REPORT OF COLUMBIA RIVER TREATY CANADIAN AND UNITED STATES ENTITIES

For the period 1 October 1981 to 30 September 1982

October 1982

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INTRODUCTION

This report describes the activities of the Canadian and United States Entities during the period 1 October 1981 through 30 September 1982 in discharging their responsibilities for formulating and carrying out operating arrangements necessary to implement the Columbia River Treaty. It is the sixteenth 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, and the U. S. Army Corps of Engineers, North Pacific Division.

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 1981-82 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 1981-82," dated September 1976.

(b) "Detailed Operating Plan for Columbia River Treaty Storage - 1 August 1981 through 31 July 1982," dated September 1981.

(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 1981-82 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 1981-82 Assured Operating Plan prepared six years ago, was used as the basis for the preparation of the 1981-82 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 1981-82 and 1982-83, 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 three average annual megawatts of usable energy in 1981-82, 5.5 in 1982-83, 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 three average megawatts of energy during the period 1 August 1981 through 31 March 1982 and 5.5 average megawatts of energy during the period from 1 April through 31 July 1982. Suitable arrangements have been made between the Bonneville Power Administration and B. C. Hydro for delivery of this energy.

Attached to this report as Appendix D is the "Report on Operation of Columbia River Treaty Projects - 1 August 1981 through 31 July 1982 dated

October 1982." 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 1981 to 30 September 1982.

General

The Coordinated System started the 1981-82 operating year with full reservoirs. BPA found its firm energy resources 320 average megawatts short of estimated firm loads and made arrangements to buy that quantity of energy for the operating year. By October, the weather had turned wet and cool, with precipitation greater than average and streamflows greater than normal. November was mild and mostly wet, and streamflows continued at greater than normal. The interruptible portion of BPA's direct service industrial load was carried with advance energy, which has the provision that it may have to be returned if it is subsequently needed for firm loads.

Precipitation was well above average in December, and streamflows over most of the basin persisted at above average levels. There was some flooding in early December in the Willamette and Rogue basins in Oregon. BPA's supply to the interruptable industrial load was switched from advance energy to direct non-firm service in early December, and this service continued through the remainder of the operating year.

The first available forecast of snowpack was on January 1, and it indicated that the basin-wide runoff through 31 July would be 94 percent of normal. The subsequent monthly updates for that forecast had an upward trend. The actual January-July runoff at The Dalles was 129.9 MAF, 119 percent of the 1963-77 average. There were near record sales of secondary energy to Southwest utilities during the 8 December - 31 July period. The Coordinated System was virtually full on 31 July, erasing any debits in the advance energy accounts for BPA's industrial customers.

The fisheries program to assist in the downstream migration of juveniles began in April. During May and June, BPA stored in the B. C. Hydro system 504,169 megawatthours of overgeneration, resulting from the flow requirements of the fish migration. That energy is still in the B. C. Hydro system.

BPA and B. C. Hydro concluded an agreement prior to the start of the operating year to store in the two feet of surcharge at Arrow Lakes and to equally share the resulting benefits of the downstream generation. B. C. Hydro released its share of the storage and took delivery of the associated energy during September; BPA in December.

Canadian storage was put on flood control operation mid-February to alleviate the effect of heavy rains on the mid- and lower Columbia River stages. This was the earliest date in the year for the shift from power to flood control operation and daily storage requests, as compared to weekly; and this persisted for several weeks. The operation was coordinated with the need to disperse mill effluents downstream from Arrow Lakes and the IJC requirements for the operation of Kootenay Lake. During the spring freshet, flood control was provided by the normal refill schedule of the Coordinated System reservoirs. The unregulated peak at The Dalles was 750,000 cfs, which would have been about ten feet above bankfull capacity at Vancouver, Washington. The maximum observed daily discharge at The Dalles was 422,000 cfs on 20 June.

Mica Reservoir

Mica began the 1981-82 operating year with its Treaty storage full and surcharged above that level during August to protect the Revelstoke diversion. The reservoir elevation was held steady for most of September and drafted for Treaty releases in October. A slight imbalance of the distribution of Treaty storage between Mica and Arrow occurred in the first half of November when Mica generation was curtailed due to lack of B. C. Hydro system load. Storage draft resumed, and balance was restored by mid-January.

Project discharges were reduced for parts of five days during April to enable a logging company to transport logs across the river. On 4 May, the reservoir reached elevation 2413.3 feet, its lowest level for the year. The filling schedule was interrupted for two days in June to pass 30,000 cfs to facilitate flow measurement at Revelstoke. In late June and thereafter, the discharge was controlled to protect the Revelstoke diversion, causing spill at Mica for the entire month of July and first half of August. Treaty storage refilled by the end of the operating year and on 30 September the reservoir was at elevation 2470.8 feet.

Arrow Reservoir

Arrow Lakes began the operating year with full Treaty storage and two feet of surcharge pursuant to the storage agreement between BPA and B. C. Hydro. B. C. Hydro drafted its share of the surcharge and took delivery of the associated energy in September; BPA did so in December. Arrow was operated for flood control in both December and February. In early May, discharge was reduced to permit the City of Trail to install pipes for its water supply system. The reservoir reached its lowest elevation of the year, 1382.9 feet on 14 May. In early July, discharges were reduced to allow divers to replace the steel cables joining the debris boom and the floating guidewall. The reservoir refilled by the end of the operating year. It was held full through summer and on 30 September was at elevation 1443.7 feet.

Duncan Reservoir

Duncan started the operating year with a full reservoir. Drafting of the reservoir started in late September, but discharges were reduced in October and November to control Kootenay Lake inflow and reduce spill at Brilliant. From early November to early February, the reservoir was drafted to meet flood control evacuation requirements. Flows during parts of February and March were reduced to prevent Kootenay Lake from exceeding the IJC rule curve. The reservoir reached its Flood Control Rule Curve elevation of 1807.8 feet by 12 April. Filling commenced by mid-May and the reservoir reached full pool by the end of the operating year. It was held full at elevation 1892.0 feet through August and September.

Libby Reservoir

Libby started the operating year with full reservoir. Drafting occurred from September through November to meet U. S. power requirements. The storage draft accelerated from December through mid-February and moderated through April for power and flood control. The lowest elevation for the year was 2342.1 feet on 24 April. The reservoir refilled by the end of the operating year and was held full during August and September. On 30 September it was at elevation 2457.9 feet.

COMMITTEE ACTIVITIES

Hydrometeorological Committee

The Hydrometeorological Committee discussed operating problems arising from data transmission being late and infrequent. The U. S. Section requested more frequent data and transmission to be as near to real time as possible. Automation of the data exchange is contributing to the achievement of these goals.

Installation of data collection platforms has increased substantially in Canada, and more are planned in 1982 and 1983. Remote data is collected by the platforms, transmitted to B. C. Hydro's Burnaby Mountain Control Center, and then relayed by BPA microwave to the Corps of Engineers' Columbia River Operational Hydromet System in Portland. A dedicated microwave channel is expected to be in operation soon. Updating will be hourly, if possible, subject to data availability.

The "Plan for Exchange of Operational Hydromet Data" was reviewed and will be updated when the changes in the Canadian hydromet data handling facilities are completed. "Columbia River Treaty, Hydrometeorological Committee Documents" is also being updated and it is anticipated that it will be re-issued in 1983.

The 1982 volume forecast was reviewed. The 1 April forecast of runoff at The Dalles was 130 MAF, almost exactly the actual runoff of 129.9 MAF.

The U. S. Section inquired about establishing additional hydromet stations in the Columbia River basin in British Columbia. The Canadian Section recommended that they deal directly with the B. C. Ministry of Environment.

The U. S. Section will also investigate acquiring additional data from B. C. including all or portions of the output of the program FLOCAST, as applicable to the Columbia River drainage in Canada, and satellite derived snow cover data for the Mica drainage.

Operating Committee

The Operating Committee coordinated the operation of the Treaty storage in accordance with the current hdyroelectric 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 1981 through 31 July 1982."

The Committee also prepared the Entity agreements listed in Appendix C and assured that the implementation of the "Arrow Lakes Storage Agreement," signed by the Entities on 24 June 1981, was consistent with the operating plans.

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 20 November 1981 in Seattle, Washington.

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. R. FORREST

Manager
Candian 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

CHARLES E. CANCILLA, SECRETARY

Bonneville Power Administration
Portland, Oregon

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	C. E. CANCILLA (BPA)
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) 1/ 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 R. C. Lamb, 6 November 1981.

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 1986-87 dated September 1981	20 November 1981
Determination of Downstream Power Benefits resulting from Canadian Storage for Operating Year 1986-87 dated September 1981	20 November 1981
Detailed Operating Plan for Columbia River Treaty Storage, 1 August 1981 through 31 July 1982 dated September 1981	20 November 1981

APPENDIX D

REPORT ON

OPERATION OF COLUMBIA RIVER

TREATY PROJECTS

1 AUGUST 1981 through 31 JULY 1982

REPORT ON

OPERATION OF COLUMBIA RIVER

TREATY PROJECTS

1 AUGUST 1981 through 31 JULY 1982

COLUMBIA RIVER TREATY OPERATING COMMITTEE

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

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

C. E. Cancilla
Bonneville Power Administration
Member, U. S. Section

G. G. Green
Corps of Engineers
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

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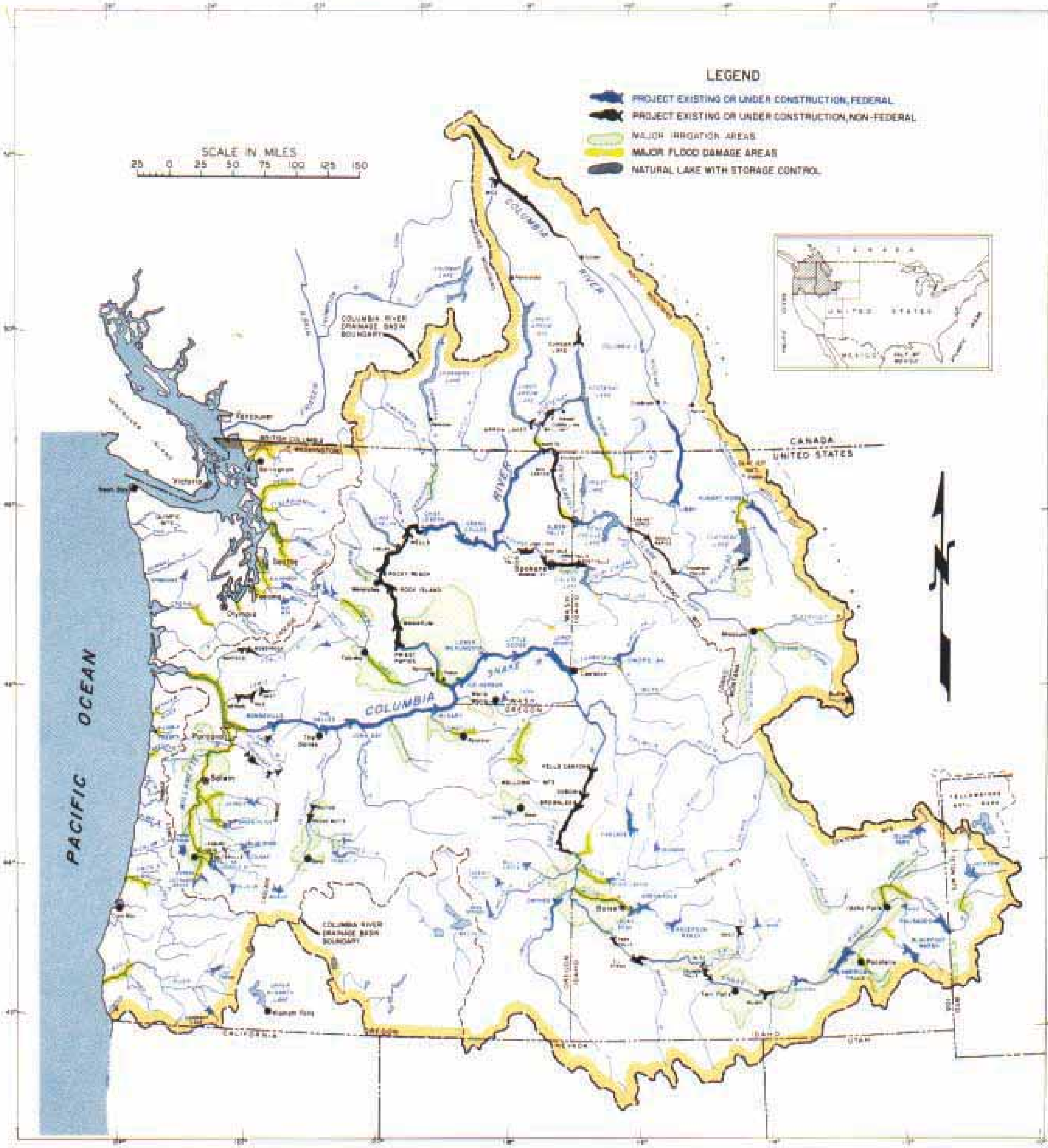


REPORT ON

OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1981 THROUGH 31 JULY 1982

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 1981 through 31 July 1982, including the major effects downstream in Canada and in the United States of America.

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 1981. 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 hot and dry weather of August 1981 continued through to mid September then switched to a wetter pattern the last two weeks of the month. The basin-wide weather continued moderately wet and cool in October with precipitation slightly above average. Mild and wet conditions prevailed throughout the Pacific Northwest during November with temperatures averaging 2 to 6 degrees above normal and precipitation slightly below normal. December precipitation was well above average except in the portion of the basin above Grand Coulee, which was only slightly above normal. Colder temperatures near the end of December resulted in heavy snowpack accumulations throughout the southern half of the basin. January 1 snow surveys indicated that conditions ranged from much above normal to below normal. Basin wide, the snowpack was at 94 percent of the January 1 normal.

A cool and damp January brought the precipitation index to 113 percent of normal for the Columbia Basin above The Dalles. Substantial increases occurred in the northern basin snowpack where January storms added above normal accumulations. As a result the basin-wide snowpack increased to 107 percent of average by 31 January. February was a very wet month over most of the Pacific Northwest. The Columbia River above The Dalles received 146 percent of the average February precipitation. However, because of the accompanying warm temperatures, most of the precipitation ran off, adding very little to the snowpack. The basin snowpack on 1 March stood at 110 percent of normal with most of the increase occurring in the Canadian portions of the basin. March precipitation remained above normal throughout the northern regions and the Snake River Basin, further increasing the snowpack to 113 percent of normal as of 1 April. April weather was quite variable, cold and wet for the first half and cool and dry the second half. The cooler temperatures delayed the snowmelt somewhat with heavy snowpacks persisting over most watersheds. A cool and dry May allowed for the normal depletion of the low and middle elevation snowpacks but left above normal upper elevation snowpacks to continue contributing runoff throughout a warm and generally dry June.

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 above normal for most of the Pacific Northwest. Many Oregon and Idaho watersheds recorded much 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 Basins above The Dalles, Oregon. Above normal amounts accumulating during each winter month yielded 124 percent of normal 1 May basin wide snowpack.

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. The mild May, June, and July weather sustained the melt season this year.

B. STREAMFLOW

Streamflow in August and September was generally below normal in the U. S. coastal and Snake River basins, and above normal in the British Columbia river basins. All other areas reported near average streamflow.

