0
	JUN 30 ECC, FT 7/		1429.6	1427.0	1425.5	1423.6	1423.5	1427.0
	BASE ECC, FT	1443.6						
	LOWER LIMIT, FT	1377.9						
	JUL 31 ECC, FT	1444.0	1444.0	1444.0	1444.0	1444.0	1444.0	1444.0

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ FOR ARROW LOCAL: FULL CONTENT (3579.6 KSFD) LESS LINE PRECEDING PLUS LINE PRECEDING THAT LESS LINE PRECEDING THAT
FOR ARROW TOTAL: FULL CONTENT (3579.6 KSFD) PLUS TWO PRECEDING LINES LESS LINE PRECEDING THAT
6/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE DATED FEBRUARY 21, 1973.
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR.
8/ FOR ARROW LOCAL: MICA MINIMUM POWER DISCHARGES.
FOR ARROW TOTAL: MICA FULL CONTENT LESS ENERGY CONTENT CURVE

Table 4
95 Percent Confidence Forecast and Variable Energy Content Curve
Duncan 1983

		INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1	PROBABLE FEB 1 - JUL 31 INFLOW, KSFD 1/		815.1	859.6	894.5	886.0	896.1	853.6
2	95% FORECAST ERROR, KSFD		154.7	116.9	113.2	106.6	94.2	93.0
3	95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD 2/		660.4	742.7	781.3	779.4	801.9	760.6
4	OBSERVED FEB 1 - DATE INFLOW, KSFD				23.9	52.9	107.9	302.4
5	RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD 3/		660.4	742.7	757.4	726.5	694.0	458.2
	ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
	ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 4/		660.4					
	MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		18.1					
	MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/		63.5					
	MIN. JAN 31 RESERVOIR ELEVATION, FT 6/		1807.4					
	JAN 31 ECC, FT 7/		1807.4					
	BASE ECC, FT	1842.1						
	LOWER LIMIT, FT	1805.8						
	ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		97.8	97.8				
	ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 4/		645.9	726.4				
	MIN MAR 1 - JUL 31 OUTFLOW, KSFD		15.3	15.3				
	MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/		75.2	-5.3				
	MIN. FEB 28 RESERVOIR ELEVATION, FT 6/		1809.5	1794.2				
	FEB 28 ECC, FT 7/		1809.5	1804.6				
	BASE ECC, FT	1842.1						
	LOWER LIMIT, FT	1804.6						
	ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		95.4	95.4	97.5			
	ASSUMED APR 1 - JUL 31 INFLOW, KSFD 4/		630.0	708.5	738.5			
	MIN. APR 1 - JUL 31 OUTFLOW, KSFD		12.2	12.2	12.2			
	MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/		88.0	9.5	-20.5			
	MIN. MAR 31 RESERVOIR ELEVATION, FT 6/		1811.7	1796.6	1794.2			
	MAR 31 ECC, FT 7/		1811.7	1800.2	1800.2			
	BASE ECC, FT	1842.0						
	LOWER LIMIT, FT	1800.2						
	ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		90.3	90.3	92.2	94.6		
	ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 4/		596.3	670.7	698.3	687.3		
	MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		9.2	9.2	9.2	9.2		
	MIN. APR 30 RESERVOIR CONTENT, KSFD 5/		118.7	44.3	16.7	27.7		
	MIN. APR 30 RESERVOIR ELEVATION, FT 6/		1816.7	1803.9	1798.2	1800.6		
	APR 30 ECC, FT 7/		1816.7	1803.9	1798.2	1800.6		
	BASE ECC, FT	1834.2						
	LOWER LIMIT, FT	1794.2						
	ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		70.5	70.5	72.0	73.9	78.1	
	ASSUMED JUN 1 - JUL 31 INFLOW, KSFD 4/		465.6	523.6	545.3	536.9	542.0	
	MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		6.1	6.1	6.1	6.1	6.1	
	MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/		246.3	188.3	166.6	175.0	169.9	
	MIN. MAY 31 RESERVOIR ELEVATION, FT 6/		1835.6	1827.3	1824.1	1825.4	1824.6	
	MAY 31 ECC, FT 7/		1835.6	1827.3	1824.1	1825.4	1824.6	
	BASE ECC, FT	1848.6						
	LOWER LIMIT, FT	1794.2						
	ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		33.3	33.3	34.0	34.9	36.9	47.2
	ASSUMED JUL 1 - JUL 31 INFLOW, KSFD 4/		219.9	247.3	257.5	253.5	256.1	216.3
	MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		3.1	3.1	3.1	3.1	3.1	3.1
	MIN. JUN 30 RESERVOIR CONTENT KSFAT 5/		489.0	461.6	451.4	455.4	452.8	492.6
	MIN. JUN 30, RESERVOIR ELEVATION, FT 6/		1866.8	1863.5	1862.2	1862.7	1862.4	1867.2
	JUN 30 ECC, FT 7/		1866.8	1863.5	1862.2	1862.7	1862.4	1867.2
	BASE ECC, FT	1872.0						
	LOWER LIMIT, FT	1794.2						
	JUL 31 ECC, FT	1892.0	1892.0	1892.0	1892.0	1892.0	1892.0	1892.0

1/ DEVELOPED BY CANADIAN ENTITY
2/ LINE 1 - LINE 2
3/ LINE 3 - LINE 4
4/ PRECEDING LINE X LINE 5
5/ FULL CONTENT (705.8 KSFD) PLUS PRECEDING LINE LESS LINE PRECEDING THAT
6/ FROM RESERVOIR ELEVATION - STORAGE CONTENT TABLE. DATED FEBRUARY 21, 1973.
7/ LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR.

Table 5
95 Percent Confidence Forecast and Variable Energy Content Curve
Libby 1983

		INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1	PROBABLE JAN 1 - JUL 31 INFLOW, KSFD		3315.4	3321.8	3238.0	3284.6	3481.2	3282.1
2	95% FORECAST ERROR, KSFD		877.2	598.8	546.6	495.1	414.7	348.4
3	OBSERVED JAN 1 - DATE INFLOW, KSFD		0.0	139.0	257.4	405.8	674.5	1472.6
4	95% CONF. DATE - JUL 31 INFLOW, KSFD 1/		2438.2	2584.0	2434.1	2383.6	2392.0	1461.1
	ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		96.94					
	ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 2/		2363.5					
	FEB MINIMUM FLOW REQUIREMENT, CFS 3/		3000.0					
	MIN. FEB 1 - JUL 31 OUTFLOW, KSFD 4/		543.0					
	MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/		666.8					
	MIN. JAN 31 RESERVOIR ELEVATION, FT 6/		2355.7					
	JAN 31 ECC, FT 7/		2355.7					
	BASE ECC, FT	2406.0						
	LOWER LIMIT, FT	2350.6						
	ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		94.17	97.14				
	ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 2/		2296.0	2510.1				
	MAR MINIMUM FLOW REQUIREMENT, CFS 3/		3000.0	3000.0				
	MIN MAR 1 - JUL 31 OUTFLOW, KSFD 4/		459.0	459.0				
	MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/		650.3	436.2				
	MIN. FEB 28 RESERVOIR ELEVATION, FT 6/		2354.4	2335.4				
	FEB 28 ECC, FT 7/		2354.4	2335.4				
	BASE ECC, FT	2405.0						
	LOWER LIMIT, FT	2308.9						
	ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		90.79	93.66	96.42			
	ASSUMED APR 1 - JUL 31 INFLOW, KSFD 2/		2213.6	2420.2	2346.9			
	APR MINIMUM FLOW REQUIREMENT, CFS 3/		3000.0	3000.0	3000.0			
	MIN. APR 1 - JUL 31 OUTFLOW, KSFD 4/		366.0	366.0	366.0			
	MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/		639.7	433.1	506.4			
	MIN. MAR 31 RESERVOIR ELEVATION, FT 6/		2353.5	2335.1	2341.8			
	MAR 31 ECC, FT 7/		2353.5	2335.1	2341.8			
	BASE ECC, FT	2403.7						
	LOWER LIMIT, FT	2289.1						
	ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		81.71	84.29	86.77	90.00		
	ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 2/		1992.2	2178.1	2112.0	2145.3		
	MAY MINIMUM FLOW REQUIREMENT, CFS 3/		3000.0	3000.0	3000.0	3000.0		
	MIN. MAY 1 - JUL 31 OUTFLOW, KSFD 4/		276.0	276.0	276.0	276.0		
	MIN. APR 30 RESERVOIR CONTENT, KSFD 5/		771.1	585.2	651.3	618.0		
	MIN. APR 30 RESERVOIR ELEVATION, FT 6/		2363.9	2349.0	2354.5	2351.8		
	APR 30 ECC, FT 7/		2363.9	2349.0	2354.5	2351.8		
	BASE ECC, FT	2402.3						
	LOWER LIMIT, FT	2287.0						
	ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		52.75	54.42	56.02	58.10	64.56	
	ASSUMED JUN 1 - JUL 31 INFLOW, KSFD 2/		1286.1	1406.2	1363.6	1384.9	1544.3	
	JUN MINIMUM FLOW REQUIREMENT, CFS 3/		3000.0	3000.0	3000.0	3000.0	3000.0	
	MIN. JUN 1 - JUL 31 OUTFLOW, KSFD 4/		183.0	183.0	183.0	183.0	183.0	
	MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/		1384.2	1264.1	1306.7	1285.4	1126.0	
	MIN. MAY 31 RESERVOIR ELEVATION, FT 6/		2404.3	2397.1	2399.6	2398.4	2388.7	
	MAY 31 ECC, FT 7/		2404.3	2397.1	2399.6	2398.4	2388.7	
	BASE ECC, FT	2426.6						
	LOWER LIMIT, FT	2287.0						
	ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		18.97	19.57	20.15	20.90	23.22	35.97
	ASSUMED JUL 1 - JUL 31 INFLOW, KSFD 2/		462.5	505.7	490.5	498.2	555.4	525.5
	JUL MINIMUM FLOW REQUIREMENT, CFS 3/		3000.0	3000.0	3000.0	3000.0	3000.0	3000.0
	MIN JUL 1 - JUL 31 OUTFLOW, KSFD 4/		93.0	93.0	93.0	93.0	93.0	93.0
	MIN. JUN 31 RESERVOIR CONTENT, KSFD 5/		2117.8	2074.6	2089.8	2082.1	2024.9	2054.8
	MIN. JUN 30, RESERVOIR ELEVATION, FEET 6/		2442.0	2440.0	2440.7	2440.3	2437.5	2439.0
	JUN 30 ECC, FT. 7/		2442.0	2440.0	2440.7	2440.3	2437.5	2439.0
	BASE ECC, FT......................................	2452.6						
	LOWER LIMIT, FT...................................	2287.0						
	JUL 31 ECC, FT		2459.0	2459.0	2459.0	2459.0	2459.0	2459.0
	JAN 1 - JUL 31 FORECAST, EARLYBIRD, MAF 8/		105.0	108.0	110.0	117.0	120.0	120.0

