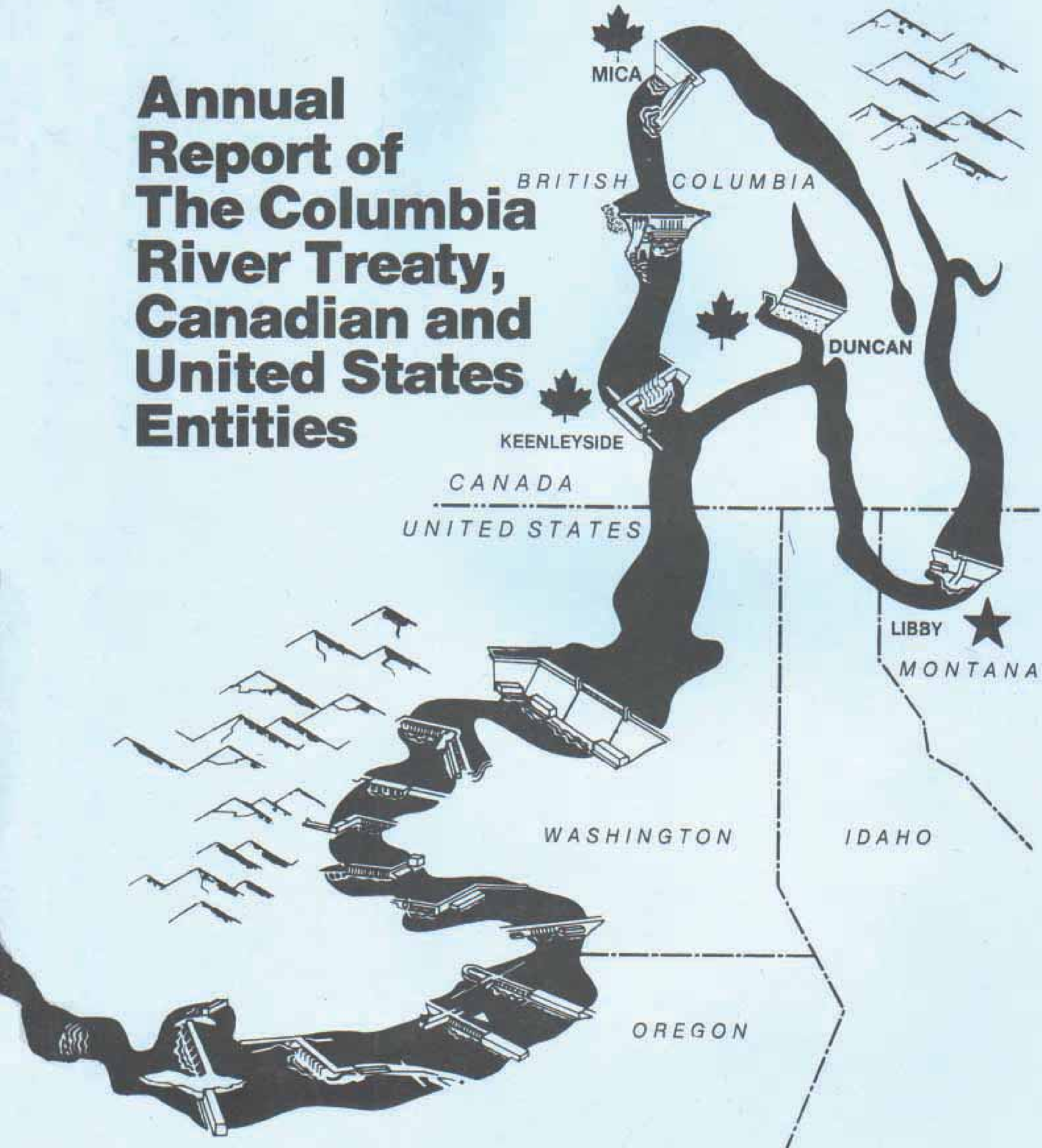
Annual Report of The Columbia River Treaty, Canadian and United States Entities



1 October 1986 through
30 September 1987

October 1987

Annual Report of
The Columbia River Treaty
Canadian and United States Entities

for the period
1 October 1986 - 30 September 1987

Executive Summary

Entity

The chairmanship of the Canadian Entity changed on 1 June 1987 as Mr. Larry I. Bell succeeded Mr. Chester A. Johnson as chairman of the B. C. Hydro and Power Authority.

Agreements approved by the Entities during the period of this report include:

- Columbia River Treaty Hydrometerological Committee Documents.
- Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1991-92, dated November 1986.
- Detailed Operating Plan for Columbia River Treaty Storage, 1 August 1986 through 31 July 1987, dated October 1986.

System Operation

The coordinated system reservoirs filled to 98% of capacity during the summer of 1986. The system remained near full through the summer. Draft for power and flood control was initiated on 2 September. A three month dry period began the last week of November when a weak ridge established itself on the Pacific Coast. The 1 January forecast for The Dalles was 88.9 MAF, the lowest since 1980. The water supply forecasts remained below normal through the spring, therefore, the system was not operated for flood control on a daily basis. The peak runoff into the lower river was 284,000 cfs at The Dalles. The coordinated system reservoirs again filled to 98% of capacity in late July 1987.

The generation at downstream projects in the United States, delivered under the Canadian Entitlement Exchange Agreement, was 418 average megawatts at rates up to 1,093 megawatts from 10 August 1986 through 31 March 1987, and 393 average megawatts at rates up to 1,052 megawatts from 1 April 1987 through 31 July 1987. All CSPE power was used to meet Pacific Northwest loads during the period of this report.

Project Operation

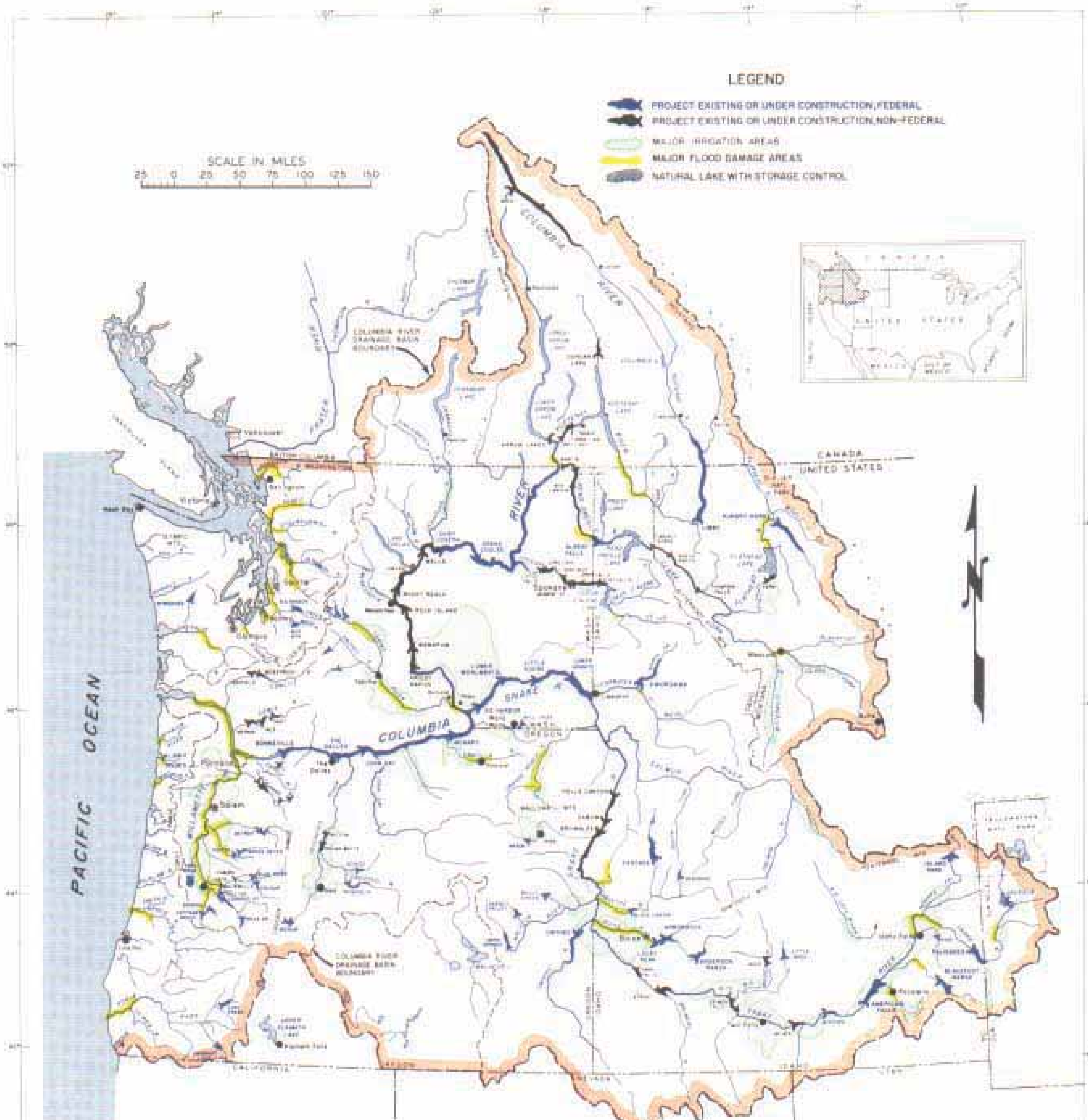
Mica Treaty storage was refilled on 10 July 1986. The reservoir was drawndown to a low storage content of 1.05 maf by 27 April. Treaty storage was refilled by 14 July; however, the total reservoir storage did not fully refill as non-Treaty accounts were only partially filled.

Arrow Reservoir started the period with Treaty storage refilled. The project was drafted to elevation 1401.1 feet by 6 March, the lowest level of the operating year. The reservoir filled through the spring reaching elevation 1440.1 feet by 30 July. Treaty storage space was refilled by 30 July 1987. The reservoir was about four feet below elevation 1444.0 on 31 July to balance the water above normal Treaty storage at Mica.

Duncan Reservoir was at full pool elevation 1892.0 feet at the beginning of the period and reached its lowest level, elevation 1815.2 feet on 20 February 1987. The reservoir refilled to elevation 1892.0 on 3 July and remained full through the rest of the period.

Libby Reservoir started the period at elevation 2458.6 feet and remained near full through Labor Day. The reservoir reached its lowest level 2357.7 feet on 4 March 1987. The reservoir filled to elevation 2459.0 feet on 20 July.

COLUMBIA RIVER AND COASTAL BASINS



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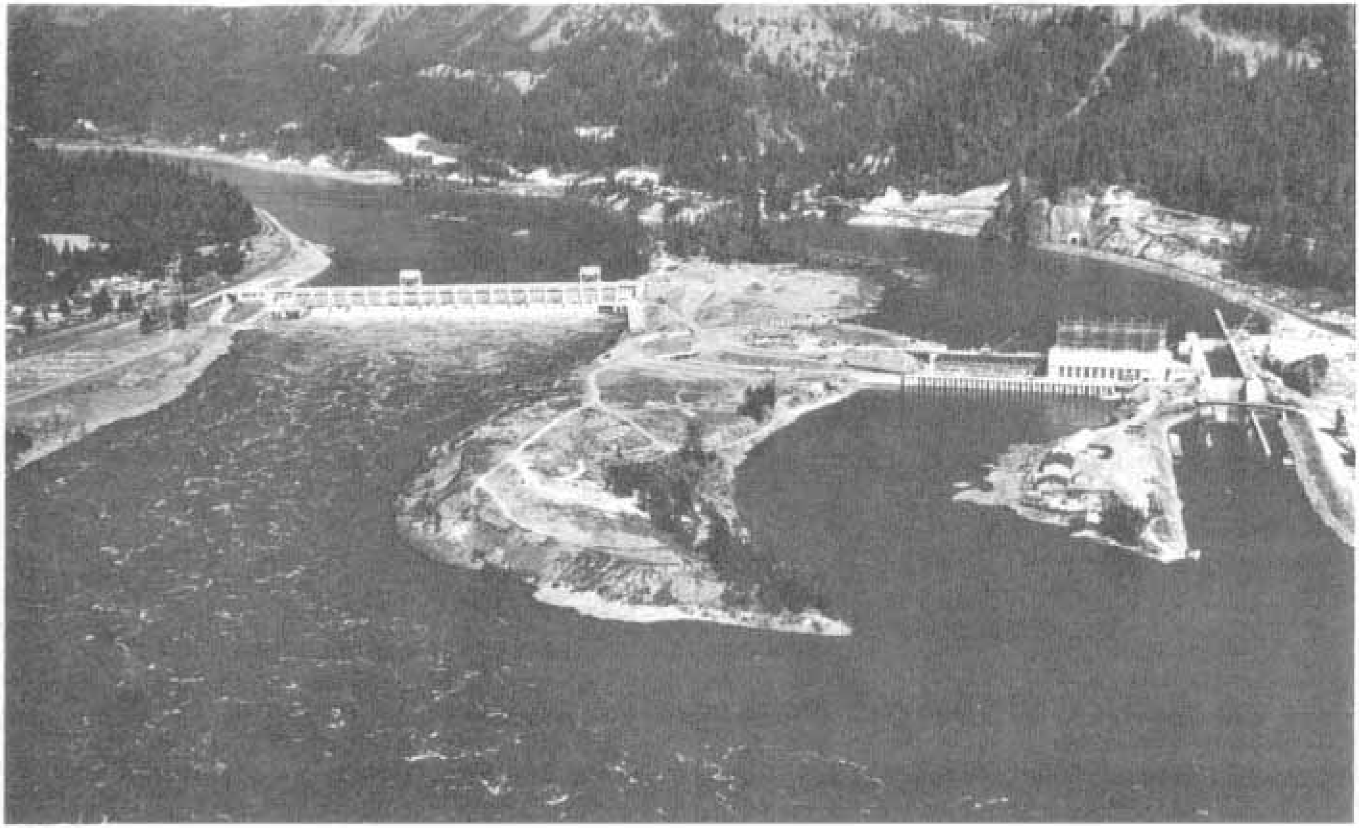
Bonneville Dam 50th Anniversary

Bonneville Dam, the first federal dam on the Columbia River, is celebrating its 50th anniversary in 1987. Located in the beautiful Columbia River Gorge, 40 miles east of Portland, the project includes a spillway, two powerhouses, a navigation lock, fish passage facilities and two visitor centers. It was designed, constructed and is operated by the U.S. Army Corps of Engineers.

Construction of the first powerhouse and navigation lock began in 1933 and was dedicated by President Franklin Delano Roosevelt on September 28, 1937. Construction of the second powerhouse on the Washington shore, began in 1974 and was completed for power production in December 1982. Powerhouse I has 10 main generating units and a smaller auxiliary unit, with a total generating capacity of 518 megawatts. Powerhouse II has eight main generating units and two smaller units with a total generating capacity of 558 megawatts, for a total project generating capacity of 1,076 megawatts.

Bonneville Dam impounds 45 mile-long Lake Bonneville, providing slack water for navigation upstream to The Dalles Dam with a minimum depth of 15 feet in the main channel. The single-lift navigation lock is 76 feet wide and 500 feet long with a 66-foot maximum lift. Construction has begun on a new navigation lock 86 feet wide, 675 feet long to correspond to the size of upriver locks.

Bonneville Dam



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I Introduction

This annual Columbia River Treaty Entity Report is for the 1987 Water Year, 1 October 1986 through 30 September 1987. It includes information on the operation of Mica, Arrow, Duncan, and Libby reservoirs during that period with additional information covering the reservoir system operating year, 1 August 1986 through 31 July 1987. The power and flood control effects downstream in Canada and the United States are described. This report is the twenty-first of a series of annual reports covering the period since the ratification of the Columbia River Treaty in September 1964.