Fall rains brought many basins west of the Cascades to above normal flows in October and November, although the upper Snake and portions of the Flathead and Clearwater basins remained below normal levels. Early December storms brought flooding in the Willamette and Rogue River basins and above average streamflows across much of Oregon. The rest of the northern and eastern basins reported near normal streamflows, except for continuing below normal flows in the Flathead.

Streamflow was generally less than average across most of the Northwest during January. Stations in western Montana, northern Idaho, Wenatchee, Chelan, Similkameen, and Owyhee basins reported flows much below normal. A change to a warm and wet weather pattern in mid February resulted in well above average streamflows over all regions except for the Similkameen River and northern Columbia and Kootenay River basins in British Columbia. In mid-February Columbia River stages at Vancouver, Washington reached flood levels as the result of high streamflows in the Lower Snake and Lower Columbia River tributaries. During March streamflows were near average along the Pacific Coast and at most high elevation stations in British Columbia, Montana, and Idaho. Most stations in the interior regions reported greater than average flows. April flows were above average in the southern and western regions, grading to average in many interior areas, and below average in the northern and eastern high elevation zones. June and July streamflows returned to near normal over all but the Snake and Clark Fork basins, which had above average flows on into the summer.

The 1981-1982 monthly modified streamflows and average monthly flows for the period 1926-1982 are shown in the following table for the Columbia River at Grand Coulee and 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

	Columbia River at Grand Coulee		Columbia River at The Dalles	
Month	Year 1981-1982	Average 1926-1982	Year 1981-1982	Average 1926-1982
AUG	128,300	97,690	154,100	133,480
SEP	63,180	60,250	86,220	92,580
OCT	51,320	51,080	84,500	88,260
NOV	49,200	46,420	84,000	90,750
DEC	42,010	43,620	95,610	95,530
JAN	35,490	38,650	88,420	91,700
FEB	78,970	42,050	203,400	105,150
MAR	73,390	48,660	184,600	119,660
APR	43,980	114,510	225,800	217,320
MAY	264,100	266,400	465,500	417,670
JUN	407,200	314,990	634,200	469,030
JUL	232,900	187,300	347,400	253,640
YEAR	126,670	109,300	221,150	181,230

The maximum mean monthly modified streamflow for the Columbia River at Grand Coulee occurred as usual in June this year and was 129 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 135 percent of the long-term average.

Maximum observed mean daily inflows during the 1981-82 operating year were 97,200 cfs at Mica on 21 June, 118,000 cfs at Arrow on 22 June, 18,800 cfs at Duncan on 22 June, and 62,600 cfs at Libby on 15 June. The maximum observed mean daily flow in the Columbia River at The Dalles was 422,000 cfs on 20 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 1982, 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 spring precipitation.

Observed 1982 April-August runoff volumes, adjusted to exclude the effects of regulation of upstream storage, are listed for eight locations in the following tabulation:

Streamflow and Location	April - August Runoff	
	Thousands of Acre-Feet	Percent of 1963-77 Average
Libby Reservoir Inflow	6530	96
Duncan Reservoir Inflow	2160	103
Mica Reservoir Inflow	11981	101
Arrow Reservoir Inflow	24969	105
Columbia River at Birchbank	44362	105
Grand Coulee Reservoir Inflow	69070	108
Snake River at Lower Granite Dam	32910	134
Columbia River at The Dalles	111330	114

III. RESERVOIR OPERATION

A. MICA RESERVOIR

Storage Evacuation Period. As shown in Chart 5, Kinbasket Lake (Mica Reservoir) was filled to elevation 2470.5 feet, slightly above its target full pool elevation of 2470.4 feet by 29 July 1981. The project began spilling on 31 July as the inflow exceeded the hydraulic capacity of the turbines. Inflows during August were well above average and Mica Reservoir was surcharged to elevation 2472.0 feet from 12 through 29 August as the project releases were controlled to protect the Revelstoke diversion.

Inflow into Mica reservoir began to recede in early September 1981. Between 6 September and early October, the reservoir level was maintained near elevation 2471.0 feet. Treaty storage release began on 2 October and the project was drafted to elevation 2466.9 feet, approximately 2 feet above its Operating Rule Curve, by 31 October.

Generation at Mica was curtailed during the first two weeks in November 1981 due to reduced B. C. Hydro system load. This reduced the Mica project outflow below its release schedule as specified in the Detailed Operating Plan and created an imbalance in Treaty storage distribution between Mica and Arrow Reservoirs of approximately 148,790 sfd at Mica by 15 November. During this period Mica Reservoir was held level near elevation 2467.0 feet.

Storage drafts resumed after 15 November 1981 with the project outflows varying between 15,000 cfs and 37,000 cfs as necessary to deliver Treaty storage to the U. S., and to meet B. C. Hydro's system load requirements. The Treaty storage imbalance between Mica and Arrow Reservoirs was reduced to zero by 14 January 1982, when Mica Reservoir was at elevation 2445.9 feet, or approximately four feet above the Operating Rule Curve.

The project continued to draft from January through April 1982 except for one period of approximately two weeks in the latter part of February and another period from 26 March to 13 April when Mica generation and discharge were curtailed due to reduced B. C. Hydro system load.

Beginning 24 April 1982 and lasting for about five days, Mica outflow was reduced to approximately 5,000 cfs for part of each day to enable a logging company to transport logs across the Columbia River. On 4 May, Mica discharge was increased to full turbine capacity, drafting the reservoir to elevation 2413.3 feet, its lowest level for the year, on 10 May.

Refill Period. The project began to fill on 11 May 1982 as a result of higher inflow and reduced project discharges. Mica Reservoir reached elevation 2421.9 feet on 31 May. On 21 and 22 June, Mica outflow was increased to 30,000 cfs to facilitate flow measurement at the Revelstoke Project site. The project outflow was then reduced to 10,000 cfs, allowing the reservoir to continue filling. Reservoir inflow peaked at 97,200 cfs on 21 June. To reduce the possibility of high releases in late July which would endanger the Revelstoke diversion, Mica outflows were increased above 10,000 cfs beginning 27 June and thereafter controlled the project outflow to maintain the discharge at Revelstoke below 75,000 cfs. Since the higher project outflows were in excess of B. C. Hydro's system load requirements, Mica spilled through the entire month of July and the first half of August. On 31 July, Mica Reservoir was at elevation 2470.8 feet, slightly above its target full pool elevation of 2470.4 feet.

B. ARROW RESERVOIR

Storage Evacuation Period. As shown in Chart 6, Arrow Reservoir was filled to elevation 1443.9 feet on 30 June 1981 and surcharged to elevation 1446.0 feet on 13 July. The reservoir storages included full Treaty storage (3,579,600 sfd), 66,050 sfd of U. S. Arrow storage and 66,050 sfd of Canadian Arrow storage. The additional Arrow storages were surplus water stored at Arrow as per the agreement (Contract No. DE-MS79-81BP90329) between B. C. Hydro and BPA.

During August 1981, as Mica Reservoir was surcharged above the target full pool elevation 2470.4 feet, Arrow Reservoir was drafted to near elevation 1445.0 feet, maintaining full Treaty storage plus Arrow surcharge in the system. The inflow into Arrow Reservoir began to recede in early September and on 10 September, B. C. Hydro began releasing from Arrow Reservoir its share of the Arrow surcharge storage (Canadian Arrow storage) along with Treaty storage releases. The release of the Canadian Arrow storage and the delivery of the resulting energy was completed by 30 September when the reservoir was at elevation 1442.7 feet, slightly above its Operating Rule Curve.

Between 5 October and 7 November 1981, Arrow Reservoir was held fairly level near elevation 1441.0 feet with the project discharges varying between 22,000 cfs and 38,000 cfs. Storage draft resumed mid-November and by 30 November Arrow Reservoir was drafted to elevation 1440.4 feet, slightly below its Flood Control Rule Curve.

During December, Arrow Reservoir was operated to meet flood control drawdown requirements with project releases varying between 38,000 cfs and 53,000 cfs. The storage releases included the release of the U. S. Arrow storage which began on 20 December and ended on 31 December.

Arrow discharge was increased to between 50,000 cfs and 65,000 cfs in January 1982, drafting the reservoir to elevation 1420.6 feet by 31 January. About mid-February rains and low elevation snowmelt produced unusually high flows in the lower Columbia River and Arrow was required to reduce its discharge for flood control purposes beginning February 17. Project outflow was at minimum discharge 5,000 cfs for the period 19 through 23 February. Reduced outflows for flood control resulted in Arrow Reservoir filling about seven feet above its Flood Control Rule Curve by 28 February. From 17 February through 10 April, Arrow discharges were based on daily requests made by the U. S. for flood control operations on the lower Columbia River.

Reservoir drawdown resumed 7 March 1982 and continued through April. Project outflows were between 60,000 cfs and 75,000 cfs during this period, drafting the reservoir to elevation 1384.0 feet by 30 April. During the period from 1 to 3 May, Arrow discharge was reduced to 25,000 cfs for part of each day to permit the City of Trail to install pipes for its water supply system in the Columbia River.

Beginning 5 May 1982, Arrow Reservoir went on free flow discharging approximately 50,000 cfs. The reservoir was drafted to elevation 1382.9 feet by 14 May, its lowest level for the year.

Refill Period. Refilling of Arrow Reservoir began 19 May 1982 when the project outflow was reduced from free flow to 40,000 cfs. Between 28 May and 28 June, Arrow releases were maintained at 15,000 cfs. Arrow Reservoir filled rapidly to elevation 1394.0 feet by 31 May and 1433.0 feet by 30 June. Daily average regulated inflow peaked at 118,000 cfs on 22 June. For the period 5 through 7 July, Arrow discharge was reduced to 15,000 cfs during part of each day to reduce the flow velocity, allowing divers to replace the steel cables joining the debris boom and the floating guidewall at the Keenleyside project. The reservoir continued to fill through July reaching a peak elevation 1445.4 feet on 22 July but was then drafted to elevation 1444.4 feet, slightly above its normal full pool, by 31 July.

C. DUNCAN RESERVOIR

Storage Evacuation Period. As shown in Chart 7, Duncan Reservoir was filled to full pool elevation 1892.0 feet on 14 July 1981. The project then discharged inflow to maintain full pool through to early September. On 20 September, Duncan discharge was increased to 7,000 cfs, drafting the reservoir to elevation 1886.9 feet by 30 September. Beginning 2 October and continuing through 7 November, Duncan outflow was reduced to control Kootenay Lake inflow and thereby help reduce spill at the Brilliant project. As a result, Duncan refilled to elevation 1889.2 feet, approximately eight feet above its Operating Rule Curve, by 7 November. Between 8 November and early January 1982, the project was drafted to meet the flood control drawdown requirement with the project outflows varying between 3,000 cfs and 6,000 cfs. On 31 December, Duncan Reservoir was slightly below Flood Control Rule Curve of elevation 1868.6 feet.

Increasing its discharge to between 8,000 cfs and 10,000 cfs, Duncan continued to be operated to meet flood control drawdown requirement during January and early February 1982. Between 18 and 24 February, Duncan outflow was reduced to inflow to prevent Kootenay Lake from exceeding the International Joint Commission (IJC) Rule Curve. Storage draft resumed on 25 February but was interrupted for about twelve days beginning 12 March when the project outflow was again reduced to inflow to keep Kootenay Lake below the IJC Rule Curve.

Duncan Reservoir was drafted to near its Flood Control Rule Curve elevation 1807.8 feet by 12 April 1982 and thereafter discharged inflow to maintain the reservoir level near the Flood Control Rule Curve.

Refill Period. The project outflow was reduced to 4,000 cfs on 17 May 1982 and Duncan Reservoir began to fill. On 28 May, the project outflow was further reduced to 100 cfs. Capturing the snowmelt runoff, Duncan was filled to elevation 1818.7 feet by 31 May and to elevation 1871.7 feet by 30 June. The reservoir inflow peaked at 18,800 cfs on 22 July. Release from Duncan was increased from 100 cfs to 4000 cfs on 5 July to reduce the rate of filling. The project continued to fill and reached full pool elevation 1892.0 feet on 29 July, after which day the project outflow was increased to release inflow.

D. LIBBY RESERVOIR

Storage Evacuation Period. On 1 August 1981, Lake Koocanusa was at elevation 2458.9 as shown on Chart 8. Water supply for the basin above Libby was near average in 1981, 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 2407.4 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 April 1982. The lake was at its lowest level at elevation 2342.1 feet on 24 April, about 35 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 May 1982. The seasonal peak was reached on 15 June with a daily average inflow of 62,600 cfs. Inflows gradually receded to near 20,000 cfs by mid-July.

Libby outflows were held at approximately inflow until mid-May 1982. Inflows increased to 54,000 cfs by 25 May and the lake filled about 34 feet in May reaching elevation 2376.19 feet by 31 May. Lake Koocanusa continued to fill through June reaching elevation 2441.81 by 30 June. During June, Libby average outflow was 5,500 cfs usually running full load on one unit, approximately 4,000 cfs. Libby continued to fill through July reaching elevation 2458.9 by 26 July. Lake Koocanusa was full at elevation 2459.0 feet on 14 August. Spill was not needed during the refill period as the project was able to release the inflow with only three generating units.

E. KOOTENAY LAKE

Storage Evacuation Period. Kootenay Lake was at elevation 1748.4 feet on 31 July 1981 as shown in Chart 9. The lake continued to discharge free flow until mid-August when the discharge was reduced to and maintained at about 40,000 cfs for the remainder of August. Kootenay Lake reached elevation 1743.5 feet on 30 August.

Between 31 August and 13 October 1981, Kootenay Lake outflow was maintained about 18,000 cfs. This reduction in discharge and the higher releases from Duncan Reservoir filled Kootenay Lake to elevation 1744.6 feet by 13 October. Between 14 and 16 October, Kootenay Lake outflow was reduced to zero for several hours each day to facilitate concrete work at the Brilliant project tailrace, and trash rack cleaning at the Kootenay Canal project. This operation caused Kootenay Lake to fill to elevation 1745.1 feet by 16 October.

During November and December 1981, the Kootenay Lake was maintained near elevation 1745.0 feet and discharged between 20,000 cfs and 30,000 cfs.

Kootenay Lake outflow was increased to 35,000 cfs on 25 December and the lake began to draft on 1 January 1982, six days before the drawdown schedule as specified in the IJC Order.

Following the IJC Rule Curve, Kootenay Lake continued to draft through February, reaching elevation 1742.7 feet by 15 February 1982. On 16 February, Kootenay Lake began discharging free flow.

Between 12 and 15 March 1982, Kootenay Lake was slightly above the IJC Rule Curve, requiring both Libby and Duncan projects to reduce their respective outflows to inflows. The lake continued to draft and by 11 March, Kootenay Lake was drafted to elevation 1739.0 feet, its lowest level for the year.

Refill Period. Kootenay Lake began to fill gradually in late April 1982 as inflow exceeded the free flow capability at Grohman Narrow. The inflow increased in May and Kootenay Lake filled quickly to elevation 1748.7 feet by 28 May.

The inflow receded in early June, allowing Kootenay Lake to be drafted to elevation 1746.8 feet by 10 June. Kootenay Lake level increased again in the latter part of June, reaching its peak elevation 1749.0 feet on 22 June. During this period, Kootenay Lake discharge ranged between 55,000 cfs and 72,000 cfs.

