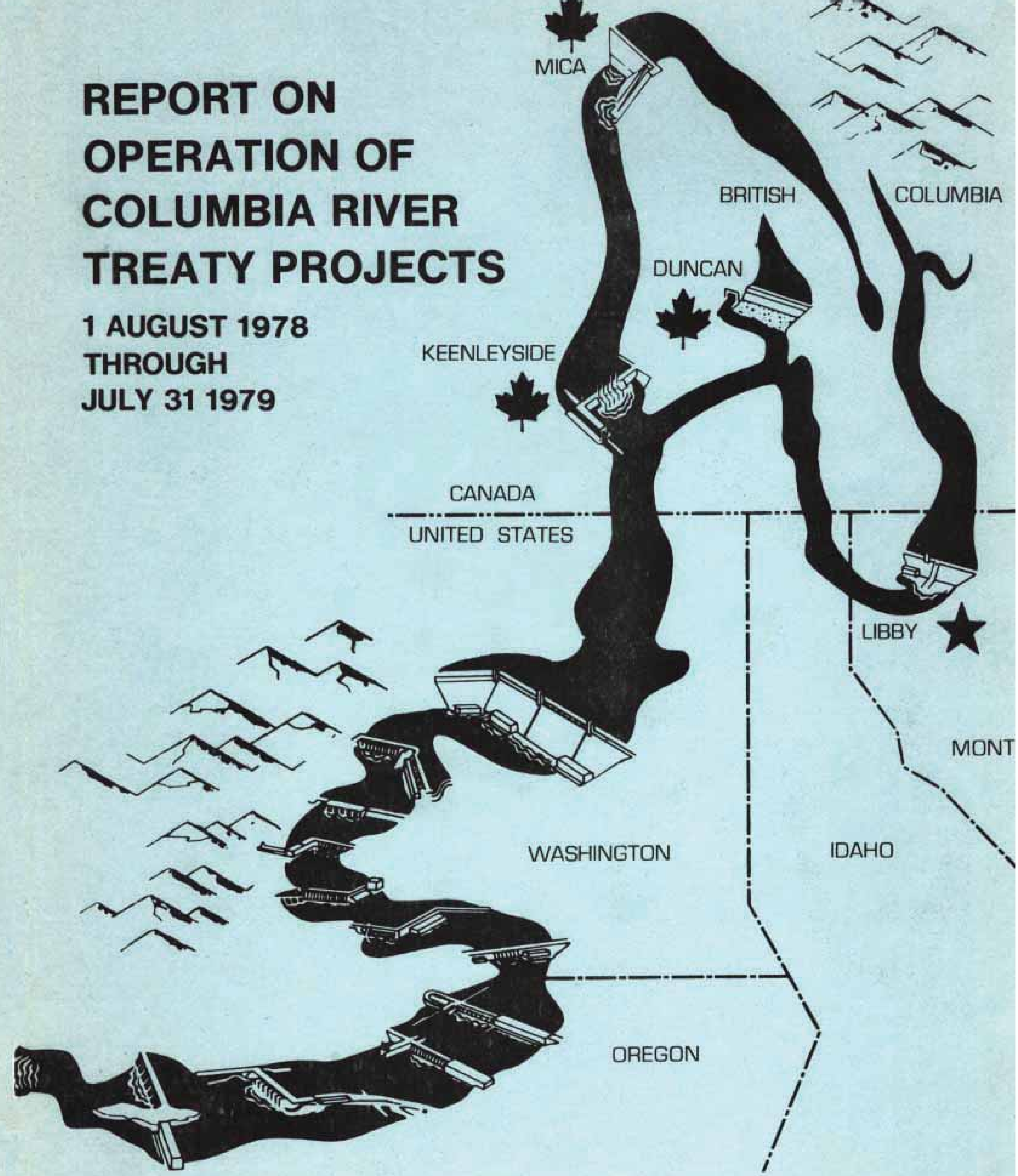
REPORT ON OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1978 THROUGH JULY 31 1979



COLUMBIA RIVER TREATY OPERATING COMMITTEE

OCTOBER 1979

REPORT ON

OPERATION OF COLUMBIA RIVER

TREATY PROJECTS

1 AUGUST 1978 THROUGH 31 JULY 1979

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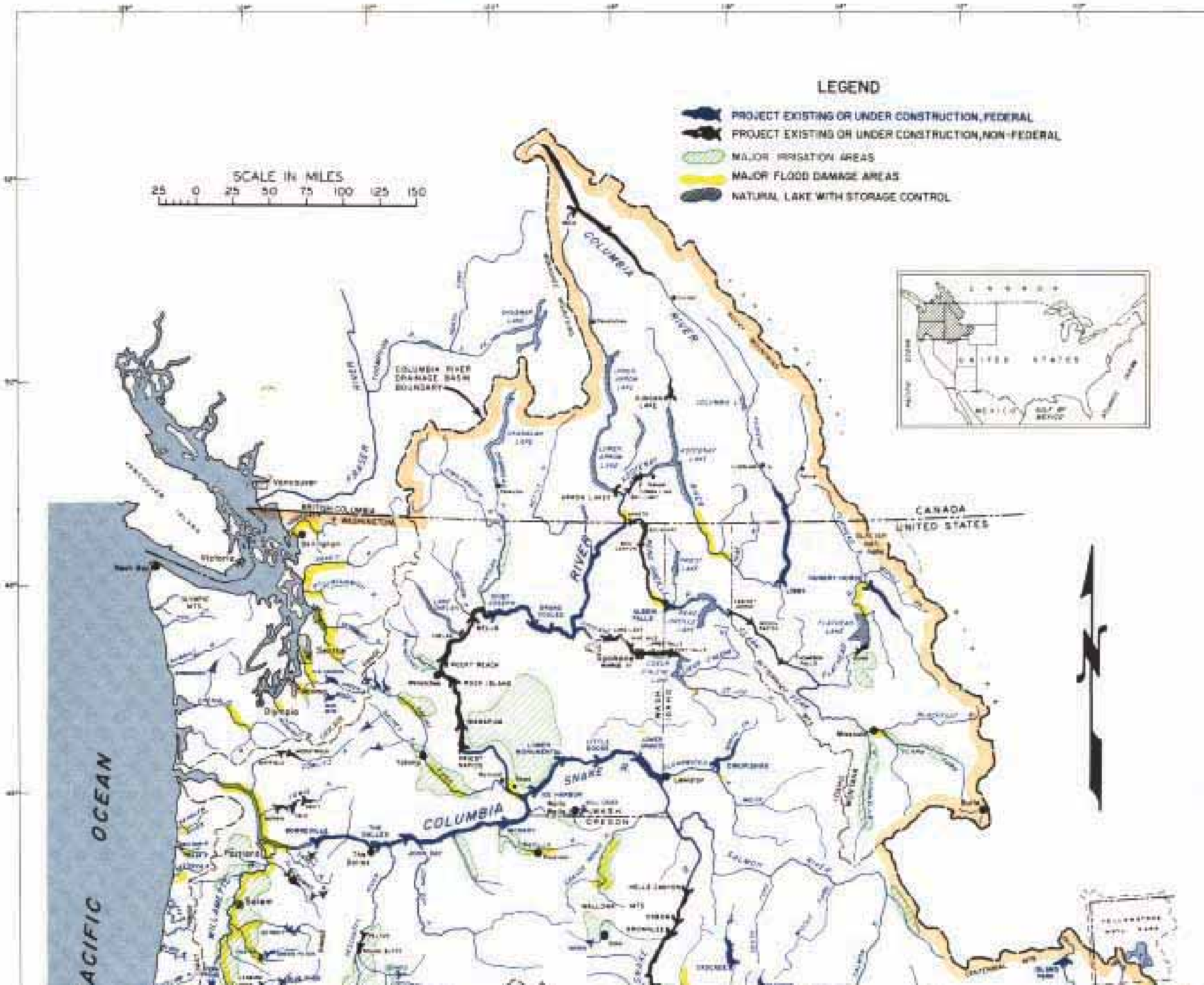


REPORT ON

OPERATION OF COLUMBIA RIVER TREATY PROJECTS

1 AUGUST 1978 THROUGH 31 JULY 1979

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. Canadian storage 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 1978 through 31 July 1979, 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 Committe in accordance with the Detailed Operating Plan for Columbia River Treaty Storage, dated September 1978. The regulation of the Canadian storage content was normally determined by the Operating Committee on a weekly basis during the entire operating year.

II. WEATHER AND STREAMFLOW

A. WEATHER

Late summer and early fall precipitation in 1978 was highly variable over the Columbia River Basin. August started out hot and dry; but by midmonth a cooling trend settled in, with above average rainfall and cool temperatures predominating over much of the basin through September. October showed a slight warming trend and below normal rainfall, with November turning cooler and drier. In December a cold, dry arctic air mass invaded the Columbia Basin, holding temperatures and precipitation to well-below normal through mid-January. The October-January cumulative precipitation was only 56 percent of the long-term basin average. Seasonal temperatures and above normal precipitation returned in February to substantially increase many deficit snowpacks, bringing the basin-wide snowpack to 87 percent of normal. March weather returned to the dry sequence of the preceding months and above-normal temperatures depleted most of the low level snow accumulation. Slightly above normal precipitation dominated throughout much of April, except in the Snake River Basin which received roughly one-half of its normal precipitation. A short warming trend followed by shower activity continued into May with monthly precipitation totals falling slightly below normal. June was generally hot and very dry, with slightly above normal temperatures and below normal precipitation continuing through July. The total August 1978 - July 1979 precipitation was 82 percent of average for the Columbia Basin above Grand Coulee and also 82 percent of average for the Columbia Basin above The Dalles.

The geographical distribution of the accumulated October through April precipitation for the basin, expressed as a percentage of the fifteen year average, 1963-1977, is shown on Chart 1. This shows the October through April precipitation to be the lowest (less than 50% of average) in areas of the Kootenai drainage, and from the lower Okanogan south along the Columbia River below Grand Coulee to The Dalles. Near average (between 80 and 120 percent of average) precipitation fell over parts of the Upper Arrow and Duncan Lake basins in British Columbia, the Clark Fork and Upper Snake River basins in Idaho and over eastern Oregon. The remainder of the basins received less than average (50 to 80 percent) precipitation with only the remote eastern edge of the Clark Fork reporting above-average accumulation.

Chart 2 depicts the winter season precipitation and temperature sequence that occurred throughout the basin, as measured by index stations in the basin. Cold temperatures and light precipitation from November through January held snow accumulations to 65 percent of average. Seasonal temperatures and heavy precipitaion throughout the remaining winter months resulted in a May 1 basin-wide snow pack that was 84 percent of normal. The areal distribution was highly variable, ranging from 29 percent of normal on some areas of Washington up to about 150 percent of average on some of the low elevation watersheds in central and southeastern Oregon.

The pattern of temperature and precipitation throughout the April-August 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 runoff which occurs during the season is produced by snowmelt, the temperatures shown are of special significance to system reservoir regulation in that they largely influence the pattern of streamflow.

B. STREAMFLOW

Above average precipitation in August and September 1978 resulted in streamflows which were 142 percent of average throughout the Columbia Basin. High streamflows continued throughout the fall in the Canadian watersheds but most of the United States' basins reported slightly less than average flows for October, November and December. A cold, dry January caused icing on the Columbia and many tributary streams, with below average streamflows reported over the entire Basin. Below or near-average flows predominated over the entire spring runoff season with the exceptions of above average flows in the Willamette and western Washington basins in February, and in the Clearwater and Flathead River drainages in May. By June, all basins reported below average flows except for near-average streamflows in the Snake and Clark Fork watersheds.

The 1978-1979 monthly modified streamflows and average monthly flows for the period 1926-1979 are shown in the following table for the Columbia River at Grand Coulee and for the Columbia River 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.

	Monthly Mean Modified Streamflow, in CFS			
	Columbia River at Grand Coulee		Columbia River at The Dalles	
Month	Year 1978-1979	Average 1926-1979	Year 1978-1979	Average 1926-1979
AUG	96300	97920	129600	134310
SEP	96160	60370	130200	93160
OCT	56560	51380	84430	89020
NOV	44560	46700	80500	91690
DEC	29020	43220	61800	95160
JAN	27150	38490	60290	91590
FEB	40080	41100	99680	103040
MAR	50260	48190	132100	118850
APR	80120	114550	167500	217260
MAY	253100	264780	408600	415370
JUN	235100	315090	325500	468110
JUL	140300	187310	171300	253550
YEAR	95730	109090	154290	180930

The maximum mean monthly adjusted streamflows occurred in May this year, and were 96 percent and 98 percent of the long-term averages at Grand Coulee and at The Dalles, respectively. During the usual maximum month, June, streamflows were down to 74 and 70 percent of normal at their respective locations.

Maximum observed mean daily inflow for Mica was 70,800 cubic feet per second (cfs) on 7 July; for Arrow, 89,100 cfs on 5 June; for Duncan, 13,200 cfs on 27 May; and for Libby, 46,700 cfs on 27 May. The maximum observed mean daily flow in the Columbia River at The Dalles was 306,200 cfs on 25 May 1979. The observed streamflow patterns for the year are shown on the inflow hydro-graphs for the Treaty reservoirs, Charts 5, 6, 7, and 8. Observed and computed unregulated hydrographs for Kootenay Lake, Columbia River at Birchbank, Grand Coulee Dam, 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. 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 of the Columbia River at The Dalles. The forecasts for Mica, Arrow, and Duncan inflow were prepared by B. C. Hydro and those for the lower Columbia River and Libby inflow were prepared by the United States Columbia River Forecasting Service. Also shown on Table 1 are the actual volumes for these five locations. Observed April-August runoff volumes, adjusted for upstream storage effects to exclude the effects of regulation, are listed for eight locations in the following tabulation:

Streamflow and Location	Thousands of Acre-Feet	Percent of 1963-77 Average
Libby Reservoir Inflow	4,205	60
Duncan Reservoir Inflow	1,670	77
Mica Reservoir Inflow	10,071	83
Arrow Reservoir Inflow	19,506	81
Columbia River at Birchbank	31,660	73
Grand Coulee Reservoir Inflow	49,136	76
Snake River at Lower Granite Dam	18,386	78
Columbia River at The Dalles	72,063	73

III. RESERVOIR OPERATION

A. MICA RESERVOIR

Storage Evacuation Period As shown on chart 5, due to below normal summer runoff, Mica Reservoir (McNaughton Lake) only reached elevation 2469.6 feet on 31 July 1978, approximately 5 feet below its full pool elevation 2475.0 feet. The reservoir continued to accumulate storage through the first two weeks in August and reached elevation 2474.4 feet on 19 August. Subsequent cool temperatures reduced the streamflow and allowed Mica Reservoir to be drafted to elevation 2473.5 feet to provide an operating margin of 1.5 feet below full pool.

During August 1978, B. C. Hydro continued to return energy to BPA that had been delivered for storage under the "Agreement to Enhance Filling of Mica Reservoir." Return of the storage energy was completed on 24 August.

As a result of high runoff produced by heavy rains during the 1978 Labour Day weekend, Mica Reservoir was surcharged above full pool to control flood water releases which could otherwise damage the Revelstoke Project diversion tunnel cofferdam, 5 km upstream of Revelstoke, B. C. During this period, excess generation was delivered to BPA in lieu of Arrow Reservoir storage release. A total of 55.7 GWh was delivered and the energy was later returned to B. C. Hydro in October.

Between 30 October and 19 November, in addition to Treaty storage release as scheduled in the 1978-79 Detailed Operating Plan, approximately 40 thousand-second-foot days (ksfd) of non-Treaty storage was released from Mica Reservoir. BPA delivered the energy generated by this water downstream in the United States to B. C. Hydro in accordance with the "Agreement to Enhance Filling of Mica Reservoir".