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 for flood control in the United States of America and in Canada. In 1964, the Canadian and the 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 of the Bonneville Power Administration (BPA) and the Division Engineer of the North Pacific Division, Army Corps of Engineers (ACE).

The following is a summary of key features of the Treaty and related documents:

1. Canada is to provide 15.5 million acre-feet (maf) of usable storage. (This has been accomplished with 7.0 maf in Mica, 7.1 maf in Arrow and 1.4 maf in Duncan.)
2. For the purpose of computing downstream benefits the U.S. hydrolectric facilities will be operated in a manner that makes the most effective use of the improved streamflow resulting from operation of the Canadian storage.

3. The U.S. and Canada are to share equally the additional power generated in the U.S. resulting from operation of the Canadian storage.

4. The U.S. paid Canada a lump sum of the $64.4 million (U.S.) for expected flood control benefits in the U.S. resulting from operation of the Canadian storage.

5. The U.S. has the option of requesting the evacuation of additional flood control space above that specified in the Treaty, for a payment of $1.875 million (U.S.) for each of the first four requests for this "on-call" storage.

6. The U.S. constructed Libby Dam with a reservoir that extends 42 miles into Canada and for which Canada made the land available.

7. Both Canada and the United States have the right to make diversions of water for consumptive uses and, in addition, after September 1984 Canada has the option of making for power purposes specific diversions of the Kootenay River into the headwaters of the Columbia River.

8. Differences arising under the Treaty which cannot be resolved by the two countries may be referred to either the International Joint Commission (IJC) or to arbitration by an appropriate tribunal.

9. The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964.

10. In the Canadian Entitlement Purchase Agreement of 13 August 1964, Canada sold its entitlement to downstream power benefits to the United States for 30-years beginning at Duncan on 1 April 1968, at Arrow on 1 April 1969, and at Mica on 1 April 1973.

11. Canada and the U.S. are each to appoint Entities to implement Treaty provisions and are to jointly appoint a Permanent Engineering Board (PEB) to review and report on operations under the Treaty.

II Treaty Organization

Entities

There was one meeting of the Columbia River Treaty Entities (including the Canadian Entity Representative and U.S. Coordinators) during the year on the morning of 5 December 1986 in Vancouver, B.C. The members of the two Entities during the period of this report were:

UNITED STATES ENTITY

Mr. James J. Jura, Chairman
Administrator, Bonneville Power Administration
Department of Energy
Portland, Oregon

Major General Mark J. Sisinyak
Division Engineer,
North Pacific Division,
Army Corps of Engineers,
Portland, Oregon

CANADIAN ENTITY

Mr. Larry I. Bell, Chairman
Chairman, British Columbia Hydro and Power Authority
Vancouver, B.C.

Major General Mark J. Sisinyak succeeded Major General George R. Robertson as North Pacific Division Engineer, U.S. Corps of Engineers on 29 August 1987. General Robertson had been a member of the U.S. Entity since September 1984. Mr. Larry I. Bell succeeded Mr. Chester A. Johnson as Chairman of the Canadian Entity and B.C. Hydro on 1 June 1987. Mr. Johnson had been Chairman of the Canadian Entity since January 1985.

The Entities have appointed Coordinators and a Representative and two joint standing committees to assist in Treaty implementation activities. These are described in subsequent paragraphs. The primary duties and responsibilities of the Entities as specified in the Treaty and related documents are:

1. Plan and exchange information relating to facilities used to obtain the benefits contemplated by the Treaty.

2. Calculate and arrange for delivery of hydroelectric power to which Canada is entitled and the amounts payable to the U.S. for standby transmission services.

3. Operate a hydrometeorological system.

4. Assist and cooperate with the Permanent Engineering Board in the discharge of its functions.

5. Prepare hydroelectric and flood control operating plans for the use of Canadian storage.

6. Prepare and implement detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under assured operating plans.

7. The Treaty provides that the two governments may, by an exchange of notes, empower or charge the Entities with any other matter coming within the scope of the Treaty.

Entity Coordinators and Representative

The Entities have appointed members of their respective staffs to serve as coordinators or focal points on Treaty matters within their organizations. The members are:

UNITED STATES ENTITY COORDINATORS

Edward W. Sienkiewicz, Coordinator
Asst. Administrator for Power and Resources Management
Bonneville Power Administration
Portland, Oregon

Robert P. Flanagan, Acting Coordinator
Chief, Engineering Division
North Pacific Division
Army Corps of Engineers
Portland, Oregon

John M. Hyde, Secretary
Bonneville Power Administration
Portland, Oregon

CANADIAN ENTITY REPRESENTATIVE

Douglas R. Forrest, Manager
Canadian Entity Services
B.C. Hydro and Power Authority
Vancouver, B.C.

On September 28, 1987 Mr. Flanagan succeeded Mr. Herbert H. Kennon who had been coordinator since 1980.

Entity Operating Committee

The Operating Committee was established in September 1968 by the Entities and is responsible for preparing and implementing operating plans as required by the Columbia River Treaty, making studies and otherwise assisting the Entities as needed. The Operating Committee consists of eight members as follows:

UNITED STATES SECTION	*CANADIAN SECTION*
Robert D. Griffin, BPA, Co-Chairman	Timothy J. Newton, BCH, Chairman
Nicholas A. Dodge, ACE, Co-Chairman	Ralph D. Legge, BCH
Russell L. George, ACE	William N. Tivy, BCH
John M. Hyde, BPA	Kenneth R. Spafford, BCH

There were six meetings of the Operating Committee during the year. The dates, places and number of persons attending those meetings were:

Date	Location	Attendees
5 November 1986	Vancouver, B.C.	12
13 January 1987	Portland, Oregon	13
16 March 1987	Vancouver, B.C.	13
12 May 1987	Portland, Oregon	13
14 July 1987	Vancouver, B.C.	12
16 September 1987	Centralia, Washington	16

The Operating Committee coordinated the operation of the Treaty storage in accordance with the current hydroelectric and flood control operating plans. This aspect of the Committee's work is described in following sections of this report which has been prepared by the Committee with the assistance of others. During the period covered by this report, the Operating Committee completed the 1986-87 Detailed Operating Plan (DOP), the 1991-92 Assured Operating Plan (AOP), and Determination of Downstream Power Benefits (DDPB), and began preparations of the 1992-93 AOP/DDPB.

The Operating Committee submitted to the PEB a number of studies to determine the impact of several proposed changes to the AOP and DDPB. On 1 May 1987, the Committee briefed the PEB on the contents of the report and the history of AOP/DDPB study methods.

Entity Hydrometeorlogic Committe

The Hydrometeorological Committee was established in September 1968 by the Entities and is responsible for planning and monitoring the operation of data facilities in accord with the Treaty and otherwise assisting the Entities as needed. The Committee consists of four members as follows:

UNITED STATES SECTION	*CANADIAN SECTION*
Mark W. Maher, BPA, Co-Chairman	Heiki Walk, BCH, Chairman
Douglas D. Speers, ACE, Co-Chairman	John R. Gordon, BCH, Member

Mr. Maher and Mr. Walk succeeded Mr. Roger G. Hearn and Mr. Ulrich Sporns who had both retired in 1986.

The Hydrometeorological Committee met on 12 February 1987 to discuss data exchange problems that developed and to discuss other business of the Committee. In general, data exchanged went smoothly and a few minor problems were quickly corrected.

Permanent Engineering Board

Provisions for the establishment of the Permanent Engineering Board (PEB) and its duties and responsibilities are included in the Treaty and related documents. The members of the PEB are presently:

UNITED STATES SECTION

Lloyd A. Duscha, Chairman,
Washington, D.C.
J. Emerson Harper, Member
Washington, D.C.

Alex Shwaiko, Alternate
Washington, D.C.
Thomas L. Weaver, Alternate
Golden, Colorado
S. A. Zanganeh, Secretary
Washington, D.C.

CANADIAN SECTION

G. M. MacNabb, Chairman
Ottawa, Ontario
T. R. Johnson, Member
Victoria, B.C.

H. M. Hunt, Alternate
Victoria, B.C.
E. M. Clark, Alternate & Secretary

In general, the duties and responsibilities of the PEB are to assemble records of flows of the Columbia River and the Kootenay River at the international boundary; report to both governments if there is deviation from the hydroelectric or flood control operating plans, and if appropriate, include recommendations for remedial action; assist in reconciling differences that may arise between the Entities; make periodic inspections and obtain reports as needed from the Entities to assure that Treaty objectives are being met; make an annual report to both governments and special reports when appropriate; consult with the Entities in the establishment and operation of a hydrometeorological system; and, investigate and report on any other Treaty related matter at the request of either government.

The Entities continued their cooperation with the PEB during the past year by providing copies of Entity agreements, operating plans, downstream power benefit computations, corrections to hydrometeorological documents, a report on the impact of proposed changes to the AOP /DDPB, and the annual Entity report to the Board for their review. The annual joint meeting of the Permanent Engineering Board and the Entities was held on the afternoon of 5 December 1986 in Vancouver, B.C. The Entities also met with the PEB on 25 June 1987 to discuss differences between the two Entities and the PEB on how to prepare AOPs and determine downstream power benefits.

PEB Engineering Committe

The PEB has established a PEB Engineering Committee (PEBCOM) to assist in carrying out its duties. The members of PEBCOM are presently:

UNITED STATES SECTION

S. A. Zanganeh, Acting Chairman
Washington, D.C.
Gary L. Fuqua, Member
Portland, Oregon
Lee F. Johnson, Alternate Member
Washington, D.C.

CANADIAN SECTION

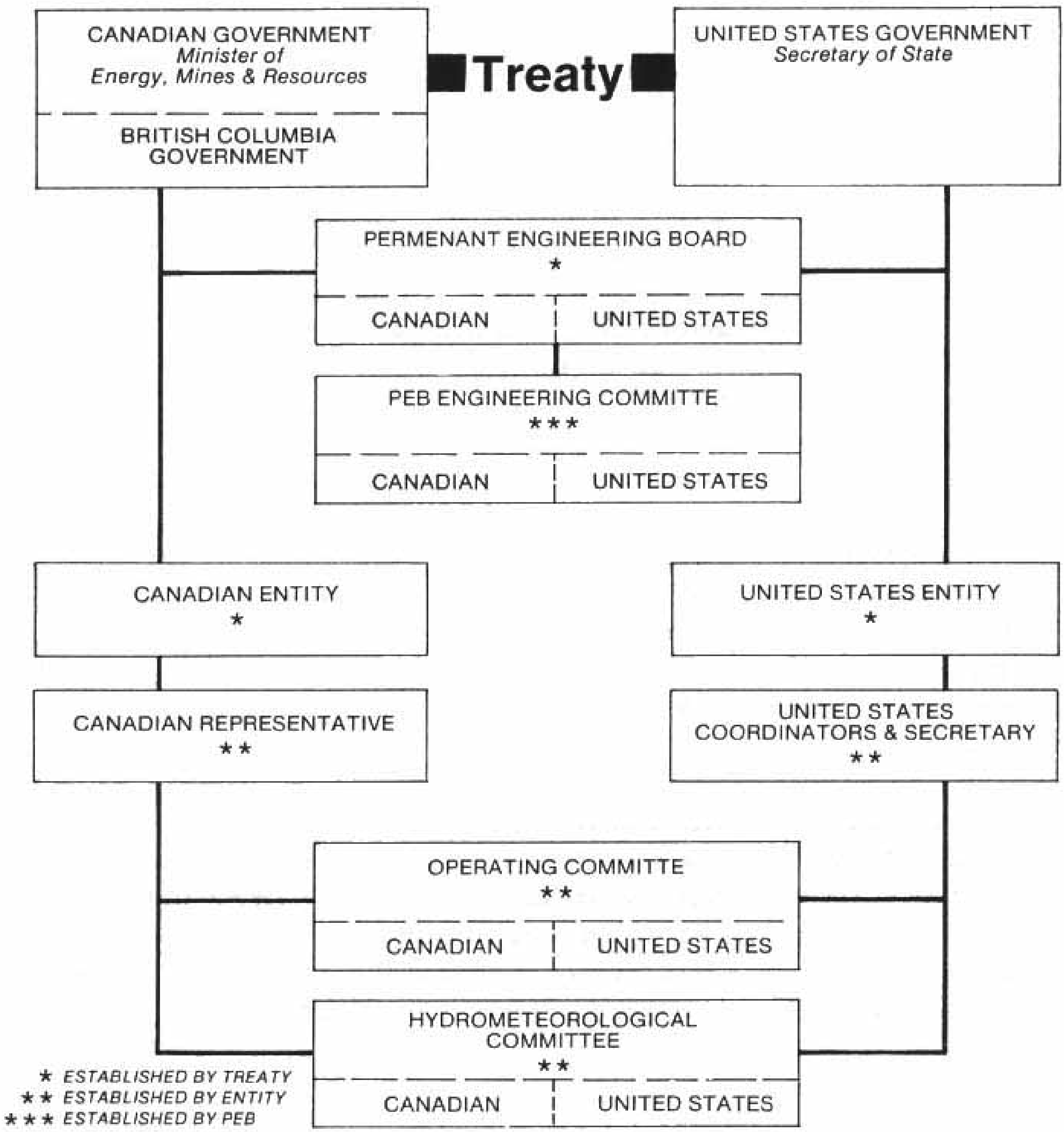
R. O. "Neil" Lyons, Chairman
Vancouver, B.C.
David B. Tanner, Member
Victoria, B.C.

International Joint Commission

The International Joint Commission (IJC) was created under the Boundary Waters Treaty of 1909 between Canada and the U.S. Its principal functions are rendering decisions on the use of boundary waters, investigating important problems arising along the common frontier not necessarily connected with waterways, and making recommendations on any question referred to it by either government. If a dispute concerning the Columbia River Treaty could not be resolved by the Entities or the PEB it would probably be referred to the IJC for resolution before being submitted to a tribunal for arbitration.

The IJC has appointed local Boards of Control to insure compliance with IJC orders and to keep the IJC currently informed. There are four such boards west of the continental divide. These are the International Kootenay Lake Board of Control, the International Columbia River Board of Control, the International Osoyoos Lake Board of Control and the International Skagit River Board of Control. The Entities and their committees conducted their Treaty activities during the period of this report so that there was no known conflict with IJC orders or rules.

Columbia River Treaty Organization



III Operating Arrangements

Power and Flood Control Operating Plans

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 the use of current estimates of loads and resources. The Protocol to the Treaty provides further detail and clarification of the principles and requirements of the Treaty.

The "Principles and Procedures for the Preparation and Use of Hydroelectric Operating Plans" dated May 1983 together with the "Columbia River Treaty Flood Control Operating Plan" dated October 1972, establish and explain the general criteria used to plan and operate Treaty storage during the period covered by this report. These documents were previously approved by the Entities.

The planning and operation of Treaty Storage as discussed on the following pages is for the operating year, 1 August through 31 July. The planning and operating for U.S. storage operated according to the Pacific Northwest Coordination Agreement is done for a slightly different operating year, 1 July through 30 June. Therefore, most of the hydrographs and reservoir charts in this report are for a 13 month period, July 1986 through July 1987.

Assured Operating Plan

The Assured Operating Plan (AOP) dated September 1981 established Operating Rule Curves for Duncan, Arrow and Mica during the 1986-87 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 1983 Principles and Procedures document. The Flood Control Storage Reservation Curves were established to conform to the Flood Control Operating Plan of 1972.

Determination of Down Stream Power Benefits

For each operating year, the determination of downstream power benefits resulting from Canadian Treaty storage is made five years in advance in conjunction with the Assured Operating Plan. For operating years 1985-86 and 1986-87 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. Therefore, in accordance with Sections 7 and 10 of the Canadian Entitlement Purchase Agreement, the Entities agreed that the United States was entitled to receive 4.5 average megawatts of energy during the period 1 August 1986 through 31 March 1987, and 3.5 average megawatts of energy during the period from 1 April through 31 July 1987. Suitable arrangements were made between the Bonneville Power Administration and B.C. Hydro for delivery of this energy. Computations indicated no loss or gain in dependable capacity during the 1986-87 operating year.