Discharges from Kootenay Lake remained at free flow until mid-July. The discharge was then reduced to between 30,000 cfs and 40,000 cfs, which was sufficient to permit drafting of the lake to elevation 1744.9 feet 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 1981-82 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 1981-82 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 1981-82 Operating Year.

The generation at downstream projects in the United States, delivered under the Canadian Entitlement Exchange Agreement was 545 average megawatts at rates up to 1,297 megawatts from 1 August 1981, through 31 March, 1982, and 520 average megawatts at rates up to 1,254 megawatts from 1 April 1982, through 31 July 1982. During the period of 1 April 1981, through 31 March 1982, the CSPE participants assigned 64 average megawatts at rates up to 150 megawatts to Pacific Southwest utilities. Beginning 1 April 1982, the assignment was 63 average megawatts at rates up to 150 megawatts. CSPE power not assigned to Pacific Southwest utilities was used to meet Pacific Northwest loads.

Review of 1981-82 Power Operations. In June 1981, BPA and B. C. Hydro entered into a contractual arrangement to store in Arrow Reservoir an additional two feet of water, surplus to downstream requirements and to be released by 31 December 1981. The benefits from this operation were equally divided based on B. C. Hydro providing storage space and downstream U.S. projects providing generation.

All Coordinated System reservoirs were full on 31 July 1981, the date that reservoirs are programmed to refill. BPA continued to market non-firm energy to Pacific Southwest utilities through mid-August. Non-firm energy for Pacific Northwest markets was available through 31 August.

The Operating Program developed for 1981-82 indicated that the Federal Columbia River Power System had an estimated firm energy deficiency of about 320 average megawatts under recurrence of critical water conditions. BPA began purchasing energy in September to cover this estimated deficiency. Purchases of energy continued through December 1981. In addition, BPA withdrew the industries' 1981-82 Hanford energy and purchased the industries' contracts with Weyerhaeuser and Longview Fibre companies.

On 10 September 1981, B. C. Hydro began releasing the Canadian half of the additional two feet of water stored in Arrow. All energy produced at downstream U. S. projects was delivered to B. C. Hydro by 30 September. The U. S. share of storage was released from 20 through 31 December.

BPA served the industrial upper quartile loads from 1 September through 7 December 1981, with energy that was subject to return if reservoirs failed to refill during the summer of 1982. On 8 December 1981, due to continued load underruns and better than median streamflow conditions, BPA restored direct service to industrial loads and began marketing non-firm energy sufficient to displace operating thermal resources.

BPA continued to make non-firm energy sales for the remainder of the 1981-82 Operating Year. Beginning 19 February 1982, non-firm energy sales were made at the hydro resource rate as surplus water could no longer be stored in reservoirs.

On 2 April 1982, operations for the juvenile fish outmigration officially began. During May and June, BPA stored 504,169 megawatthours of overgeneration with B. C. Hydro. This energy remained stored in Williston Lake at the end of the operating year.

During the period of 8 December 1981 through 31 July 1982, BPA sold 15,070,319 megawatthours of non-firm energy to Pacific Southwest utilities. These sales were 97 percent of the record sales made in 1976.

All Coordinated System reservoirs were virtually full on 31 July 1982. All obligations by BPA industrial customers to return energy during the 1982-83 Operating Year were cancelled.

B. FLOOD CONTROL

Heavy rains in mid-February 1982 caused high flows in the mid and lower Columbia and other portions of the Pacific Northwest. The Treaty Projects were put under flood control operation on 17 February. Arrow outflow was reduced from 44,000 cfs to 5,000 cfs, then increased to 15,000 cfs on 24 February, after it was determined the lower flow did not disperse effluents produced by mills downstream of Arrow. Arrow outflow reductions were made to reduce the Lower Columbia River stage. Less than two feet of storage was used in Arrow Lake for flood control regulation although scheduled drafting stopped. Treaty project operations were scheduled on a daily basis from 17 February through 10 April to reduce flooding and for post-flood evacuation of space filled during the flood operations. Columbia River stages at Vancouver, Washington peaked at 19.8 feet on 21 February. The unregulated peak stage would have been 23.6 feet, flood stage is 16.0 feet.

Flood control during the spring runoff was provided by the normal refill operation of the Treaty projects and other storage reservoirs in the Columbia River basin and by the use of streamflow forecasts prepared daily. The unregulated peak at The Dalles was 750,000 cfs which would have been about 10 feet above bankfull capacity. The maximum observed daily discharge during the spring runoff was 422,000 cfs on 20 June. The observed and unregulated hydrographs for 1 July 1981 through 31 July 1982, at The Dalles are shown on the summary hydrograph on Chart 12 for comparison with historical flows. On Chart 13, the effects of regulation at The Dalles by Mica, Arrow, Duncan and Libby are separated from the other major storage projects in the basin.

Chart 14 documents the relative filling of Arrow and Grand Coulee during the principal filling period, and compares the coordinated regulation of the two reservoirs to guidelines in the Flood Control Operating Plan.

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 1976 established Operating Rule Curves for Duncan, Arrow and Mica during the 1981-82 operating year. The Operating Rule Curves provided guidelines for refill levels as well as drawdown levels. They were derived from Critical Rule Curves, Assured 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 1981 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 1981-82

Pacific Northwest Coordination Agreement final regulation. The Variable Refill Curves and flood control requirements subsequent to 1 January 1982 were determined on the basis of seasonal volume runoff forecasts during actual operation.

B. POWER OPERATION

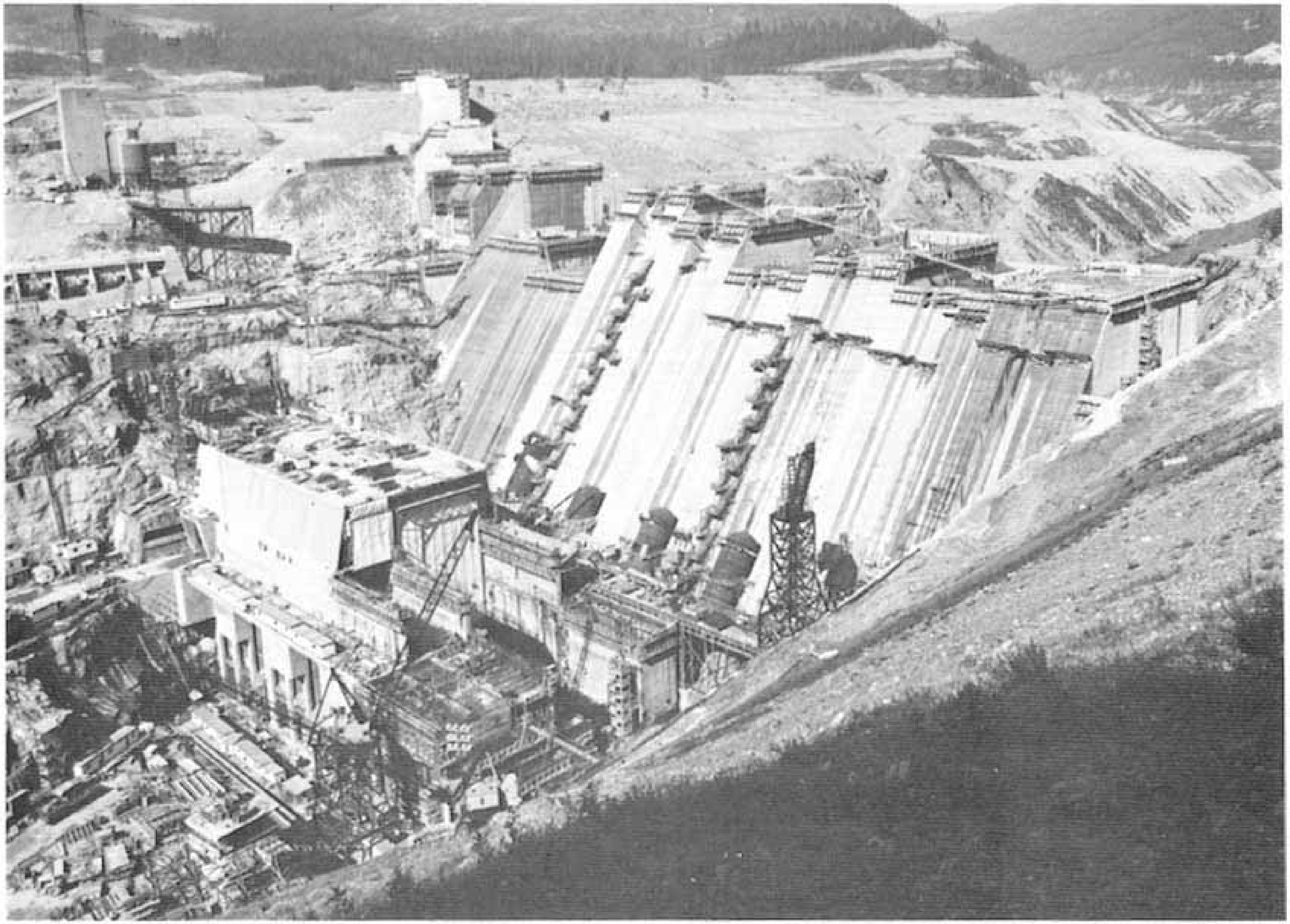
Consistent with all Detailed Operating Plans prepared since the installation of generation at Mica, the 1981-82 Detailed Operating Plan was designed to achieve optimum power generation at site in Canada and downstream in Canada and the United States, consistent with project operating limits and flood 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.

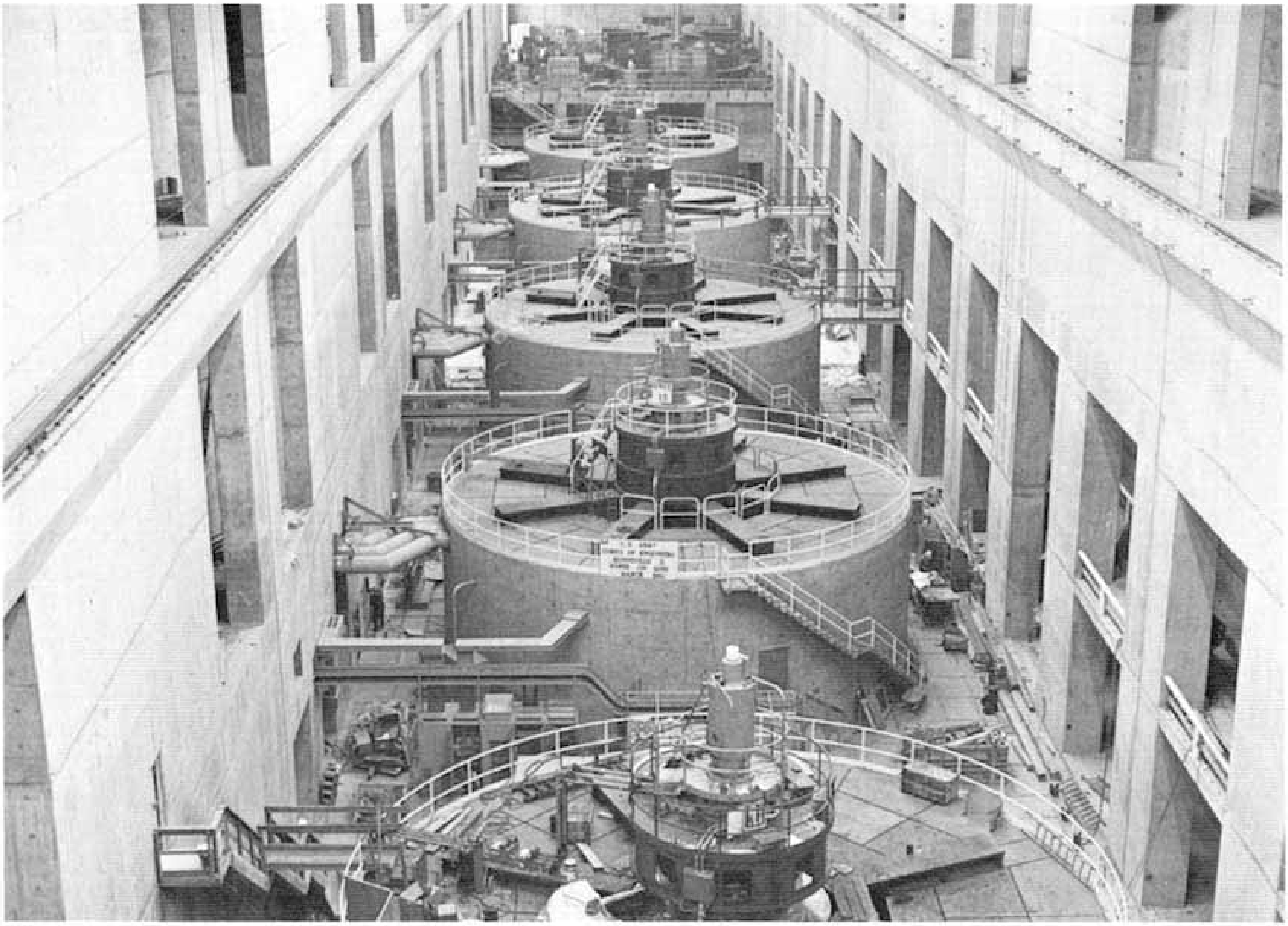
C. FLOOD CONTROL OPERATION

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.