1/ LINE 1 - LINE 2 - LINE 3.
2/ PRECEEDING LINE TIMES LINE 4.
3/ BASED ON POWER DISCHARGE REQUIREMENTS, DETERMINED FROM 8/.
4/ CUMULATIVE MINIMUM OUTFLOW FROM 3/, FROM DATE TO JULY.
5/ FULL CONTENT (2487.3 KSFD) PLUS 4/, AND MINUS 2/.
6/ ELEV. FROM 5/, STORAGE CONTENT TABLE, DATED JUNE 1980.
7/ ELEV. FROM 6/, BUT LIMITED . BASE ECC, & . ECC LOWER LIMIT.
8/ USED TO CALCULATE THE POWER DISCHARGE REQUIREMENTS FOR 3/.

Table 6
Computation of Initial Controlled Flow
Columbia River at The Dalles
1 May 1983

1 May Forecast of May-August Unregulated Runoff Volume, MAF		86.1
Less Estimated Depletions, MAF		1.5
Less Upstream Storage Corrections, MAF		
MICA	5.3	
ARROW	5.0	
LIBBY	3.5	
DUNCAN	1.2	
HUNGRY HOUSE	.9	
FLATHEAD LAKE	.5	
NOXON	.0	
PEND OREILLE LAKE	.5	
GRAND COULEE	4.6	
BROWNLEE	.5	
DWORSHAK	.8	
JOHN DAY	.2	
TOTAL	23.0	23.0
Forecast of Adjusted Residual Runoff Volume, MAF		61.0
Computed initial Controlled Flow From Chart 1 of Flood Control Operating Plan, KCFS		400.0

Chart 1
Seasonal Precipitation
Columbia River Basin
October 1982-March 1983
Percent of 1963-1977 Average

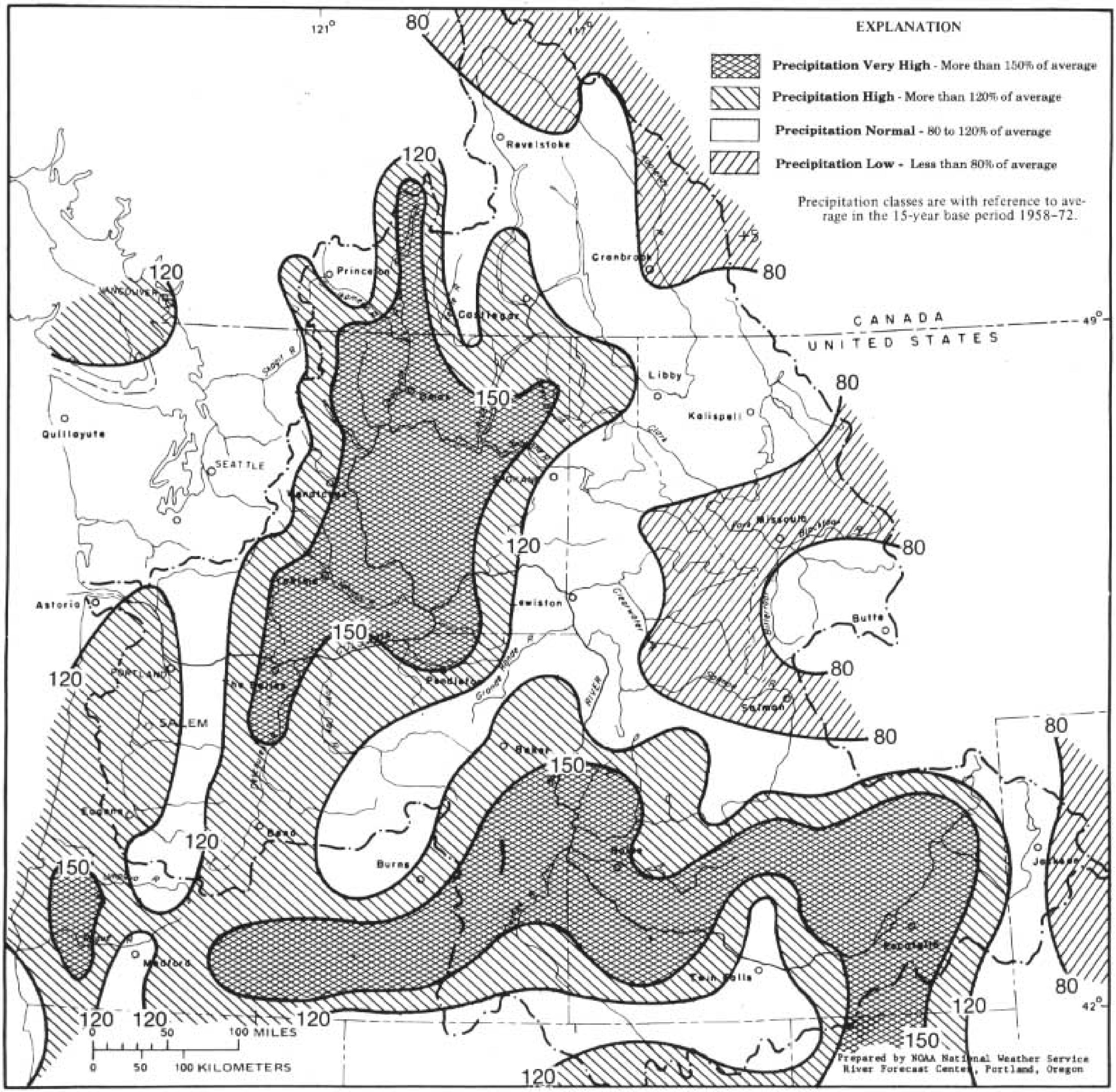


Chart 2
Winter Season
Temperature and Precipitation Indexes 1982-83
Columbia River Basin above The Dalles