Detailed Operating Plan

During the period covered by this report, storage operations were implemented by the Operating Committee in accordance with the "Detailed Operating Plan for Columbia River Treaty Storage" (DOP), dated October 1986. The DOP established criteria for determining the Operating Rule Curves for use in actual operations. Except for minor changes at Arrow, the DOP used the AOP critical rule curves for Canadian projects. The Canadian Entity agreed to modify the Arrow first year critical rule curve to improve the hydroregulation in the 1986-87 Pacific Northwest Coordination Agreement operating plan. The Variable Refill Curves and flood control requirements subsequent to 1 January 1987 were determined on the basis of seasonal volume runoff forecasts during actual operation. The regulation of the Canadian storage was conducted by the Operating Committee on a weekly basis except when flood control requirements necessitated daily regulation.

Entity Agreements

During the period covered by this report, three agreements were officially approved by the Entities. The following tabulation indicates the date each of these were signed or approved and gives a description of the agreement:

Date Agreement Signed by Entities	Description
5 December 1986	Columbia River Treaty Hydromteorological Committee Documents.
5 December 1986	Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1991-92, dated November 1986.
5 December 1986	Detailed Operating Plan for Columbia River Treaty Storage, 1 August 1986 through 31 July 1987, dated October 1986.

Long Term Non-Treaty Storage Contract

In accordance with the 9 April 1984 Entity Agreement which approved the contract between B.C. Hydro and BPA relating to the initial filling of non-Treaty storage, coordinated use of non-Treaty storage, and Mica and Arrow refill enhancement, the Operating Committee monitored the storage operations made under the agreement to insure that they did not adversely impact operation of Treaty storage required by the Detailed Operating Plan.

IV Weather and Streamflow

Weather

Chart 1 is a geographical illustration of the seasonal precipitation in the Columbia River Basin, in percent of normal, for the period 1 October 1986 through 31 March 1987. Chart 2 shows an index of the accumulated snowpack in the Columbia Basin above The Dalles in percent of normal for the period 1 January through 1 May 1986. Indices of temperature and precipitation in the Columbia Basin for the period 1 September 1986 to 31 August 1987 are shown on charts 3, 4, and 5. The following paragraphs describe significant weather events between 1 August 1986 and 30 September 1987.

Columbia Basin weather during the September 1986 to August 1987 period cycled through three categories. September through November was variable, December through February was dry and March through August was wet. September 1986 began with near normal temperatures and precipitation. Then the circulation changed on 9 September when a deep low pressure system in the upper atmosphere established itself off the Pacific Northwest coast. This system produced temperatures 5^{o} to 15^{o}F below normal and well above-normal precipitation. This weather persisted until 4 October when the low was replaced by an upper air high pressure system. This system produced warm, dry weather throughout the Columbia Basin for 3 weeks. On 18 October the ridge began to weaken, permitting some cooling and showers in the northern part of the basin. Not until the 27th did the ridge break down, permitting normal precipitation and temperatures. This weather persisted until 5 November when the circulation switched to the northwest, producing below normal temperatures and normal precipitation. This pattern lasted until the 16th when a low pressure system moved into the Gulf of Alaska and the circulation switch to the southwest, bringing normal temperatures and above normal precipitation. On the 22nd, a concentrated area of heavy precipitation centered itself over western Washington, producing some flooding.

On 29 November, a 3-month dry period began when a weak ridge established itself on the Pacific Coast. This produced a west to northwest circulation with cooler than normal air with light precipitation in lieu of the normal southwest circulation of warmer, moister air. This pattern continued, with some small weather systems passing through the basin, until 24 January when the coastal ridge was replaced by an offshore low that brought in warmer, moister air that produced above normal precipitation. Heavy rains in the Portland, Oregon area produced flooding on many small streams on 31 January and 1 February. This surge of moisture lasted until 4 February when a large high pressure ridge began to build over Idaho. This pattern continued, with only minor storms getting through until 23 February when the circulation turned toward the west and northwest, producing cooler, showery weather.

On 2 March, the overall weather pattern changed again. An upper air low stagnated off the northern California coast, producing a flow of very warm, moist air from the Hawaiian Islands. By the 18th, high pressures returned and the circulation had moved to a northwesterly flow with normal temperatures and below normal precipitation. This continued until 6 April when the high pressure ridge gave way to a series of weak Gulf of Alaska troughs which brought light precipitation and cooler temperatures. These storms continued to bring moisture to western Washington and southern British Columbia until the 20th when a new high pressure area began to build over the intermountain area. With the exception of the first three days of May, this pattern continued for four weeks. The establishment of this high was accompanied by high temperatures on May 6-9. Temperatures rose to 20^{o} to $25^{o}F$ above normal before cooler air moved into the basin. On 18 May a small surface low and subtropical moisture combined to bring significant precipitation and below normal temperatures to southern Idaho. This cool weather continued through 3 June when an upper air ridge of high pressure built on the coast. Except for two periods of cool showery weather this pattern remained until the first part of July. During these periods, 8-10th and 16-23rd, cool showery weather dominated. On 5 July an upper air low pressure trough began sending storms into the basin, producing more than twice the normal precipitation and temperatures 10^{o}-$15^{o}F$ below normal. Only Puget Sound, the Canoe River drainage in British Columbia, and a small section of the Owyhee and Bruncan basins in southern Idaho escaped above normal precipitation. August generally remained under the domination of weak weather systems from the Gulf of Alaska, with normal precipitation and below normal temperatures. The only interruption of this pattern came on this 5th, 8-10th, and the 27-31st.

The final precipitation index figure for the Columbia Basin above The Dalles each month differs from the preliminary precipitation index figure. The preliminary index is computed daily based on 16 usually representative stations. The final index is based on 60 stations and is computed at the end of each month after all the data are collected. There is usually some slight difference between the preliminary and the final monthly precipitation figures. The following tabulation shows the 25-year average (1961-1985) monthly precipitation in the Columbia Basin above The Dalles as compared to the final and the preliminary (prelim) indices for Water Year 1987 (WY 87).

Month	25-Year Average (in.)	WY 87 Indices Final (%)	WY 87 Indices Prelim (%)	Month	25-Year Average (in.)	WY 87 Indices Final (%)	WY 87 Indices Prelim (%)
* Oct '86	1.76	57	43	Apr '87	1.65	70	78
* Nov '86	2.71	131	127	May '87	1.80	121	113
* Dec '86	3.29	33	33	Jun '87	1.93	66	70
* Jan '87	3.33	63	53	Jul '87	1.06	217	230
Feb '87	2.19	64	61	Aug '87	1.27	68	98
Mar '87	1.93	122	116	Sep '87	1.51	20	20

* October through January are based on the 20-Year Average.

Streamflow

The observed inflow and outflow hydrographs for the period 1 July 1986 to 31 July 1987 are shown on charts 6 through 9 for the four Treaty reservoirs. Observed flows with the computed unregulated flow hydrographs for the same 13-month period for Kootenay Lake, Columbia River at Birchbank, Grand Coulee and The Dalles are shown on charts 10, 11, 12, and 13, respectively. Chart 14 is a hydrograph of observed and two unregulated flows at The Dalles during the April through July 1987 period including one that would have occurred if regulated only by the Treaty reservoirs. The following paragraphs describe significant streamflow events from the summer of 1986 through September 1987.

Streamflows in the basin above The Dalles were below normal for the entire operating year. These flows were a direct reflection of the dry conditions as the precipitation for the basin was below normal for the operating year. The peak runoff into the lower river was 284,000 cfs at The Dalles.

The 1986-87 monthly modified streamflows and the average monthly flows for the 1929-1978 period are shown in the following table for the Columbia River at Grand Coulee and at The Dalles. These modified flows have been corrected for storage in lakes and reservoirs to exclude the effects of regulation, and are adjusted to the 1980 level of development for irrigation.

Time Period	Columbia River at Grand Coulee in cfs		Columbia River at The Dalles in cfs	
	Modified Flow 1986-1987	Average 1929-1978	Modified Flow 1986-1987	Average 1929-1978
Aug '86	91,580	103,142	119,500	139,054
Sep '86	50,210	64,457	87,920	97,214
Oct '86	42,780	50,650	87,730	87,349
Nov '86	45,490	45,525	93,160	89,536
Dec '86	32,310	43,793	74,990	95,166
Jan '87	25,780	38,482	65,680	91,901
Feb '87	29,730	41,045	76,080	102,817
Mar '87	71,430	50,359	142,400	122,728
Apr '87	123,800	117,432	201,200	221,814
May '87	262,600	272,024	376,100	421.758
Jun '87	202,400	325,692	256,700	479,654
Jul '87	123,600	195,586	154,400	216,610
YEAR	91,809	112,678	144,238	180,649

Seasonal Runoff Forecasts and Volumes

Observed 1987 April through August runoff volumes, adjusted to exclude the effects of regulation of upstream storage, are listed below for eight locations in the Columbia Basin:

Location	Volume In 1000 Acre-Feet	Percent of 1961-80 Average
Libby Reservoir Inflow	4,991	77
Duncan Reservoir Inflow	1,918	93
Mica Reservoir Inflow	10,927	94
Arrow Reservoir Inflow	21,446	81
Columbia River at Birchbank	35,684	87
Grand Coulee Reservoir Inflow	47,297	76
Snake River at Lower Granite Dam	11,079	46
Columbia River at The Dalles	65,164	68

Forecasts of seasonal runoff volume, based on precipitation and snowpack data, were prepared in 1987 as usual 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. Also shown in table 1 are the actual volumes for these five locations. The forecasts for Mica, Arrow and Duncan inflow 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.

The 1 April 1987 forecast of January through July runoff for the Columbia River above The Dalles was 80.0 maf and the actual observed runoff was 76.5 maf, a 5 percent differential. The following tabulation summarizes monthly forecasts since 1970 of the January through July runoff for the Columbia River above The Dalles compared to the actual runoff measured in millions of acre-feet (maf):

Year	Jan	Feb	Mar	Apr	May	Jun	Actual
1970	82.5	99.5	93.4	94.3	95.1	--	95.7
1971	110.9	129.5	126.0	134.0	133.0	135.0	137.5
1972	110.1	128.0	138.7	146.1	146.0	146.0	151.7
1973	93.1	90.5	84.7	83.0	80.4	78.7	71.2
1974	123.0	~~135.0~~	140.0	146.0	149.0	147.0 147	156.3
1975	96.1	106.2	114.7	116.7	115.2	113.0	112.4
1976	113.0	116.0	121.0	124.0	124.0	124.0	122.8
1977	75.7	62.2	55.9	58.1	53.8	57.4	53.8
1978	120.0	114.0	108.0	101.0	104.0	105.0	105.6
1979	88.0	78.6	93.0	87.3	89.7	89.7	83.1
1980	88.9	88.9	88.9	89.7	90.6	97.7	95.8
1981	106.0	84.7	84.5	81.9	83.2	95.9	103.4
1982	110.0	120.0	126.0	130.0	131.0	128.0	129.9
1983	110.0	108.0	113.0	121.0	121.0	119.0	118.7
1984	113.0	103.0	97.6	102.0	107.0	114.0	119.1
1985	131.0	109.0	105.0	98.6	98.6	100.0	87.7
1986	96.8	93.3	103.0	106.0	108.0	108.0	108.3
1987	88.9	81.9	78.0	80.0	76.7	75.8	76.5

V Reservoir Operation

General

The operating year began with the coordinated reservoir system officially filled to 98% of capacity. The system remained near full through the summer. Reservoir draft for power and flood control was initiated on 2 September. The reservoir system drafted through the autumn months for power and flood control. U.S. reservoirs with flood control reached their winter flood control elevations well ahead of schedule and Canadian projects were operating close to their winter flood control elevations early in December.

The 1 January forecast for The Dalles was 88.9 MAF, the lowerest since 1980. Drier than average conditions through mid-January continued to deteriorate the forecast, therefore, the draft of reservoirs in the coordinated system was slowed as VECCs were expected to rise. The coordinated system operated to proportional draft points through January. In February BPA reduced their non firm and surplus firm energy sales due to concern for reservoir refill and because of soft market prices.

The water supply forecasts remained well below normal through the spring resulting in the system not being operated for flood control on a daily basis. Mica, Arrow, Duncan, and Grand Coulee were all officially released from flood control requirements on 10 June. The coordinated system reached 98.42 percent of its full capacity on 27 July allowing the first year FELCC to be adopted for the 1987-88 operating year.

In 1987 the U.S. reservoir system operated to provide flows for downstream migration of juvenile anadromous fish. Water budget releases from Grand Coulee were requested for the period 25 through 31 May to provide 220,000 cfs at McNary. Grand Coulee outflow was increased to 155,000 cfs which resulted in a weekly average flow of 191,000 cfs at McNary. Grand Coulee outflow was reduced for the period 1 through 7 June to provide 140,000 cfs flow at Priest Rapids. For a five-day period beginning on 5 June Grand Coulee outflow was increased to 155,000 cfs. The 3.45 maf Water Budget for Priest Rapids was fully utilized between 25 May and 10 June.

Mica Reservoir

Treaty storage space at Mica was refilled by 10 July 1986. Non-Treaty storage accounts continued to fill and the reservoir reached its full pool elevation 2475.0 feet on 10 August. Subsequent releases of the non-Treaty storages caused the reservoir to draft slightly to elevation 2472.6 feet by 31 August. Releases from the non-Treaty storage accounts drafted Mica another five feet in September. During October, the reservoir was generally maintained near 2465.0 feet as the Treaty storage account was drafted for flood control space and the non-Treaty storage accounts were being filled at about the same rate. Total project outflow averaged between 8,000 cfs and 18,000 cfs during this period. Because the Arrow reservoir level was below the 31 October trigger point, the Mica Treaty storage release for November was increased from 14,000 cfs to 23,000 cfs as per the 1986-87 Detailed Operating Plan. The December discharge schedule remained unchanged at 25,000 cfs. By 31 December, Mica was drafted to elevation 2445.6 feet, about five feet below its Operating Rule Curve for the month after adjusting for the non-Treaty storages at Mica. Beginning in mid-January and continuing through February and March, both the Treaty and non-Treaty storage accounts were heavily drafted to meet load requirements. By 27 April, Mica was drafted to elevation 2388.5 feet, its lowest level for the current operating year. After adjusting for the non-Treaty storages, Mica was slightly below its Operating Rule Curve for April.

Inflows into the Mica projects were below average in April but quickly increased to above average in May and June, peaking at 83,030 cfs on 15 June. During this period, the project outflow was reduced at times to zero discharge, and the reservoir quickly filled to elevations 2417.4 feet and 2449.2 feet by 31 May and 30 June, respectively. By 14 July the Treaty storage account was completely refilled. Since the non-Treaty storage accounts were only partially filled at the time, the actual reservoir level was only 2462.2 feet, about 13 feet below full pool elevation 2475.0 feet. During August, Mica reservoir was drafted slightly due to releases from the non-Treaty storage accounts.

Revelstoke Reservoir

During this past operating year, Revelstoke project was basically discharging inflow and operating within 5 to 10 feet below its normal full pool elevation 1880.0 feet. For about two weeks in early June, the reservoir was filled to elevation 1881.0 feet to facilitate debris clearing on the reservoir.