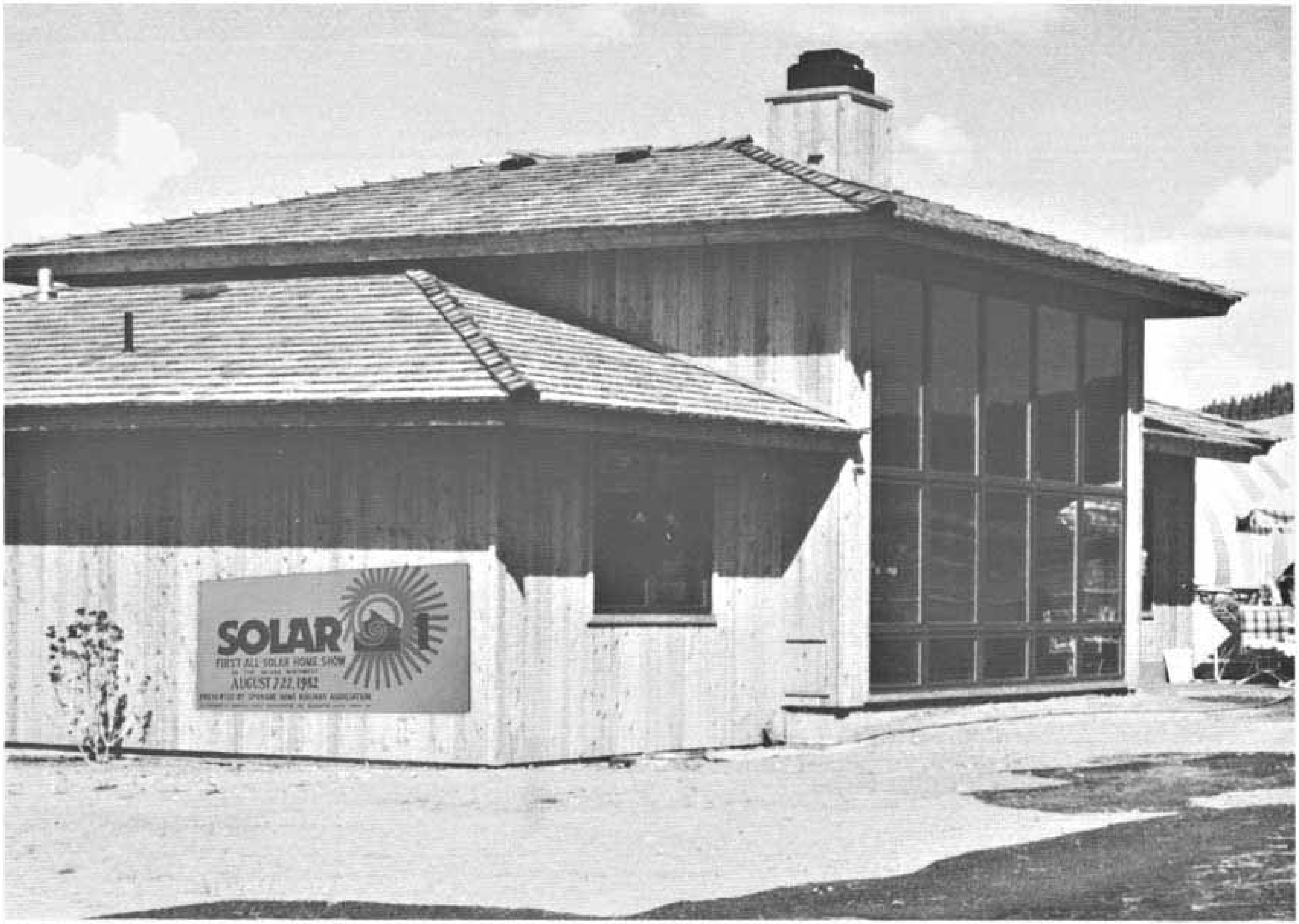
Flood control operation of the Columbia River Treaty projects during the refill period was controlled in part by the computed Initial Controlled Flow of the Columbia River at The Dalles. Other operating rules and local criteria were utilized to prepare day-to-day streamflow forecasts for key points in 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.



As of September 1982, construction of B.C. Hydro's Revelstoke project was progressing well. An earthfillled wing dam can be seen extending from the concrete dam on the right bank (top center). First power from the project is scheduled for 1984 and when fully installed at 2700 Mw (six 450 Mw units) it will be the largest project in B.C. Hydro's system. (B.C. Hydro photograph.)



Five of the eight 66.5 Mw generating units in the Bonneville Dam Second Powerhouse were completed and operable as of 31 July 1982. The remaining three are scheduled to be completed during the fall of 1982. (Corps of Engineers photograph.)



The Bonneville Power Administration conservation efforts included involvement in Solar 1, Spokane's first all-solar home show. (BPA photograph.)

Table 1
Unregulated Runoff Volume Forecasts
Millions of Acre-Feet
1982

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	1.96	21.1	11.0	6.50	110.0
February	2.13	23.7	11.9	6.61	120.0
March	2.26	24.9	12.4	7.14	126.0
April	2.24	25.1	12.3	7.38	130.0
May	2.14	25.2	12.1	7.54	131.0
June	2.18	24.5	11.9	7.25	129.0
July	2.25	24.7	12.3	7.09	133.0
Actual	2.16	25.0	12.0	6.53	129.9

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 1982

		INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUN 1
1	PROBABLE FEB 1 - JUL 31 INFLOW, KSFD 1/		4517.3	4936.9	5088.2	5038.5	4958.7	4848.2
2	95% FORECAST ERROR, KSFD		718.5	541.5	499.6	487.7	476.7	474.2
3	95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD 2/		3798.8	4395.4	4588.6	4550.8	4482.0	4374.0
4	OBSERVED FEB 1 - DATE INFLOW, KSFD				113.1	225.9	360.2	1033.3
5	RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD 3/		3798.8	4395.4	4475.5	4324.9	4121.8	3340.7
	ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
	ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 4/		3798.8					
	MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		2180.0					
	MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/	1860.0	1910.4					
	MIN. JAN 31 RESERVOIR ELEVATION, FT 6/	2437.1	2438.2					
	JAN 31 ECC, FT 7/		2437.1					
	ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		97.8	97.8				
	ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 4/		3715.2	4298.7				
	MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		1760.0	1760.0				
	MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/	1349.4	1574.0	990.5				
	MIN. FEB 28 RESERVOIR ELEVATION, FT 6/	2426.1	2431.0	2418.1				
	FEB 28 ECC, FT 7/		2426.1	2418.1				
	ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		95.4	95.4	97.6			
	ASSUMED APR 1 - JUL 31 INFLOW, KSFD 4/		3624.1	4193.2	4368.1			
	MIN. APR 1 - JUL 31 OUTFLOW, KSFD		1295.0	1295.0	1295.0			
	MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/	920.1	1200.1	631.0	456.1			
	MIN. MAR 31 RESERVOIR ELEVATION, FT 6/	2416.5	2422.6	2409.8	2405.7			
	MAR 31 ECC, FT 7/		2416.5	2409.8	2405.7			
	ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		91.0	91.0	93.1	95.4		
	ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 4/		3456.9	3999.8	4166.7	4126.0		
	MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		920.0	920.0	920.0	920.0		
	MIN. APR 30 RESERVOIR CONTENT, KSFD 5/	562.9	992.3	449.4	282.5	323.2		
	MIN. APR 30 RESERVOIR ELEVATION, FT 6/	2408.0	2418.1	2405.6	2401.6	2402.5		
	APR 30 ECC, FT 7/		2408.0	2405.6	2401.6	2402.5		
	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/		2814.9	3257.0	3392.4	3360.4	3359.3	
	MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		610.0	610.0	610.0	610.0	610.0	
	MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/	937.7	1324.3	882.2	746.8	778.8	779.9	
	MIN. MAY 31 RESERVOIR ELEVATION, FT 6/	2416.9	2425.5	2415.6	2412.5	2413.3	2413.3	
	MAY 31 ECC, FT 7/		2416.9	2415.6	2412.5	2413.3	2413.3	
	ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		36.9	36.9	37.8	38.7	40.8	49.8
	ASSUMED JUL 1 - JUL 31 INFLOW, KSFD 4/		1401.8	1621.9	1691.7	1673.7	1673.5	1663.7
	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/	2317.3	2437.4	2217.3	2147.5	2165.5	2165.7	2175.5
	MIN. JUN 30 RESERVOIR ELEVATION, FT 6/	2446.6	2449.0	2444.5	2443.1	2443.5	2443.5	2443.7
	JUN 30 ECC, FT 7/		2446.6	2444.5	2443.1	2443.5	2443.5	2443.7
	JUL 31 ECC, FT	2470.4	2470.4	2470.4	2470.4	2470.4	2470.4	2470.4
	MICA ACCUMULATED DEAD STORAGE	6346.8	6346.8	6346.8	6346.8	6346.8	6346.8	6346.8

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 MARCH 25, 1974.
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 1982

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUN 1
		TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
1 PROBABLE FEB 1 - JUL 31 INFLOW, KSFD 1/		9149.5	10312.1	10821.1	11009.0	11060.1	10682.3
2 95% FORECAST ERROR, KSFD		1509.4	1170.2	1082.1	908.2	850.8	822.0
3 95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD 2/		7640.1	9141.9	9739.0	10100.8	10209.3	9860.3
4 OBSERVED FEB 1 - DATE INFLOW, KSFD				305.1	684.2	1229.7	3152.2
5 RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD 3/		7640.1	9141.9	9433.9	9416.6	8979.8	6708.1
ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 4/		7640.1					
MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		1464.0					
MICA REFILL REQUIREMENTS, KSFD 8/		1669.2					
MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/	1631.0	527.0*					
MIN. JAN 31 RESERVOIR ELEVATION, FT 6/	1411.7	1377.9					
JAN 31 ECC, FT 7/		1390.0					
ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		97.5	97.5				
ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 4/		7449.1	6913.4				
MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		1314.0	1314.0				
MICA REFILL REQUIREMENTS, KSFD 8/.................		2179.8	2538.7				
MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/	1017.9	336.6*	336.6*				
MIN. FEB 28 RESERVOIR ELEVATION, FT 6/	1400.1	1377.9	1377.9				
FEB 28 ECC, FT 7/		1386.0	1386.0				
ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		94.7	94.7	97.1			
ASSUMED APR 1 - JUL 31 INFLOW, KSFD 4/		7235.2	8657.4	9160.3			
MIN. APR 1 - JUL 31 OUTFLOW, KSFD		1159.0	1159.0	1159.0			
MICA REFILL REQUIREMENTS, KSFD 8/.................		2609.0	2898.2	3073.1			
MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/	1533.0	112.5	21.5*	21.5*			
MIN. MAR 31 RESERVOIR ELEVATION, FT 6/	1409.9	1380.7	1377.9	1377.9			
MAR 31 ECC, FT 7/		1380.7	1378.4	1378.4			
ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		89.0	89.0	91.2	94.0		
ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 4/		6799.7	8136.3	8603.7	8851.6		
MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		1009.0	1009.0	1009.0	1009.0		
MICA REFILL REQUIREMENTS, KSFD 8/.................		2976.3	3079.8	3246.7	3206.0		
MIN. APR 30 RESERVOIR CONTENT, KSFD 5/	1702.4	765.2	-467.9	-768.4	-1057.0		
MIN. APR 30 RESERVOIR ELEVATION, FT 6/	1413.0	1395.0	1377.9	1377.9	1377.9		
APR 30 ECC, FT 7/		1395.0	1377.9	1377.9	1377.9		
ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		68.7	68.7	70.4	77.6	77.2	
ASSUMED JUN 1 - JUL 31 INFLOW, KSFD 4/		5248.7	6280.5	6641.5	6836.5	6932.3	
MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		854.0	854.0	854.0	854.0	854.0	
MICA REFILL REQUIREMENTS, KSFD 8/.................		2591.5	2647.0	2782.4	2750.4	2749.3	
MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/	2456.8	1776.3	800.1	574.6	347.6	250.6	
MIN. MAY 31 RESERVOIR ELEVATION, FT 6/	1426.1	1414.3	1395.7	1391.1	1386.1	1383.9	
MAY 31 ECC, FEET 7/		1414.3	1395.7	1391.1	1386.1	1383.9	
ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		31.9	31.9	32.7	33.7	35.9	46.4
ASSUMED JUL 1 - JUL 31 INFLOW, KSFD 4/		2437.2	2916.3	3084.9	3173.4	3223.7	3112.0
MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		434.0	434.0	434.0	434.0	434.0	434.0
MICA REFILL REQUIREMENTS, KSFD 8/		1211.9	1311.9	1381.7	1363.7	1363.5	1353.7
MIN. JUN 30 RESERVOIR ELEVATION, FT 6/	3553.4	2788.3	2409.2	2310.5	2203.9	2153.4	2254.7
MIN. JUN 30, RESERVOIR ELEVATION, FT 6/	1443.6	1431.6	1425.3	1423.6	1421.8	1421.0	1422.7
JUN 30 ECC, FT 7/		1431.6	1425.3	1423.6	1421.8	1421.0	1422.7
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 PRECEDING LINE 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 28, 1974.
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
* LOWER LIMIT, BASED ON 1936-37 HYDRO CONDITION.

Table 4

95 Percent Confidence Forecast and Variable Energy Content Curve Duncan 1982

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUN 1
1 PROBABLE FEB 1 - JUL 31 INFLOW, KSFD 1/		837.4	917.5	977.7	964.4	920.2	924.3
2 95% FORECAST ERROR, KSFD		154.8	118.1	114.0	107.3	94.9	94.1
3 95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD 2/		682.6	779.4	863.7	857.1	625.3	830.2
4 OBSERVED FEB 1 - DATE INFLOW, KSFD				23.1	41.9	72.3	225.9
5 RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD 3/		682.6	799.4	840.6	815.2	753.0	604.3
ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 4/		682.6					
MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		18.1					
MIN. JAN 31 RESERVOIR CONTENT, KSFD 5/	332.7	209.1*					
MIN. JAN 31 RESERVOIR ELEVATION, FT 6/	1847.2	1803.3					
JAN 31 ECC, FT 7/		1830.3					
ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		97.8	97.8				
ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 4/		667.6	781.8				
MIN MAR 1 - JUL 31 OUTFLOW, KSFD		15.3	15.3				
MIN. FEB 28 RESERVOIR CONTENT, KSFD 5/	294.2	110.9*	110.9*				
MIN. FEB 28 RESERVOIR ELEVATION, FT 6/	1842.1	1805.6	1794.2				
FEB 28 ECC, FT 7/		1815.5	1815.5				
ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		95.4	95.4	97.5			
ASSUMED APR 1 - JUL 31 INFLOW, KSFD 4/		651.2	762.6	819.6			
MIN. APR 1 - JUL 31 OUTFLOW, KSFD		12.2	12.2	12.2			
MIN. MAR 31 RESERVOIR CONTENT, KSFD 5/	303.2	66.8	2.3*	2.3*			
MIN. MAR 31 RESERVOIR ELEVATION, FT 6/	1843.8	1808.0	1794.2	1794.2			
MAR 31 ECC, FT 7/		1808.0	1794.8	1794.8			
ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		90.3	90.3	92.2	94.6		
ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 4/		616.4	721.9	775.0	771.2		
MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		9.2	9.2	9.2	9.2		
MIN. APR 30 RESERVOIR CONTENT, KSFD 5/	236.4	98.6	-6.9	-60.0	-56.2		
MIN. APR 30 RESERVOIR ELEVATION, FT 6/	1834.2	1813.4	1794.2	1794.2	1794.2		
APR 30 ECC, FT 7/		1813.4	1794.2	1794.2	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/		481.2	563.6	605.2	602.4	588.1	
MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		6.1	6.1	6.1	6.1	6.1	
MIN. MAY 31 RESERVOIR CONTENT, KSFD 5/	343.5	230.7	148.3	106.7	109.5	123.8	
MIN. MAY 31 RESERVOIR ELEVATION, FT 6/	1848.6	1833.4	1821.3	1814.8	1815.2	1817.5	
MAY 31 ECC, FT 7/		1833.4	1821.3	1814.8	1815.2	1817.5	
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/		227.3	266.2	285.8	284.5	277.9	285.2
MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		3.1	3.1	3.1	3.1	3.1	3.1
MIN. JUN 30 RESERVOIR ELEVATION, FT 5/	560.4	481.6	442.7	423.1	424.4	431.0	423.7
MIN. JUN 30, RESERVOIR ELEVATION, FT 6/	1875.3	1865.9	1861.1	1858.7	1858.9	1859.7	1858.8
JUN 30 ECC, FT 7/		1865.9	1861.1	1858.7	1858.9	1859.7	1858.8
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.
* LOWER LIMIT, BASED ON 1936-37 HYDRO CONDITION.