The cold and clear weather predominated through December 1978 and January 1979, during which time Mica Reservoir was heavily drafted to meet winter peak demand with turbine discharge ranging between 30,000 cfs to 40,000 cfs. By 31 January 1979, the reservoir was at elevation 2434.2 feet. A snowslide in mid-February destroyed several towers supporting the two Mica transmission lines causing a total line outage which lasted several days.

Mica Reservoir continued to draft through March and April and was at its lowest elevation 2403.8 feet on 3 May. Between 10 March and 20 April, B. C. Hydro released non-Treaty storage for downstream generation. By 20 April, 252,078 sfd or 0.5 million acre feet of non-Treaty storage had been released, which was the limit specified in the "Agreement to Enhance Filling of Mica Reservoir".

Refill Period Streamflow began to rise early in May; and as Mica generation was curtailed to permit import by B. C. Hydro of "Fish Flow 1979" energy, Mica Reservoir gradually filled and reached elevation 2415.0 feet on 31 May. Between 30 May and 3 June 1979 Mica discharges were reduced to permit removal of the floating bridge north of Revelstoke which had been used since 26 June 1978 to bypass highway traffic around highway reconstruction. The reservoir continued to rise rapidly through June. Early in July it became apparent the Arrow Reservoir might not refill because of a deficient runoff. It was then decided to discharge full turbine capacity at Mica to help fill the Arrow Reservoir and to maintain the water level through the summer. Because of this operation, Mica Reservoir only filled to 2456.6 feet on 31 July, 1979.

B. ARROW RESERVOIR

Storage Evacuation Period As indicated in Chart 6 Arrow Reservoir filled to full pool elevation 1444.0 feet on 16 July 1978.

Between August and early October, the reservoir surcharged between 1444.0 feet to 1446.0 feet with non-Treaty storage released from Mica as well as storage accumulated in Arrow Reservoir as a result of in-lieu energy delivery to BPA. During this period, the project outflow averaged 50,000 cfs except for the first two weeks in September when the outflow was increased up to 110,000 cfs to discharge flood water accumulated during heavy rains over the 1978 Labour Day weekend. Between 30 October and 19 November, a small amount of non-Treaty Mica storage in addition to Treaty storage was released from Arrow Reservoir. The generation produced in the U.S. by the non-Treaty storage release was delivered to B. C. Hydro by BPA.

Arrow Reservoir continued to draft through November and December and by 31 December 1978, the reservoir was at elevation 1434.8 feet. A near normal snowpack on 1 January 1979 indicated the reservoir was approximately 40 feet above its Variable Refill Curve. Consequently, Arrow Reservoir was heavily drafted in January and February to generate at downstream projects. Storage draft slackened in March as a result of a lower volume forecast and the reservoir reached elevation 1403.0 feet on 27 March 1979.

The reservoir remained near elevation 1403.0 feet through most of April. On 21 April, the project outflow was reduced to 5,000 cfs for one day to facilitate installation of a sewage outfall in the Columbia River near Trail.

Refill Period During May and June 1979, the reservoir outflow was adjusted weekly as required for downstream power and "Fish Flow", when the outflow varied between 10,000 cfs and 50,000 cfs. Streamflow rose substantially after late April and the reservoir rapidly filled from elevation 1403.1 feet on 30 April to 1433.2 feet on 30 June 1979. By early July, The Dalles volume forecast was significantly reduced from earlier estimates and a storage deficit was anticipated. To distribute the deficit among Columbia Basin storage projects, Arrow Reservoir discharges were increased to 76,000 cfs and the Reservoir reached its maximum elevation of 1438.0 feet on 23 July.

C. DUNCAN RESERVOIR

Storage Evacuation Period As shown on chart 7 Duncan Reservoir filled to full pool, elevation 1892.0 feet, on 23 July 1978. The reservoir continued to discharge inflow through mid-October and was then drafted to help fill Kootenay Lake. For approximately one week in early November, the reservoir outflow was reduced to minimum discharge of 100 cfs to lessen spilling due to unit outages at the Kootenay Canal Project. During November and December, Duncan Reservoir discharged as required for downstream generation and the reservoir drafted to elevation 1827.6 feet on 31 January 1979.

The below average 1 February snowpack indicated that the reservoir was below its Variable Refill Curve and hence the reservoir discharge was reduced to 100 cfs from 17 February through 10 March. The volume forecast improved in March and another 55 ksfd storage was released before the outflow was again reduced to 100 cfs.

Refill Period Duncan Reservoir outflows were maintained at 100 cfs from April through July 1979. The reservoir exceeded the Variable Refill Curve on 25 May and reached full pool elevation of 1892.0 feet on 21 July. Outflow was then adjusted to equal inflow thereby maintaining the reservoir near full pool.

D. LIBBY RESERVOIR

Storage Evacuation Period On 1 August 1978, Libby Reservoir was at elevation 2458.8 feet, less than 0.3 feet from full and its highest elevation of 1978. Libby remained in the top foot during August then began to draft to meet U.S. power requirements in early September.

Outflow from Libby was limited to a maximum of 15,000 cfs during September and most of October by flow restrictions at the Libby Re-regulating dam construction site. The completion of stone placement around bridge piers at the site permitted full use of Libby powerhouse (20,000 cfs) after 26 October.

Libby was drafted heavily in November and December with powerhouse releases at maximum most of the time. The lake reached elevation 2397.0 feet on 1 January 1979. This was 13 feet below the 1 January flood control requirement and 28 feet above the 31 January Variable Refill Curve. Continuation of releases for flood control and power through January drafted Libby to elevation 2369.2 feet by 1 February, within 1 foot of the 31 January Variable Refill Curve.

When the 1 February volume inflow forecast indicated there was less than a 95 percent probability of refilling the project, Libby outflow was reduced to 4,000 cfs, the minimum outflow desired by local interests. The lake continued to draft slowly through February, March and early April as inflows remained less than the 4,000 cfs outflow. The lake reached its lowest point of the year, elevation 2364.0 feet, on 9 April and at that time was about 16 feet below the 30 April Variable Refill Curve.

Refill Period Libby outflows were maintained between 3,000 and 4,000 cfs from 6 February through 24 July, with the exception of two minor non-power increases on 11 June and 14 July. On 11 June the outflow was increased over a four-hour period to provide a 4-foot tailwater elevation increase to be observed by an environmental committee with the state of Montana. On 14 July, a flow of 12,000 cfs was provided for five hours for the Libby Logger's Day raft race.

Inflows to Libby increased during late April and May to a seasonal peak of 46,700 cfs on 27 May. After a smaller peak of 42,100 cfs on 6 June, inflows gradually receded through the remainder of the refill period.

The rate of fill at Libby slowed when outflows were increased on 25 July to begin operating the project in accordance with the proportional draft guidelines. The lake was at elevation 2450.7 feet on 31 July.

E. KOOTENAY LAKE

Storage Evacuation Period Kootenay Lake peaked at elevation 1747.6 feet on 11 June 1978, and was subsequently drafted to approximately elevation 1743.0 feet by mid-August as indicated in Chart 9. The lake level was maintained near elevation 1743.0 feet through the remainder of August. During September, with increased outflow from Duncan Reservoir, Kootenay Lake gradually filled and was at elevation 1745.0 feet on 29 September, approximately 0.3 feet below the IJC rule curve. This level was maintained through December 1978. As the Kootenay Canal project has a higher plant efficiency, most of the water was used for generation at the Canal project with only 5,000 cfs normally discharged through the other projects on the river.

Draft of Kootenay Lake for flood control space began on 7 January 1979 and its level dropped to elevation 1738.5 feet by 11 April. During March and April, the Kootenay Lake outflow was maintained at about 12,000 cfs due to unit outage at the Brilliant project.

Refill Period Snowmelt runoff began earlier than normal in the Kootenay Lake watershed. With inflow exceeding the free flow capability during May 1979, the lake rose rapidly and reached its peak elevation of 1743.7 feet on 28 May. This was lower than in previous years as the runoff was well below average. Kootenay Lake outflow was subsequently controlled to maintain the lake level near elevation 1743.0 feet as measured at Nelson.

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 1978-79 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 1978-79 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 during the 1978-79 Operating Year.

The generation at downstream projects in the United States, delivered under the Canadian Entitlement Exchange Agreement was 658 average megawatts at rates up to 1350 megawatts from 1 August 1978 through 31 March 1979 and 621 average megawatts at rates up to 1331 megawatts, from 1 April 1979 through 31 July 1979. During the period 1 April 1978 through 31 March 1979, the CSPE participants assigned 74 average megawatts at rates up to 150 megawatts to Pacific Southwest utilities. Beginning 1 April 1979 the assignment was 71 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 1978-79 Operations All major reservoirs were full on 31 July 1978, except Mica, which filled during the first half of August.

BPA was able to supply most of its Northwest secondary energy requirements during August. Heavy precipitation during the first week of September caused reservoirs to approach their normal full elevations creating a temporary surplus energy condition. From September 6-10, BPA exported surplus energy to California that it was unable to store in reservoirs. Decreasing amounts of secondary energy were delivered to both industries and investor-owned utilities until deliveries were curtailed October 24. BPA continued to serve the IF-1 upper quartile industrial load with advance energy deliveries. Secondary energy deliveries to public agencies were curtailed November 24. BPA entered into an agreement with Portland General Electric Company to advance up to 400,000 megawatthours of energy in November and December to help offset the shutdown of Trojan Nuclear Plant for investigation of safety problems.

November and December 1978 were among the coldest months ever recorded across the Pacific Northwest. The mean temperature at the three load centers averaged 5.5° F and 6.3° F below normal during November and December, respectively. Precipitation was low during these months with only 30 to 60 percent of normal recorded at stations around the Columbia River Basin. Streamflows receded as a result of the below normal temperatures and precipitation. Coordinated System reservoirs on December 31, 1978, were 2.2 billion kilowatthours below operating program rule curves as a result of advance energy deliveries by BPA to its non-firm industrial load and to Portland General Electric Company and failure of the Trojan plant to operate as planned. In late December, the Nuclear Regulatory Commission gave Portland General Electric Company permission to operate Trojan. The plant began generating again on January 2, 1979.

The January 1, 1979, probable January-July volume runoff forecast of the Columbia River at The Dalles, Oregon was 88 million acre-feet or 80 percent of the 15-year average runoff. Volume runoff forecasts of inflow to several reservoirs were, however, sufficiently high to enable lowering of their operating rule curves and thereby creating some potential secondary energy on the system.

The indicated amount of secondary energy was not sufficient to warrant restoration of deliveries to all Northwest markets and displace the higher cost generation from the Hanford project. BPA decided to return to its industrial customers the Hanford generation which had been withdrawn as a result of the Trojan shutdown. It was further decided to restrict deliveries to the industries' nonfirm load effective midnight January 10, 1979. Subsequent studies indicated that secondary energy could be made available to the BPA preference customers, and this service was restored effective midnight January 19, 1979.

January 1979 was the coldest January of the century. Mean temperatures at the three load centers averaged 7.3° F below normal. January precipitation for the entire Columbia Basin averaged only 44 percent of normal. As a result, the February 1 forecast of the January-July volume runoff of the Columbia River at The Dalles dropped 9.4 MAF to 78.6 MAF.

In contrast to the three preceding months, February was much wetter and milder than normal across the Columbia Basin. Precipitation was persistent and widespread with most stations reporting about 150 percent of normal February precipitation. The March 1 probable January-July volume runoff forecasted for the Columbia River at The Dalles jumped 14.4 MAF to 93.0 MAF. BPA restored secondary energy deliveries on March 9 to the upper quartile of its industrial load with an equal amount of secondary energy made available to the investor-owned utilities. With the availability of secondary energy from BPA, the industries sold a major portion of their Hanford energy to Pacific Southwest utilities, but retained the right to recall subject to specified conditions.

During May the Federal Columbia River Power System was required to discharge water to assist in the downstream migration of juvenile fish. This resulted in BPA marketing secondary and surplus energy that it would have otherwise conserved in reservoirs in order to provide a greater probability of refill. Between May 7 and 31, BPA marketed surplus power in the amount of 392,467 megawatthours in order to satisfy the mid-Columbia minimum streamflows requested by the fishery agencies. This was the first time since September 1978 that BPA had sold surplus energy to the Pacific Southwest. BPA also stored excess generation with California utilities and B.C. Hydro.

Secondary energy deliveries to investor-owned utilities were curtailed on June 29. Direct service to the upper quartile non-firm industrial load was restricted on July 1, 1979. This load was served by advancing the industries their 1979-80 Hanford energy. Secondary energy deliveries to Public Agencies were curtailed on July 6, 1979.

Precipitation during June and July was much below normal. The actual January-July 1979 volume runoff of the Columbia River at The Dalles was 83.2 million acre-feet or 75.9 percent of the 15-year average.

Reservoirs were about 4 million acre-feet (4.4 billion kilowatthours) below their normal full content on July 31, 1979. This deficiency equals 9.3 percent of the total Coordinated System's storage energy.

B. FLOOD CONTROL

Flood control was not a significant factor for the operation of Treaty storage reservoirs for the spring runoff of 1979, with the unregulated peak at The Dalles being only slightly greater than bankfull capacity. With the Columbia Basin reservoirs being operated for power and refill, the maximum observed daily discharge during the spring runoff was 306,000 cfs at The Dalles. By comparison the unregulated peak was calculated to be 482,000 cfs. Low spring flows were also observed on upstream tributaries. The observed and unregulated hydrographs for 1 July 1978 through 31 July 1979 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 of 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 Septebmer 1973 established Operating Rule Curves for Duncan, Arrow and Mica during the 1978-79 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, and simulated 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 1978 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 1978-79 Pacific Northwest Coordination Agreement final regulation. The Variable Refill Curves and flood control requirements subsequent to 1 January 1979, 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 1978-79 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.