Arrow Reservoir

As shown in Chart 7, the Treaty storage space in Arrow reservoir was refilled on 18 July 1986. Between August and early September, in order to avoid spilling in B.C. Hydro's system, discharges from projects upstream of Arrow were curtailed and the Arrow reservoir was drawndown to as low as elevation 1438.5 during this period. The reservoir was later refilled to elevation 1442.0 feet by early October. On 31 October after adjusting for the non-Treaty storage in Arrow at the time, the reservoir Treaty storage level was determined to be slightly below the 1442.0 feet elevation, triggering higher Treaty storage releases from the Mica project in November. In December the Arrow reservoir resumed drafting the Treaty storage for flood control space. During this period, the reservoir discharges varied between 42,000 cfs and 60,000 cfs. By 31 December the Arrow reservoir was drawndown to an elevation of 1428.1 feet. Total Treaty storage at Arrow, including that in Revelstoke at the time, was about three feet below its Flood Control Rule Curve for December. To meet power requirements, the Arrow reservoir was heavily drafted in January with project outflows increased to as high as 85,000 cfs. In addition, about 10,000 cfs of non-Treaty storage which was released from Mica also passed through Arrow. By early February, in response to a low runoff forecast, storage draft at Arrow was curtailed to enhance refill. Discharge at the project was reduced to as low as 38,000 cfs. Towards the end of February, Arrow leveled off at 1401.5 feet. The project resumed drafting on 3 March and by 6 March, the reservoir reached its lowest level of the current operating year, elevation 1401.1 feet, approximately ten feet below its Operating Rule Curve at that time.

Arrow project again curtailed its discharges during March and April and the reservoir gradually filled to elevation 1417.8 feet by 30 April. During the period from 26 April until 15 May, the project outflow was at its minimum of 5,000 cfs. The inflows in May were well above average, peaking at 88,900 cfs on 12 May. The Arrow reservoir quickly filled and reached elevation 1435.4 feet by 23 May. During the period from 24 May to 8 June, Arrow reservoir was drafted to meet downstream requirements.

The project resumed filling on 9 June and continued until early July. By 30 July the reservoir was filled to elevation 1440.1 feet. Including the Treaty storage at Revelstoke at the time, the Arrow reservoir Treaty storage account was considered completely refilled as of that day. Subsequently, discharges at Arrow were adjusted to equal natural flows at the project.

Duncan Reservoir

As shown in Chart 8, Duncan reservoir was refilled to its full pool elevation 1892.0 feet by 23 July 1986. During the period from late July until early September, the project was discharging inflow, maintaining the reservoir level about 1892.0 feet. On 5 September the Duncan reservoir outflow was increased to 4,500 cfs, drafting the reservoir. Outflow was later reduced to below inflow and the reservoir slowly refilled to full pool towards the end of November.

During December, Treaty storage at the Duncan reservoir was evacuated for flood control space. The project outflow was increased to as high as 10,000 cfs during the month, drafting the reservoir to elevation 1866.1 feet by 31 December, slightly below its Flood Control Rule Curve for the month. Duncan reservoir continued to draft in January and February to meet downstream storage requirements, with the project discharges varying between 6,000 cfs to 10,000 cfs during this period. By 20 February Duncan was drawn down to elevation 1815.2 feet, its lowest level for the current operating year.

Beginning 21 February and continuing until mid-June, the project released its minimum discharge of 100 cfs. Duncan reservoir began filling in late February when the project outflow was reduced to 100 cfs. The reservoir gradually filled through March and April to elevation 1828.9 feet, slightly below its Operating Rule Curve, by 30 April. During May, the inflows into the Duncan reservoir were well above average, peaking at 17,460 cfs on 12 May. The reservoir filled about 35 feet to elevation on 1862.7 feet by 31 May, well above its Operating Rule Curve for the month. Inflows in the month of June were near average.

Beginning 15 June discharge at the project was gradually increased towards reservoir inflows. On 3 July the Duncan reservoir reached full pool, elevation 1892.0 feet. During August, Duncan continued to discharge inflows, maintaining the reservoir full at elevation 1892.0 feet.

Libby

Lake Koocanusa was essentially full at elevation 2458.6 feet on 31 July, 1986. The lake remained full until late August when about one foot of provisional draft occurred to meet upper quartile industrial loads. After Labor Day the reservoir began drafting more rapidly as the hydrosystem began operating in accordance with proportional draft requirements. On 30 September the reservoir was at elevation 2445.2 feet, slightly below the end-of-month proportional draft point due the provisional draft in August.

The project continued drafting throughout autumn with the October-November discharge averaging 22,700 cfs. This was the highest average outflow for this period since the project was constructed. By 30 November, Lake Koocanusa was at elevation 2393.9 feet and nearly all the provisional draft had occurred. Rainfall in November resulted in the reservoir system returning to operation to ECCs after being operated in accordance with proportional draft requirements for much of the autumn. Consequently, the discharge was reduced to minimum in late November. In mid-December, the system began being proportionally drafted again and the Libby outflow was increased up to 24,000 cfs for about a week. On 31 December the reservoir was at elevation 2389.3 feet, about eight feet below ECC (after adjusting for provisional draft) and 22 feet below the 1 January flood control requirement of 2411 feet.

The outflow was again increased to 24,000 cfs in early January when the water supply forecast indicated additional draft could occur for nonfirm energy production. By mid-January, however, it became apparent that the unusually dry weather in the Northwest would result in a significant drop in expected water supply. Thus, the outflow was reduced to 4,000 cfs on 17 January.

The outflow remained at 4,000 cfs until late February when it was increased to 20,000 cfs for about ten days for firm energy sales. The outflow was again reduced to 4,000 cfs on 4 March. The lake reached its lowest level of the year, 2357.7 feet, on this date. On 17 March, the outflow was reduced to 3,000 cfs since the lake was 28 feet below its official end-of-month Variable Energy Content Curve (VECC) and 14 feet below the VECC based on 3,000 cfs minimum outflow. The official VECC was based on 4,200 cfs discharge for April to June and 6,000 cfs in July.

The inflow to Lake Koocanusa began rising in late April and the seasonal peak of 52,400 cfs occurred on 13 May, about three weeks earlier than usual. By the end of May the inflow had receded to 22,000 cfs. The early runoff and the lower-than-average snowpack resulted in the June-July inflow volume being the fourth lowest since 1928. The project outflow was held at 3,000 cfs until 16 June. The lake reached elevation 2454.1 feet on 29 June and was held in its top five feet from 24 June to 8 September.

Kootenay Lake

As shown in Chart 10, after filling to its peak elevation in early June, Kootenay Lake was gradually drafted during July and early August. On 4 August, Kootenay Lake reached its summer level of 1743.32 feet at Nelson.

In early September Kootenay Lake outflow was curtailed to began filling towards its normal operating level for the winter months elevation 1745.32 feet. By 8 October the reservoir reached elevation 1745.32 feet. During the period from October till December, Kootenay Lake operated between elevations 1744.5 feet and 1745, with discharges varying between 18,000 cfs and 43,000 cfs during this period.

Following the International Joint Commission (IJC) Rule Curve, Kootenay Lake was drawndown from January through March. On 19 March, Kootenay Lake went on free flow. The lake reached its lowest level for the current operating year at elevation 1738.7 feet by 4 April. Kootenay Lake continued to discharge free flow through April until early May. Between 8 May and 21 May, the reservoir discharges were maintained at about 41,000 cfs. During this period, the high runoffs into Kootenay Lake quickly filled the lake to a peak elevation of 1746.3 feet by 17 May.

Kootenay Lake inflows receded in June and the reservoir slowly drafted to elevation 1743.32 feet as measured at Nelson, its summer operating level, by 26 June. Kootenay Lake was then maintained at this level through July and August.

In early September, Kootenay Lake outflow was again reduced to about 18,000 cfs to begin filling towards its normal operating level for the winter months, elevations 1745.32 feet.

VI Power and Flood Control Accomplishments

General

During the period covered by this report, Duncan, Arrow, Mica, and Libby reservoirs were operated in accord with the Columbia River Treaty. More specifically the operation of the reservoirs was in accordance with:

1. "Columbia River Treaty Hydroelectric Operating Plan - Assured Operating Plan for Operating Year 1986-87," dated September 1981.
2. "Detailed Operating Plan for Columbia River Treaty Storage - 1 August 1986 through 31 July 1987," dated October 1986.
3. "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 1986-87 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 1986-87 Assured Operating Plan prepared in 1981, was used as the basis for the preparation of the 1986-87 Detailed Operating Plan.

Power

The Canadian Entitlement to downstream power benefits from Duncan, Arrow, and Mica for the 1986-87 operating year had been purchased in 1964 by the Columbia Storage Power Exchange (CSPE). In accordance with Canadian Entitlement Exchange Agreement dated 13 August 1964, the U.S. Entity delivered capacity and energy to the CSPE participants.

The generation at downstream projects in the United States, delivered under the Canadian Entitlement Exchange Agreement was 418 average megawatts at rates up to 1,093 megawatts, from 1 August 1986, through 31 March 1987, and 393 average megawatts, at rates up to 1,052 megawatts, from 1 April 1987, through 31 July 1987. All CSPE power was used to meet Pacific Northwest loads.

The Coordinated System reservoirs were 99 percent full on August 1, 1986 and after being drawn down during the 1986-87 operating year, recovered to near full elevations on 31 July 1987. The following table shows the status of the energy stored in coordinated system reservoirs in billions of kilowatt hours at the end of each month compared to operating rule curves during the 1986-87 operating year:

Month	Rule Curves	Actual	Difference
Aug '86	46.4	45.3	-1.1
Sep '86	43.9	42.6	-1.3
Oct '86	39.7	38.8	-0.9
Nov '86	35.8	35.8	0.0
Dec '86	31.8	30.5	-1.3
Jan '87	27.9	23.7	4.2
Feb '87	22.6	19.8	-2.8
Mar '87	21.7	21.2	-0.5
Apr '87	23.8	25.5	1.7
May '87	32.7	36.4	3.7
Jun '87	42.8	43.2	0.4
Jul '87	46.4	45.5	-0.5

NOTE: During the January-June period of 1987, volume runoff forecasts to cyclic reservoirs were sufficient to lower the operating rule curves below the assured refill curves.

The following table shows BPA nonfirm and surplus firm sales in megawatt-hours to northwest and southwest utilities during the 1986-87 operating year.

	To Northwest Utilities		To Southwest Utilities	
Period	Nonfirm	Surplus Firm	Nonfirm	Surplus Firm
Aug '86	95,588	456,662	234,683	1,799,398
Sep '86	0	149,417	0	2,009,008
Oct '86	0	31,350	0	1,381,049
Nov '86	0	50,646	60,494	1,890,687
Dec '86	6,635	2,702	320,469	1,836,812
Jan '87	28,265	6,155	449,979	897,817
Feb '87	302	0	0	219,620
Mar '87	0	14,450	0	64,600
Apr '87	45,049	102,110	176,340	61,590
May '87	1,213,279	0	2,138,733	120,120
Jun '87	319,053	121,000	352,329	231,281
Jul '87	0	0	0	121,301
TOTAL	1,708,171	934,492	3,733,027	10,633,283

Flood Control

The Columbia reservoir system including Treaty projects in Canada were not operated on a daily basis for flood control in 1987. All projects with winter flood control elevation were drafted to these elevations by late fall. Flood control during the spring runoff was provided by the normal refill operation of the Treaty reservoirs and other storage reservoirs in the Columbia River Basin. The observed and unregulated hydrographs for the Columbia River at The Dalles between 1 July 1986 and 31 July 1987 are shown on Chart 13 along with a summary hydrograph of historical flows. As shown on Chart 14, the unregulated peak flow at The Dalles would have been 439,000 cfs on 15 May and it was controlled to a maximum of 284,000 cfs on 17 May.

The observed peak stage at Vancouver, Washington was 8.8 feet and the unregulated stage would have been 15.5 feet. Chart 15 documents the relative filling of Arrow and Grand Coulee during the principal filling period, and compares the regulation of these two reservoirs to guidelines in the Treaty Flood Control Operating Plan.

Computations of the Initial Controlled Flow (ICF) for system flood control operation were made in accordance with the Treaty Flood Control Operating Plan. The results of these computations started out on 1 January 1987 at 285,000 cfs then decreased to 275,000 cfs on 1 February, decreased to 240,000 cfs on 1 March, and increased to 250,000 cfs on 1 April and decreased to 210,000 cfs on 1 May. Data for the 1 May ICF computation are given in Table 6.

Table 1

Unregulated Runoff Volume Forecasts
Millions of Acre-Feet
1987

	DUNCAN	ARROW	MICA	LIBBY	UNREGULATED RUNOFF COLUMBIA RIVER AT THE DALLES, OREGON
Forecast Date - 1st of	Most Probable 1 April-31 August	Most Probable 1 January-31 August	Most Probable 1 April-31 August	Most Probable 1 April-31 August	Most Probable 1 January-31 July
January	2.0	21.1	10.8	6.2	88.9
February	1.9	20.5	10.5	5.9	81.9
March	1.9	18.9	10.3	5.4	78.0
April	1.9	20.2	10.5	5.5	80.0
May	2.0	20.4	10.4	5.5	76.7
June	2.0	19.5	10.6	5.4	75.8
Actual	1.9	21.4	10.9	5.0	76.5

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

Table 2

95 Percent Confidence Forecast and Variable Energy Content Curve Mica 1987

	INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1 PROBABLE FEB 1 - JUL 31 INFLOW, KSFD [1]		4488.6	4378.5	4255.5	4460.2	4401.7	4650.0
2 95% FORECAST ERROR, KSFD		665.8	537.9	498.3	485.6	457.9	448.9
3 95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD [2]		3822.8	3840.6	3757.2	3974.6	3943.8	4201.1
4 OBSERVED FEB 1 - DATE INFLOW, KSFD		0.0	0.0	101.4	261.2	542.8	1730.6
5 RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD [3]		3822.8	3840.6	3655.8	3713.4	3401.0	2470.5
ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
ASSUMED FEB 1 - JUL 31 INFLOW, KSFD [4]		3822.8					
MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		2180.0					
MIN. JAN 31 RESERVOIR CONTENT, KSFD [5]		1886.4					
MIN. JAN 31 RESERVOIR ELEVATION, FT [6]		2436.9					
JAN 31 ECC, FT [7]		2436.7					
BASE ECC, FT	2436.7						
LOWER LIMIT, FT	2402.0						
ASSUMED MAR 1 - JUL 31 INFLOW, % OF VOLUME		97.9	97.9				
ASSUMED MAR 1 - JUL 31 INFLOW, KSFD [4]		3742.5	3759.9				
MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		1760.0	1760.0				
MIN. FEB 28 RESERVOIR CONTENT, KSFD [5]		1546.7	1529.3				
MIN. FEB 28 RESERVOIR ELEVATION, FT [6]		2429.7	2429.3				
FEB 28 ECC, FT [7]		2423.3	2423.3				
BASE ECC, FT	2423.3						
LOWER LIMIT, FT	2394.2						
ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		95.6	95.6	97.7			
ASSUMED APR 1 - JUL 31 INFLOW, KSFD [4]		3654.6	3671.6	3571.7			
MIN. APR 1 - JUL 31 OUTFLOW, KSFD		1295.0	1295.0	1295.0			
MIN. MAR 31 RESERVOIR CONTENT, KSFD [5]		1169.6	1152.6	1252.5			
MIN. MAR 31 RESERVOIR ELEVATION, FT [6]		2421.4	2421.0	2423.2			
MAR 31 ECC, FT [7]		2415.0	2415.0	2415.0			
BASE ECC, FT	2415.0						
LOWER LIMIT, FT	2394.2						
ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		91.0	91.0	93.0	95.2		
ASSUMED MAY 1 - JUL 31 INFLOW, KSFD [4]		3478.7	3494.9	3399.9	3535.2		
MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		920.0	920.0	920.0	920.0		
MIN. APR 30 RESERVOIR CONTENT, KSFD [5]		970.5	954.3	1049.3	914.0		
MIN. APR 30 RESERVOIR ELEVATION, FT [6]		2416.9	2416.5	2418.7	2415.6		
APR 30 ECC, FT [7]		2408.2	2408.2	2409.2	2408.2		
BASE ECC, FT	2408.2						
LOWER LIMIT, FT	2394.1						
ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		73.7	73.7	75.3	77.1	81.0	
ASSUMED JUN 1 - JUL 31 INFLOW, KSFD [4]		2817.7	2830.5	2752.8	2863.0	2754.8	
MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		610.0	610.0	610.0	610.0	610.0	
MIN. MAY 31 RESERVOIR CONTENT, KSFD [5]		1321.8	1308.7	1386.4	1276.0	1384.4	
MIN. MAY 31 RESERVOIR ELEVATION, FT [6]		2424.7	2424.4	2426.2	2423.7	2426.1	
MAY 31 ECC, FT [7]		2413.6	2413.6	2413.6	2413.6	2413.6	
BASE ECC, FT	2413.6						
LOWER LIMIT, FT	2394.1						
ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		36.5	36.5	37.3	38.2	40.1	49.0
ASSUMED JUL 1 - JUL 31 INFLOW, KSFD [4]		1395.3	1401.8	1363.6	1418.5	1363.8	1222.9
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]		2443.9	2437.4	2475.6	2420.7	2475.4	2616.3
MIN. JUN 30 RESERVOIR ELEVATION, FT [6]		2448.5	2448.3	2449.1	2448.0	2449.1	2452.0
JUN 30 ECC, FT [7]		2443.3	2443.3	2443.3	2443.3	2443.3	2443.3
BASE ECC, FT	2443.3						
LOWER LIMIT, FT	2394.1						
JUL 31 ECC, FT	2470.1	2470.1	2470.1	2470.1	2470.1	2470.1	2470.1