Table 5

95 Percent Confidence Forecast and Variable Energy Content Curve Libby 1982

	INITIAL	JAN 1	FEB 1	MAR 1	APR 1	MAY 1	JUN 1
1 PROBABLE JAN 1 - JUL 31 INFLOW, KSFD		3285.7	3320.0	3569.4	3719.9	3796.0	3665.9
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	74.2	200.6	335.4	504.8	1299.8
4 95% CONF. DATE - JUL 31 INFLOW, KSFD 1/		2408.4	2647.0	2822.3	2889.3	2876.5	2017.7
ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		96.94					
ASSUMED FEB 1 - JUL 31 INFLOW, KSFD 2/		2334.7					
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/		695.6					
MIN. JAN 31 RESERVOIR ELEVATION, FT 6/		2358.1					
JAN 31 ECC, FT 7/		2358.1					
BASE ECC, FT	2403.1						
LOWER LIMIT, FT	2357.8						
ASSUMED MAR 1 - JUL 31 INFLOW, % of VOLUME		94.17	97.14				
ASSUMED MAR 1 - JUL 31 INFLOW, KSFD 2/		2268.0	2571.3				
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/		678.3	375.0				
MIN. FEB 28 RESERVOIR ELEVATION, FT 6/		2356.7	2329.8				
FEB 28 ECC, FT 7/		2356.7	2329.8				
BASE ECC, FT	2401.7						
LOWER LIMIT, FT	2305.2						
ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		90.79	93.66	96.42			
ASSUMED APR 1 - JUL 31 INFLOW, KSFD 2/		2186.6	2479.2	2721.2			
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/		666.7	374.1	132.1			
MIN. MAR 31 RESERVOIR ELEVATION, FT 6/		2355.7	2329.7	2303.2			
MAR 31 ECC, FT 7/		2355.7	2329.7	2303.2			
BASE ECC, FT	2400.4						
LOWER LIMIT, FT	2287.0						
ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		81.71	84.29	86.77	90.00		
ASSUMED MAY 1 - JUL 31 INFLOW, KSFD 2/		1967.9	2231.2	2448.9	2600.4		
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/		795.4	532.1	314.4	162.9		
MIN. APR 30 RESERVOIR ELEVATION, FT 6/		2365.8	2344.1	2323.4	2307.0		
APR 30 ECC, FT 7/		2365.8	2344.1	2323.4	2307.0		
BASE ECC, FT	2399.0						
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/		1270.4	1440.5	1581.0	1678.7	1857.1	
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/		1399.9	1229.8	1089.3	991.6	813.2	
MIN. MAY 31 RESERVOIR ELEVATION, FT 6/		2405.2	2395.0	2386.2	2379.5	2367.1	
MAY 31 ECC, FT 7/		2405.2	2395.0	2386.2	2379.5	2367.1	
BASE ECC, FT	2423.9						
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/		456.9	518.0	568.7	603.9	667.9	725.8
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. MAY 31 RESERVOIR CONTENT, KSFD 5/		2123.4	2062.3	2011.6	1976.4	1912.4	1854.5
MIN. JUN 30, RESERVOIR ELEVATION, FEET 6/		2442.3	2439.4	2436.9	2435.2	2432.1	2429.3
JUN 30 ECC, FT. 7/		2442.3	2439.4	2436.9	2435.2	2432.1	2429.3
BASE ECC, FT..	2450.1						
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/		110.0	119.0	131.0	128.0	130.0	127.0

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/, INTERP. FROM NWPP STORAGE CONTENT TABLE.
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 1982

1 May Forecast of May-August Unregulated Runoff Volume, MAF		101.0
Less Estimated Depletions, MAF		1.5
Less Upstream Storage Corrections, MAF		
MICA	5.2	
ARROW	5.0	
LIBBY	3.9	
DUNCAN	1.3	
HUNGRY HORSE	1.6	
FLATHEAD LAKE	.5	
NOXON	.0	
PEND OREILLE LAKE	.5	
GRAND COULEE	4.8	
BROWNLEE	.5	
DWORSHAK	1.7	
JOHN DAY	.2	
TOTAL	25.2	25.2
Forecast of Adjusted Residual Runoff Volume, MAF		74.3
Computed Initial Controlled Flow From Chart 1 of Flood Control Operating Plan, KCFS		485.0

Chart 1

Seasonal Precipitation
Columbia River Basin
October 1981 - March 1982
Percent of 1963 - 1977 Average

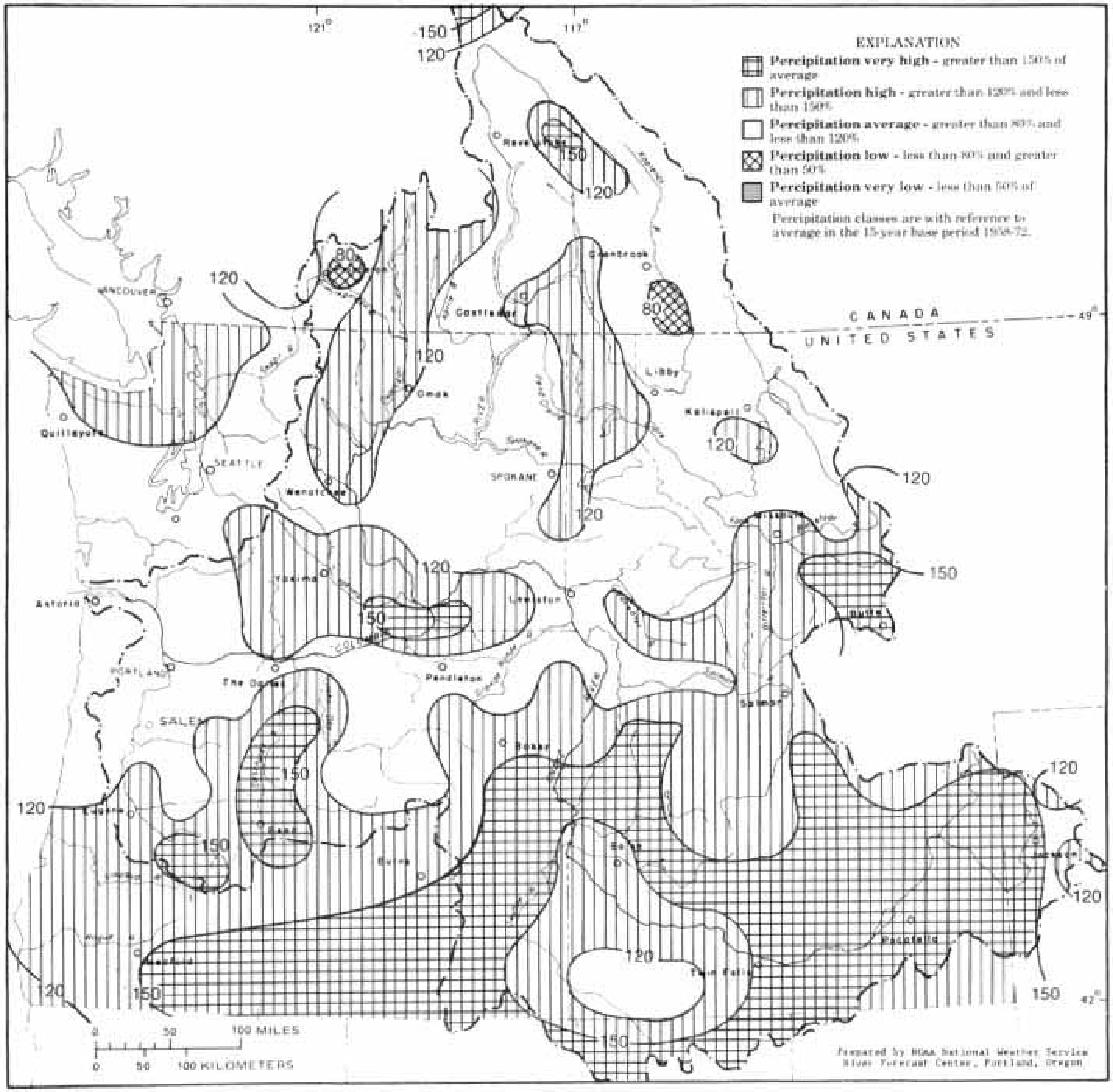


Chart 2

Winter Season
Temperature and Precipitation Indexes 1981-82
Columbia River Basin above The Dalles

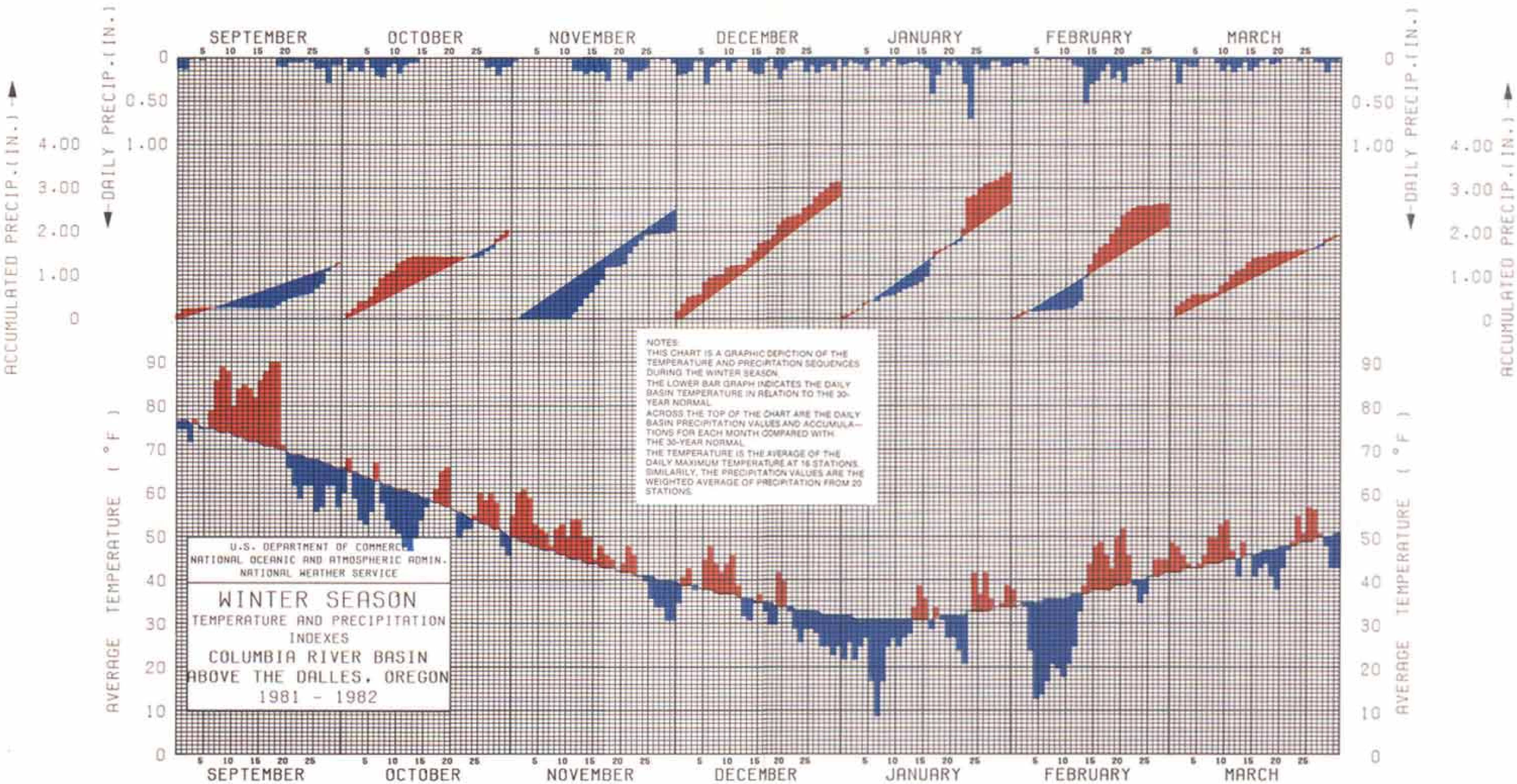


Chart 3

Snowmelt Season
Temperature and Precipitation Indexes 1981-82
Columbia River Basin above The Dalles

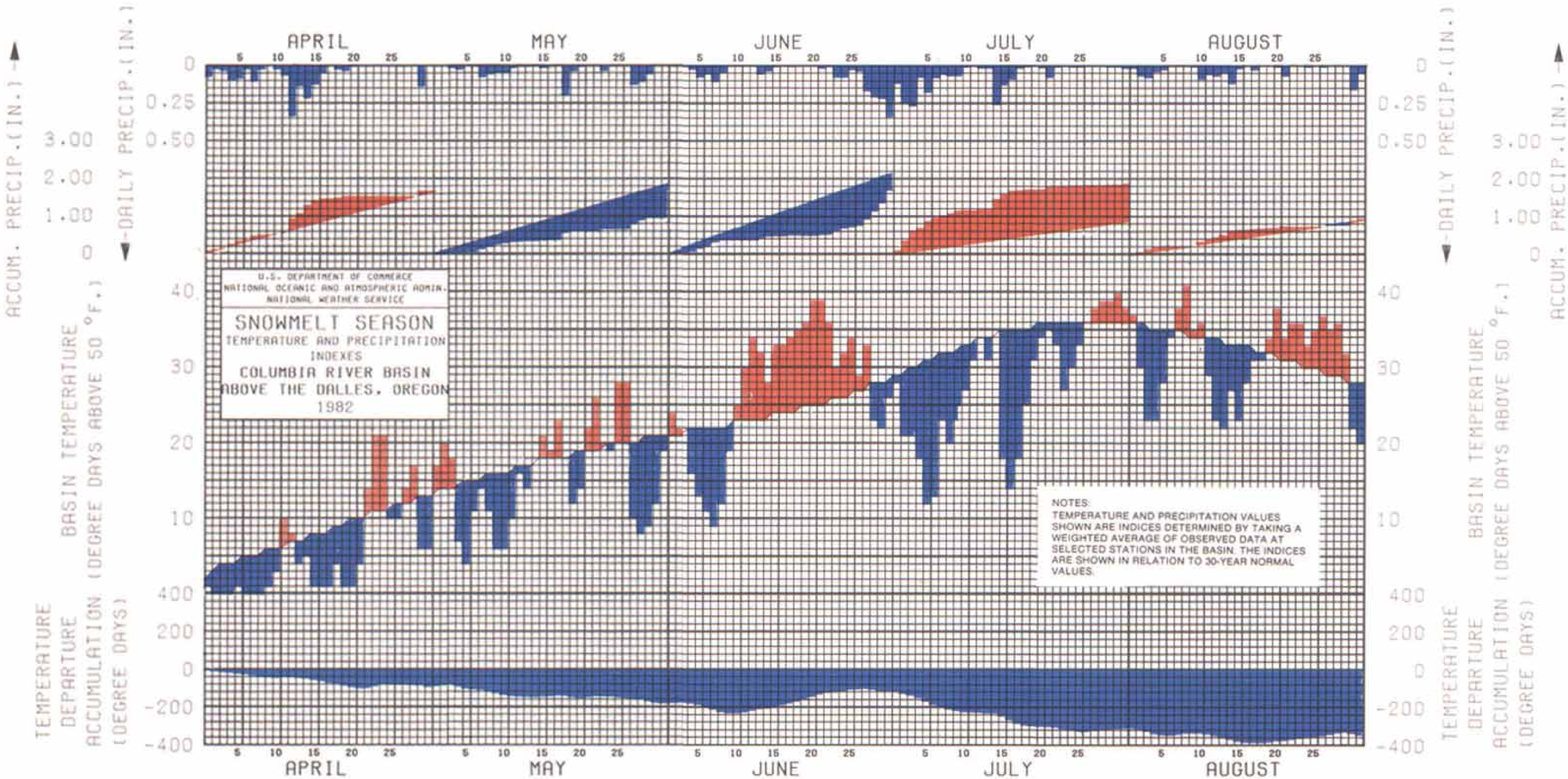


Chart 4

Snowmelt Season
Temperature and Precipitation Indexes 1981-82
Columbia River Basin at Canada