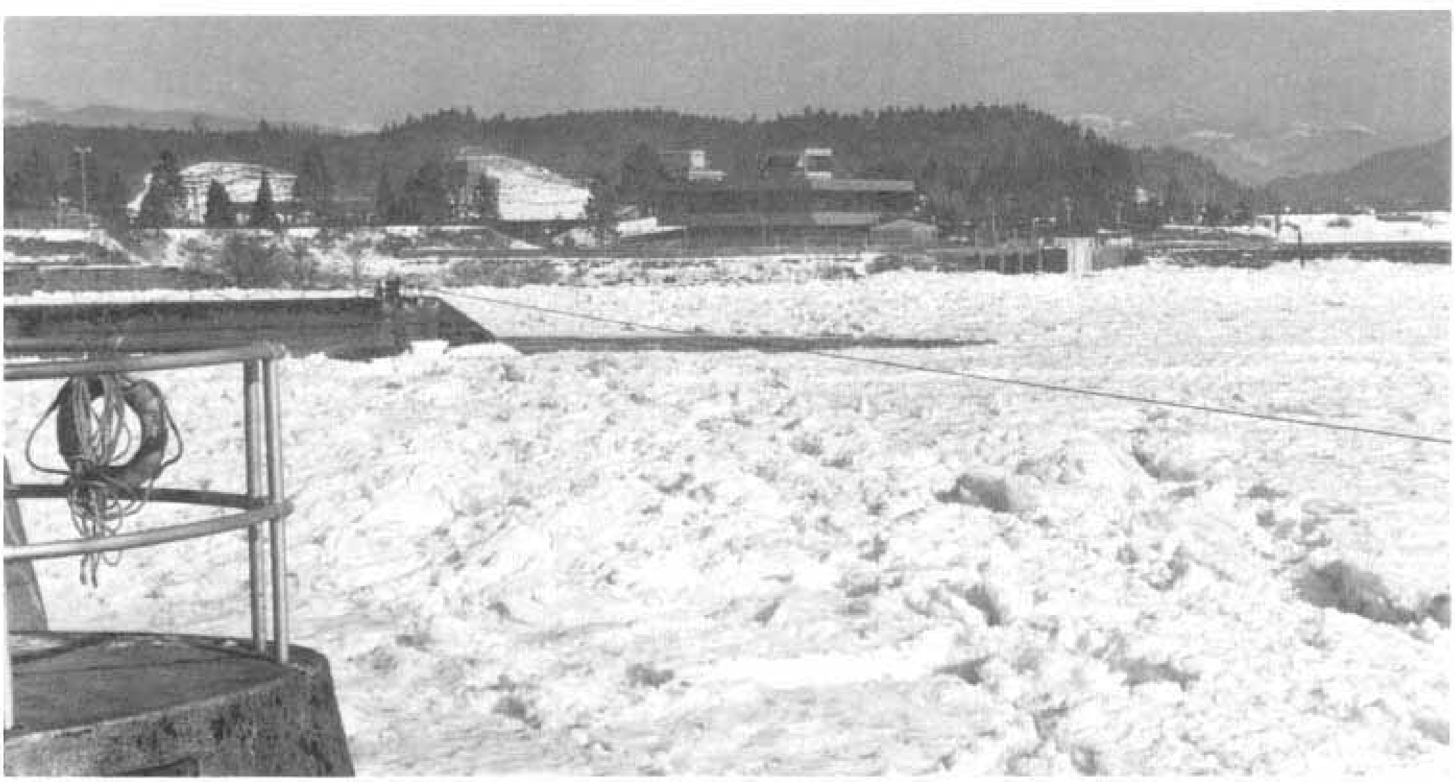
The power facilities in the United States which are downstream from the Treaty storage projects are all operated under the Pacific Northwest Coordination Agreement dated September 1964. Optimum generation in the United States was assured by the adoption, in the Assured and Detailed Operating Plans, of 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

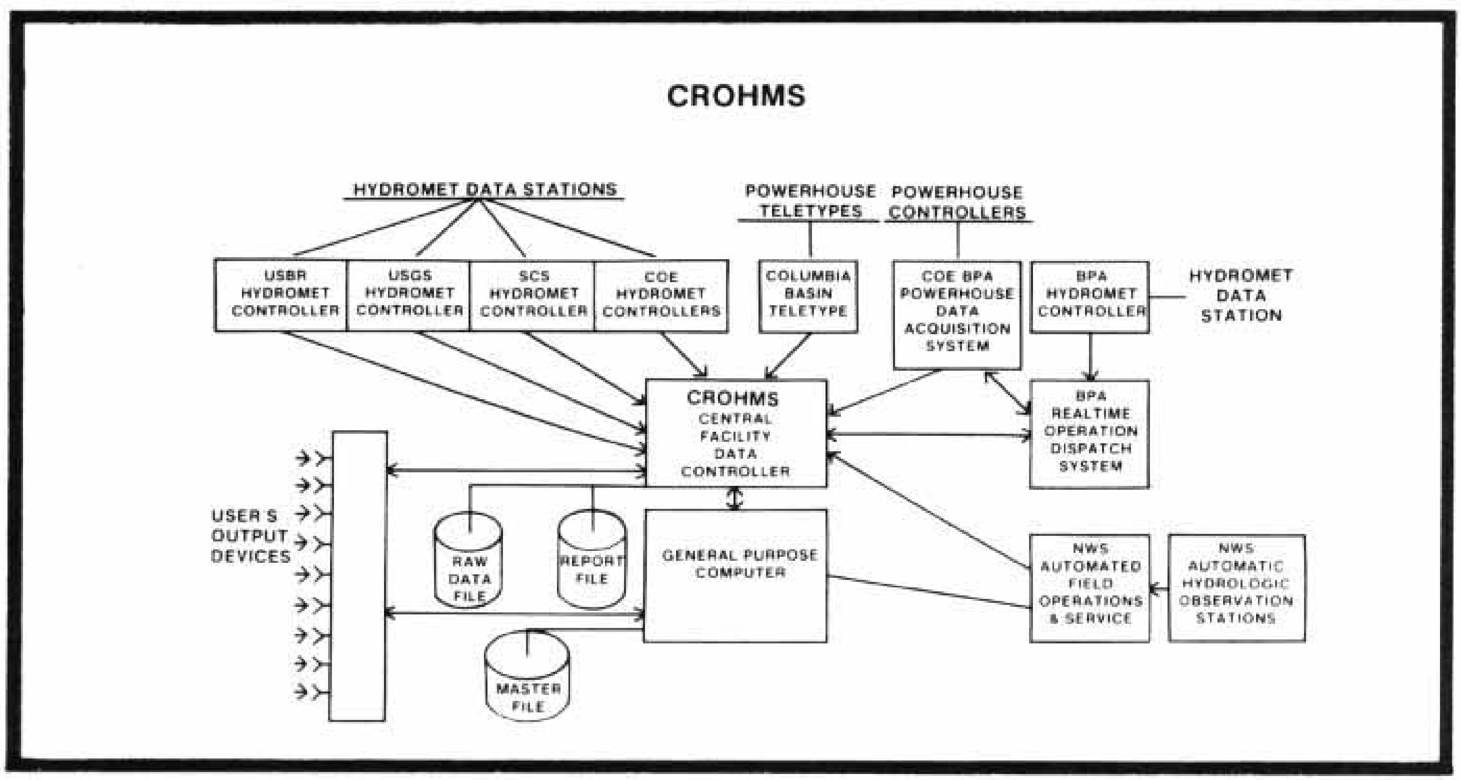
The Flood Control Operating Plan was designed to minimize flood damage both in Canada and in the United States. The flood control operation during the drawdown period consisted of evacuating and holding available storage space, consistent with refill criteria, sufficient to control the maximum flood that could occur under forecast conditions. Runoff volume forecasts determined the volume of storage space required.

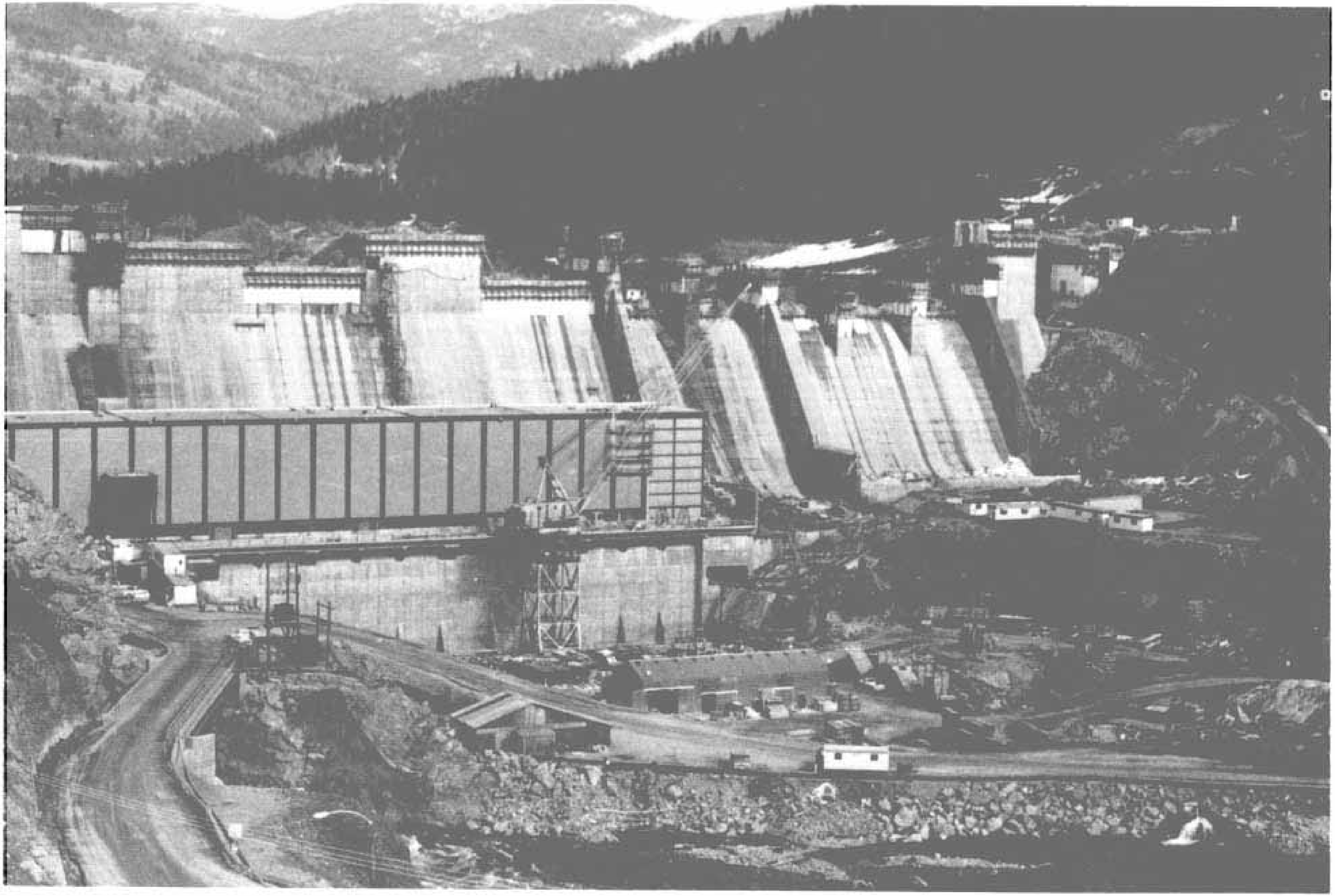
Flood control operation of the Columbia River Treaty projects during the refill period was controlled in part by the computed Initial Controlled Flow of the Columbia River at The Dalles. Other operating rules and local criteria were utilized to prepare day-to-day streamflow forecasts for key points in 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 Columbia River Forecasting Service for periods of 30 to 45 days using both moderate and severe snowmelt sequences.

Ice in the forebay of the Bonneville powerhouse was severe enough to block navigation for several days in mid-January 1979 and again for several days during the first week of February 1979. The last previous blockage by ice at Bonneville was during the winter of 1956-57. (Army Corps of Engineers photo)



A schematic diagram of major elements in the Columbia River Operational and Hydromet Management System is shown below.
The CROHMS interagency data bank is operated by the Army Corps of Engineers Automatic Data Processing Center in Portland, Oregon.
The CROHMS central facility data controller is comprised of two Interdata 7/32 computers shown behind operator Silvia Gray.
The Corps' general purpose computer supporting CROHMS is presently an IBM 370/155 computer.





B.C. Hydro's Seven Mile hydro-electric development on the Pend d' Oreille River southeast of Trail is now well advanced with work almost complete on the concrete dam and equipment being installed in the powerhouse. Powerhouse is designed to house four generating units, each with a rated capacity of 202,000 kilowatts. Three units are scheduled to be in service in 1980. A fourth may be added at some later date.

Floating bridge used to bypass highway traffic around road construction at Rwelstoke site. BCH photo

TABLE 1

UNREGULATED RUNOFF VOLUME FORECASTS
MILLIONS OF ACRE-FEET
1979

	DUNCAN	ARROW	MICA	LIBBY	UNREGULATED RUNOFF COLUMBIA RIVER AT THE DALLES, OREGON
Forecast Date - 1st of	Most Probable 1 Apr - 31 Aug	Most Probable 1 Apr - 31 Aug	Most Probable 1 Apr - 31 Aug	Most Probable 1 Apr - 31 Aug	Most Probable 1 Jan - 31 Jul
January	1.88	22.0	11.40	6.24	88.0
February	1.77	20.4	9.73	5.22	78.6
March	1.98	22.6	11.70	5.87	93.0
April	1.93	21.7	11.35	5.43	87.3
May	1.95	21.9	11.36	5.48	89.7
June	1.94	21.8	11.17	5.37	89.7
July	1.85	21.7	11.13	4.46	83.7
Actual	1.67	19.5	10.07	4.20	83.2

NOTE: These data are as used in actual operations. Subsequent revisions have been made in some cases. July forecast values are from National Weather Service - River Forecast Center, Portland computations.

MICA RESERVOIR COMPUTATION FORM

1979

95 Percent Confidence Forecast and Variable Refill Curve

	Initial	Jan 1	Feb 1	Mar 1	Apr 1	May 1	Jun 1
1. Probable Feb 1-July 31 Inflow, KSFD 1/		4702.2	4404.3	4853.5	4720.6	4721.2	4634.7
2. 95% Forecast Error, KSFD		719.4	529.6	454.5	457.4	454.9	448.6
3. 95% Confidence Feb 1-July 31 Inflow, KSFD 2/		3982.8	3874.7	4399.0	4263.2	4266.3	4186.1
4. Observed Feb 1-Date Inflow, KSFD				121.4	243.3	431.7	1122.7
5. 95% Confidence Date-July 31 Inflow, KSFD 3/		3982.8	3874.7	4277.6	4019.9	3834.6	3063.4
Assumed Feb 1-July 31 Inflow, % Volume		100.0					
Assumed Feb 1-July 31 Inflow, KSFD 4/		3982.8					
Min. Feb 1-July 31 Outflow, KSFD		2643.0					
Min. Jan 31 Reservoir Content, KSFD 5/	8004.8	2189.4					
Min. Jan 31 Reservoir Elevation, Feet 6/	2432.8	2448.4					
Jan 31 Variable Refill Curve, Feet 7/		2432.8					
Assumed Mar 1-July 31 Inflow, % Volume		97.8	97.8				
Assumed Mar 1-July 31 Inflow, KSFD 4/		3895.2	3789.5				
Min. Mar 1-July 31 Outflow, KSFD		1747.0	1747.0				
Min. Feb 28 Reservoir Content, KSFD 5/	7664.4	1381.0	1486.7				
Min. Feb 28 Reservoir Elevation, Feet 6/	2425.4	2431.5	2433.8				
Feb 28 Variable Refill Curve, Feet 7/		2425.4	2425.4				
Assumed Apr 1-July 31 Inflow, % Volume		95.4	95.4	97.6			
Assumed Apr 1-July 31 Inflow, KSFD 4/		3799.6	3696.5	4175.0			
Min. Apr 1-July 31 Outflow, KSFD		1220.0	1220.0	1220.0			
Min. Mar 31 Reservoir Content, KSFD 5/	7218.8	949.6	1052.7	574.2			
Min. Mar 31 Reservoir Elevation, Feet 6/	2415.4	2422.1	2424.4	2413.6			
Mar 31 Variable Refill Curve, Feet 7/		2415.4	2415.4	2413.6			
Assumed May 1-July 31 Inflow, % Volume		91.0	91.0	93.1	95.4		
Assumed May 1-July 31 Inflow, KSFD 4/		3624.3	3526.0	3982.5	3835.0		
Min. May 1-July 31 Outflow, KSFD		920.0	920.0	920.0	920.0		
Min. Apr 30 Reservoir Content, KSFD 5/	6968.0	824.9	923.2	466.7	614.2		
Min. Apr 30 Reservoir Elevation, Feet 6/	2409.6	2419.3	2421.5	2411.1	2414.5		
Apr 30 Variable Refill Curve, Feet 7/		2409.6	2409.6	2409.6	2409.6		
Assumed Jun 1-July 31 Inflow, % Volume		74.1	74.1	75.8	77.7	81.5	
Assumed Jun 1-July 31 Inflow, KSFD 4/		2951.3	2871.2	3242.5	3123.4	3125.2	
Min. Jun 1-July 31 Outflow, KSFD		610.0	610.0	610.0	610.0	610.0	
Min. May 31 Reservoir Content, KSFD 5/	7502.0	1187.9	1268.0	896.7	1015.8	1014.0	
Min. May 31 Reservoir Elevation, Feet 6/	2421.8	2427.3	2429.1	2420.9	2423.6	2423.5	
May 31 Variable Refill Curve, Feet 7/		2421.8	2421.8	2420.9	2421.8	2421.8	
Assumed Jul 1-July 31 Inflow, % Volume		36.9	36.9	37.8	38.7	40.6	49.8
Assumed Jul 1-July 31 Inflow, KSFD 4/		1469.7	1429.8	1616.9	1555.7	1556.9	1525.6
Min. Jul 1-July 31 Outflow, KSFD		310.0	310.0	310.0	310.0	310.0	310.0
Min. June 30 Reservoir Content, KSFD 5/	8881.0	2369.5	2409.4	2222.3	2283.5	2282.3	2313.6
Min. June 30 Reservoir Elevation, Feet 6/	2451.0	2452.1	2452.9	2449.1	2450.3	2450.3	2451.0
June 30 Variable Refill Curve, Feet 7/		2451.0	2451.0	2449.1	2450.3	2450.3	2451.0
July 31 Variable Refill Curve, Feet	2474.5	2474.5	2474.5	2474.5	2474.5	2474.5	2474.5
Mica Accumulated Dead Storage		6565.1	6565.1	6565.1	6565.1	6565.1	6565.1