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 FEBRUARY 21, 1973
7 LOWER OF ELEVATION ON PRECEDING LINE OR ELEVATION DETERMINED PRIOR TO YEAR

Table3

95 Percent Confidence Forecast and Variable Energy Content Curve Arrow 1987

	INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1 PROBABLE FEB 1 - JUL 31 INFLOW, KSFD [1]		4709.5	4613.3	4293.8	4680.8	4866.5	5085.3
2 95% FORECAST ERROR, KSFD		1130.6	948.7	802.3	633.6	555.5	557.2
3 95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD [2]		3578.9	3664.5	3491.5	4047.2	4311.0	4528.4
4 OBSERVED FEB 1 - DATE INFLOW, KSFD		0.0	0.0	207.4	513.1	1043.8	2619.1
5 RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD [3]		3578.9	3664.5	3284.1	3534.1	3267.2	1909.0
ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
ASSUMED FEB 1 - JUL 31 INFLOW, KSFD [4]		3578.9					
MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		1835.0					
MICA REFILL REQUIREMENTS, KSFD [9]		2180.0					
MIN. JAN 31 RESERVOIR CONTENTS, KSFD [5]		-344.3					
MIN. JAN 31 RESERVOIR ELEVATION, FT [6]		1377.9					
JAN 31 ECC, FT [7]		1392.1					
BASE ECC, FT	1419.7						
LOWER LIMIT, FT	1392.1						
LOWER LIMIT, FT	1392.1						
ASSUMED MAR 1 - JUL 31 INFLOW, % OF VOLUME		97.2	97.2				
ASSUMED MAR 1 - JUL 31 INFLOW, KSFD [4]		3478.7	3561.9				
MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		1695.0	4088.4				
MICA REFILL REQUIREMENTS, KSFD [9]		1760.0	1760.0				
MIN. FEB 28 RESERVOIR CONTENT, KSFD [5]		35.9	2346.1				
MIN. FEB 28 RESERVOIR ELEVATION, FT [6]		1378.8	1424.2				
FEB 28 ECC, FT [7]		1383.8	1413.6				
BASE ECC, FT	1413.6						
LOWER LIMIT, FT	1383.8						
ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		93.8	93.8	96.5			
ASSUMED APR 1 - JUL 31 INFLOW, KSFD [4]		3357.0	3437.3	3169.2			
MIN. APR 1 - JUL 31 OUTFLOW, KSFD		1540.0	3933.4	4039.0			
MICA REFILL REQUIREMENTS, KSFD [9]		1295.0	1295.0	1295.0			
MIN. MAR 31 RESERVOIR CONTENT, KSFD [5]		467.6	2780.7	3154.4			
MIN. MAR 31 RESERVOIR ELEVATION, FT [6]		1388.8	1431.4	1437.4			
MAR 31 ECC, FT [7]		1388.8	1407.8	1407.8			
BASE ECC, FT	1407.8						
LOWER LIMIT, FT	1382.3						
ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		86.1	86.1	88.6	91.8		
ASSUMED MAY 1 - JUL 31 INFLOW, KSFD [4]		3081.4	3155.1	2909.7	3244.3		
MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		1343.1	3295.8	3379.0	3379.0		
MICA REFILL REQUIREMENTS, KSFD [9]		920.0	920.0	920.0	920.0		
MIN. APR 30 RESERVOIR CONTENT, KSFD [5]		921.2	2800.2	3128.9	2794.3		
MIN. APR 30 RESERVOIR ELEVATION, FT [6]		1398.2	1431.8	1437.0	1431.7		
APR 30 ECC, FT [7]		1398.2	1409.6	1409.6	1409.6		
BASE ECC, FT	1409.6						
LOWER LIMIT, FT	1377.9						
ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		62.2	62.2	64.0	66.3	72.3	
ASSUMED JUN 1 - JUL 31 INFLOW, KSFD [4]		2226.1	2279.3	2101.8	2343.1	2362.2	
MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		1139.6	2374.6	2418.0	2418.0	2418.0	
MICA REFILL REQUIREMENTS, KSFD [9]		610.0	610.0	610.0	610.0	610.0	
MIN. MAY 31 RESERVOIR CONTENT, KSFD [5]		1883.1	3064.8	3285.8	3044.5	3025.4	
MIN. MAY 31 RESERVOIR ELEVATION, FT [6]		1416.2	1436.0	1439.5	1435.7	1435.4	
MAY 31 ECC, FT [7]		1416.2	1425.6	1425.6	1402.6	1425.6	
BASE ECC, FT	1425.6						
LOWER LIMIT, FT	1377.9						
ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		26.8	26.8	27.6	28.6	31.2	43.2
ASSUMED JUL 1 - JUL 31 INFLOW, KSFD [4]		959.1	982.1	906.4	1010.8	1019.4	824.7
MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		592.1	1452.7	1488.0	1488.0	1488.0	1488.0
MICA REFILL REQUIREMENTS, KSFD [9]		310.0	310.0	310.0	310.0	310.0	310.0
MIN. JUN 30 RESERVOIR CONTENT, KSFD [5]		2902.6	3740.2	3851.2	3746.8	3738.2	3932.9
MIN. JUN 30 RESERVOIR ELEVATION, FT [6]		1433.4	1444.0	1444.0	1444.0	1444.0	1444.0
JUN 30 ECC, FT [7]		1433.4	1444.0	1444.0	1444.0	1444.0	1444.0
BASE ECC, FT	1444.0						
LOWER LIMIT, FT	1377.9						
JUL 31 ECC, FT	1444.0	1444.0	1444.0	1444.0	1444.0	1444.0	1444.0

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

Table 4

95 Percent Confidence Forecast and Variable Energy Content Curve Duncan 1987

		INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1	PROBABLE FEB 1 - JUL 31 INFLOW, KSFD [1]		857.8	834.4	809.1	814.1	867.6	913.5
2	95% FORECAST ERROR, KSFD		154.1	118.6	113.5	105.6	95.4	94.0
3	95% CONFIDENCE FEB 1 - JUL 31 INFLOW, KSFD [2]		703.7	715.8	695.6	708.5	772.2	819.5
4	OBSERVED FEB 1 - DATE INFLOW, KSFD		0.0	0.0	15.0	39.7	107.0	366.1
5	RESIDUAL 95% DATE - JUL 31 INFLOW, KSFD [3]		703.7	715.8	680.6	668.8	665.2	453.4
	ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		100.0					
	ASSUMED FEB 1 - JUL 31 INFLOW, KSFD [4]		703.7					
	MIN. FEB 1 - JUL 31 OUTFLOW, KSFD		51.3					
	MIN. JAN 31 RESERVOIR CONTENT, KSFD [5]		53.4					
	MIN. JAN 31 RESERVOIR ELEVATION, FT [6]		1805.6					
	JAN 31 ECC, FT [7]		1805.6					
	BASE ECC, FT	1848.9						
	LOWER LIMIT, FT	1794.5						
	ASSUMED MAR 1 - JUL 31 INFLOW, % OF VOLUME		97.9	97.9				
	ASSUMED MAR 1 - JUL 31 INFLOW, KSFD [4]		688.9	700.8				
	MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		48.2	204.6				
	MIN. FEB 28 RESERVOIR CONTENT, KSFD [5]		65.4	209.7				
	MIN. FEB 28 RESERVOIR ELEVATION, FT [6]		1807.7	1830.4				
	FEB 28 ECC, FT [7]		1807.7	1830.4				
	BASE ECC, FT	1841.4						
	LOWER LIMIT, FT	1794.6						
	ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		95.5	95.5	97.5			
	ASSUMED APR 1 - JUL 31 INFLOW, KSFD [4]		672.0	683.6	663.6			
	MIN. APR 1 - JUL 31 OUTFLOW, KSFD		45.4	201.5	207.4			
	MIN. MAR 31 RESERVOIR CONTENT, KSFD [5]		79.2	223.8	249.6			
	MIN. MAR 31 RESERVOIR ELEVATION, FT [6]		1810.1	1832.4	1836.0			
	MAR 31 ECC, FT [7]		1810.1	1832.4	1836.0			
	BASE ECC, FT	1843.2						
	LOWER LIMIT, FT	1794.4						
	ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		90.1	90.1	92.0	94.3		
	ASSUMED MAY 1 - JUL 31 INFLOW, KSFD [4]		634.0	644.9	626.2	630.7		
	MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		34.2	152.0	156.4	156.4		
	MIN. APR 30 RESERVOIR CONTENT, KSFD [5]		106.0	212.8	236.0	231.5		
	MIN. APR 30 RESERVOIR ELEVATION, FT [6]		1814.7	1830.9	1834.1	1833.5		
	APR 30 ECC, FT [7]		1814.7	1830.9	1834.1	1833.5		
	BASE ECC, FT	1840.3						
	LOWER LIMIT, FT	1794.4						
	ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		69.7	69.7	71.2	73.0	77.4	
	ASSUMED JUN 1 - JUL 31 INFLOW, KSFD [4]		490.5	498.9	484.6	488.2	514.9	
	MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		22.7	100.8	103.7	103.7	103.7	
	MIN. MAY 31 RESERVOIR CONTENT, KSFD [5]		238.0	307.7	324.9	321.3	294.6	
	MIN. MAY 31 RESERVOIR ELEVATION, FT [6]		1834.4	1843.9	1846.2	1845.7	1842.2	
	MAY 31 ECC, FT [7]		1834.4	1843.9	1846.2	1845.7	1842.2	
	BASE ECC, FT	1854.3						
	LOWER LIMIT, FT	1794.2						
	ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		32.4	32.4	33.1	33.9	36.0	46.5
	ASSUMED JUL 1 - JUL 31 INFLOW, KSFD [4]		228.0	231.9	225.3	226.7	239.5	210.8
	MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		11.5	51.2	52.7	52.7	52.7	52.7
	MIN. JUN 30 RESERVOIR CONTENT, KSFD [5]		489.3	525.1	533.2	531.8	519.0	547.7
	MIN. JUN 30 RESERVOIR ELEVATION, FT [6]		1866.8	1871.1	1872.1	1871.9	1870.4	1873.8
	JUN 30 ECC, FT [7]		1866.8	1871.1	1872.1	1871.9	1870.4	1873.8
	BASE ECC, FT	1877.5						
	LOWER LIMIT, FT	1794.2						
	JUL 31 ECC, FT	1892.0	1892.0	1892.0	1892.0	1892.0	1892.0	1892.0

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

Table 5

95 Percent Confidence Forecast and Variable Energy Content Curve Libby 1987

	INITIAL	JAN 1 TOTAL	FEB 1 TOTAL	MAR 1 TOTAL	APR 1 TOTAL	MAY 1 TOTAL	JUN 1 TOTAL
1 PROBABLE JAN 1 - JUL 31 INFLOW, KSFD		3149.0	3011.2	2763.7	2851.8	2841.3	2720.5
2 95% FORECAST ERROR, KSFD		886.8	606.4	552.5	533.4	474.5	367.4
3 OBSERVED JAN 1 - DATE INFLOW, KSFD			88.6	171.8	311.3	633.5	1656.6
4 95% CONF. DATE - JUL 31 INFLOW, KSFD [1]		2262.2	2316.0	2039.4	2007.1	1733.2	702.4
ASSUMED FEB 1 - JUL 31 INFLOW, % OF VOLUME		97.1					
ASSUMED FEB 1 - JUL 31 INFLOW, KSFD [2]		2197.5					
FEB MINIMUM FLOW REQUIREMENT, CFS [3]		3000.0					
MIN. FEB 1 - JUL 31 OUTFLOW, KSFD [4]		543.0					
MIN. JAN 31 RESERVOIR CONTENT, KSFD [5]		856.0					
MIN. JAN 31 RESERVOIR ELEVATION, FT [6]		2369.1					
JAN 31 ECC, FT [7]		2369.1					
BASE ECC, FT	2407.2						
LOWER LIMIT, FT	2313.5						
ASSUMED MAR 1 - JUL 31 INFLOW, % OF VOLUME		94.5	97.3				
ASSUMED MAR 1 - JUL 31 INFLOW, KSFD [4]		2137.1	2252.5				
MAR MINIMUM FLOW REQUIREMENT, CFS [3]		3000.0	3000.0				
MIN. MAR 1 - JUL 31 OUTFLOW, KSFD		459.0	649.1				
MIN. FEB 1 RESERVOIR CONTENT, KSFD [5]		832.4	907.0				
MIN. FEB 1 RESERVOIR ELEVATION, FT [6]		2367.3	2372.7				
FEB 28 ECC, FT [7]		2367.3	2370.7				
BASE ECC, FT	2405.7						
LOWER LIMIT, FT	2303.7						
ASSUMED APR 1 - JUL 31 INFLOW, % OF VOLUME		91.2	93.9	96.6			
ASSUMED APR 1 - JUL 31 INFLOW, KSFD [4]		2064.1	2175.4	1969.7			
APR MINIMUM FLOW REQUIREMENT, CFS [3]		3000.0	4128.0	4200.0			
MIN. APR 1 - JUL 31 OUTFLOW, KSFD		366.0	566.1	568.2			
MIN. MAR 31 RESERVOIR CONTENT, KSFD [5]		812.4	891.2	1109.0			
MIN. MAR 31 RESERVOIR ELEVATION, FT [6]		2365.7	2371.6	2386.9			
MAR 31 ECC, FT [7]		2365.7	2371.6	2386.9			
BASE ECC, FT	2404.4						
LOWER LIMIT, FT	2287.0						
ASSUMED MAY 1 - JUL 31 INFLOW, % OF VOLUME		88.5	91.1	93.7	97.0		
ASSUMED MAY 1 - JUL 31 INFLOW, KSFD [4]		2001.9	2109.9	1910.3	1946.7		
MAY MINIMUM FLOW REQUIREMENT, CFS [3]		3000.0	4128.0	4200.0	4200.0		
MIN. MAY 1 - JUL 31 OUTFLOW, KSFD		321.0	494.1	505.2	505.2		
MIN. APR 30 RESERVOIR CONTENT, KSFD [5]		829.6	894.8	1105.4	1069.0		
MIN. APR 30 RESERVOIR ELEVATION, FT [6]		2367.0	2371.9	2386.7	2384.1		
APR 30 ECC, FT [7]		2367.0	2371.9	2386.7	2384.1		
BASE ECC, FT	2403.0						
LOWER LIMIT, FT	2287.0						
ASSUMED JUN 1 - JUL 31 INFLOW, % OF VOLUME		56.9	57.5	59.1	61.2	67.1	
ASSUMED JUN 1 - JUL 31 INFLOW, KSFD [4]		1286.3	1331.8	1205.9	1228.7	1163.5	
JUN MINIMUM FLOW REQUIREMENT, CFS [3]		3000.0	4128.0	4200.0	4200.0	4200.0	
MIN. JUN 1 - JUL 31 OUTFLOW, KSFD		183.0	304.3	312.0	312.0	312.0	
MIN. MAY 31 RESERVOIR CONTENT, KSFD [5]		1407.2	1482.9	1616.6	1593.8	1659.0	
MIN. MAY 31 RESERVOIR ELEVATION, FT [6]		2405.4	2410.0	2417.1	2415.8	2419.3	
MAY 31 ECC, FT [7]		2405.4	2410.0	2417.1	2415.8	2419.3	
BASE ECC, FT	2427.0						
LOWER LIMIT, FT	2287.0						
ASSUMED JUL 1 - JUL 31 INFLOW, % OF VOLUME		19.4	20.0	20.5	21.3	23.3	34.7
ASSUMED JUL 1 - JUL 31 INFLOW, KSFD [4]		439.1	462.8	418.9	426.9	404.2	244.0
JUN MINIMUM FLOW REQUIREMENT, CFS [3]		3000.0	5820.0	6000.0	6000.0	6000.0	6000.0
MIN. JUL 1 - JUL 31 OUTFLOW, KSFD		93.0	180.4	186.0	186.0	186.0	186.0
MIN. JUN 30 RESERVOIR CONTENT, KSFD [5]		2164.4	2228.1	2277.6	2269.6	2292.3	2452.5
MIN. JUN 30 RESERVOIR ELEVATION, FT [6]		2443.4	2446.4	2448.8	2448.4	2449.5	2456.5
JUN 30 ECC, FT [7]		2443.4	2446.4	2448.8	2448.4	2449.5	2452.5
BASE ECC, FT	2452.5						
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]		93.3	80.6	78.2	78.9	77.0	75.7