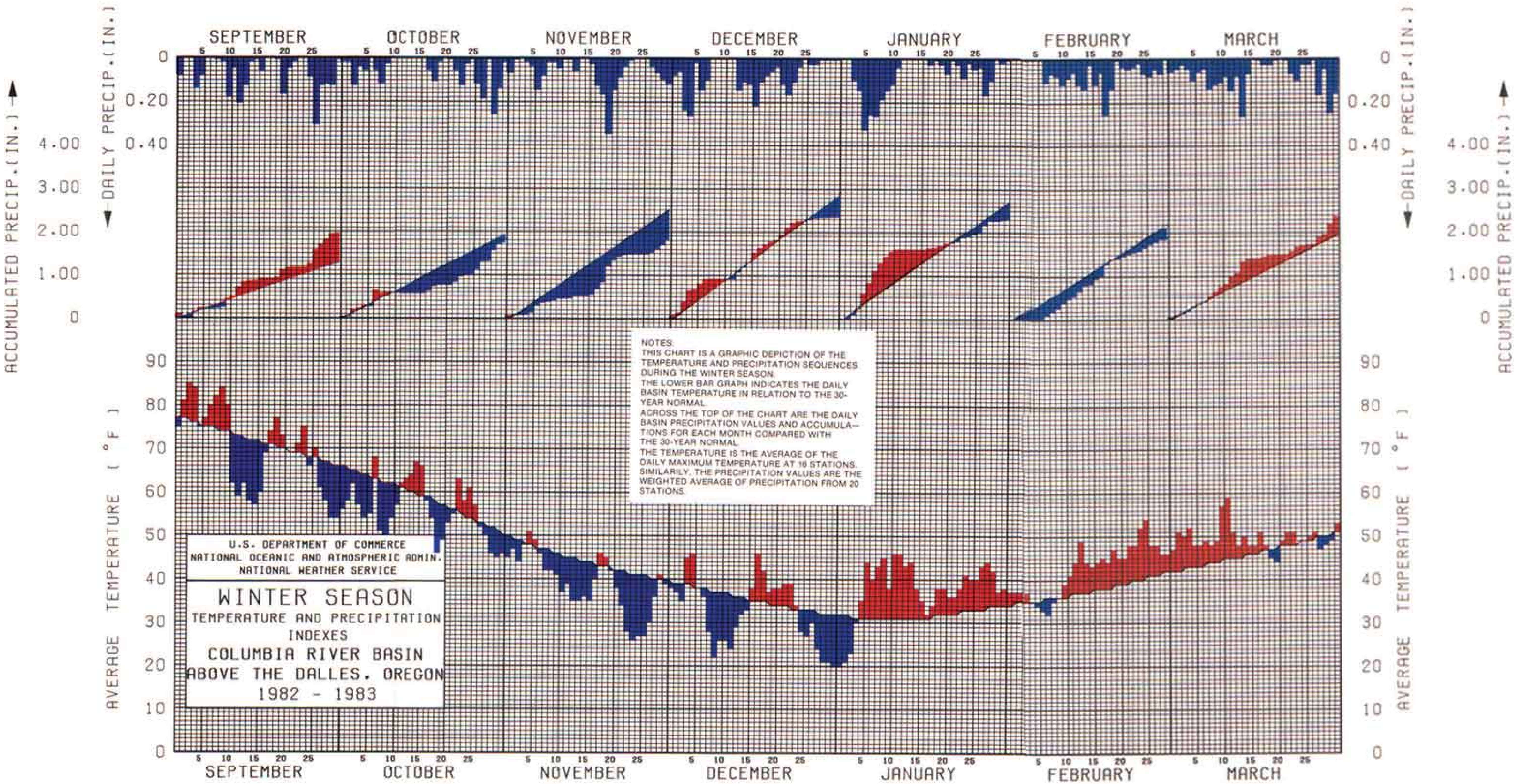
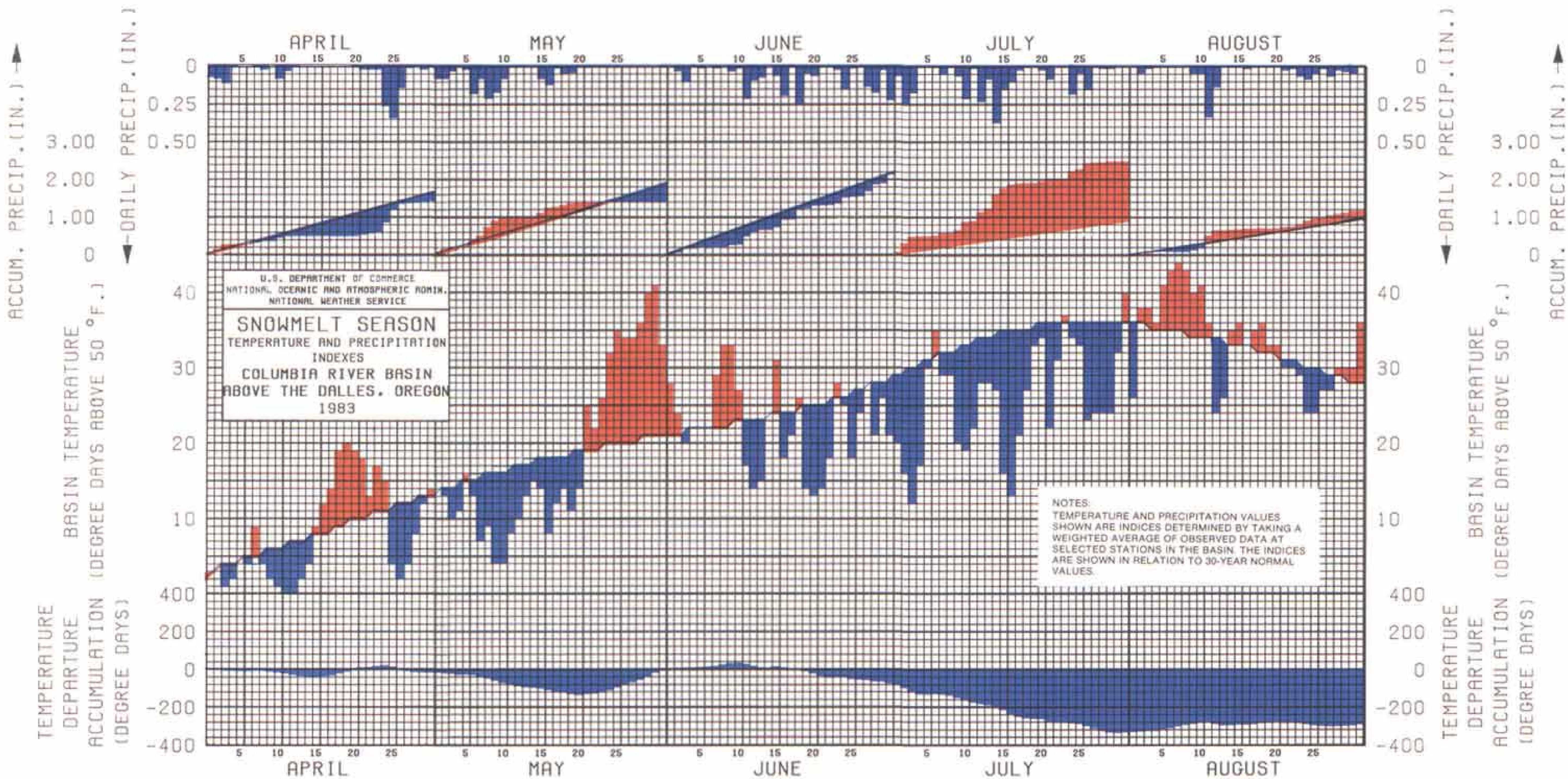


Chart 3
Snowmelt Season
Temperature and Precipitation Indexes 1982-83
Columbia River Basin above The Dalles



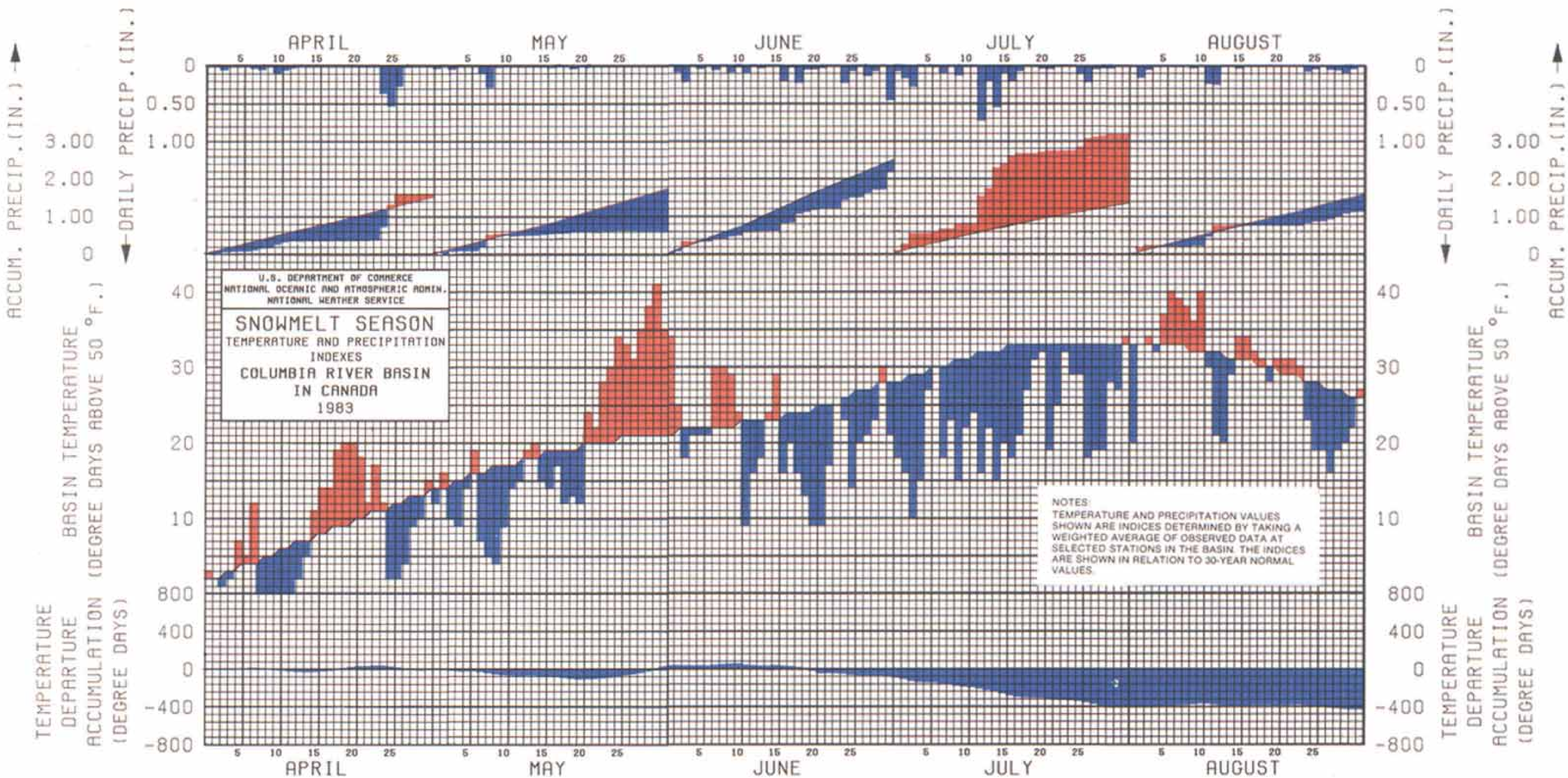

APRIL
MAY
JUNE
JULY
AUGUST
ACCUM. PRECIP. (IN.)
DAILY PRECIP. (IN.)
BASIN TEMPERATURE (DEGREE DAYS ABOVE 50 °F.)
TEMPERATURE DEPARTURE ACCUMULATION (DEGREE DAYS)
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMIN.
NATIONAL WEATHER SERVICE
SNOWMELT SEASON
TEMPERATURE AND PRECIPITATION INDEXES
COLUMBIA RIVER BASIN
IN CANADA
1983
NOTES:
TEMPERATURE AND PRECIPITATION VALUES SHOWN ARE INDICES DETERMINED BY TAKING A WEIGHTED AVERAGE OF OBSERVED DATA AT SELECTED STATIONS IN THE BASIN. THE INDICES ARE SHOWN IN RELATION TO 30-YEAR NORMAL VALUES.