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 (Footnote 5 Plus the Accumulated Dead Storage)
7/Lower of Elevation on Preceding Line or Elevation Determined by Adding Dead Storage to Initial Contents
8/Limited to Lower Limit for Variable Refill Curve

ARROW LAKES RESERVOIR COMPUTATION FORM

1979

95 Percent Confidence Forecast and Variable Refill Curve

	Initial	Jan 1	Feb 1	Mar 1	Apr 1	May 1	Jun 1
		ARROW LOCAL	ARROW LOCAL	ARROW TOTAL	ARROW TOTAL	ARROW TOTAL	ARROW LOCAL
1. Probable Feb 1-July 31 Inflow, KSFD 1/		4842.4	4444.0	9895.1	9689.9	9911.6	4988.1
2. 95% Forecast Error, KSFD		944.0	751.7	986.5	867.6	856.4	552.3
3. 95% Confidence Feb 1-July 31 Inflow, KSFD 2/		3848.4	3692.3	8908.6	8822.3	9055.2	4435.8
4. Observed Feb 1-Date Inflow, KSFD				323.7	770.1	1401.2	1944.4
5. 95% Confidence Date-July 31 Inflow, KSFD 3/		3848.4	3692.3	8584.9	8052.2	7654.0	2491.4
Assumed Feb 1-July 31 Inflow, % Volume		100.0					
Assumed Feb 1-July 31 Inflow, KSFD 4/		3848.4					
Min. Feb 1-July 31 Outflow, KSFD		2039.1					
Mica Refill Requirements, KSFD 8/		2643.0					
Min. Jan 31 Reservoir Content, KSFD 5/	2367.5	683.6					
Min. Jan 31 Reservoir Elevation, Feet 6/	1424.6	1393.3 9/					
Jan 31 Variable Refill Curve, Feet 7/		1393.3 9/					
Assumed Mar 1-July 31 Inflow, % Volume		97.3	97.3				
Assumed Mar 1-July 31 Inflow, KSFD 4/		3744.5	3592.6				
Min. Mar 1-July 31 Outflow, KSFD		1899.1	3645.0				
Mica Refill Requirements, KSFD 8/		1747.0	1747.0				
Min. Feb 28 Reservoir Content, KSFD 5/	1314.2	353.1	1885.0				
Min. Feb 28 Reservoir Elevation, Feet 6/	1405.8	1386.2 9/	1416.3				
Feb 28 Variable Refill Curve, Feet 7/		1386.2 9/	1405.8				
Assumed Apr 1-July 31 Inflow, % Volume		94.1	94.1	97.1			
Assumed Apr 1-July 31 Inflow, KSFD 4/		3621.3	3474.4	8335.9			
Min. Apr 1-July 31 Outflow, KSFD		1744.1	3490.0	889.0			
Mica Refill Requirements, KSFD 8/		1220.0	1220.0	2955.0			
Min. Mar 31 Reservoir Content, KSFD 5/	1251.1	482.4	2375.2	89.9			
Min. Mar 31 Reservoir Elevation, Feet 6/	1404.6	1389.1	1424.7	1380.1 9/			
Mar 31 Variable Refill Curve, Feet 7/		1389.1	1404.6	1380.1 9/			
Assumed May 1-July 31 Inflow, % Volume		87.2	87.2	91.2	94.0		
Assumed May 1-July 31 Inflow, KSFD 4/		3355.8	3219.7	7829.4	7569.0		
Min. May 1-July 31 Outflow, KSFD		1408.7	2965.0	683.8	1583.8		
Mica Refill Requirements, KSFD 8/		920.0	920.0	3126.3	3126.3		
Min. Apr 30 Reservoir Content, KSFD 5/	1441.6	712.5	2404.9	.0	720.7		
Min. Apr 30 Reservoir Elevation, Feet 6/	1408.2	1393.9	1425.2	1377.9	1394.1		
Apr 30 Variable Refill Curve, Feet 7/		1393.9	1408.2	1377.9	1394.1		
Assumed Jun 1-July 31 Inflow, % Volume		63.9	63.9	70.4	72.6	77.2	
Assumed Jun 1-July 31 Inflow, KSFD 4/		2459.1	2359.4	6043.7	5845.9	5908.9	
Min. Jun 1-July 31 Outflow, KSFD		1006.3	2143.5	471.8	1134.2	1006.3	
Mica Refill Requirements, KSFD 8/		610.0	610.0	2632.5	2592.3	2592.3	
Min. May 31 Reservoir Content, KSFD 5/	2179.1	1516.8	2753.7	640.1	1460.2	1269.3	
Min. May 31 Reservoir Elevation, Feet 6/	1421.4	1409.6	1431.0	1392.0	1408.5	1404.9	
May 31 Variable Refill Curve, Feet 7/		1409.6	1421.4	1392.4	1408.5	1404.9	
Assumed Jul 1-July 31 Inflow, % Volume		27.5	27.5	32.7	33.7	35.9	43.0
Assumed Jul 1-July 31 Inflow, KSFD 4/		1058.3	1015.4	2807.3	2713.6	2747.8	1071.3
Min. Jul 1-July 31 Outflow, KSFD		616.9	1348.5	266.6	699.2	616.9	534.6
Mica Refill Requirements, KSFD 8/		310.0	310.0	1306.9	1245.7	1246.9	310.0
Min. June 30 Reservoir Content, KSFD 5/	3416.4	2828.2	3579.6	2345.9	2810.9	2695.6	2732.9
Min. June 30 Reservoir Elevation, Feet 6/	1441.5	1432.2	1444.0	1424.2	1431.9	1430.1	1430.7
June 30 Variable Refill Curve, Feet 7/		1432.2	1441.5	1424.2	1431.9	1430.1	1430.7
July 31 Variable Refill Curve, Feet	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/Full Content (3579.6 KSFD) Less Line Preceding Plus Line Preceding That Less Line Preceding That For Arrow Local. For Arrow Total, Full Content (3579.6 KSFD) Plus Two Preceding Lines Less Line Preceding That.
6/From Reservoir Elevation-Storage Content Table Dated Feb. 28, 1974
7/Lower of the Elevation on Preceding Line or Elevation Determined Prior to Year (Initial)
8/Mica Minimum Power Discharges For Arrow Local. For Arrow Total, Mica Full Content Less Variable Refill Curve From Mica Computation Form
9/Limited to Lower Limit for Variable Refill Curve

DUNCAN RESERVOIR COMPUTATION FORM

1979

95 Percent Confidence Forecast and Variable Refill Curve

	Initial	Jan 1	Feb 1	Mar 1	Apr 1	May 1	Jun 1
1. Probable Feb 1-July 31 Inflow, KSFD 1/		813.2	761.8	853.9	828.9	834.8	827.9
2. 95% Forecast Error, KSFD		153.7	119.8	110.4	105.1	95.7	94.2
3. 95% Confidence Feb 1-July 31 Inflow, KSFD 2/		659.5	642.0	743.5	723.8	739.1	733.7
4. Observed Feb 1-Date Inflow, KSFD				17.1	34.8	68.4	222.3
5. 95% Confidence Date-July 31 Inflow, KSFD 3/		659.5	642.0	726.4	689.0	670.7	511.4
Assumed Feb 1-July 31 Inflow, % Volume		100.0					
Assumed Feb 1-July 31 Inflow, KSFD 4/		659.5					
Min. Feb 1-July 31 Outflow, KSFD		135.2					
Min. Jan 31 Reservoir Content, KSFD 5/	232.9	181.5					
Min. Jan 31 Reservoir Elevation, Feet 6/	1833.7	1826.3					
Jan 31 Variable Refill Curve, Feet 7/		1826.3					
Assumed Mar 1-July 31 Inflow, % Volume		97.8	97.8				
Assumed Mar 1-July 31 Inflow, KSFD 4/		645.0	627.8				
Min. Mar 1-July 31 Outflow, KSFD		132.4	210.5				
Min. Feb 28 Reservoir Content, KSFD 5/	145.5	193.2	288.5				
Min. Feb 28 Reservoir Elevation, Feet 6/	1820.9	1828.0	1841.3				
Feb 28 Variable Refill Curve, Feet 7/		1820.9	1820.9				
Assumed Apr 1-July 31 Inflow, % Volume		95.4	95.4	97.5			
Assumed Apr 1-July 31 Inflow, KSFD 4/		62911	612.4	708.2			
Min. Apr 1-July 31 Outflow, KSFD		129.3	207.4	51.2			
Min. Mar 31 Reservoir Content, KSFD 5/	258.1	206.0	300.8	48.8			
Min. Mar 31 Reservoir Elevation, Feet 6/	1837.2	1829.0	1843.0	1804.7			
Mar 31 Variable Refill Curve, Feet 7/		1829.9	1837.2	1804.7			
Assumed May 1-July 31 Inflow, % Volume		90.3	90.3	92.2	94.6		
Assumed May 1-July 31 Inflow, KSFD 4/		595.5	579.7	669.7	651.8		
Min. May 1-July 31 Outflow, KSFD		97.5	156.4	38.2	104.1		
Min. Apr 30 Reservoir Content, KSFD 5/	236.4	207.5	282.5	74.3	158.1		
Min. Apr 30 Reservoir Elevation, Feet 6/	1834.2	1830.1	1840.5	1809.3	1822.8		
Apr 30 Variable Refill Curve, Feet 7/		1830.1	1834.2	1809.3	1822.8		
Assumed Jun 1-July 31 Inflow, % Volume		70.5	70.5	72.0	73.9	78.1	
Assumed Jun 1-July 31 Inflow, KSFD 4/		464.9	452.6	523.0	509.2	523.8	
Min. Jun 1-July 31 Outflow, KSFD		64.7	103.7	25.6	69.1	64.7	
Min. May 31 Reservoir Content, KSFD 5/	343.5	305.6	356.9	208.4	265.7	246.7	
Min. May 31 Reservoir Elevation, Feet 6/	1848.6	1843.6	1850.3	1830.2	1838.2	1835.6	
May 31 Variable Refill Curve, Feet 7/		1843.6	1848.6	1830.2	1838.2	1835.6	
Assumed Jul 1-July 31 Inflow, % Volume		33.3	33.3	34.0	34.9	36.9	47.2
Assumed Jul 1-July 31 Inflow, KSFD 4/		219.6	213.8	247.0	240.5	247.5	241.4
Min. Jul 1-July 31 Outflow, KSFD		32.9	52.7	13.0	35.1	32.9	30.6
Min. June 30 Reservoir Content, KSFD 5/	532.4	519.1	544.7	471.8	500.4	491.2	495.0
Min. June 30 Reservoir Elevation, Feet 6/	1872.0	1870.4	1873.5	1864.7	1868.2	1867.1	1867.5
June 30 Variable Refill Curve, Feet 7/		1870.4	1872.0	1864.7	1868.2	1867.1	1867.5
July 31 Variable Refill Curve, Feet	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) Plus Preceding Line Less Line Preceding That
6/From Reservoir Elevation-Storage Content Table Dated Feb. 21, 1973
7/Lower of Elevation on Preceding Line or Elevation Determined Prior to the Year (Initial)
8/Limited to Lower Limit for Variable Refill Curve

LIBBY 1979

95 PERCENT CONFIDENCE FORECAST AND VARIABLE ENERGY CONTENT CURVE

		Jan 1	Feb 1	Mar 1	Apr 1	May 1	Jun 1
Probable Jan 1-Jul 31 Inflow, KAF		6294.0	5367.8	5877.6	5512.0	5561.5	5459.3
95% Forecast Error, KSFD		3173.2	2706.3	2963.3	2779.0	2803.9	2752.4
Observed Jan 1-Date Inflow, KSFD		877.5	598.8	546.6	495.1	414.7	348.4
95% Conf. Date-Jul 31 Inflow, KSFD	1/	0.0	97.2	181.8	290.4	426.8	1114.9
Assumed Feb 1-Jul 31 Inflow, % Volume		2295.8	2010.3	2234.9	1993.4	1962.5	1289.2
Assumed Feb 1-Jul 31 Inflow, KSFD	2/	96.94					
Feb Minimum Flow Requirement, CFS	3/	2225.5					
Min Feb 1-Jul 31 Outflow, KSFD	4/	3000.0					
Min Jan 31 Reservoir Content, KSFD	5/	616.2					
Min Jan 31 Reservoir Content, Feet	6/	878.0					
Jan 31 Energy Content Curve, Feet	7/	2371.8					
Base Energy Content Curve, Feet 2403.1		2371.8					
Lower Limit for VECC, Feet 2345.3							
Assumed Mar 1-Jul 31 Inflow, % Volume		94.17	97.14				
Assumed Mar 1-Jul 31 Inflow, KSFD	2/	2161.9	1952.8				
Mar Minimum Flow Requirement, CFS	3/	3000.0	3000.0				
Min Mar 1-Jul31 Outflow, KSFD	4/	532.2	605.4				
Min Feb 28 Reservoir Content, KSFD	5/	857.6	1139.9				
Min Feb 28 Reservoir Content, Feet	6/	2370.4	2389.6				
Feb 28 Energy Content Curve, Feet	7/	2370.4	2389.6				
Base Energy Content Curve, Feet 2401.7							
Lower Limit for VECC, Feet 2326.1							
Assumed Apr 1-Jul 31 Inflow, % Volume		90.79	93.66	96.42			
Assumed Apr 1-Jul 31 Inflow, KSFD	2/	2084.3	1882.8	2154.9			
Apr Minimum Flow Requirement, CFS	3/	3600.0	4200.0	3000.0			
Min Apr 1-Jul 31 Outflow, KSFD	4/	439.2	512.4	366.0			
Min Mar 31 Reservoir Content, KSFD	5/	842.2	1116.9	698.4			
Min Mar 31 Reservoir Content, Feet	6/	2369.3	2388.1	2358.3			
Mar 31 Energy Content Curve, Feet	7/	2369.3	2388.1	2358.3			
Base Energy Content Curve, Feet 2400.4							
Lower Limit for VECC, Feet 2294.3							
Assumed May 1-Jul 31 Inflow, % Volume		81.71	84.29	86.77	90.0		
Assumed May 1-Jul 31 Inflow, KSFD	2/	1875.9	1694.5	1939.2	1794.1		
May Minimum Flow Requirement, CFS	3/	3600.0	4200.0	3000.0	3348.0		
Min May 1-Jul 31 Outflow, KSFD	4/	331.2	386.4	276.0	308.0		
Min Apr 30 Reservoir Content, KSFD	5/	942.6	1179.3	824.1	1001.2		
Min Apr 30 Reservoir Content, Feet	6/	2376.2	2392.0	2367.9	2380.2		
Apr 30 Energy Content Curve, Feet	7/	2376.2	2392.0	2367.9	2380.2		
Base Energy Content Curve, Feet 2399.0							
Lower Limit for VECC, Feet 2287.0							
Assumed Jun 1-Jul 31 Inflow, % Volume		52.75	54.42	56.02	58.10	64.56	
Assumed Jun 1-Jul 31 Inflow, KSFD	2/	1211.0	1094.0	1252.0	1158.2	1267.0	
Jun Minimum Flow Requirement, CFS	3/	3600.0	4200.0	3000.0	3348.0	3240.0	
Min Jun 1-Jul 31 Outflow, KSFD	4/	219.6	256.2	183.0	204.2	197.6	
Min May 31 Reservoir Content, KSFD	5/	1495.9	1649.5	1418.3	1533.4	1418.0	
Min May 31 Reservoir Content, Feet	6/	2410.8	2419.2	2406.3	2412.9	2406.3	
May 31 Energy Content Curve, Feet	7/	2410.8	2419.2	2406.3	2412.9	2406.3	
Base Energy Content Curve, Feet 2423.9							
Lower Limit for VECC, Feet 2287.0							
Assumed Jul 1- Jul 31 Inflow, % Volume		18.97	19.57	20.15	20.90	23.22	35.97
Assumed Jul 1- Jul 31 Inflow, KSFD	2/	435.5	393.4	450.3	416.6	455.7	463.7
Jul Minimum Flow Requirement, CFS	3/	3600.0	4200.0	3000.0	3348.0	3240.0	3132.0
Min Jul 1-Jul 31 Outflow, KSFD	4/	111.6	130.2	93.0	103.8	100.4	97.1
Min Jun 30 Reservoir Content, KSFD	5/	2163.4	2224.1	2130.0	2174.5	2132.1	2120.7
Min Jun 30 Reservoir Content, Feet	6/	2444.3	2447.2	2442.6	2444.8	2442.7	2442.2
Jun 30 Energy Content Curve, Feet	7/	2444.3	2447.2	2442.6	2444.8	2442.7	2442.2
Base Energy Content Curve, Feet 2459.0							
Lower Limit for VECC, Feet 2287.0							
Jul 31 Energy Content Curve, Feet		2459.0	2459.0	2459.0	2459.0	2459.0	2459.0
Jan 1-Jul 31 Forecast,-Earlybird, MAF	8/	85.0	78.5	93.0	87.1	88.0	88.9
At The Dalles -Official, MAF		88.0	78.6	93.0	87.3	89.7	89.7