1 LINE 1 - LINE 2 LINE 3.
2 PRECEDING 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 (2510.5 KSFD) PLUS 4, AND MINUS 2.
6 ELEVATION FROM 5, STORAGE CONTENT TABLE, DATED JUNE 1980.
7 ELEVATION FROM 6, BUT LIMITED BASE ECC, AND ECC LOWER LIMT.
8 USED TO CALCULATE THE POWER DISCHARGE REQUIREMENTS FOR 3

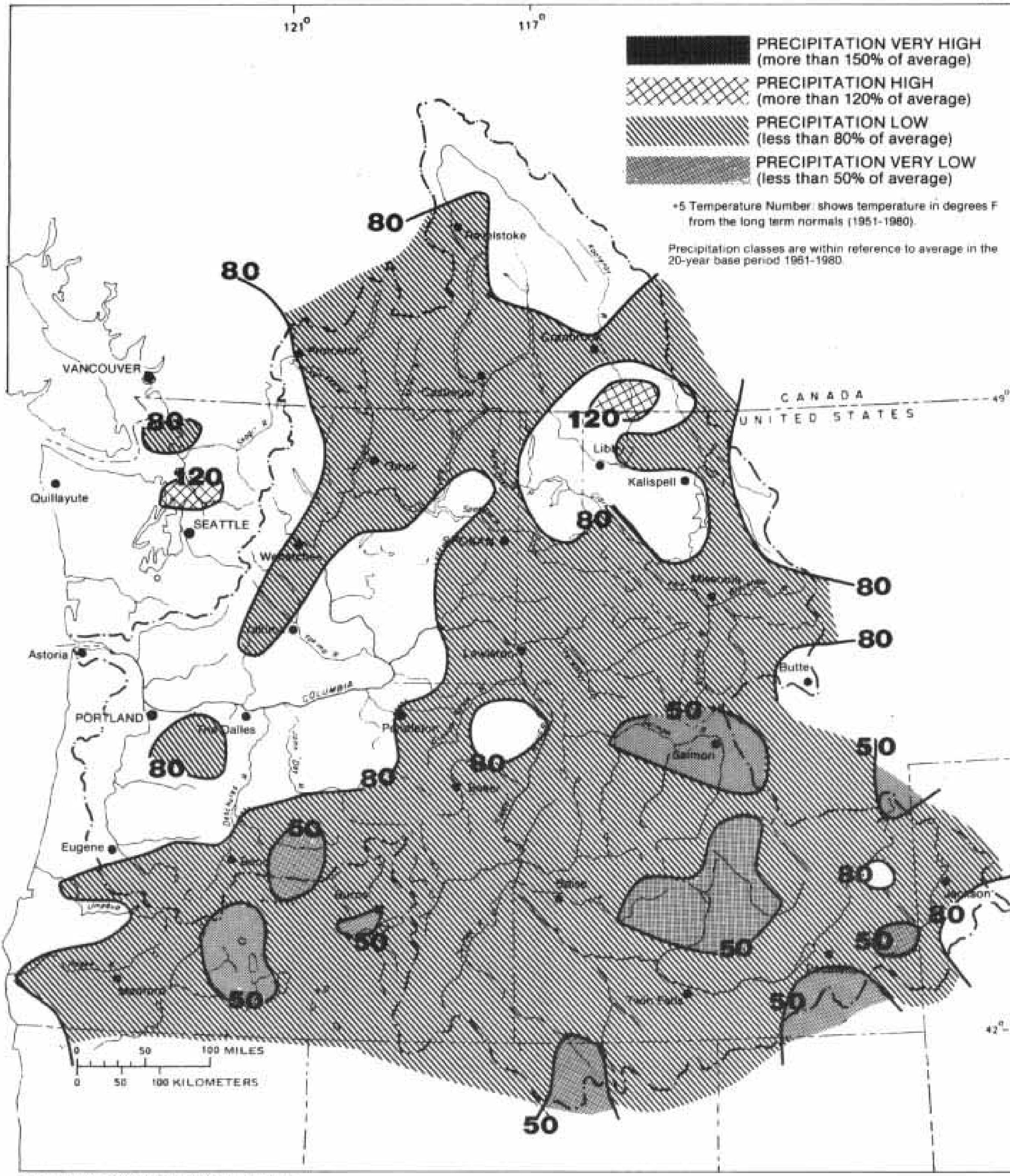
Table 6

Computation of Initial Controlled Flow Columbia River at The Dalles 1 May 1987

1 May Forecast of May-August Unregulated Runoff Volume, MAF		54.0
Less Estimated Depletions, MAF		1.5
Less Upstream Storage Corrections, MAF		
MICA	5.8	
ARROW	3.2	
LIBBY	3.5	
DUNCAN	1.0	
HUNGRY HORSE	.8	
FLATHEAD LAKE	.5	
NOXON	.0	
PEND OREILLE LAKE	.5	
GRAND COULEE	.8	
BROWNLEE	.0	
DWORSHAK	.2	
JOHN DAY	.1	
TOTAL	17.9	17.9
Forecast of Adjusted Residual Runoff Volume, MAF		36.1
Computed Initial Controlled flow from Chart 1 of Flood Control Operating Plan, 1,000 cfs		210.0

Chart 1

Seasonal Precipitation Columbia River Basin October 1986 - March 1987 Percent of 1961-1985 Average



Prepared by: NOAA, National Weather Service
Northwest River Forecast Center
Portland, Oregon

Chart 2
Columbia Basin Snowpack

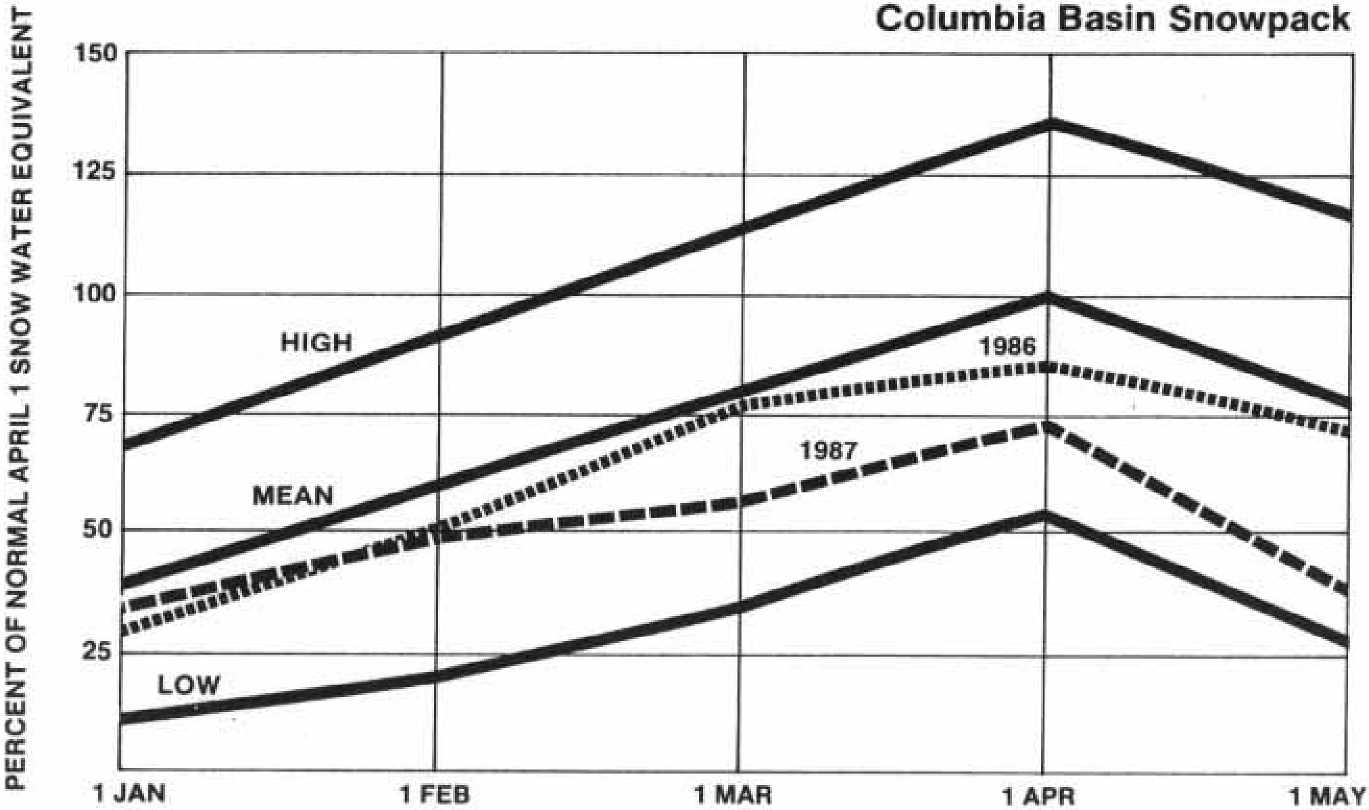


Chart 3
Winter Season
Temperature and Precipitation Index 1986 - 1987
Columbia River Basin Above The Dalles

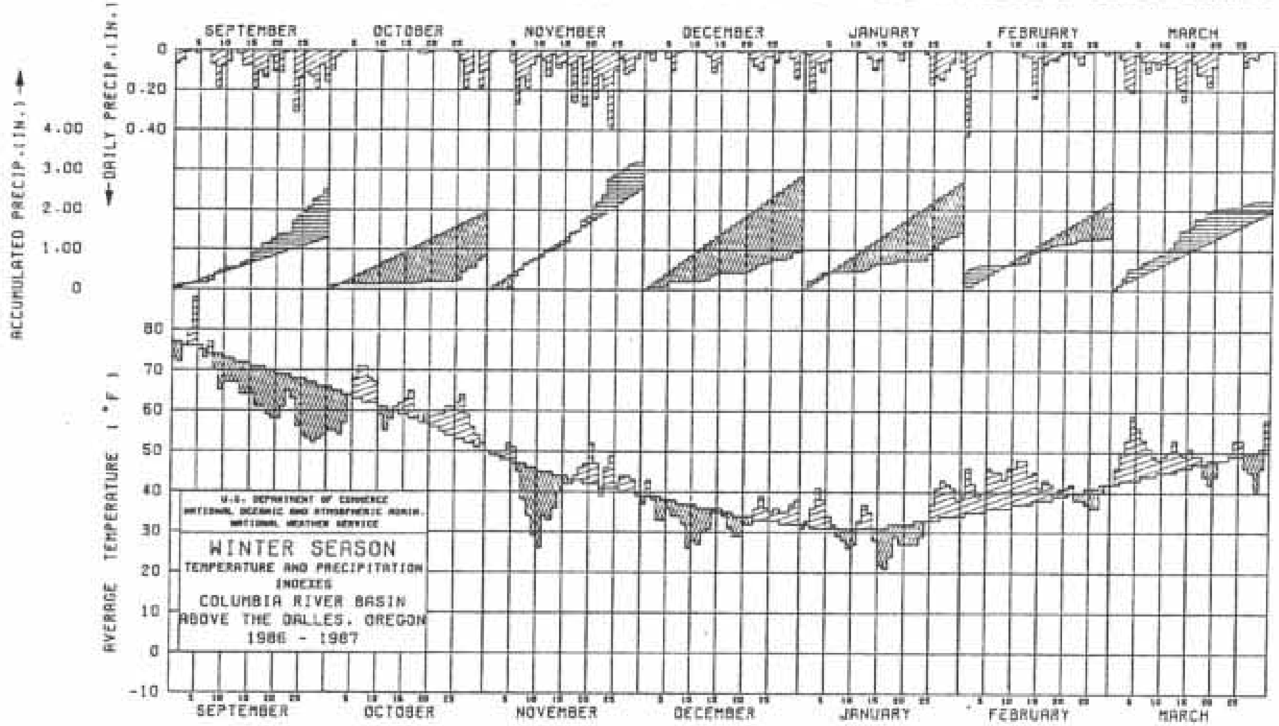


Chart 4

Snowmelt Season
Temperature and Precipitation Index 1986 - 1987
Columbia River Basin above The Dalles