Chart 5
Regulation of Mica
1 July 1982 - 31 July 1983

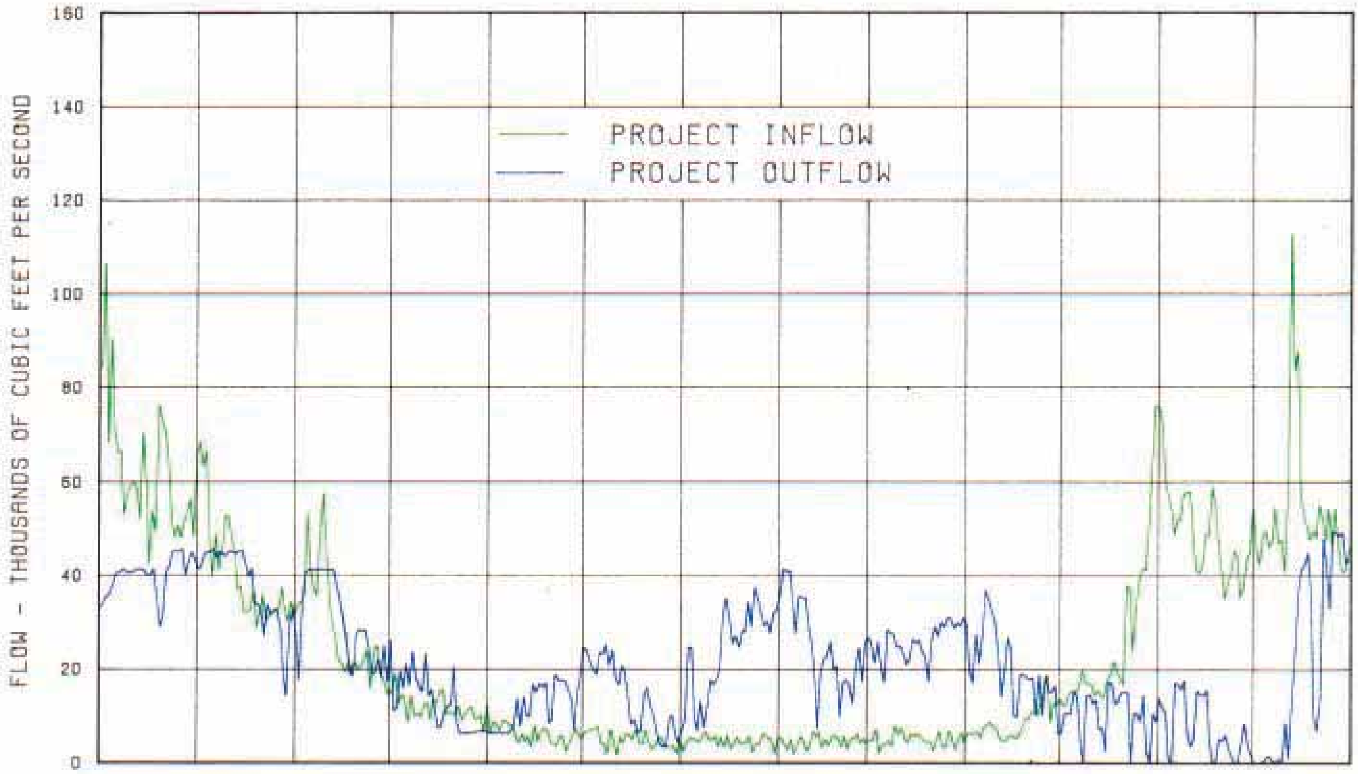


Chart 6
Regulation of Arrow
1 July 1982 - 31 July 1983

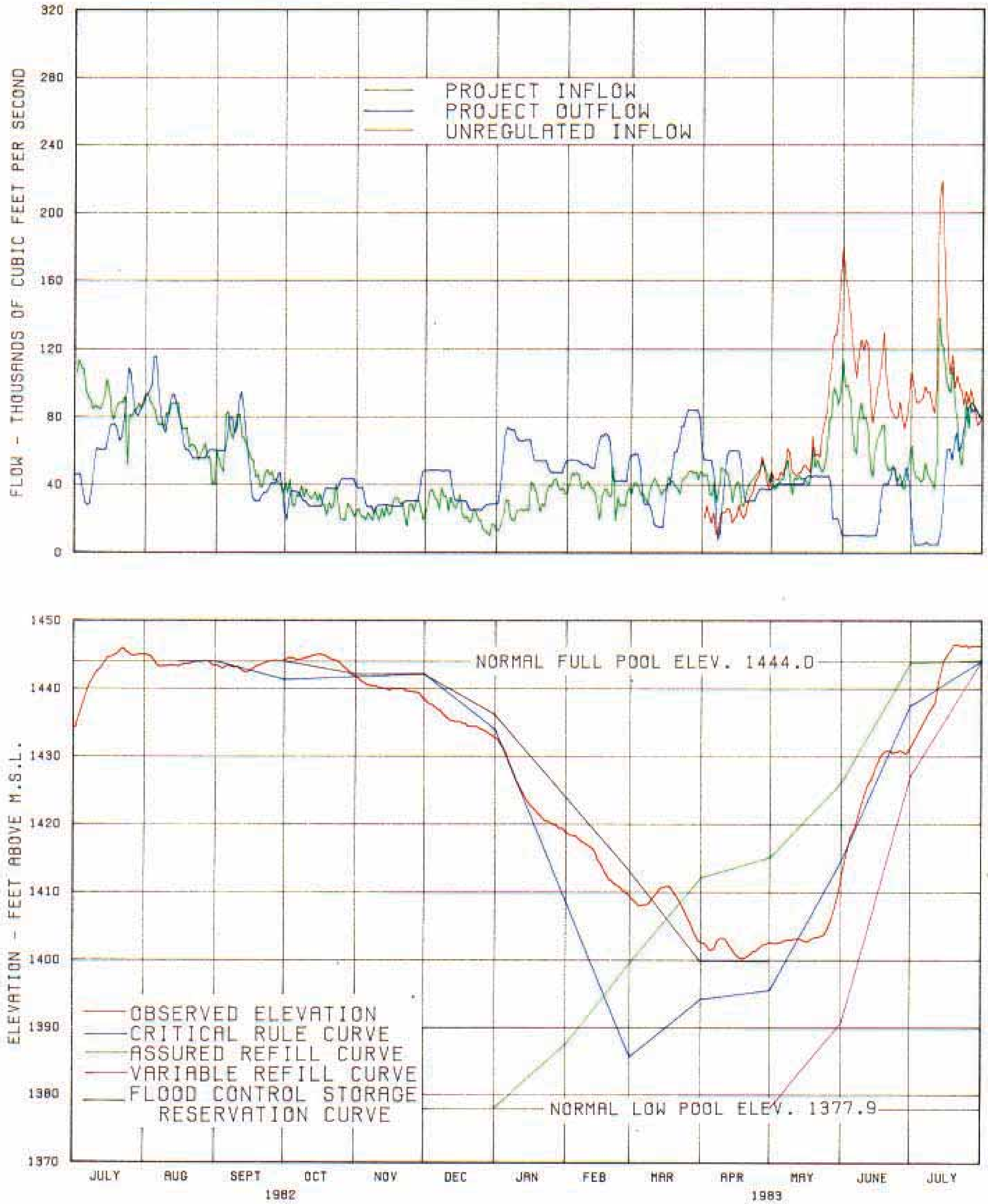
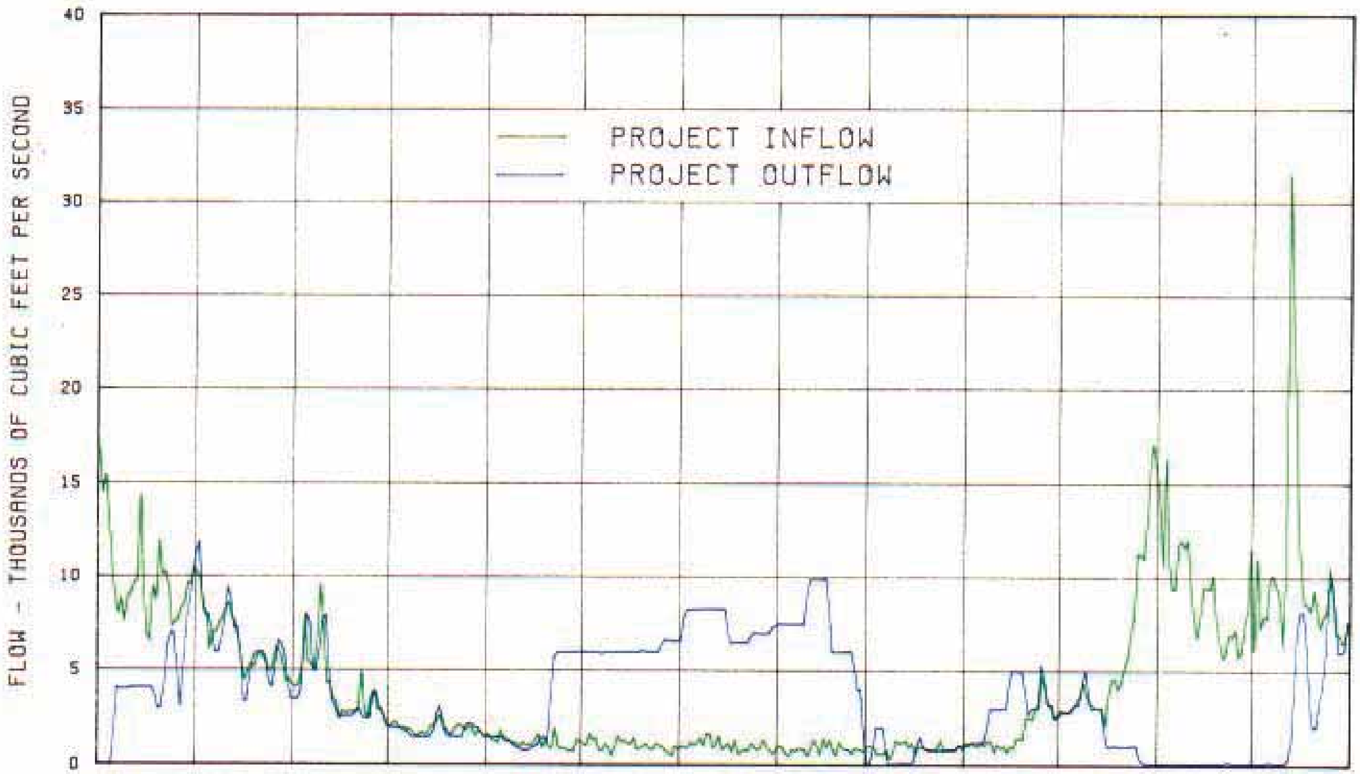