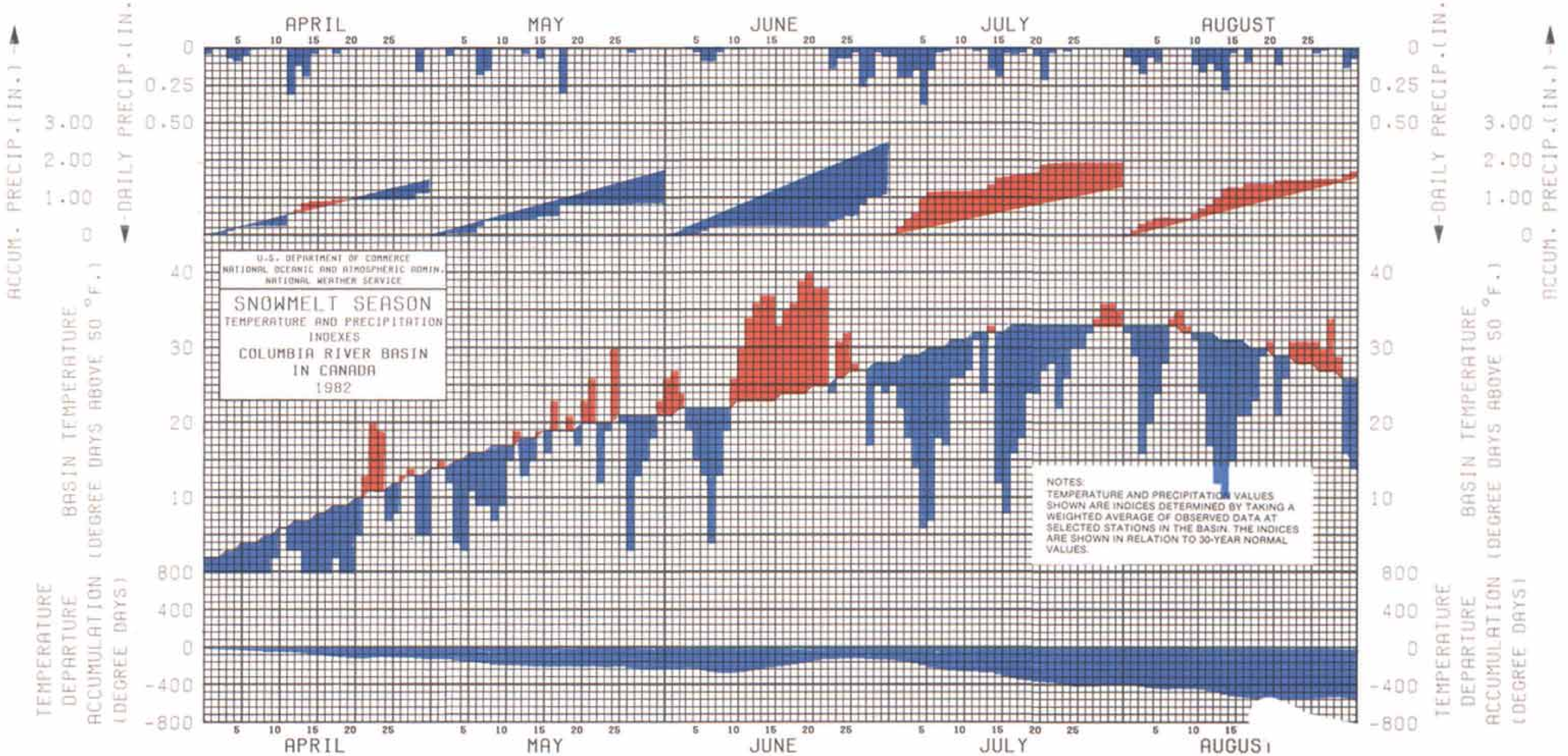


Chart 5

Regulation of Mica
1 July 1981 - 31 July 1982

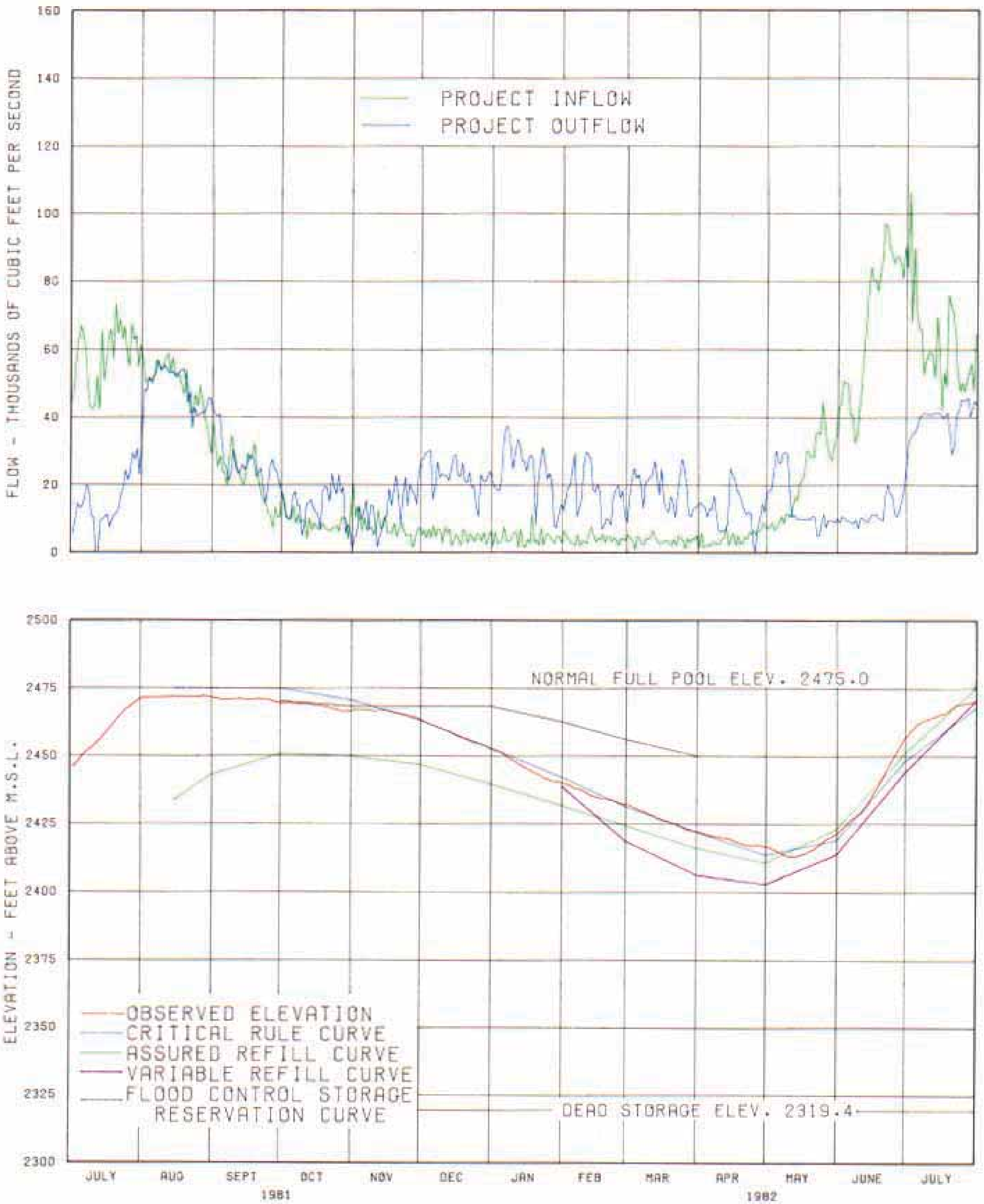


Chart 6

Regulation of Arrow
1 July 1981 - 31 July 1982

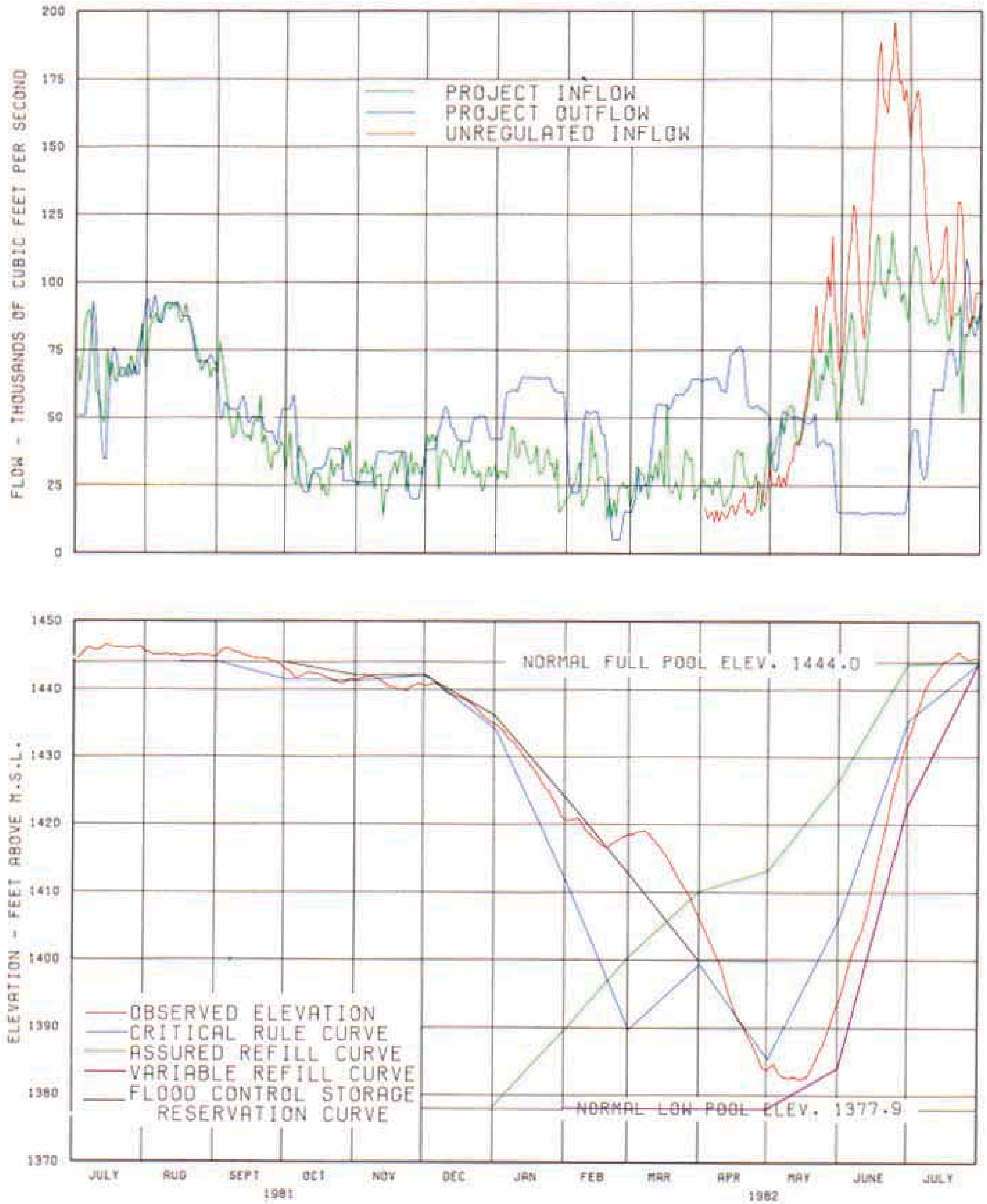


Chart 7

Regulation of Duncan
1 July 1981 - 31 July 1982

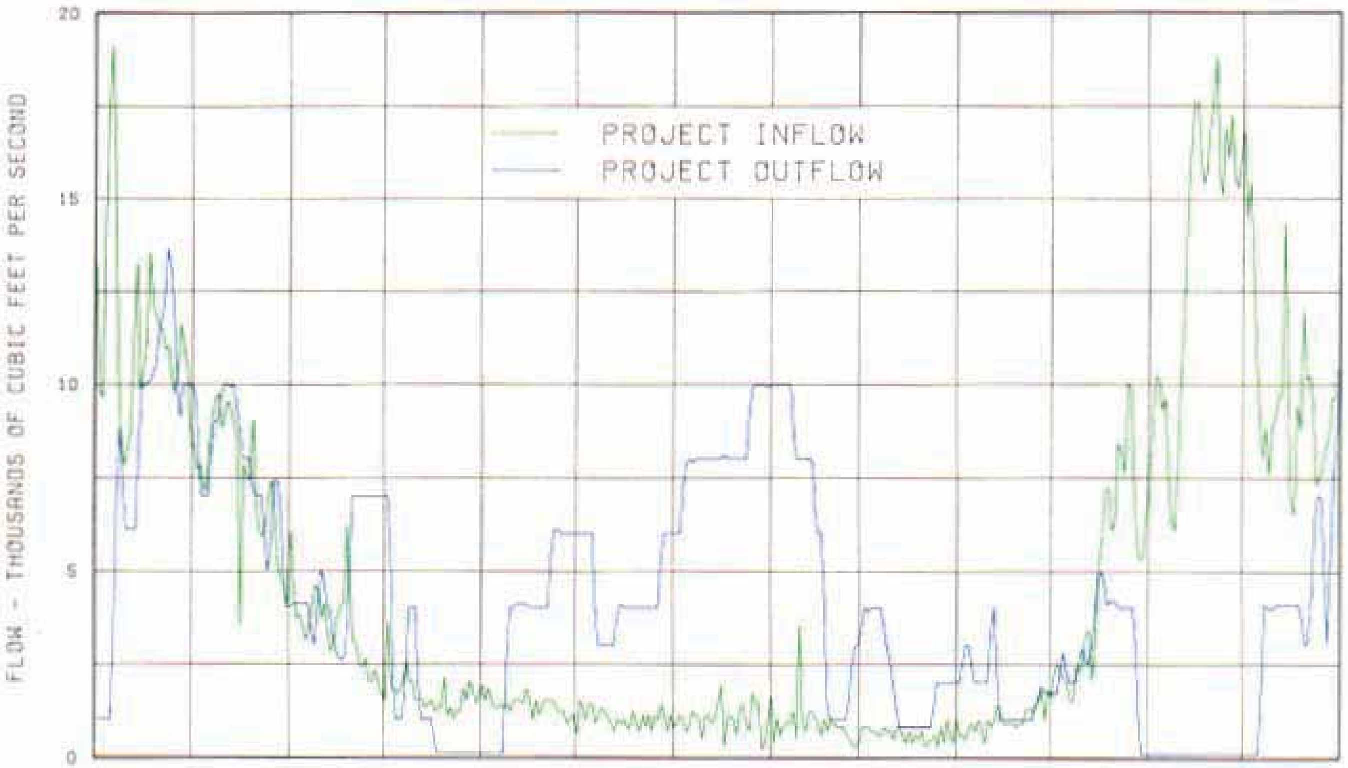


Chart 8