1/ Expected Inflow Minus (95% Error & Jan 1-Date Inflow)
2/ Preceeding Line Times Line 1/
3/ Based on Power Discharge Requirements From 8/
4/ Cumulative Total From 3/
5/ Full Content (2487.3 KSFD) Plus Outflow Minus Inflow, (2487.3 + 4/ - 2/)
6/ From Interpolation of Storage Content Table
7/ Elev. From 5/, But < Base ECC, And > ECC Lower Limit
8/ Used to Calculate the Minimum Flow Required

COMPUTATION OF INITIAL CONTROLLED FLOW
COLUMBIA RIVER AT THE DALLES, OREGON
1 MAY 1979

1 May Forecast of May - August Unregulated Runoff Volume, MAF		69.8
Less Estimated Depletions, MAF		1.5
Less Upstream Storage Corrections, MAF		
Mica	5.8	
Arrow	4.8	
Libby	3.3	
Duncan	1.1	
Hungry Horse	1.1	
Flathead Lake	0.5	
Noxon	0.1	
Pend Oreille Lake	0.5	
Grand Coulee	4.2	
Brownlee	0.3	
Dworshak	1.1	
John Day	0.3	
TOTAL	23.1	23.1
Forecast of Adjusted Residual Runoff Volume, MAF		45.2
Computed Initial Controlled Flow From Chart 1 of Flood Control Operating Plan, KCFS		280.0

CHART 1

SEASONAL PRECIPITATION

COLUMBIA RIVER BASIN

OCTOBER 78 - APRIL 79 PRECIPITATION
PERCENT OF 1963-77 AVERAGE

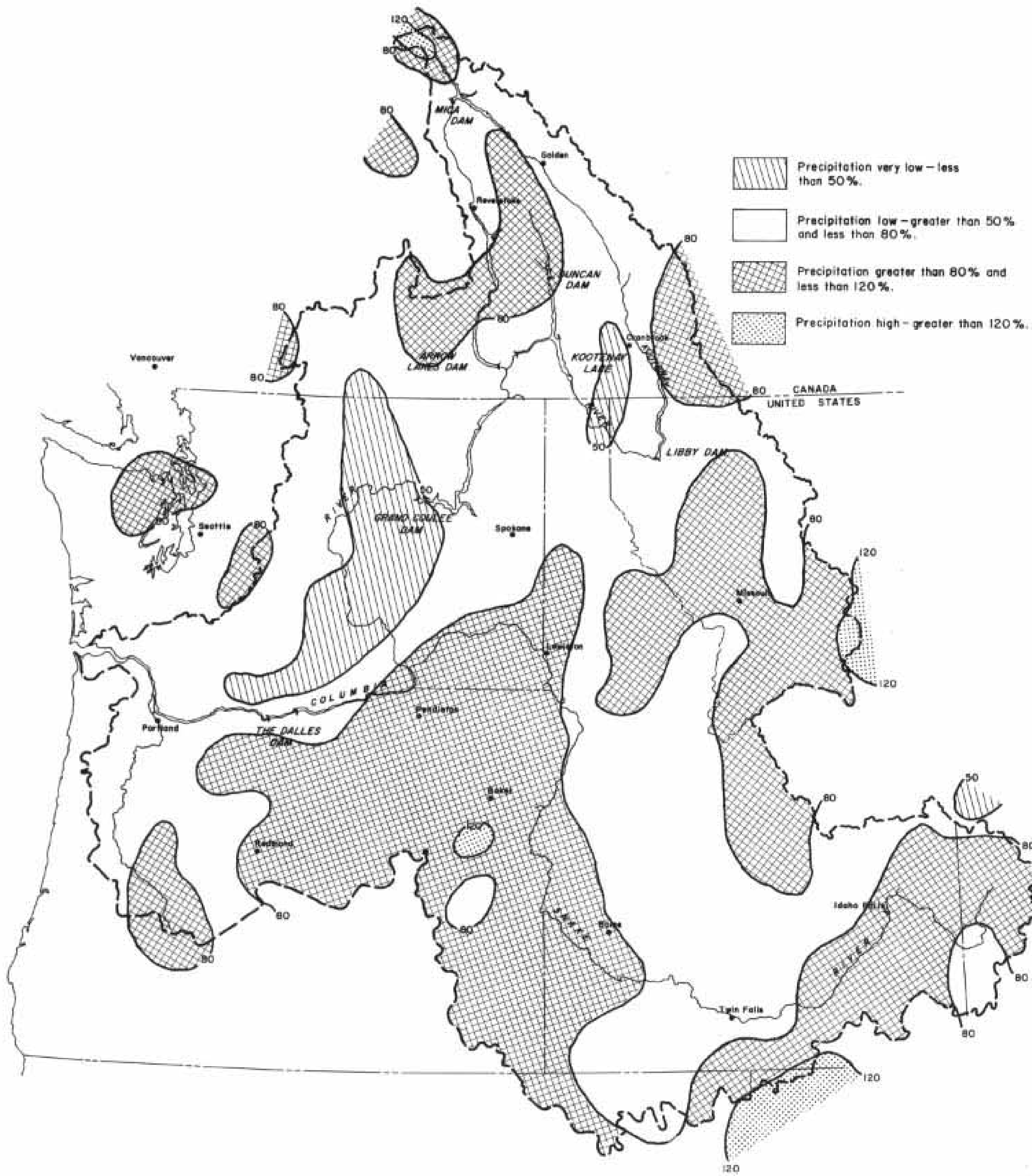


CHART 2

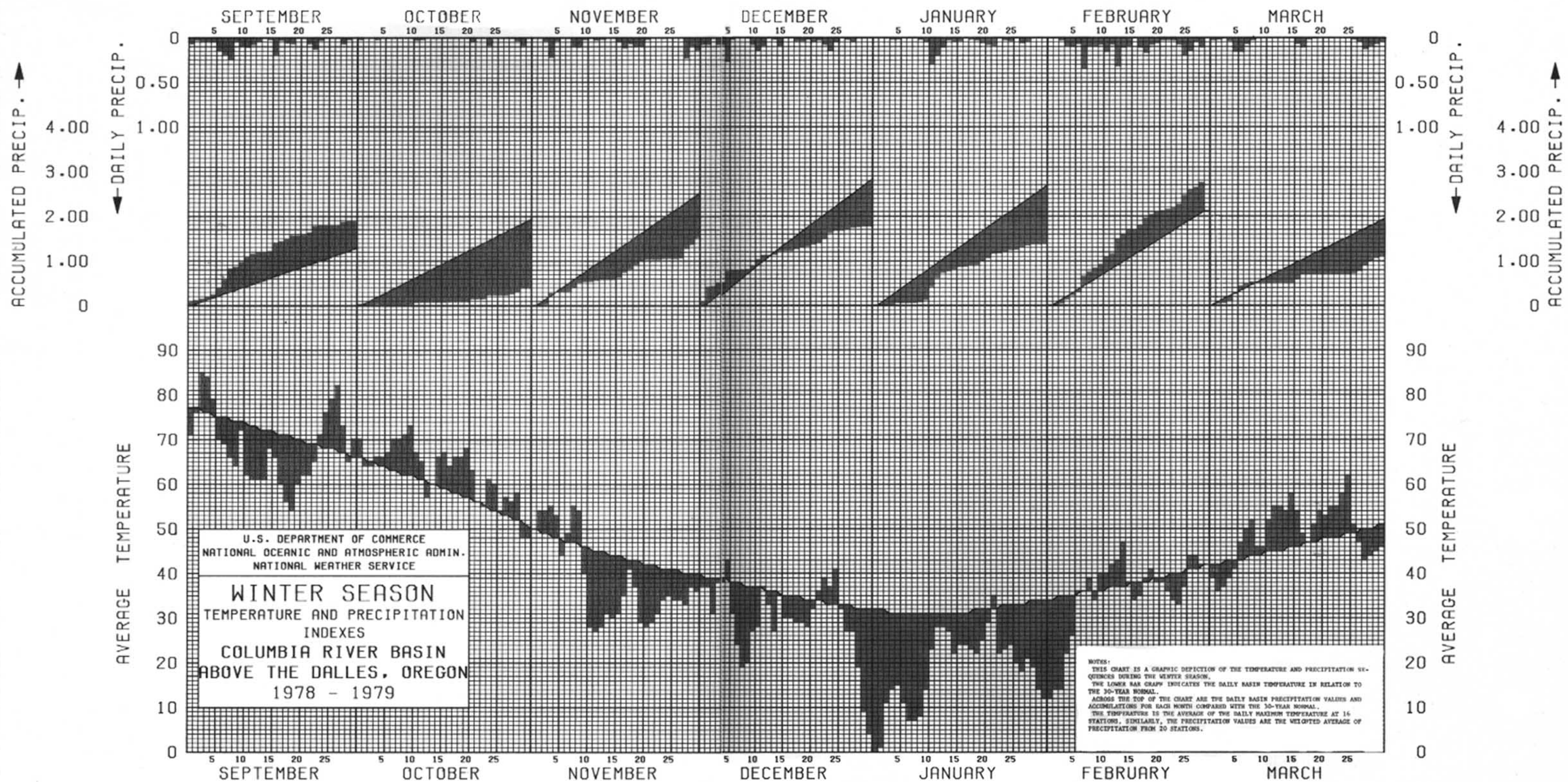
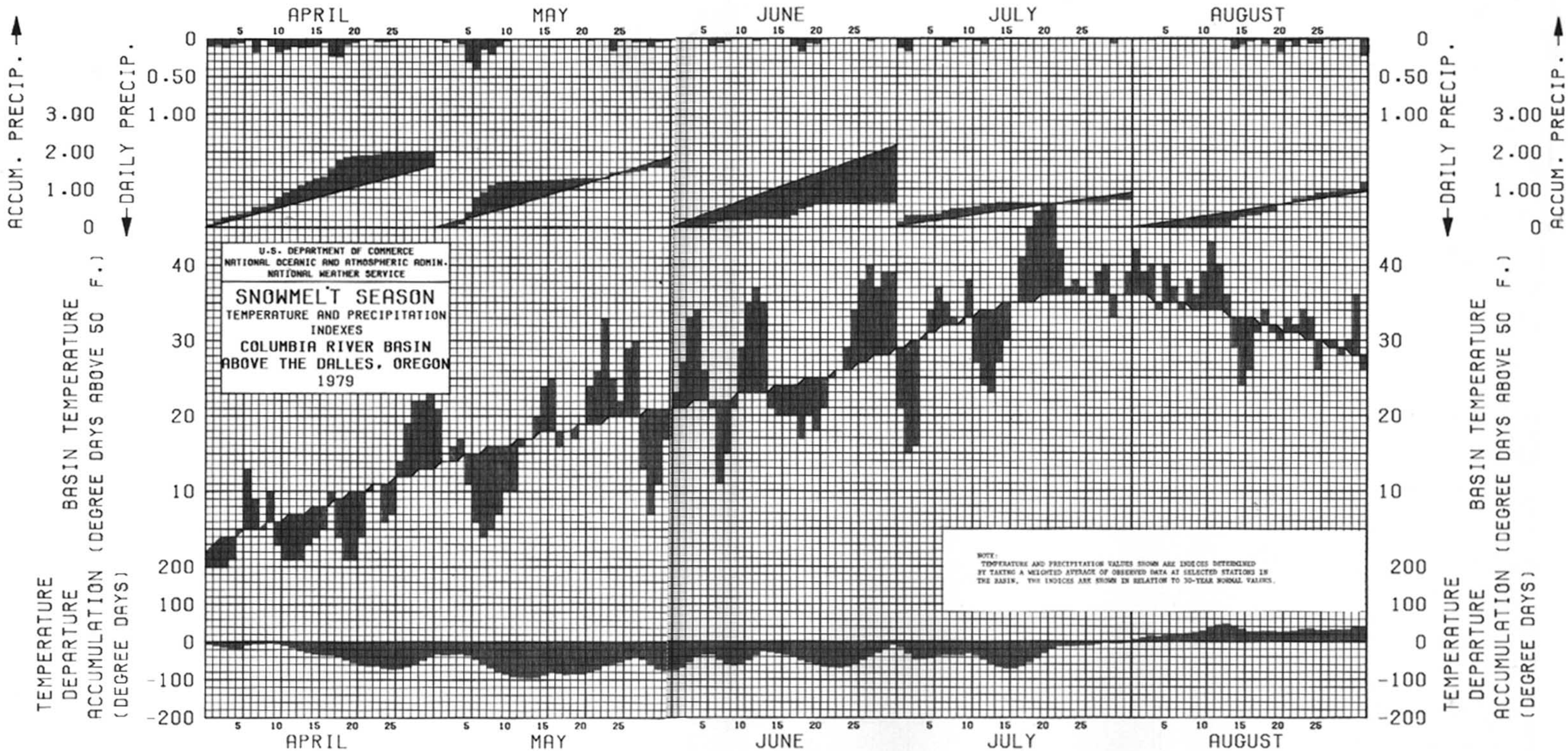
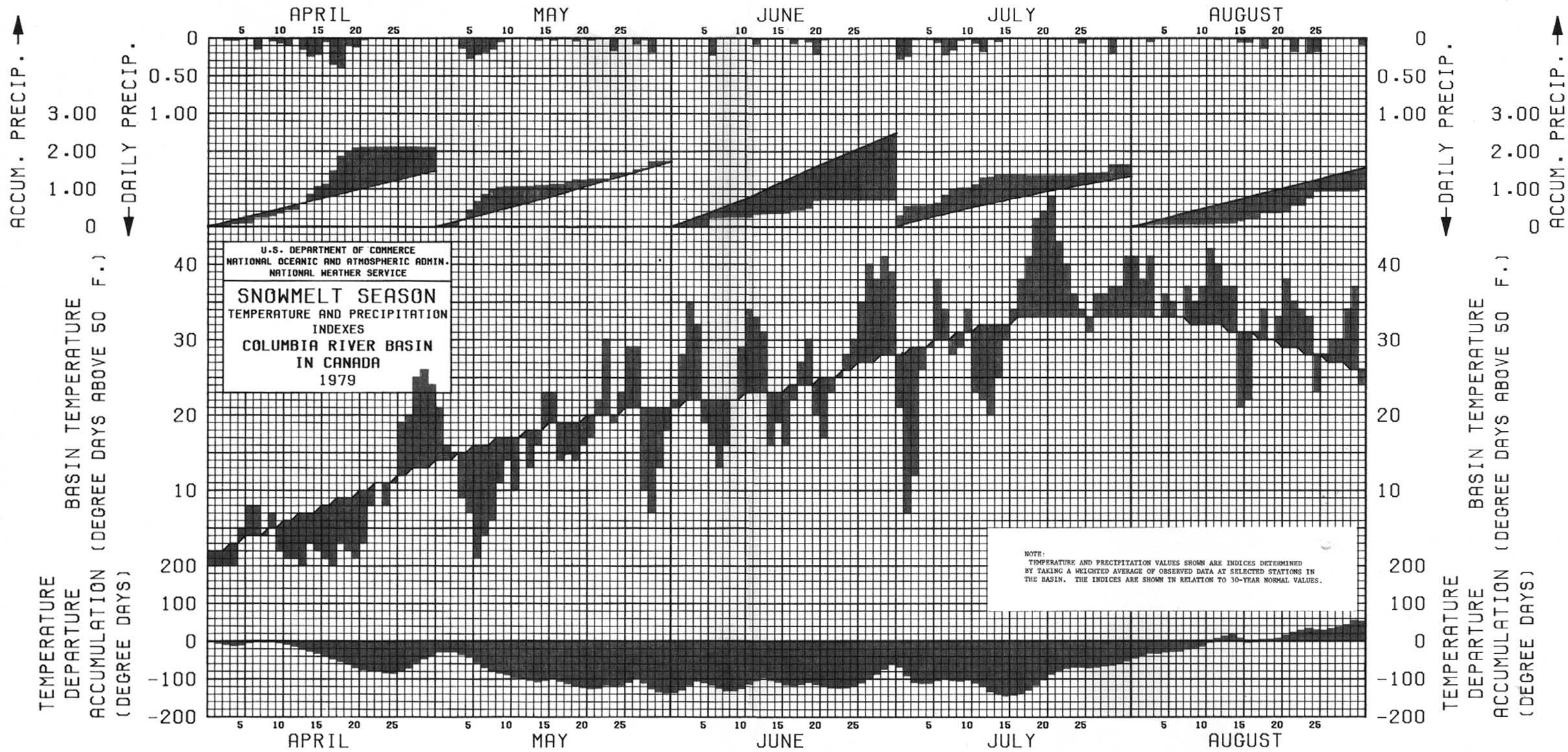

SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
ACCUMULATED PRECIP.
DAILY PRECIP.
0
0.50
1.00
4.00
3.00
2.00
1.00
0
AVERAGE TEMPERATURE
90
80
70
60
50
40
30
20
10
0
5 10 15 20 25
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMIN.
NATIONAL WEATHER SERVICE
WINTER SEASON
TEMPERATURE AND PRECIPITATION INDEXES
COLUMBIA RIVER BASIN
ABOVE THE DALLES, OREGON
1978 - 1979
NOTES:
THIS CHART IS A GRAPHIC DEPICTION OF THE TEMPERATURE AND PRECIPITATION SEQUENCES DURING THE WINTER SEASON.
THE LOWER BAR GRAPH INDICATES THE DAILY BASIN TEMPERATURE IN RELATION TO THE 30-YEAR NORMAL.
ACROSS THE TOP OF THE CHART ARE THE DAILY BASIN PRECIPITATION VALUES AND ACCUMULATIONS FOR EACH MONTH COMPARED WITH THE 30-YEAR NORMAL.
THE TEMPERATURE IS THE AVERAGE OF THE DAILY MAXIMUM TEMPERATURE AT 16 STATIONS. SIMILARLY, THE PRECIPITATION VALUES ARE THE WEIGHTED AVERAGE OF PRECIPITATION FROM 20 STATIONS.

CHART 3



U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMIN.
NATIONAL WEATHER SERVICE
SNOWMELT SEASON
TEMPERATURE AND PRECIPITATION INDEXES
COLUMBIA RIVER BASIN ABOVE THE DALLES, OREGON
1979
APRIL
MAY
JUNE
JULY
AUGUST
5
10
15
20
25
ACCUM. PRECIP.
DAILY PRECIP.
0
0.50
1.00
3.00
2.00
1.00
0
BASIN TEMPERATURE (DEGREE DAYS ABOVE 50 F.)
40
30
20
10
TEMPERATURE DEPARTURE ACCUMULATION (DEGREE DAYS)
200
100
0
-100
-200
NOTE:
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 4


U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMIN.
NATIONAL WEATHER SERVICE
SNOWMELT SEASON
TEMPERATURE AND PRECIPITATION INDEXES
COLUMBIA RIVER BASIN IN CANADA
1979
APRIL
MAY
JUNE
JULY
AUGUST
5
10
15
20
25
ACCUM. PRECIP.
DAILY PRECIP.
0
0.50
1.00
3.00
2.00
1.00
0
BASIN TEMPERATURE (DEGREE DAYS ABOVE 50 F.)
40
30
20
10
TEMPERATURE DEPARTURE ACCUMULATION (DEGREE DAYS)
200
100
0
-100
-200
NOTE:
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.

REGULATION OF MICA
1 JULY 1978 - 31 JULY 1979

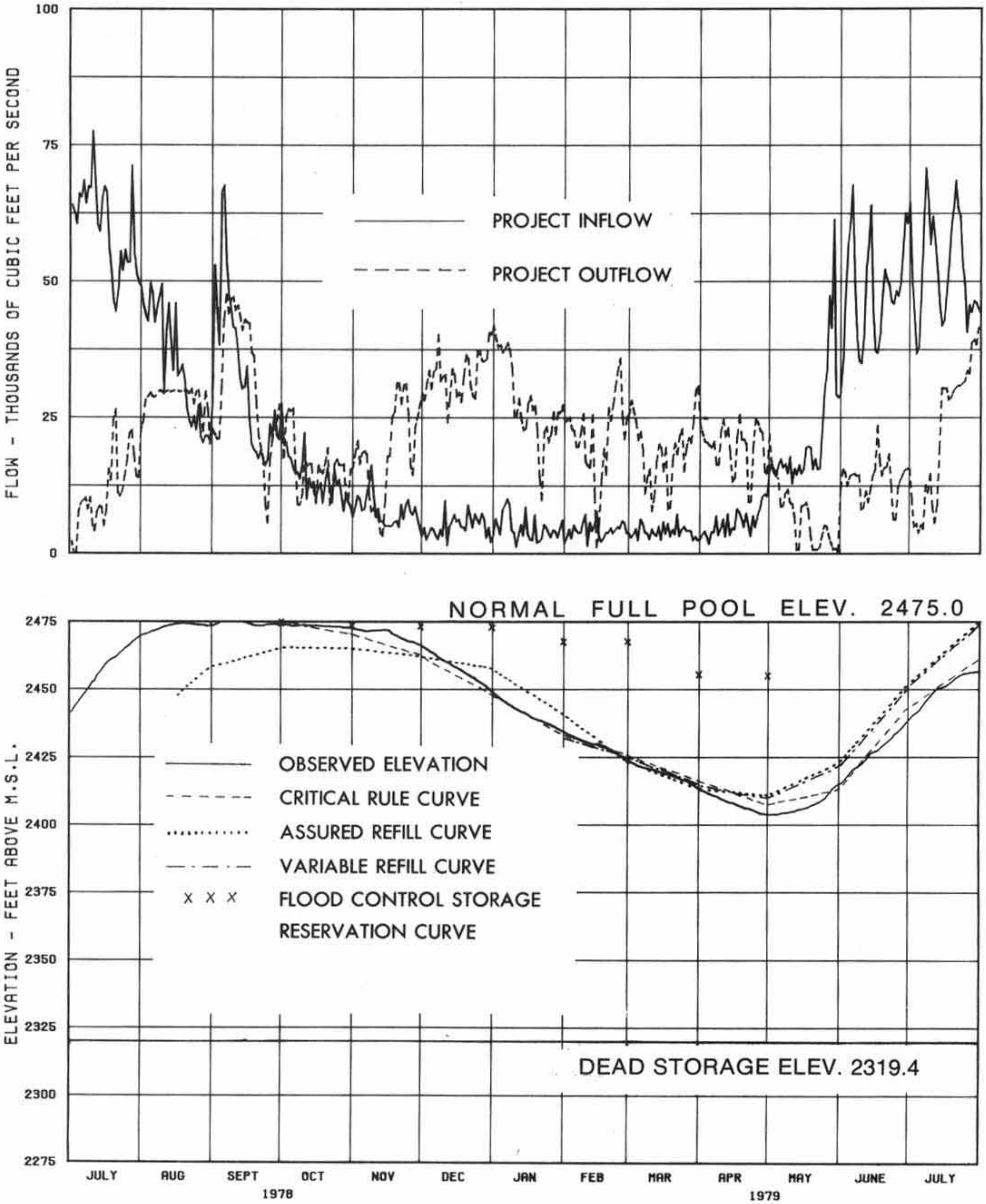
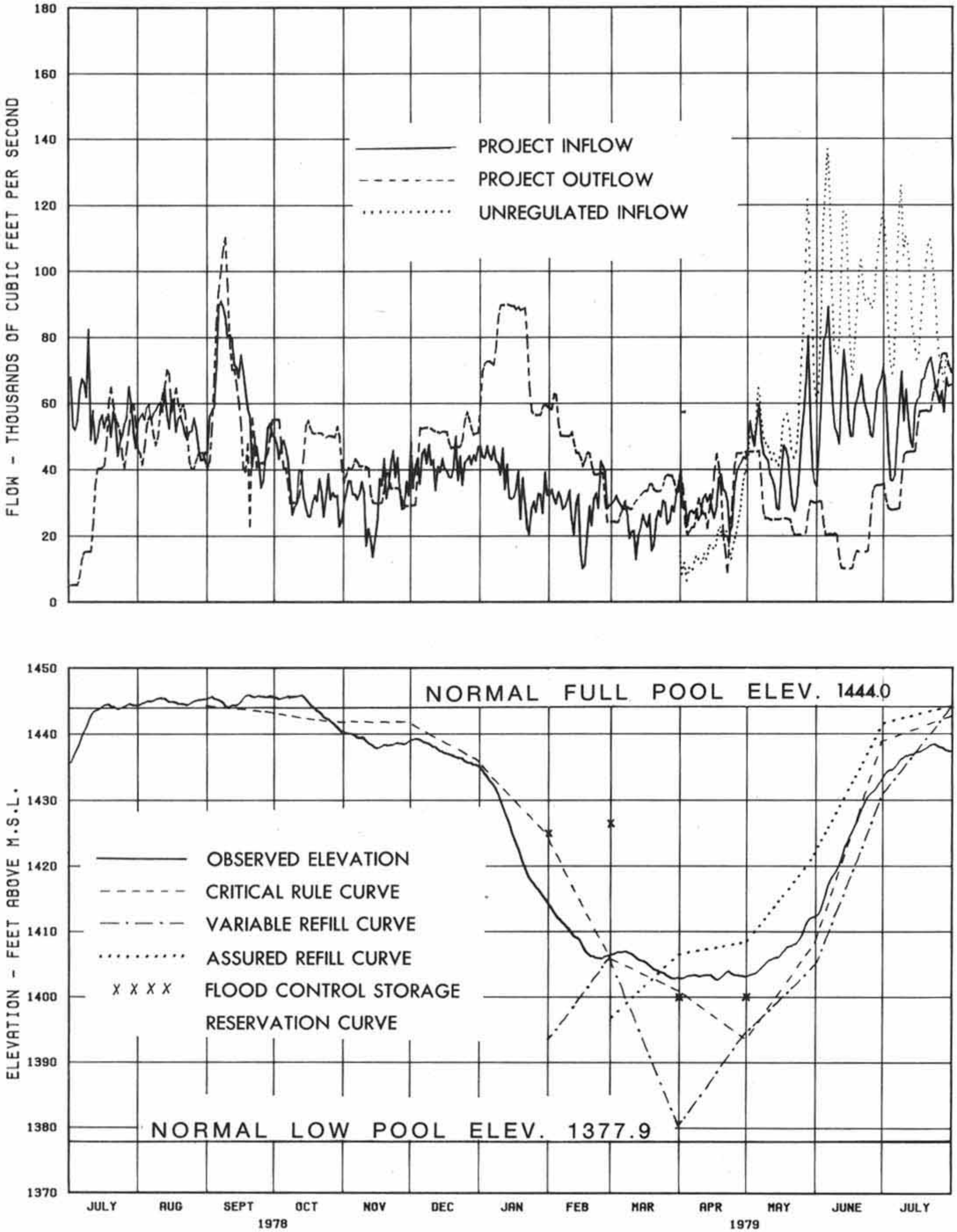