Chart 7
Regulation of Duncan
1 July 1982 - 31 July 1983



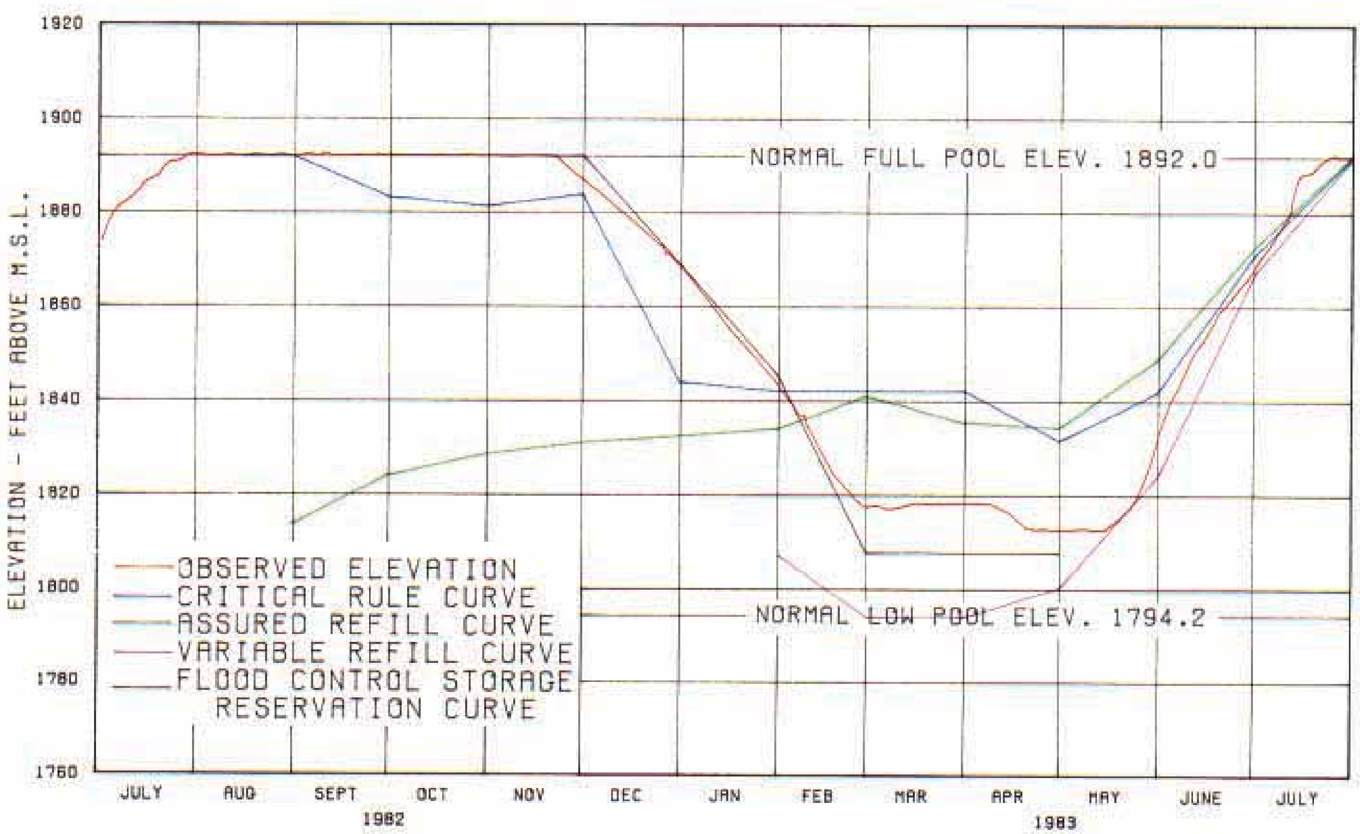


Chart 8
Regulation of Libby
1 July 1982 - 31 July 1983

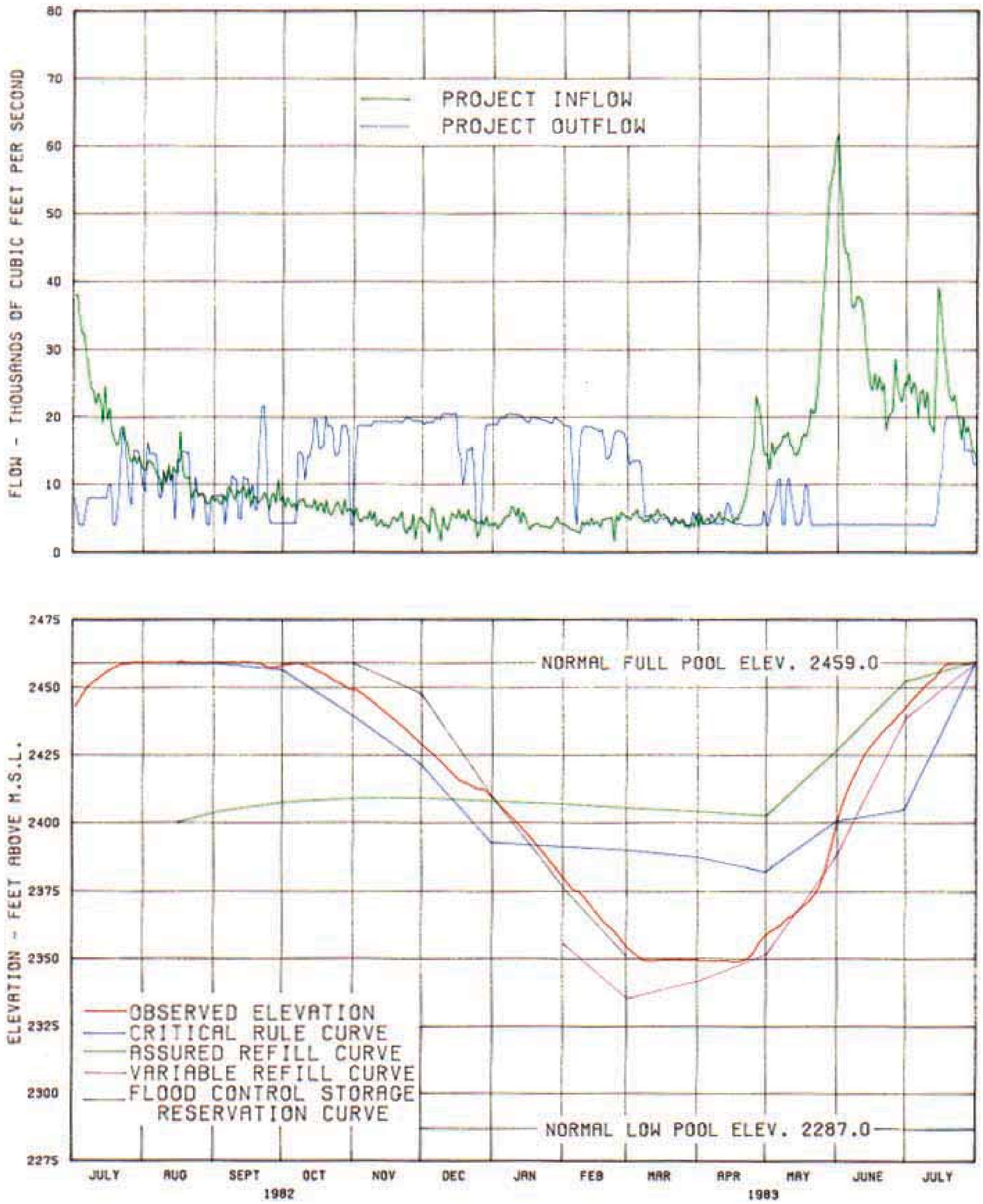
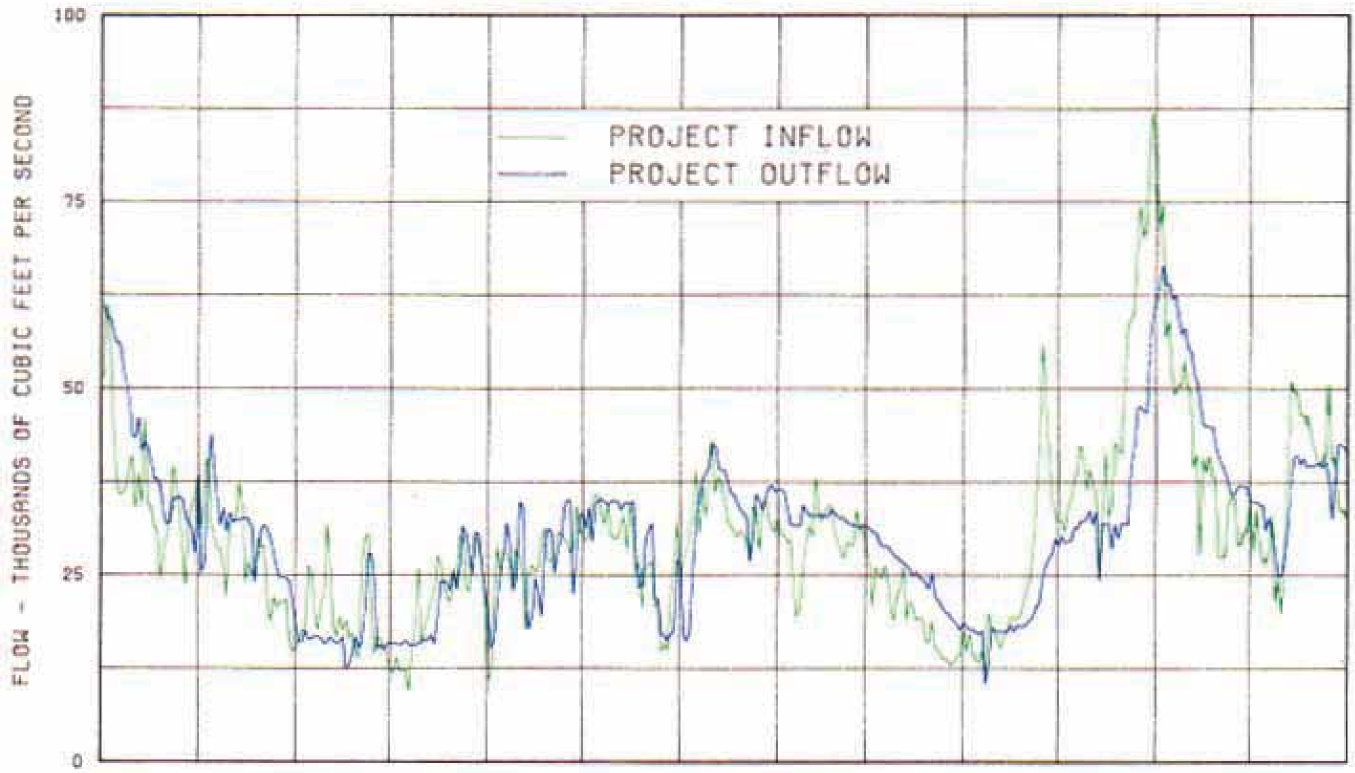