Regulation of Libby
1 July 1981 - 31 July 1982

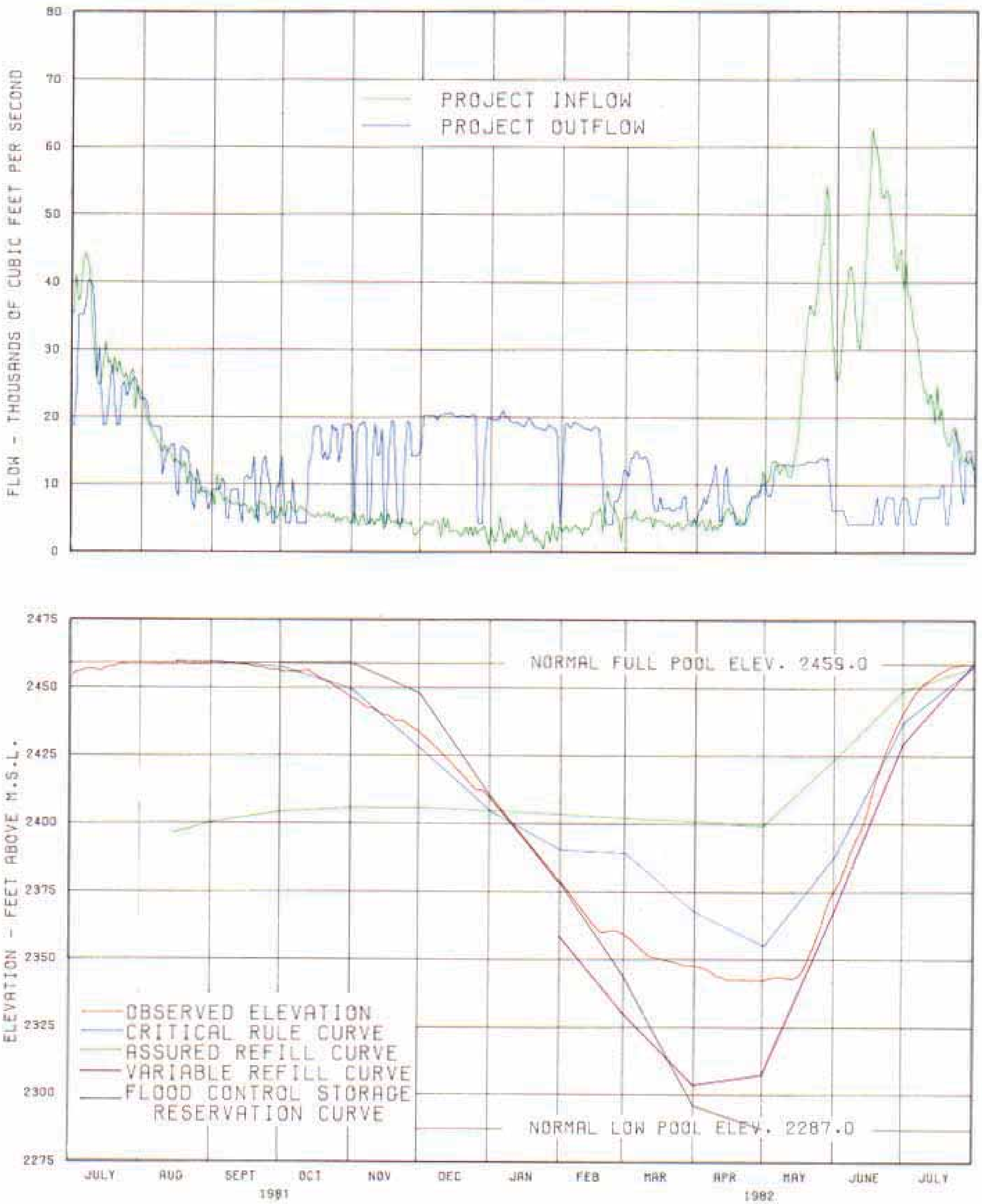


Chart 9

Regulation of Kootenay Lake
1 July 1981 - 31 July 1982

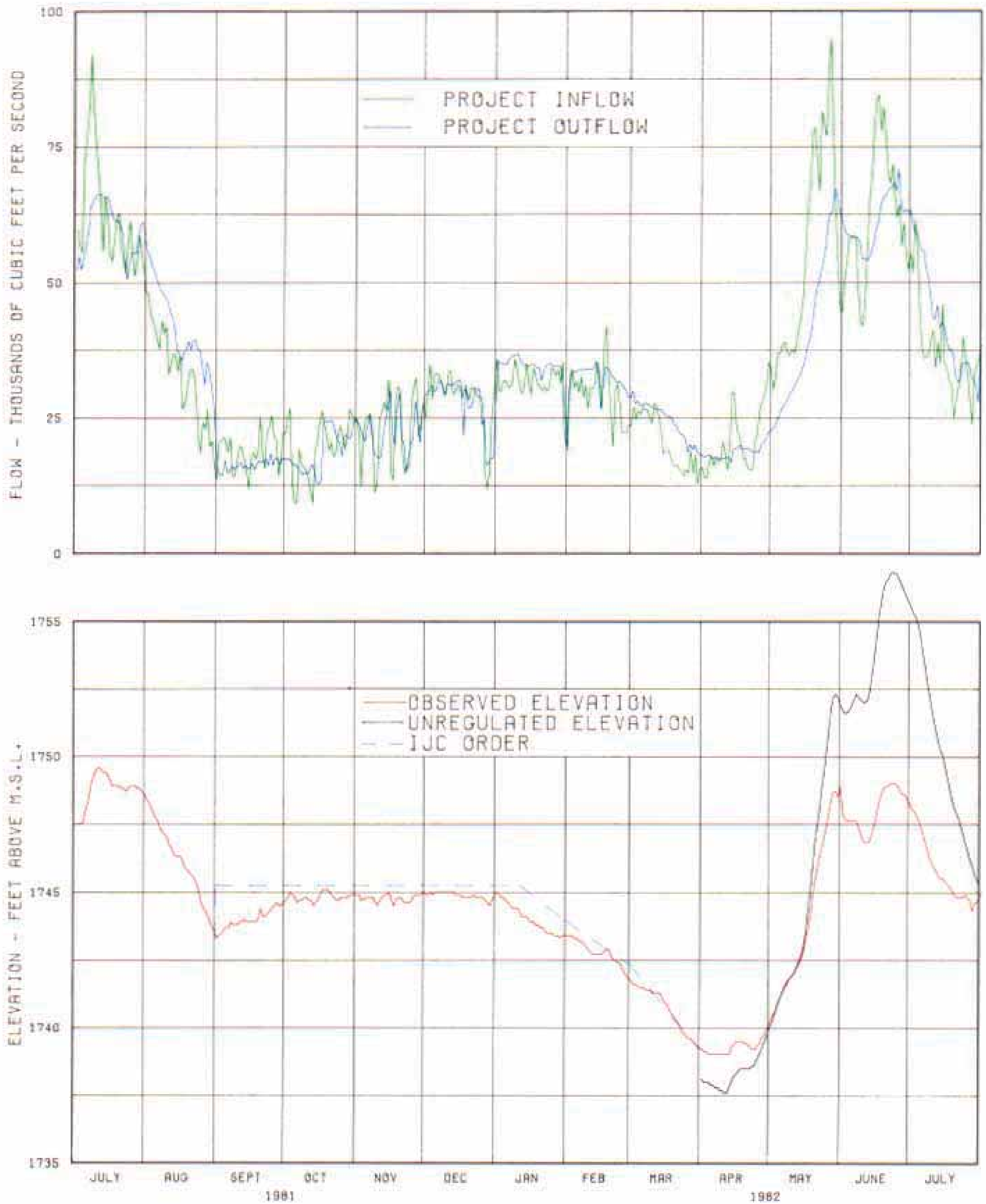


Chart 10
Columbia River at Birchbank
1 July 1981 - 31 July 1982

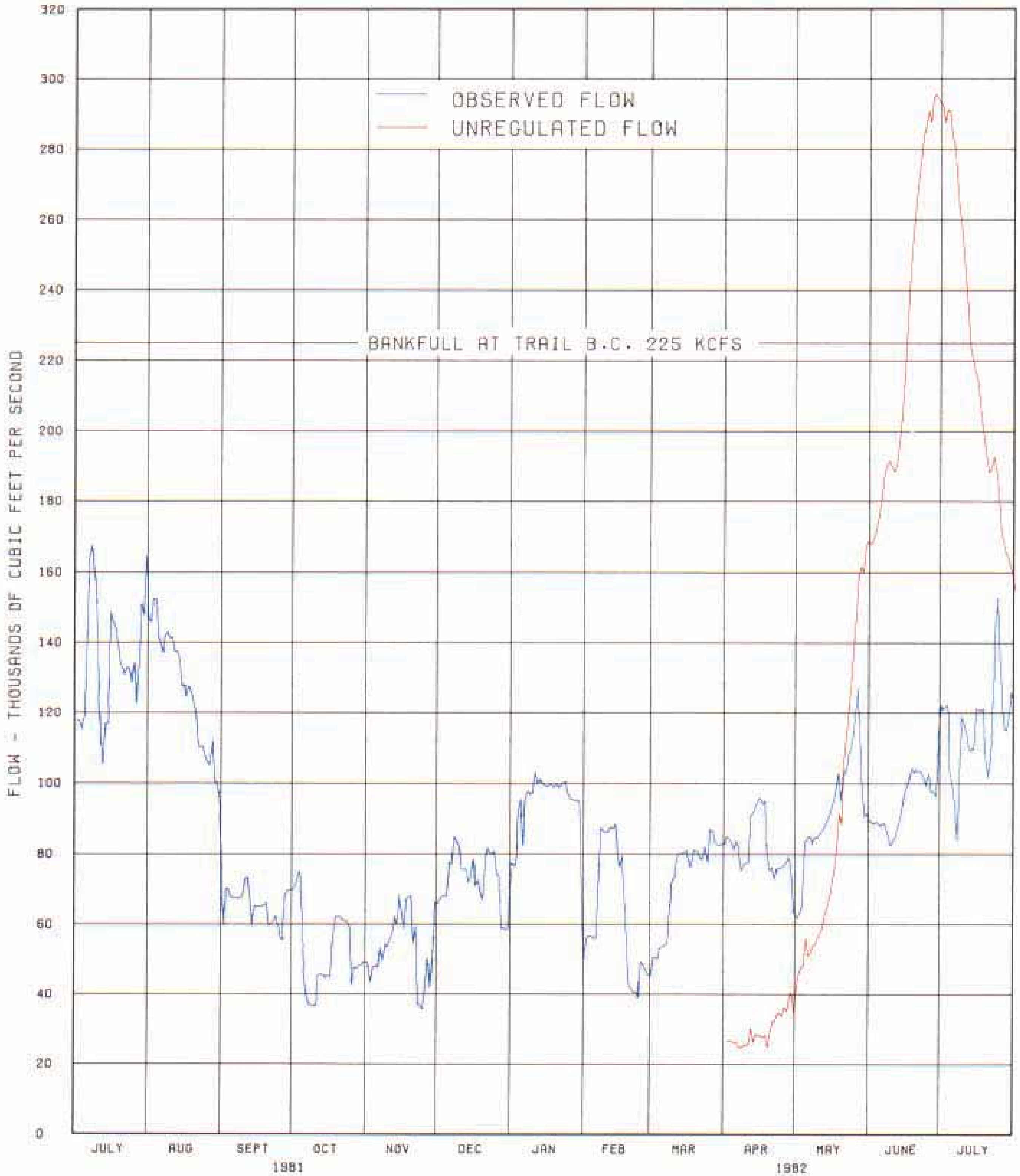
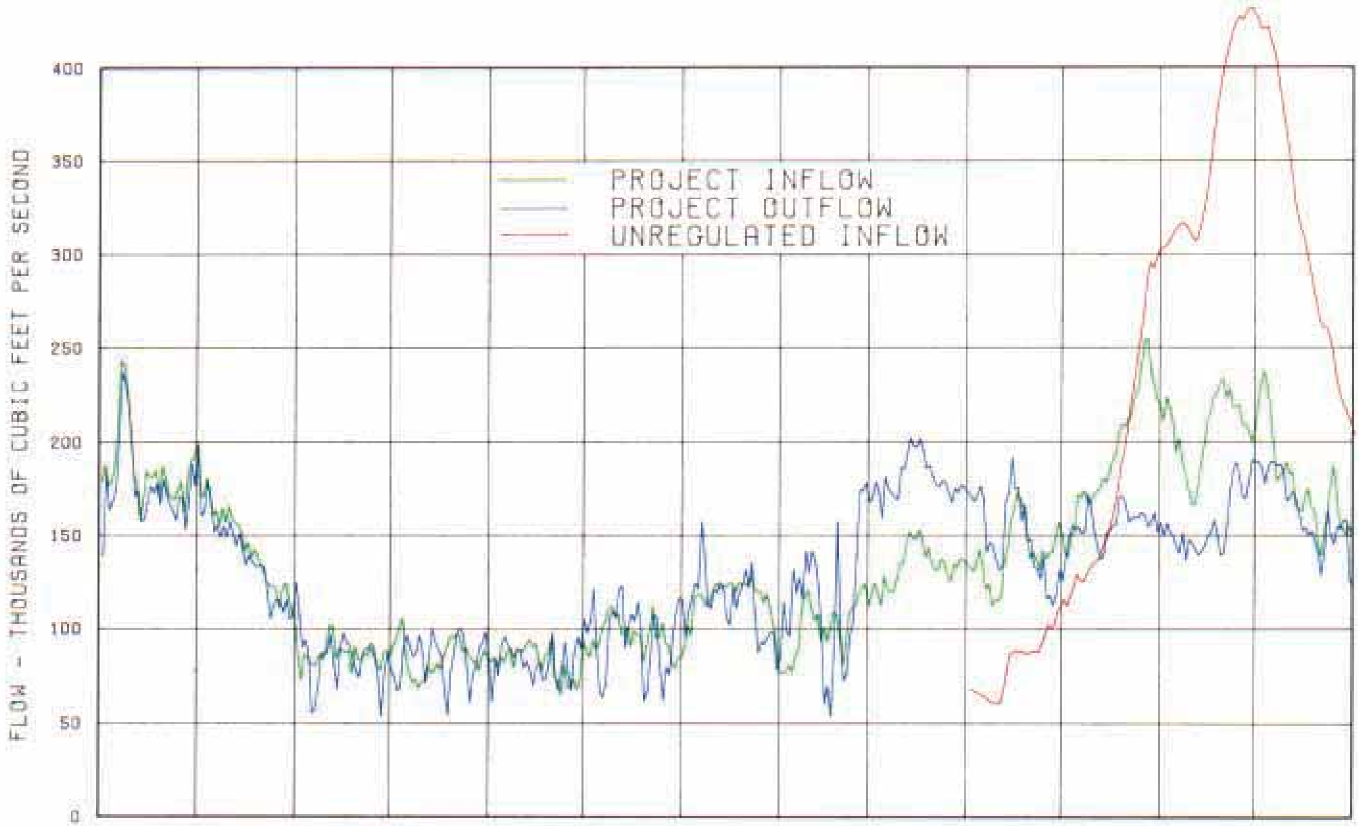