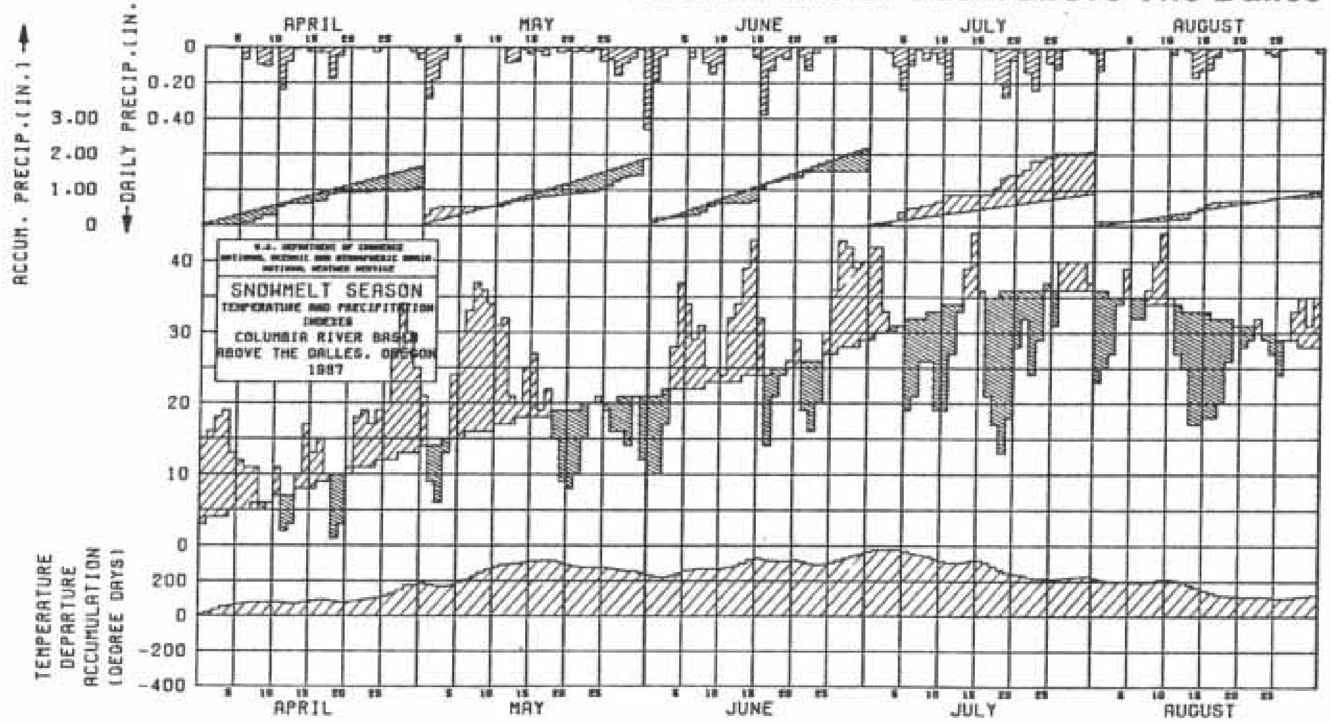


Chart 5

Snowmelt Season
Temperature and Precipitation Index 1986 - 1987
Columbia River Basin in Canada

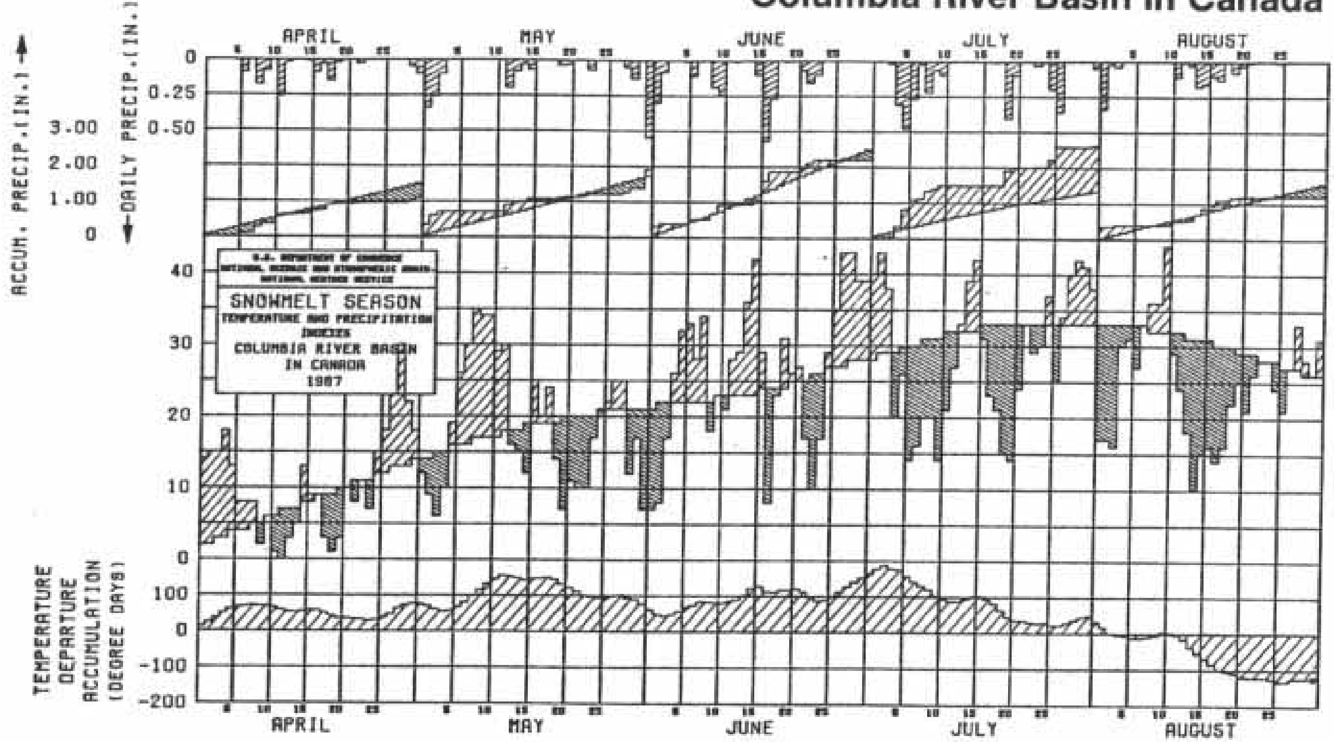


Chart 6

Regulation of Mica
1 July 1986 - 31 July 1987

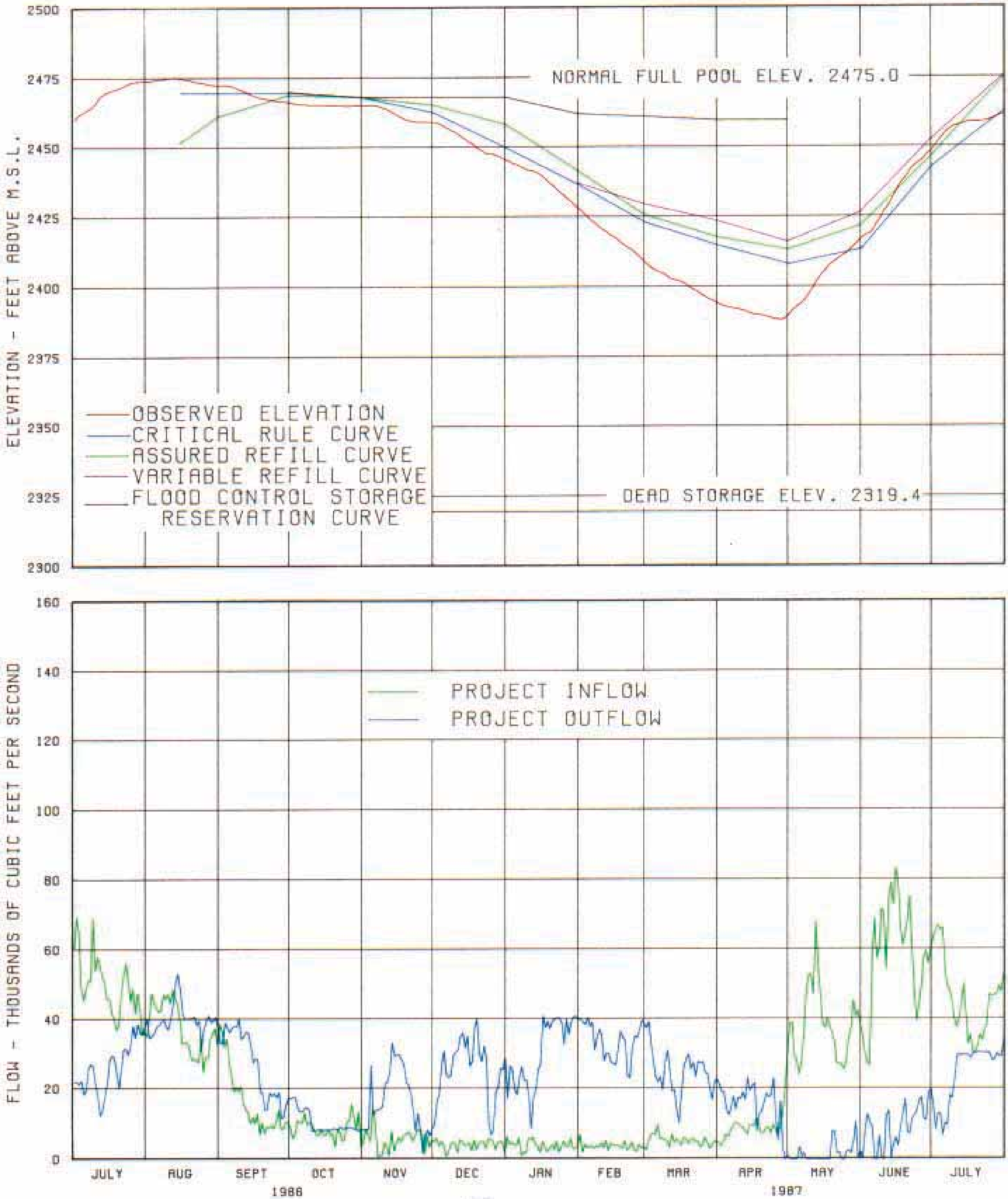


Chart 7

Regulation of Arrow
1 July 1986 - 31 July 1987

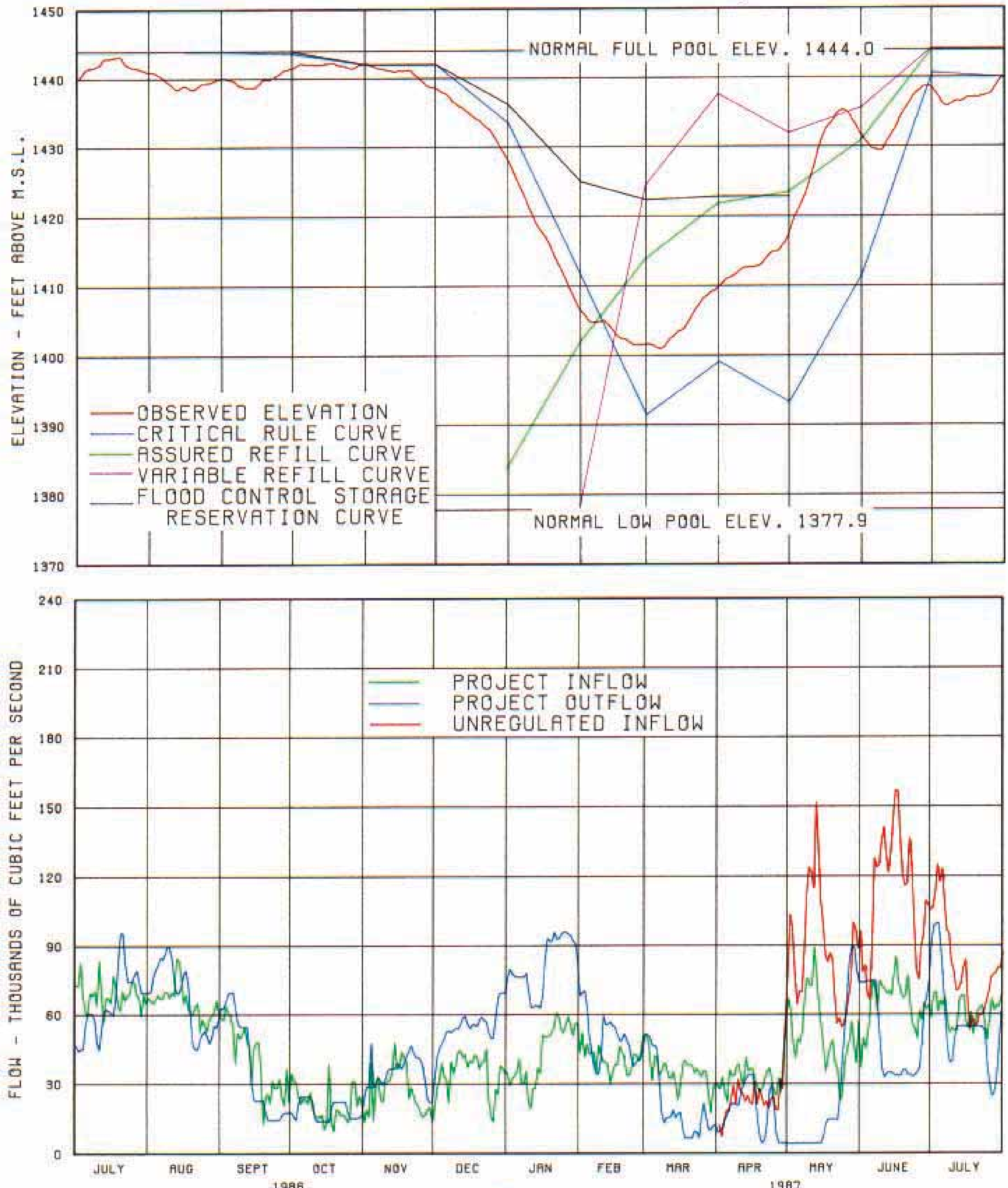
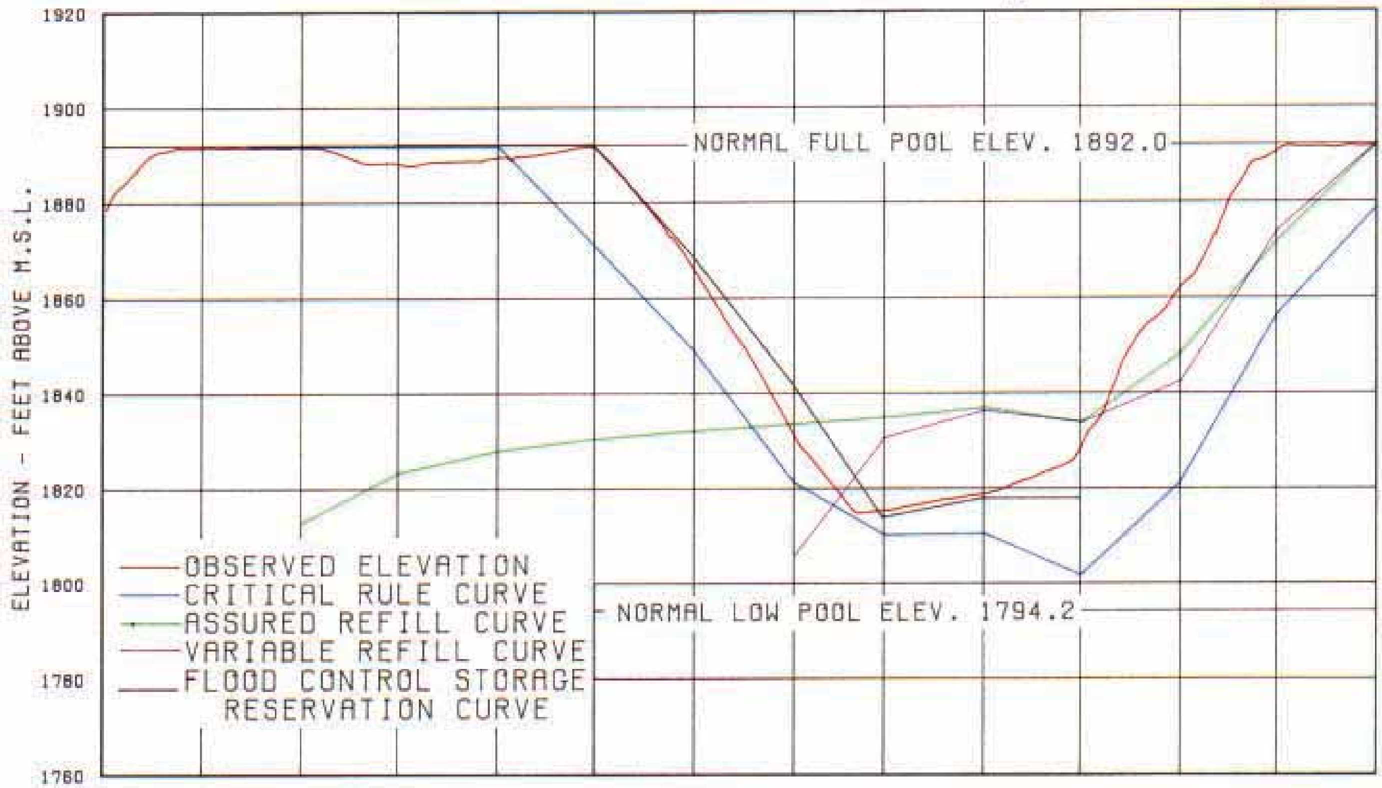