Chart 9
Regulation of Kootenay Lake
1 July 1982 - 31 July 1983



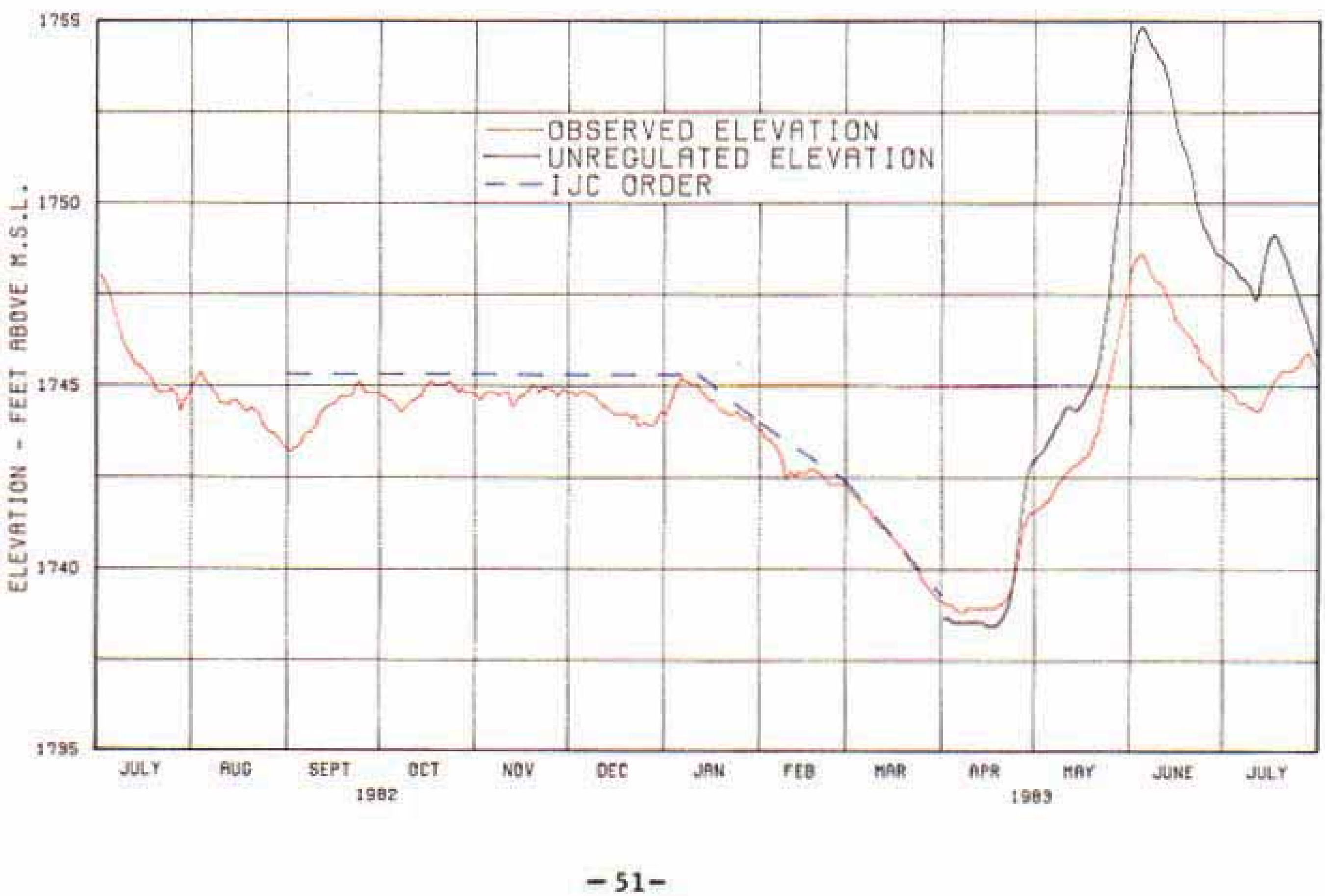


Chart 10
Columbia River at Birchbank
1 July 1982 - 31 July 1983

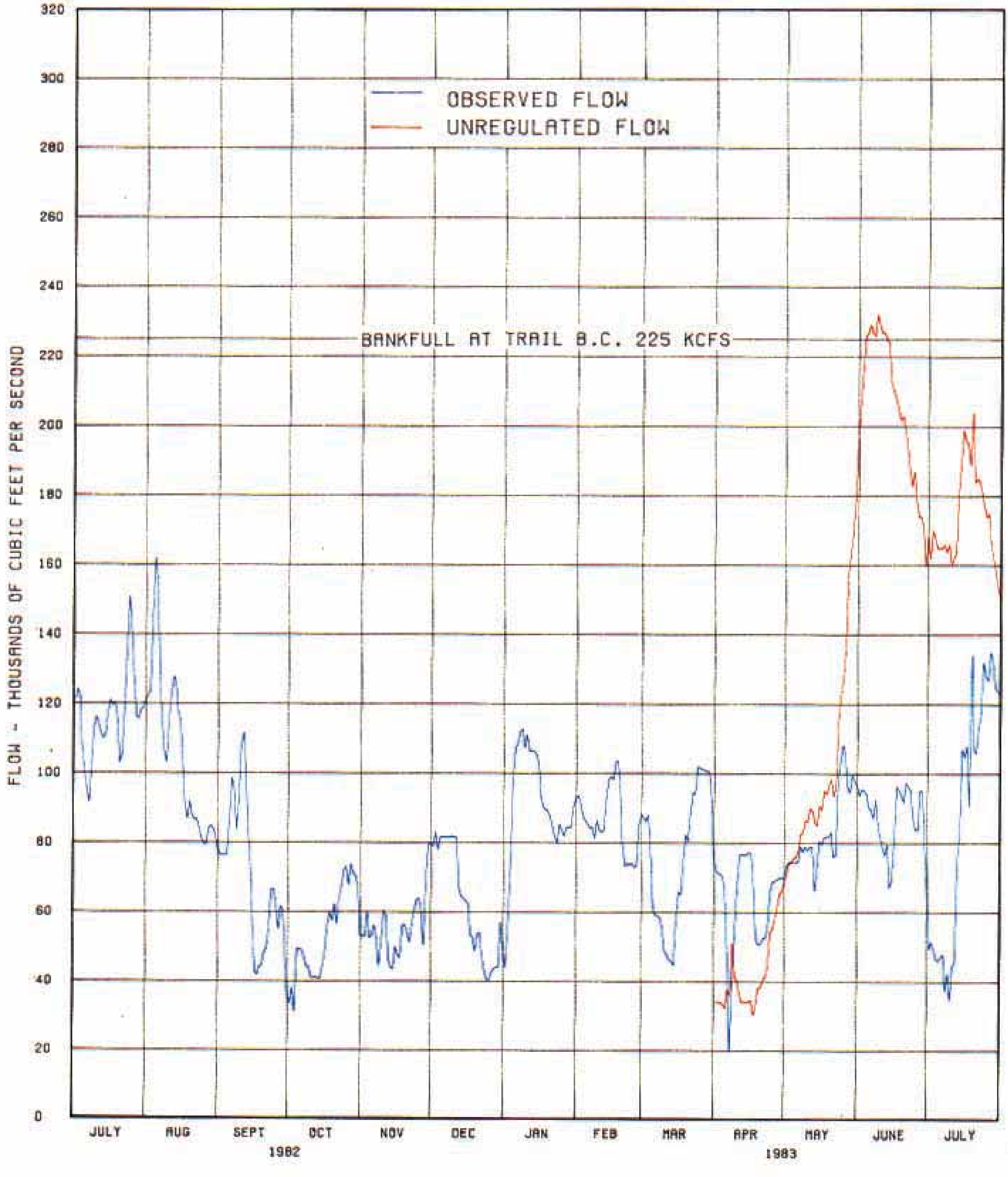
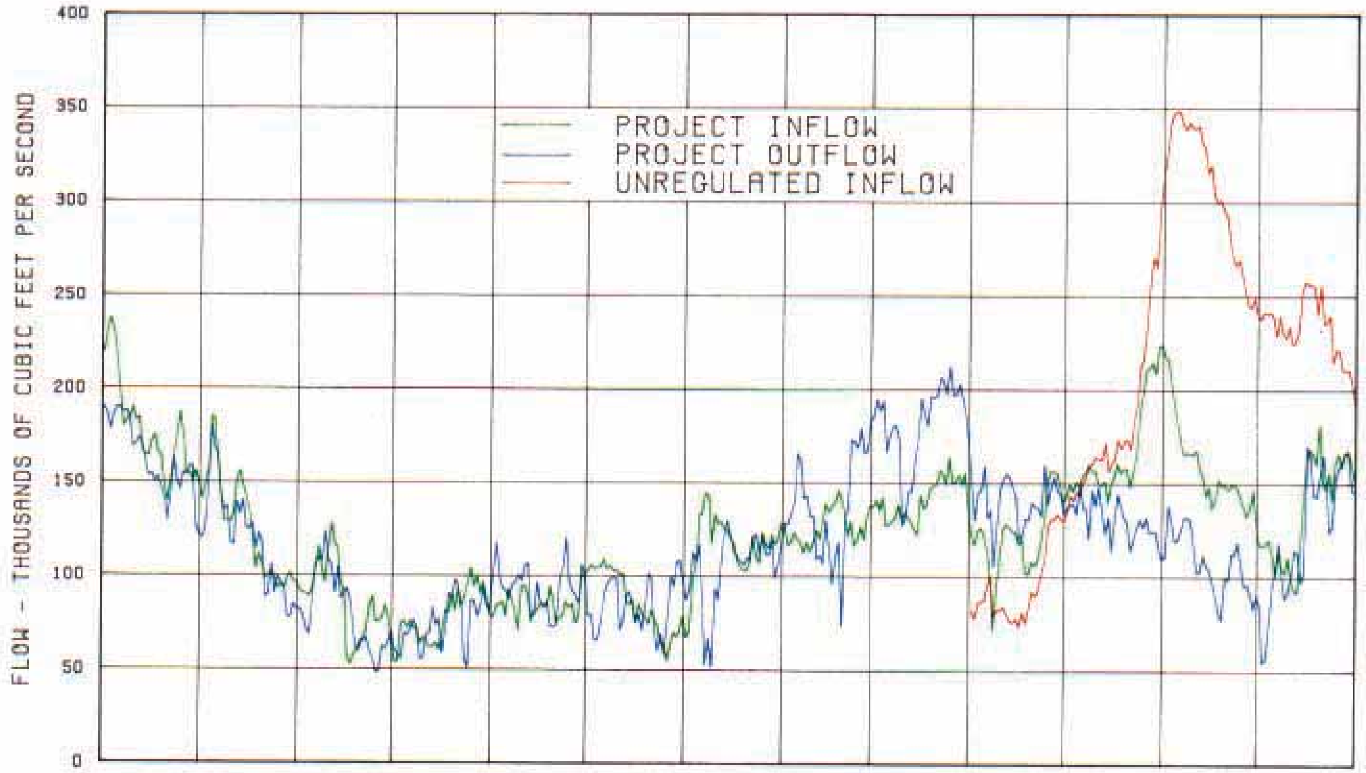