Chart 11

Regulation of Grand Coulee
1 July 1981 - 31 July 1982



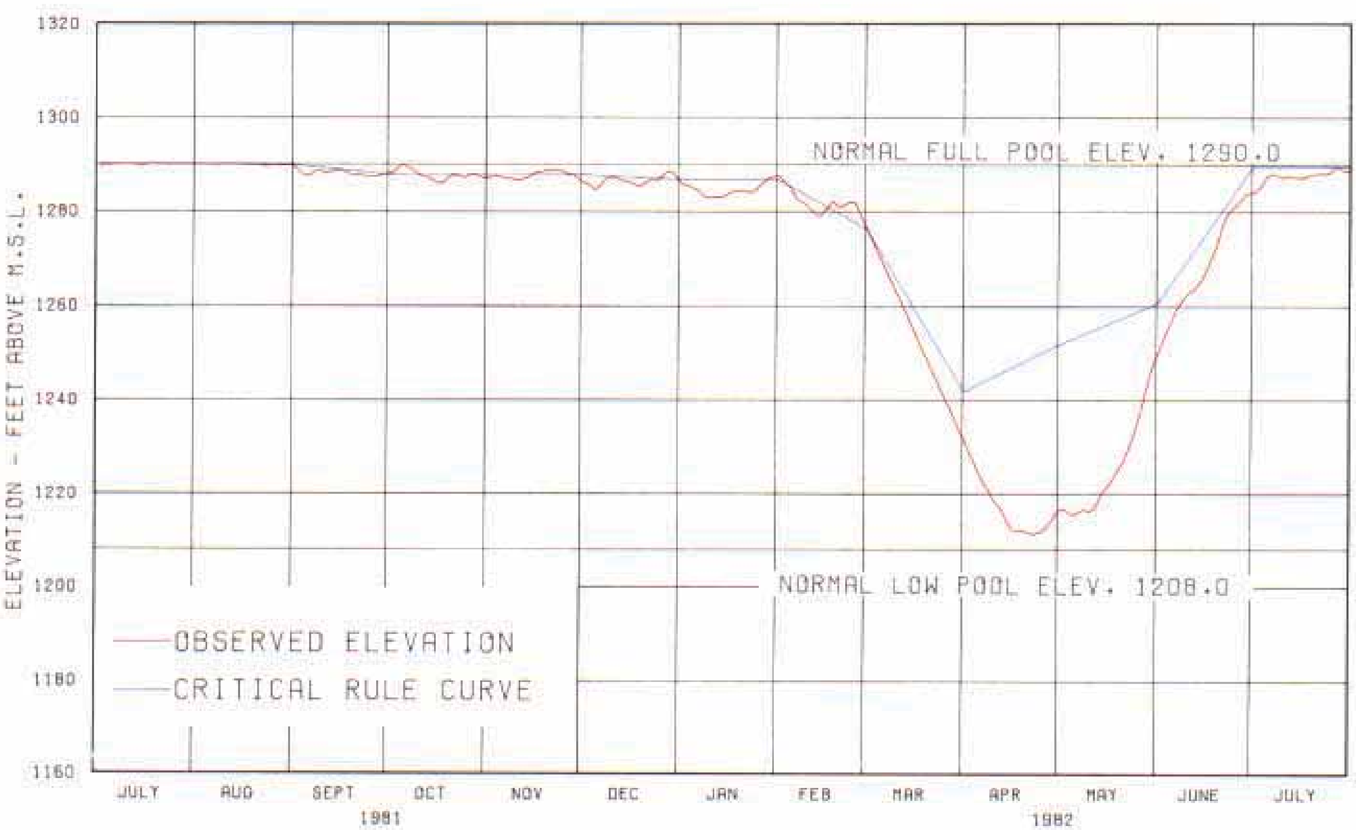


Chart 12

Columbia River at The Dalles
1 July 1981 - 31 July 1982

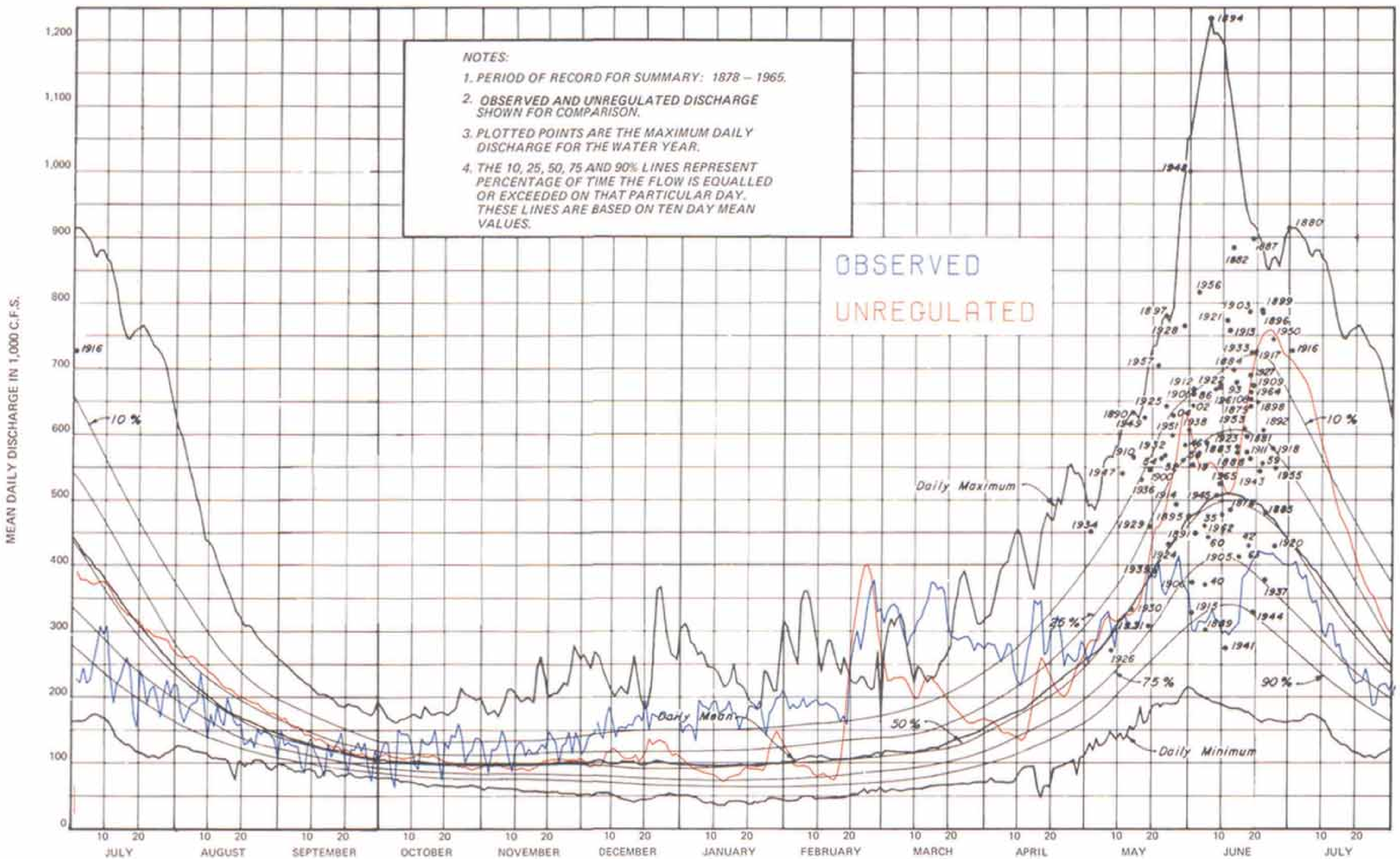


Chart 13

Columbia River at The Dalles
1 April 1982 - 31 July 1982

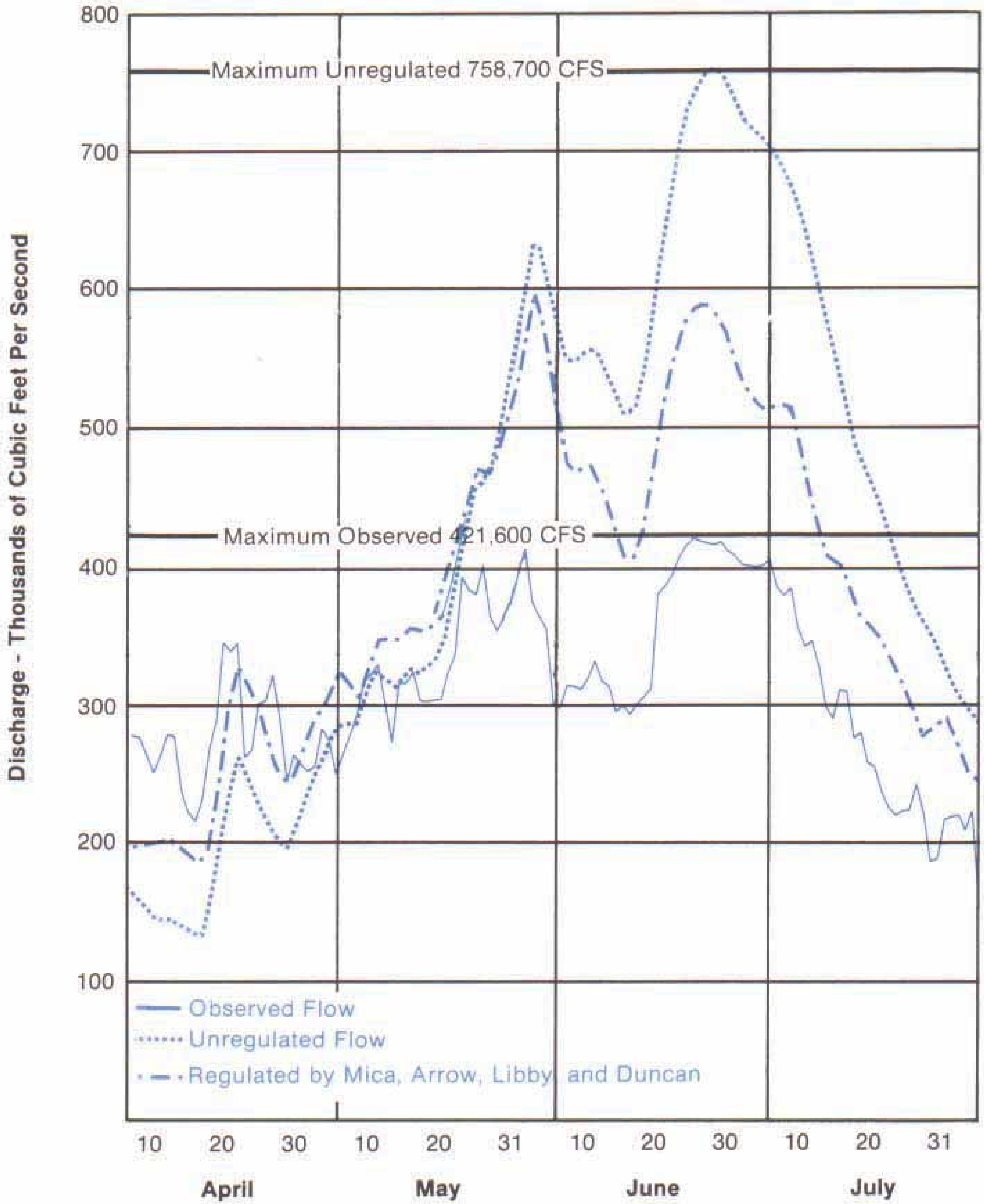
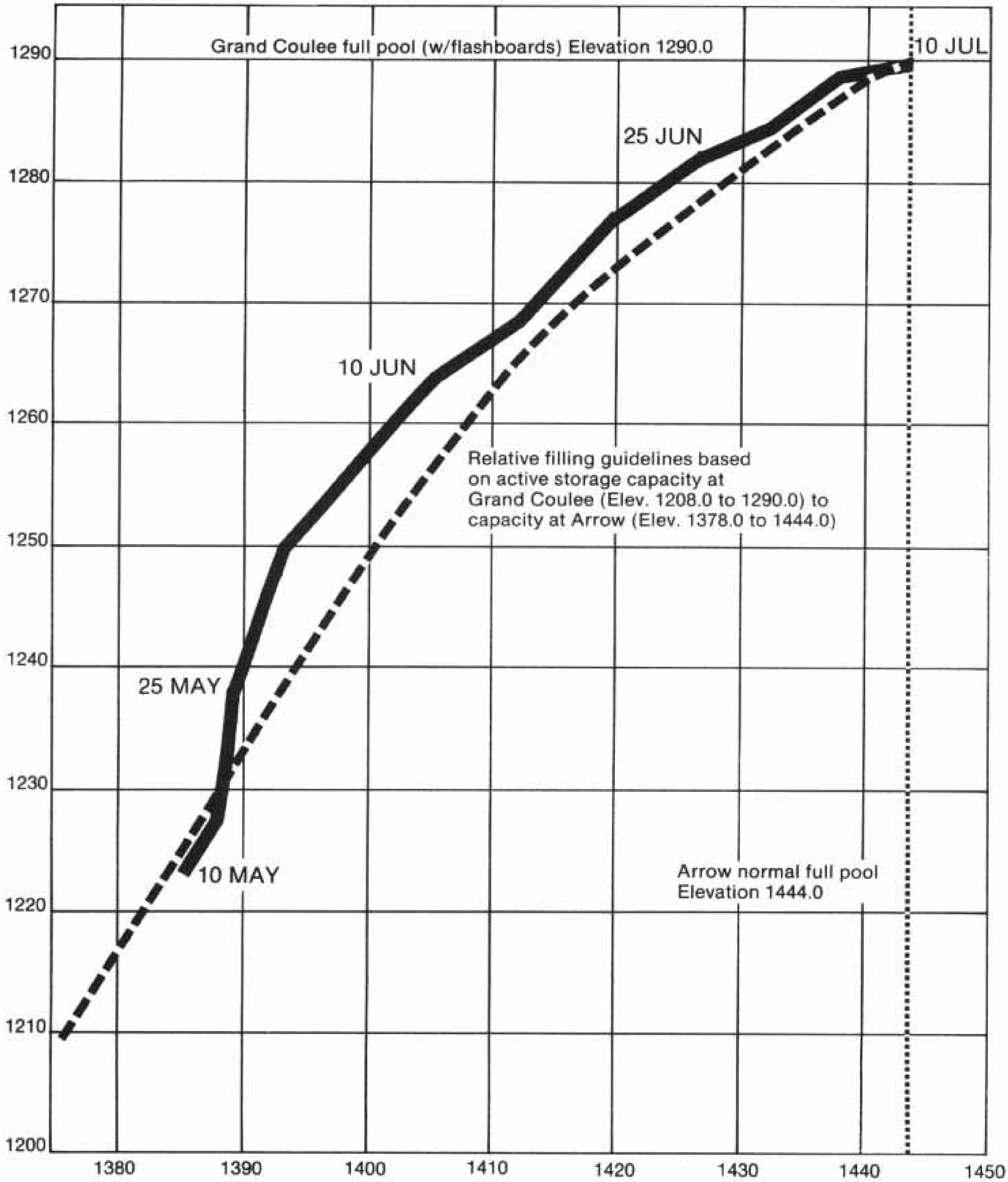


Chart 14

1982 Relative Filling Arrow and Grand Coulee



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