CHART 6
ARROW

REGULATION OF ARROW
1 JULY 1978 — 31 JULY 1979



REGULATION OF DUNCAN
1 JULY 1978 - 31 JULY 1979

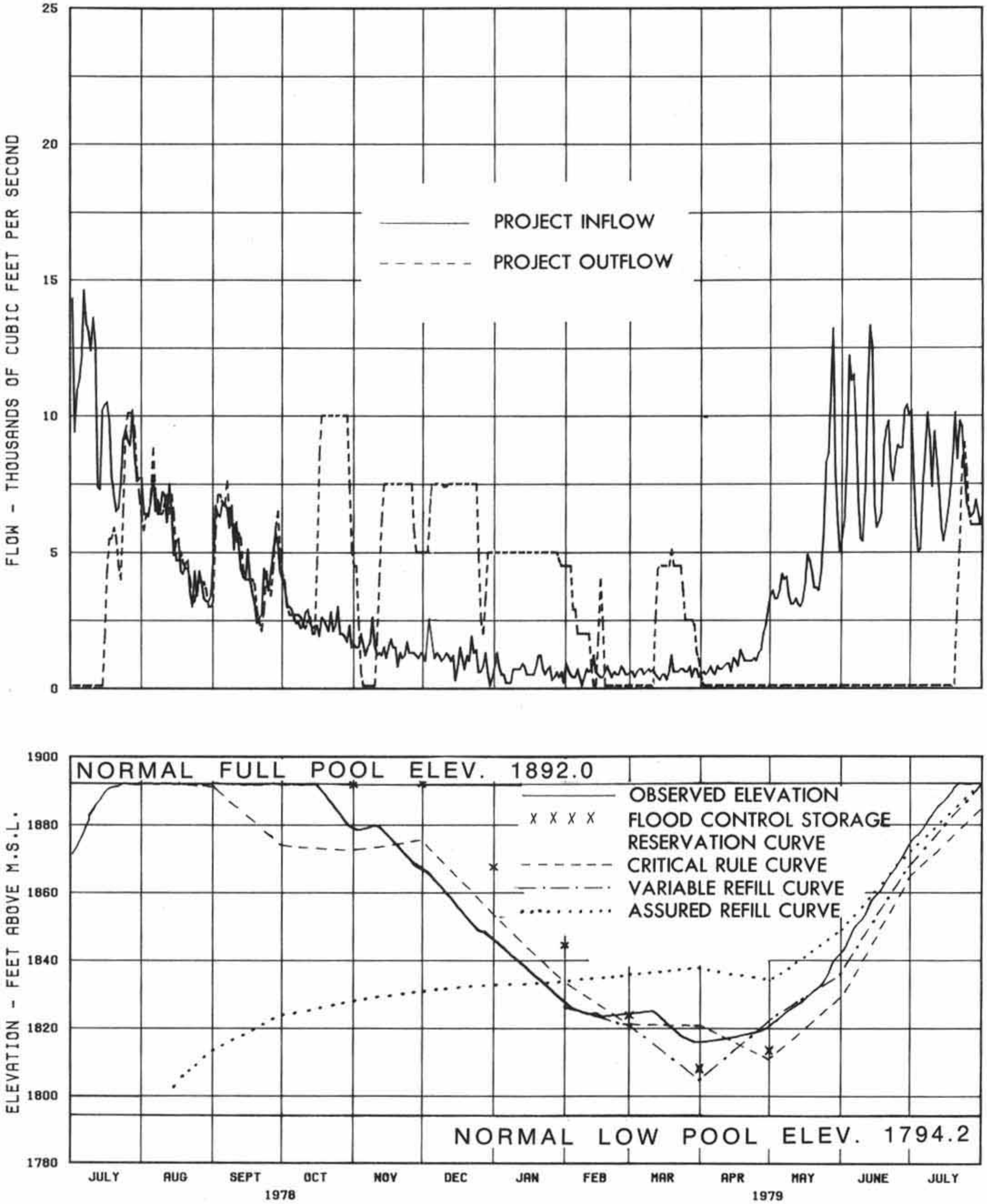


CHART 8
LIBBY

REGULATION OF LIBBY
1 JULY 1978 - 31 JULY 1979

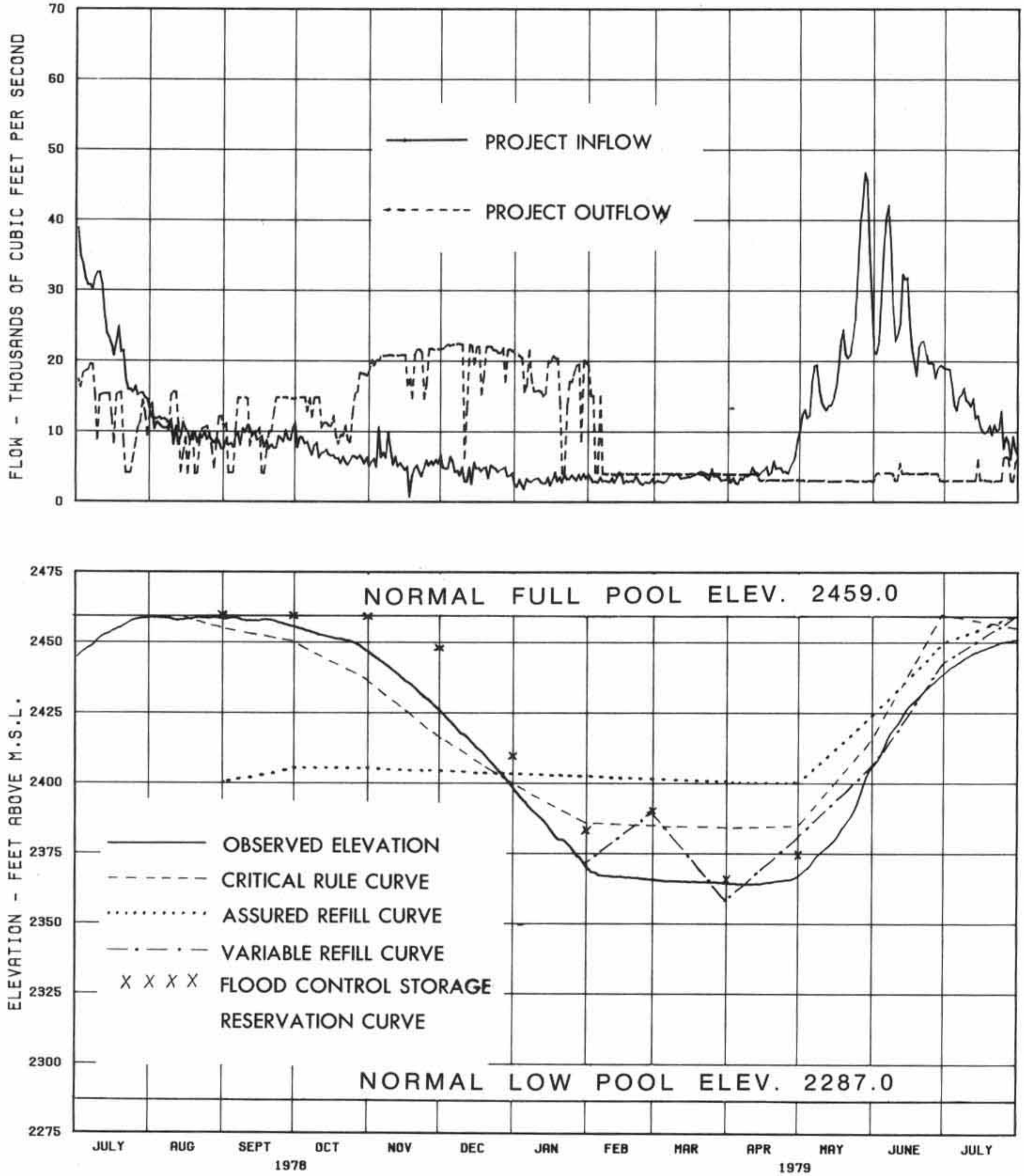
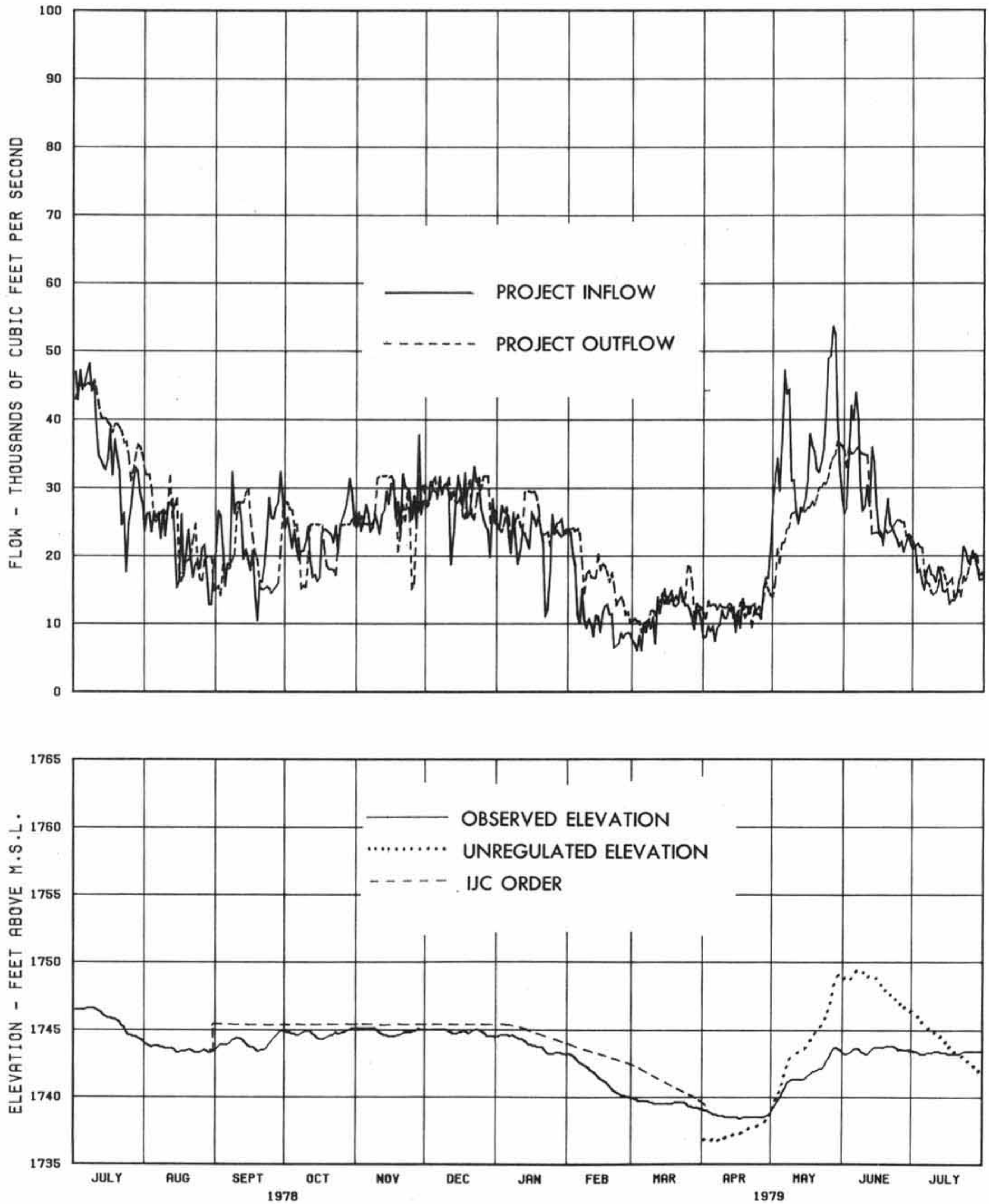