Chart 11
Regulation of Grand Coulee
1 July 1982 - 31 July 1983



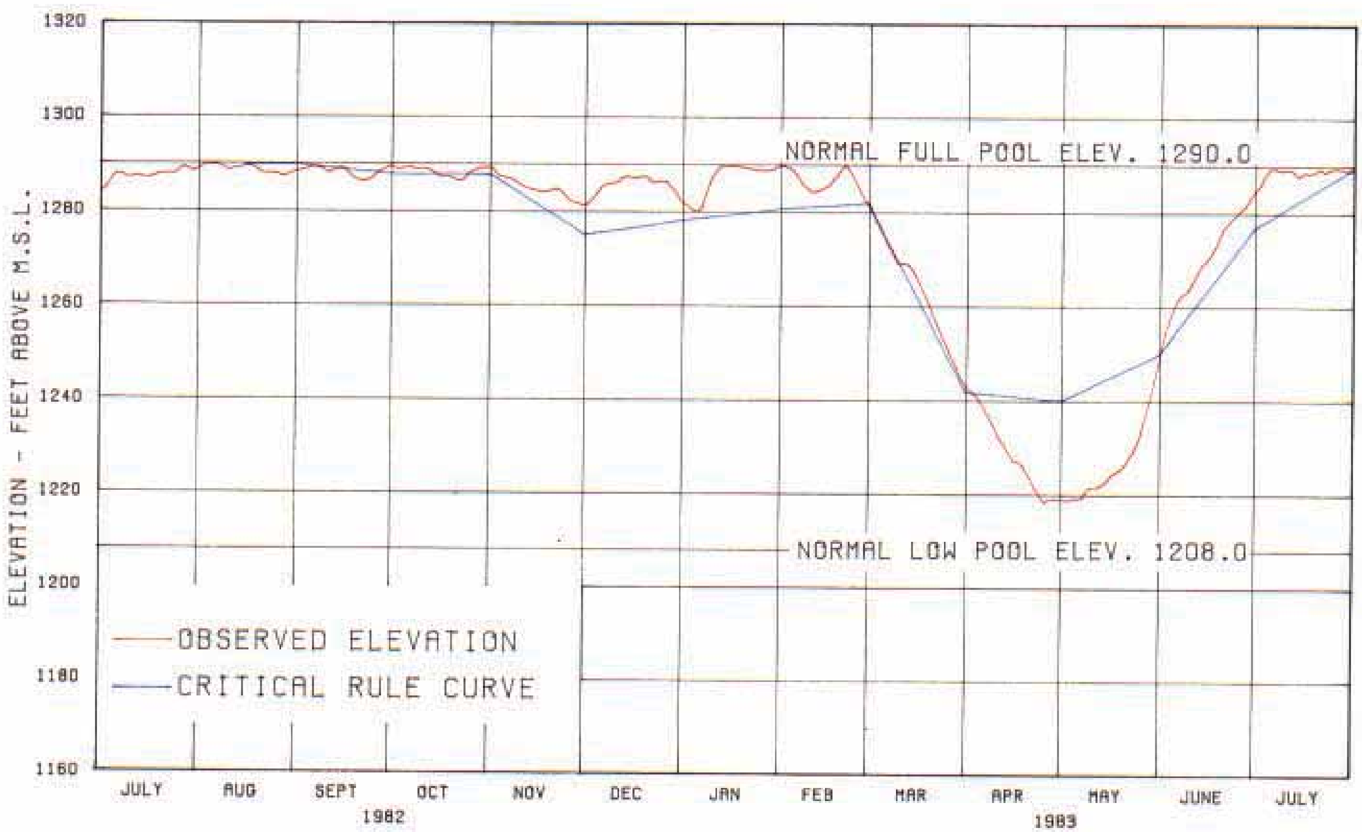


Chart 12
Columbia River at The Dalles
1 July 1982 - 31 July 1983

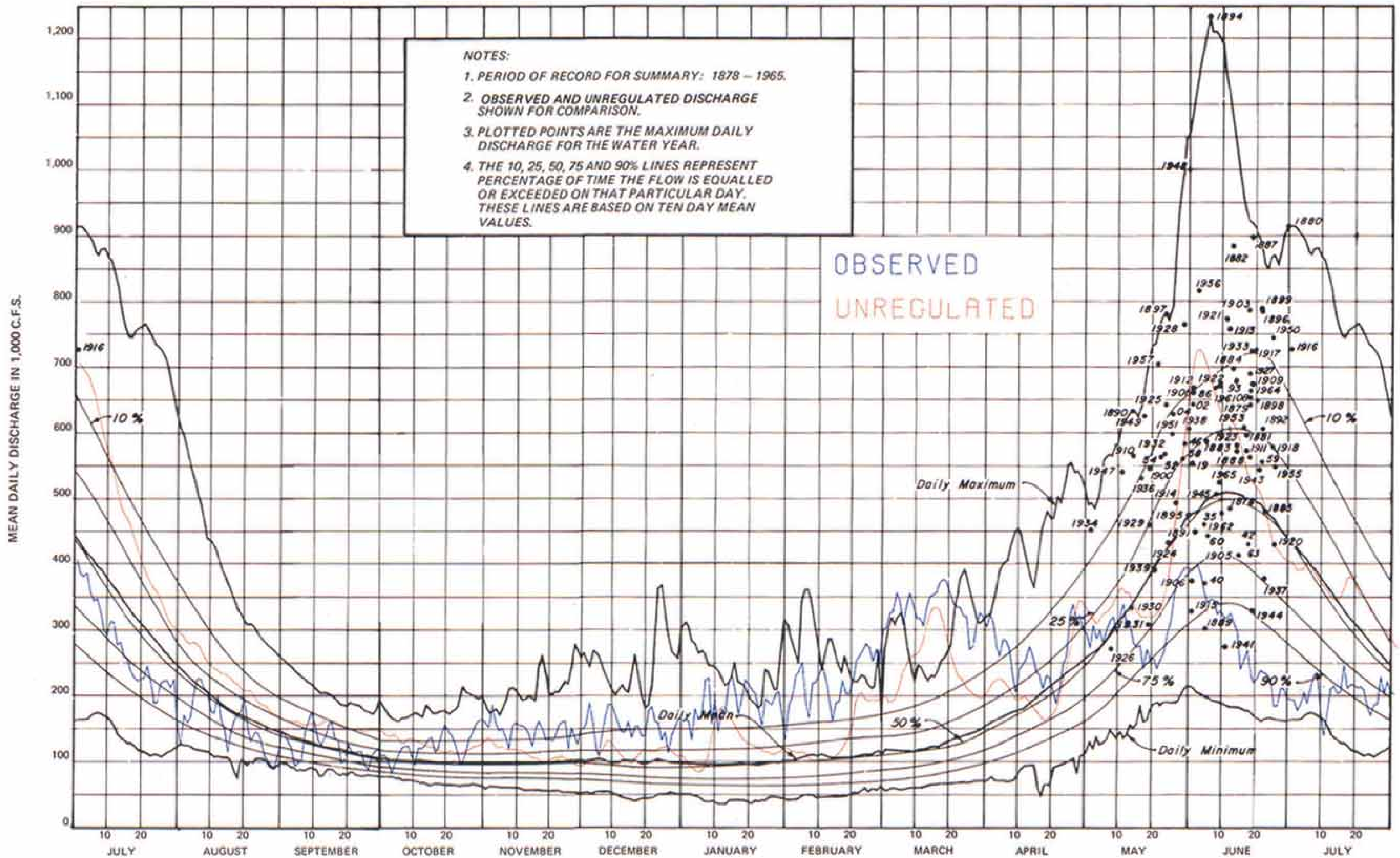


Chart 13
Columbia River at The Dalles
1 April 1983 - 31 July 1983

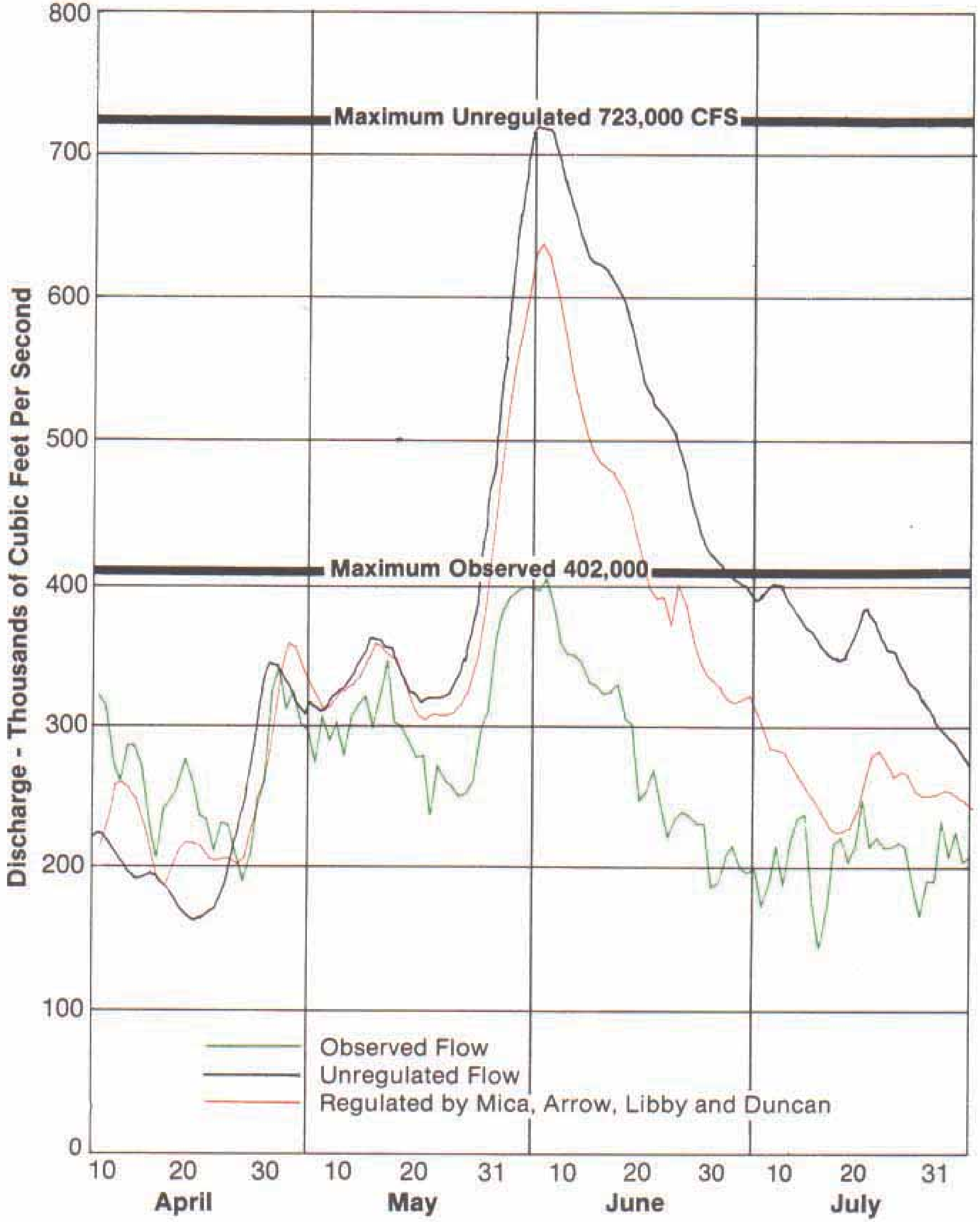
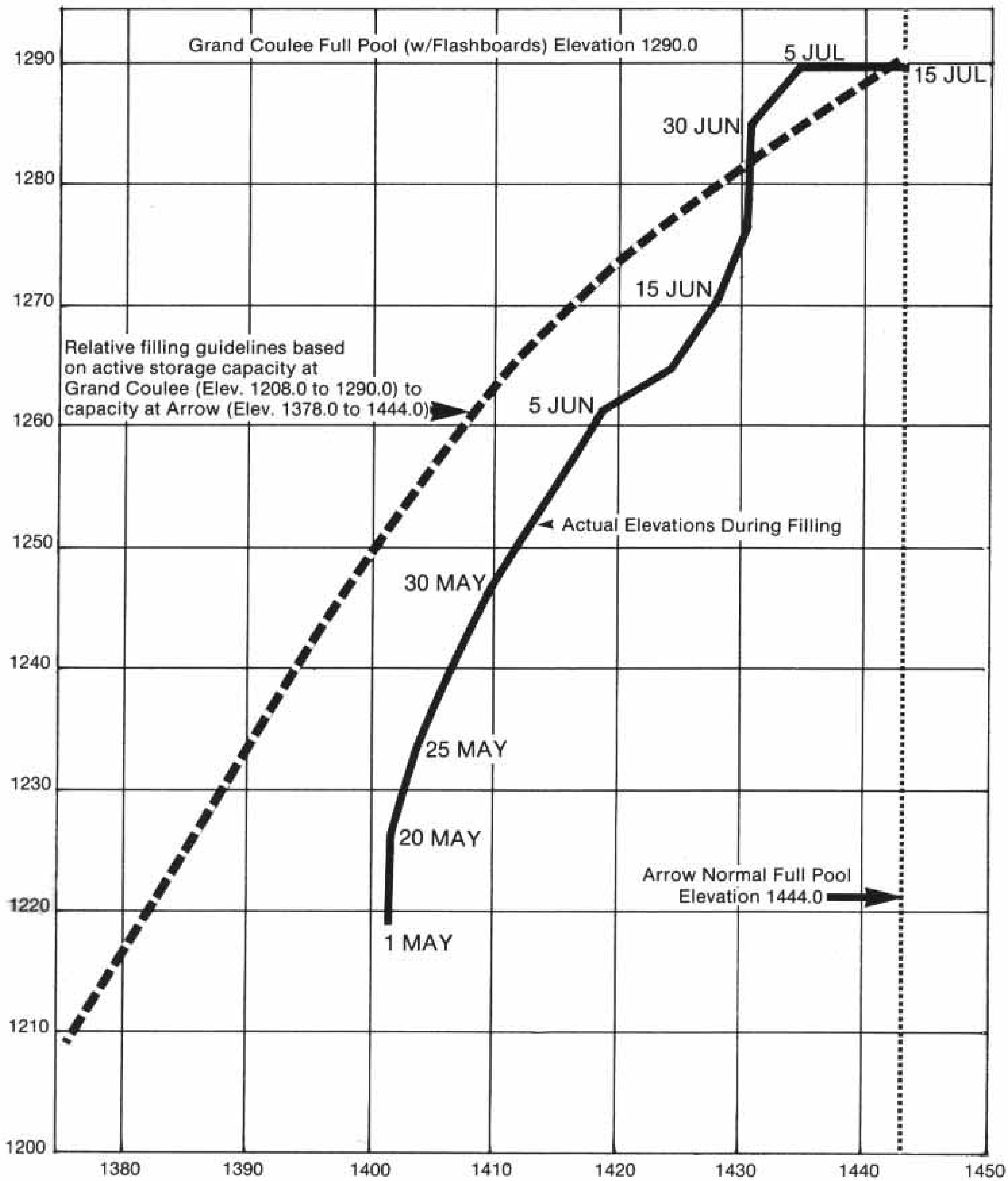


Chart 14

1983 Relative Filling Arrow and Grand Coulee



Arrow Lake Elevation-Feet above M.S.L.
(Avg. of Nakusp and Fauquier)

REFERENCES

The following documents governed the operation of the Columbia Treaty Projects during the period 1 August 1982 through 31 July 1983:

1. "Principles and Procedures or the Preparation and Use of Hydroelectric Operating Plans" dated 1 May 1979.

2. "Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operation Year 1982-83," dated September 1977.

3. "Detailed Operating Plan for Columbia River Treaty Storage - August 1982 through 31 July 1983," dated September 1981.

4. "Columbia River Treaty Flood Control Operating Plan," dated October 1972.