CHART 9
KOOTENAY LAKE

REGULATION OF KOOTENAY LAKE
1 JULY 1978 - 31 JULY 1979



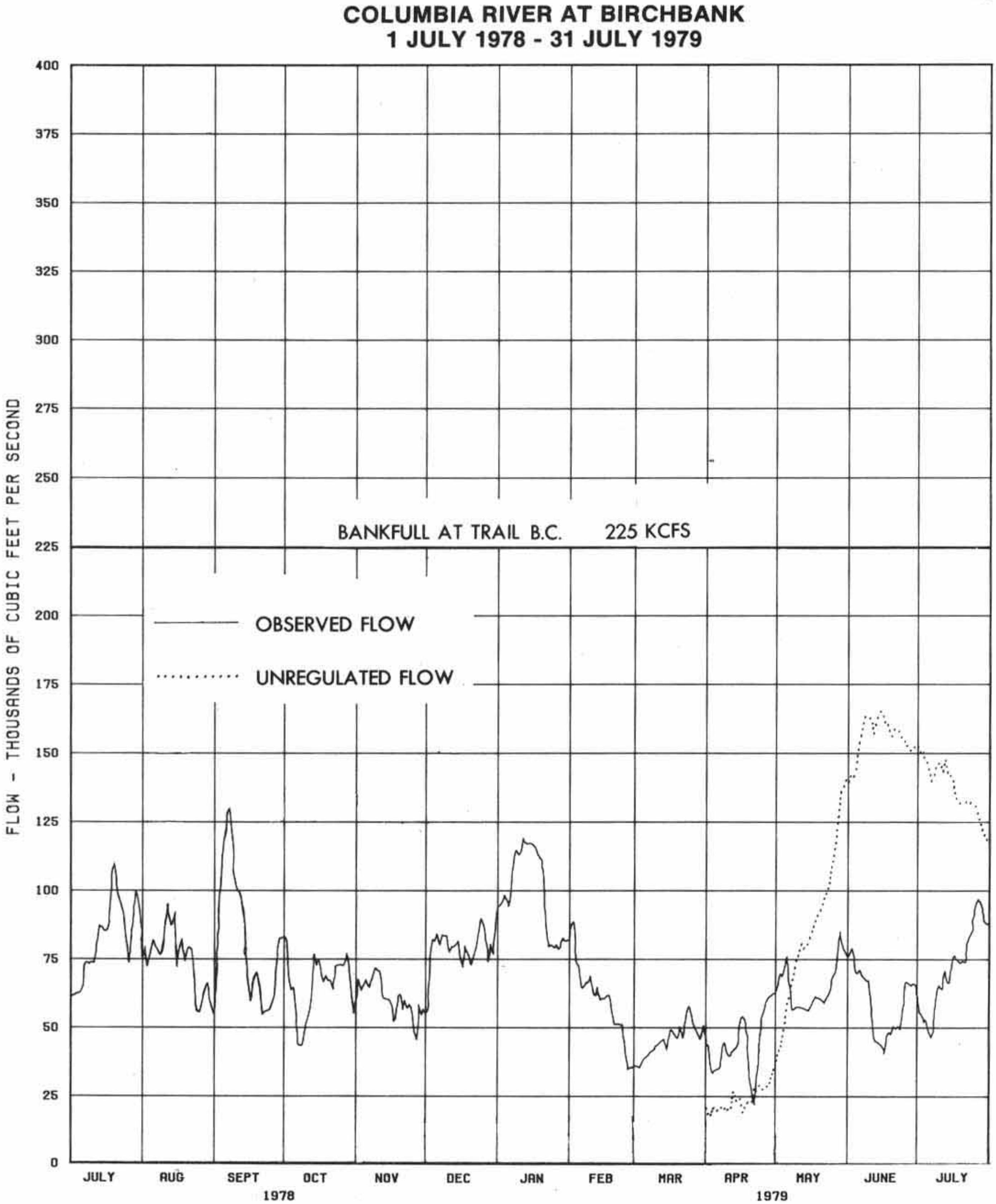
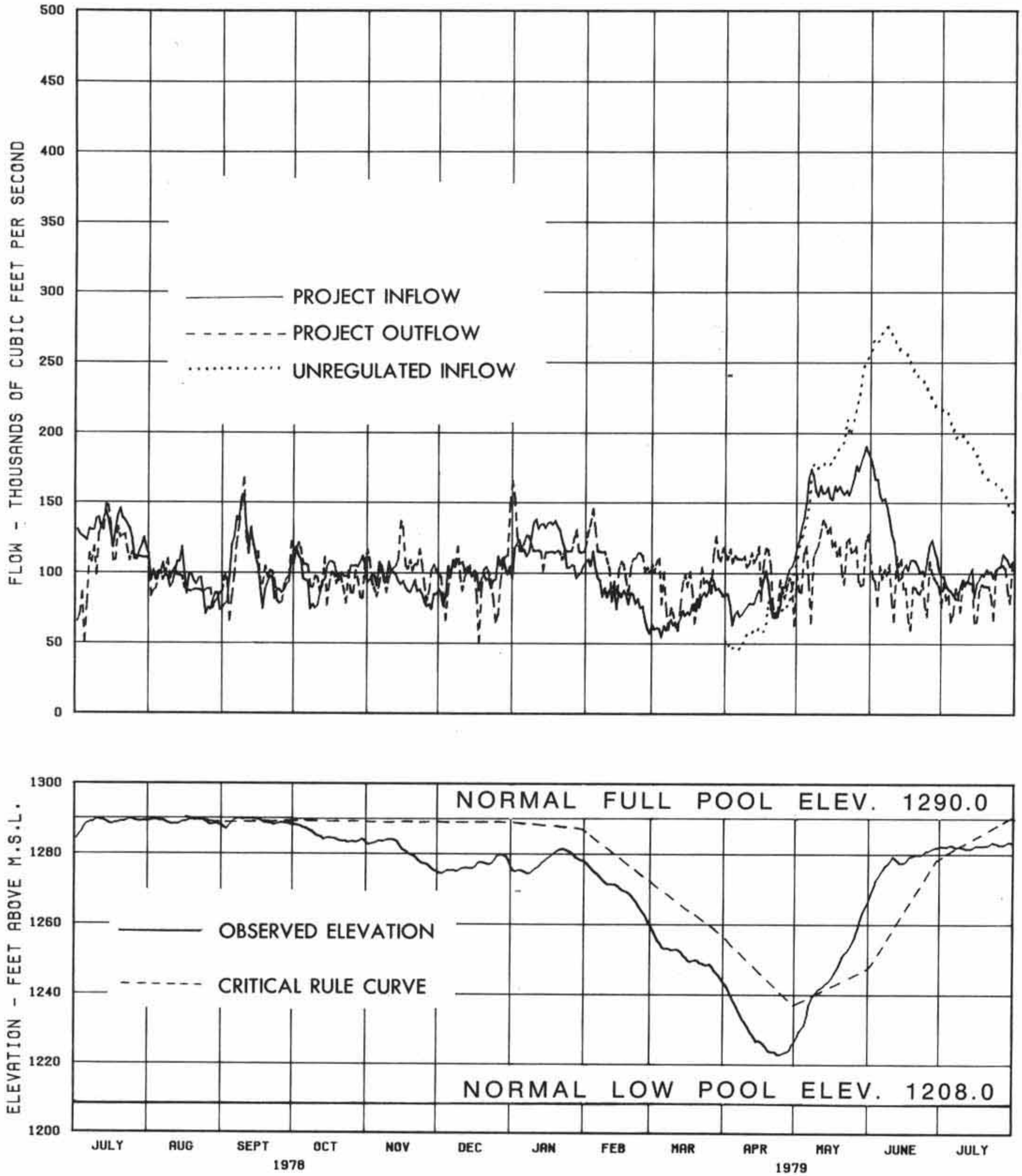
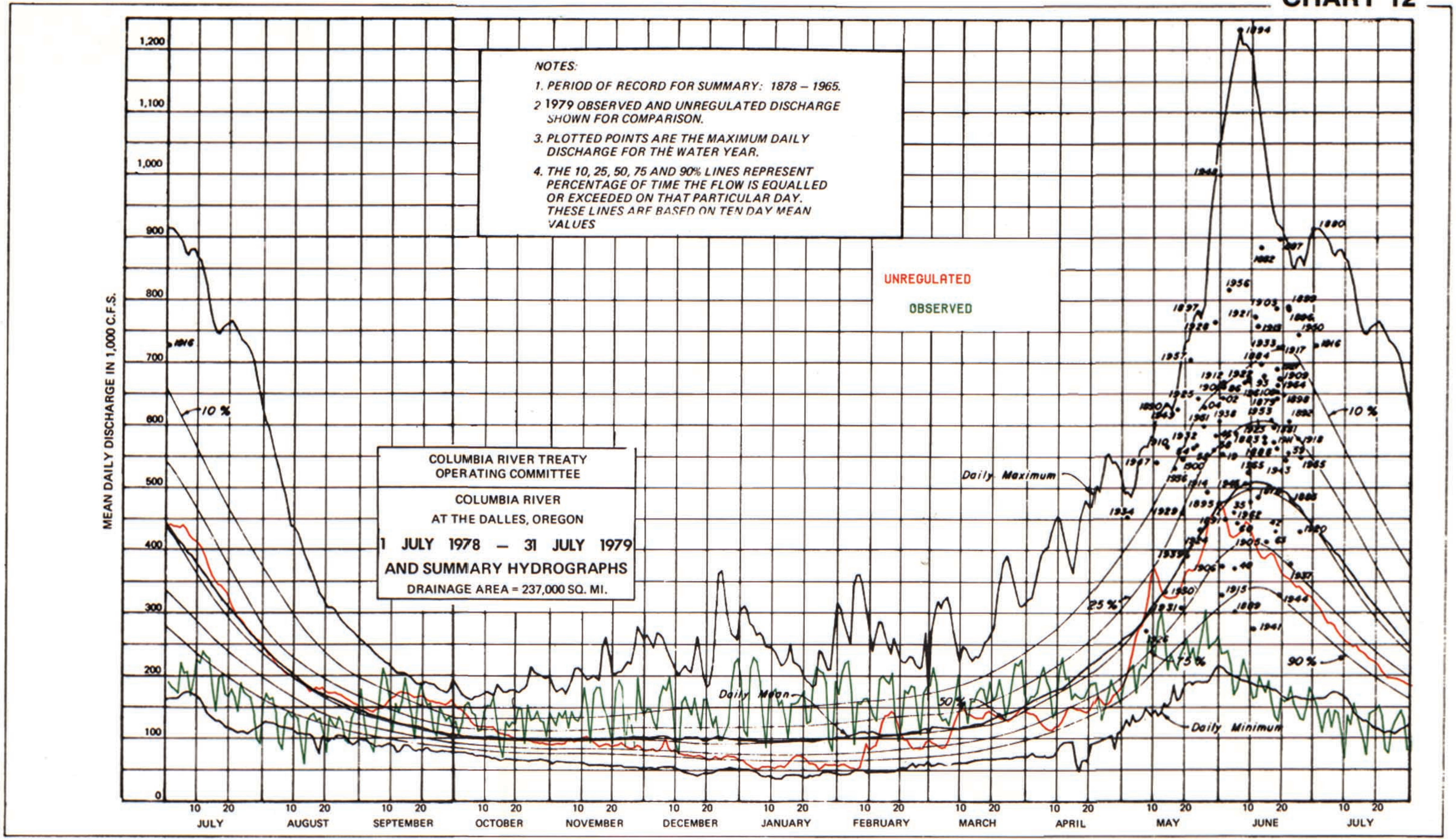

COLUMBIA RIVER AT BIRCHBANK
1 JULY 1978 - 31 JULY 1979
FLOW - THOUSANDS OF CUBIC FEET PER SECOND
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
BANKFULL AT TRAIL B.C. 225 KCFS
OBSERVED FLOW
UNREGULATED FLOW
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
1978
1979

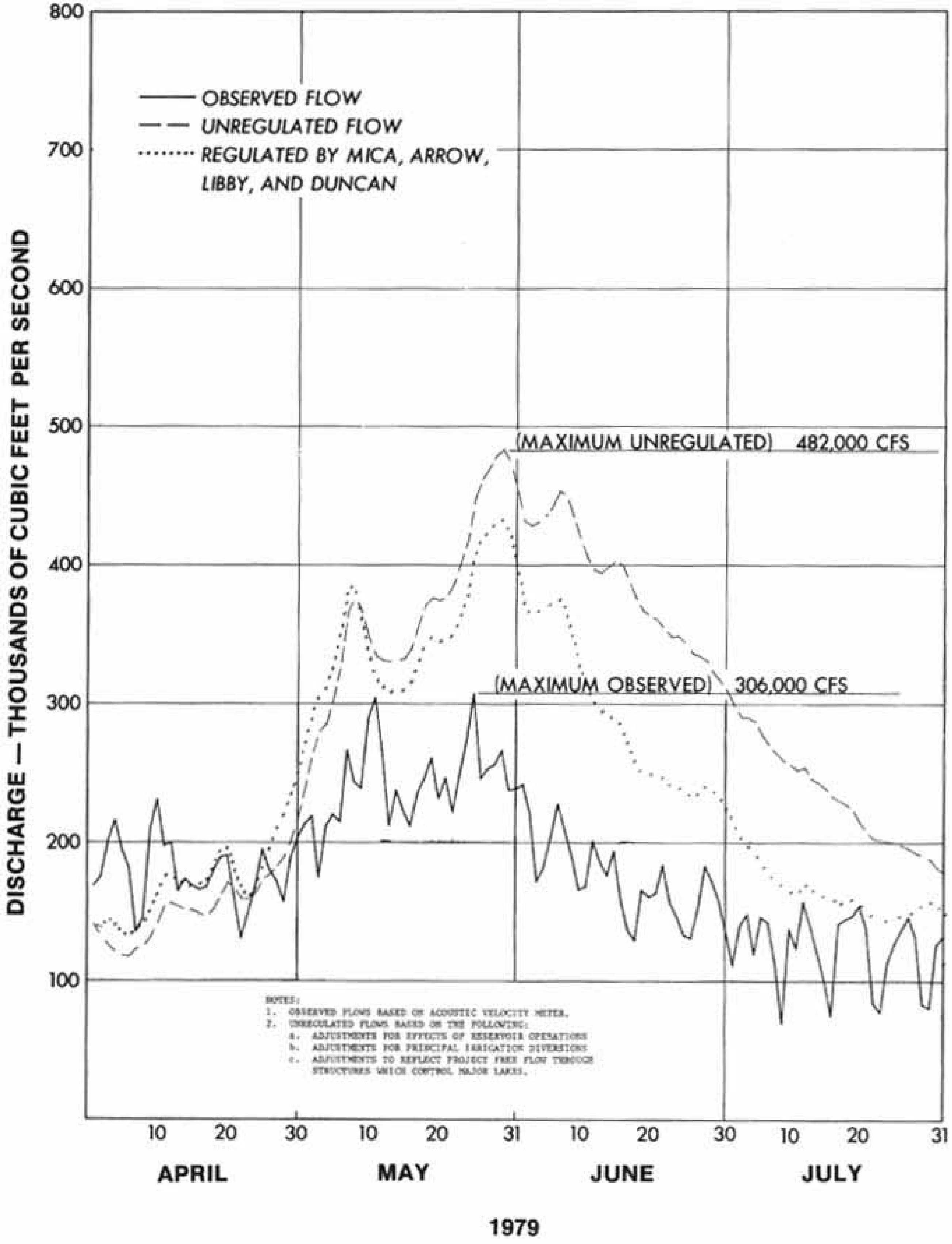
CHART 11
GRAND COULEE

REGULATION OF GRAND COULEE
1 JULY 1978 - 31 JULY 1979



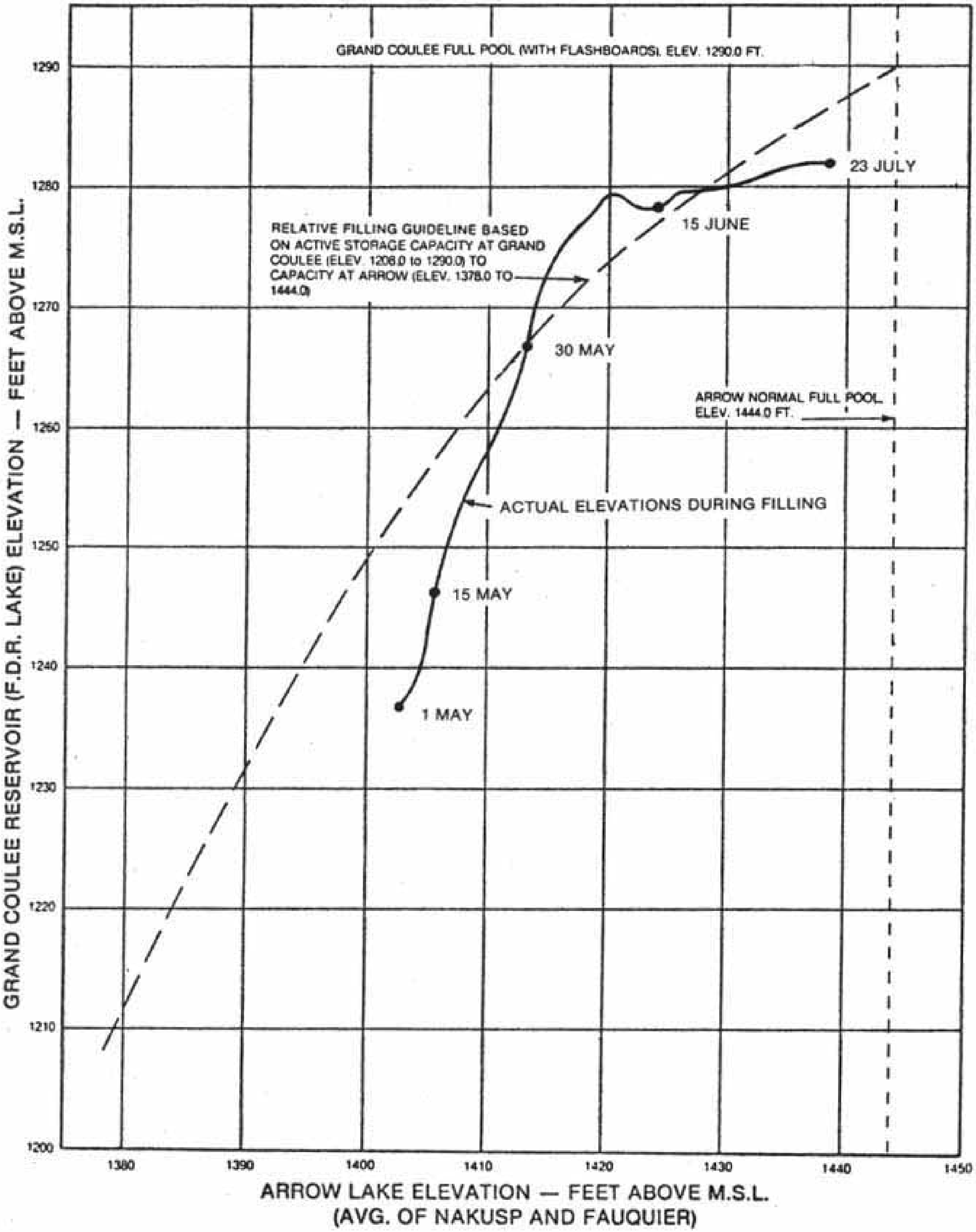

NOTES:
1. PERIOD OF RECORD FOR SUMMARY: 1878 – 1965.
2 1979 OBSERVED AND UNREGULATED DISCHARGE SHOWN FOR COMPARISON.
3. PLOTTED POINTS ARE THE MAXIMUM DAILY DISCHARGE FOR THE WATER YEAR.
4. THE 10, 25, 50, 75 AND 90% LINES REPRESENT PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY. THESE LINES ARE BASED ON TEN DAY MEAN VALUES
UNREGULATED
OBSERVED
COLUMBIA RIVER TREATY OPERATING COMMITTEE
COLUMBIA RIVER AT THE DALLES, OREGON
1 JULY 1978 – 31 JULY 1979
AND SUMMARY HYDROGRAPHS
DRAINAGE AREA = 237,000 SQ. MI.
MEAN DAILY DISCHARGE IN 1,000 C.F.S.
Daily Maximum
Daily Mean
Daily Minimum
10 %
25 %
50 %
75 %
90 %
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY

COLUMBIA RIVER AT THE DALLES
1 APRIL 1979 - 31 JULY 1979



1979

RELATIVE FILLING
ARROW AND GRAND COULEE



REFERENCES

The following documents governed the operation of the Columbia Treaty Projects during the period 1 August 1978 through 31 July 1979:

1. "Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans for Canadian Treaty Storage", dated 25 July 1967.

2. "Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1978-79", dated September 1973.

3. "Detailed Operating Plan for Columbia River Treaty Storage - 1 August 1978 through 31 July 1979", dated September 1978.

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