Chart 8

Regulation of Duncan
1 July 1986 - 31 July 1987



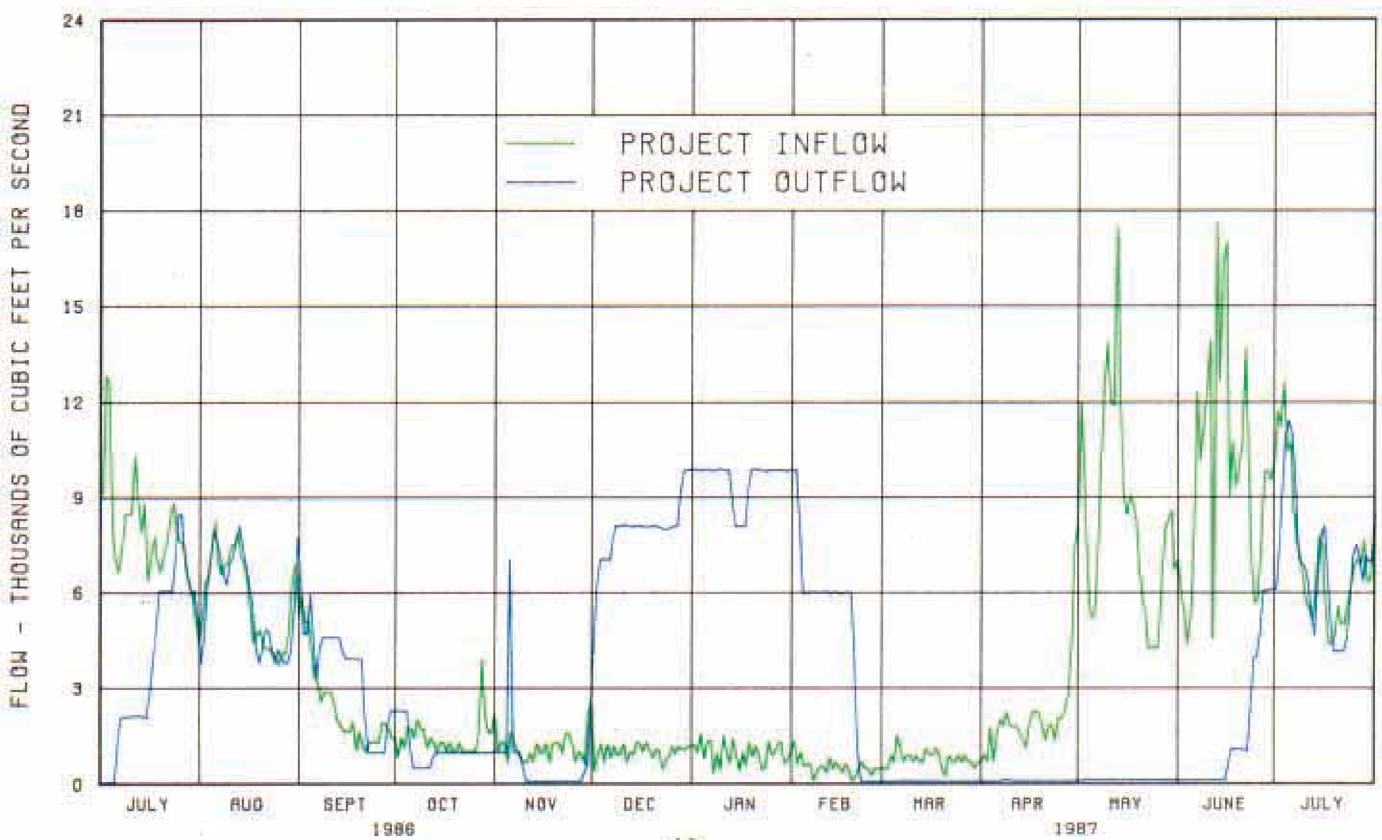


Chart 9

Regulation of Libby
1 July 1986 - 31 July 1987

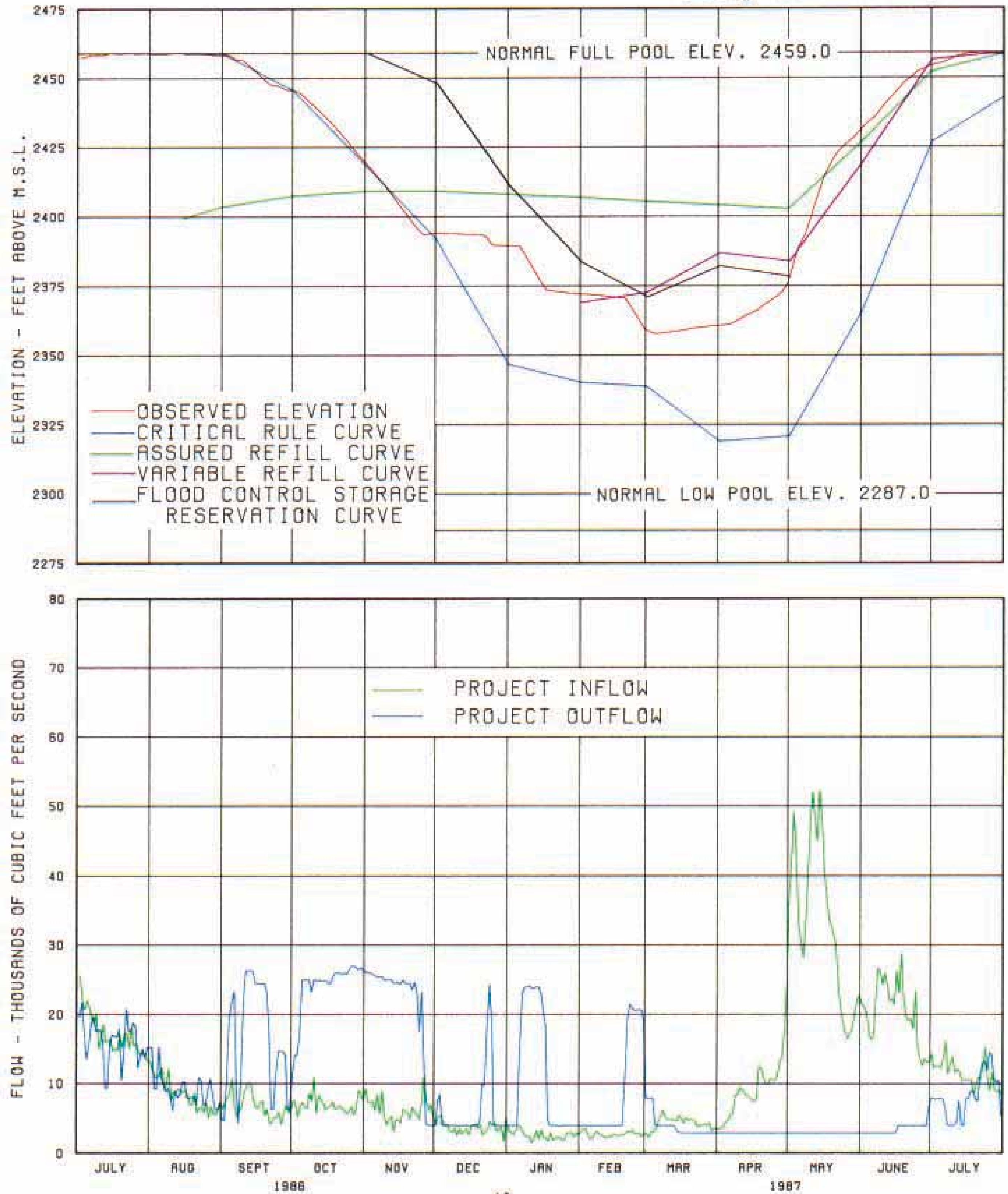


Chart 10

Regulation of Kootenay Lake
1 July 1986 - 31 July 1987

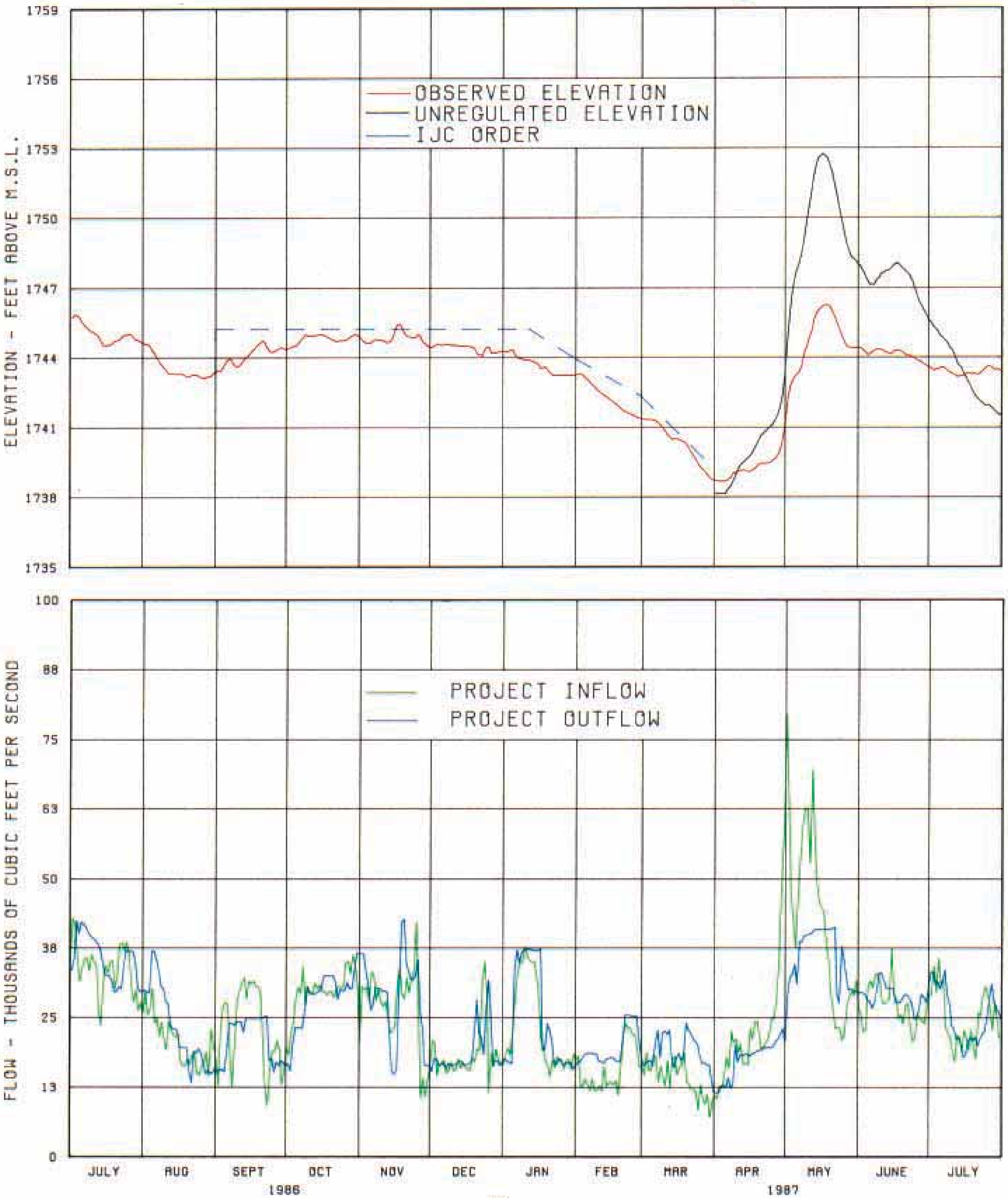


Chart 11

Columbia River at Birchbank
1 July 1986 - 31 July 1987

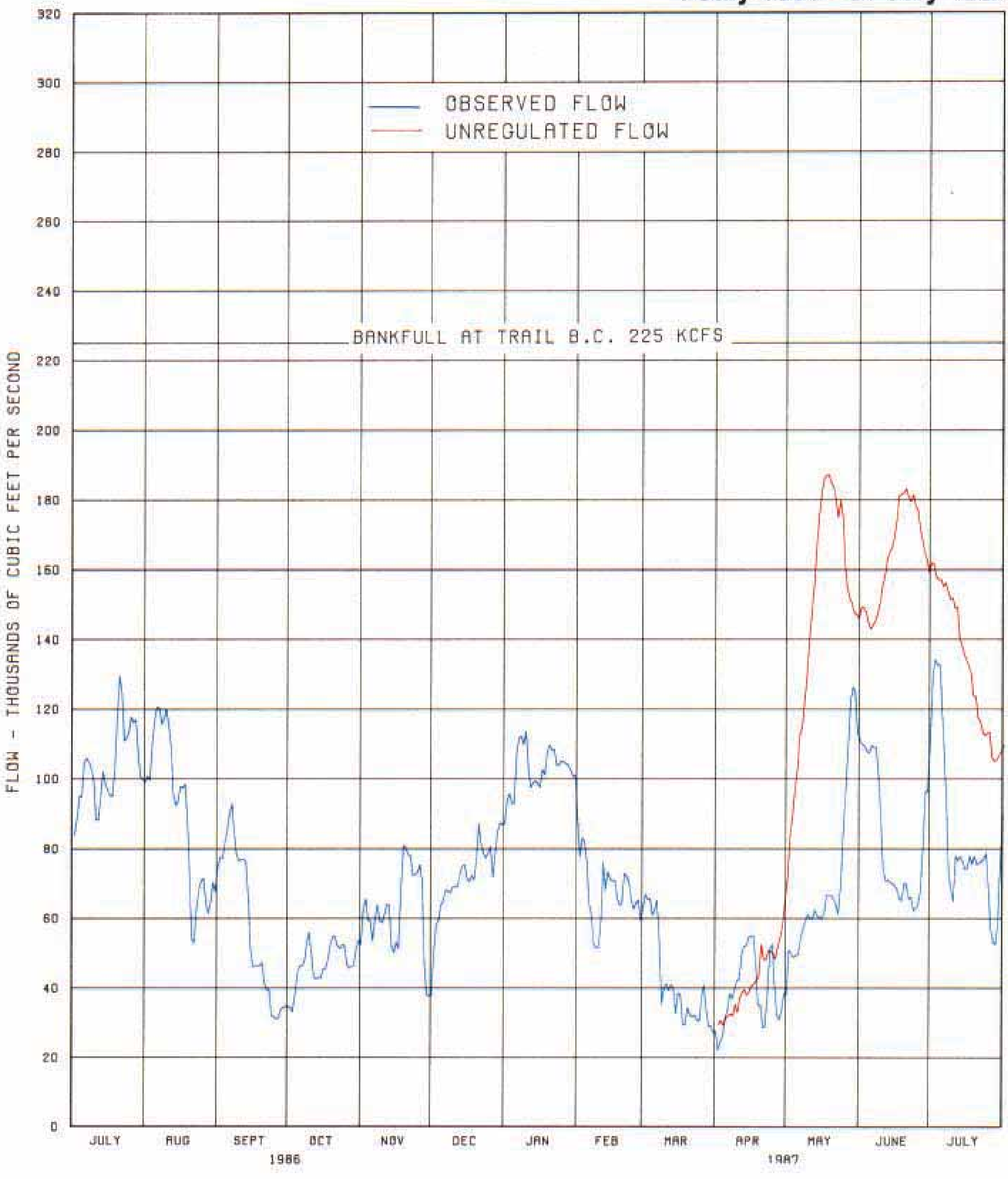


Chart 12

Regulation of Grand Coulee
1 July 1986 - 31 July 1987

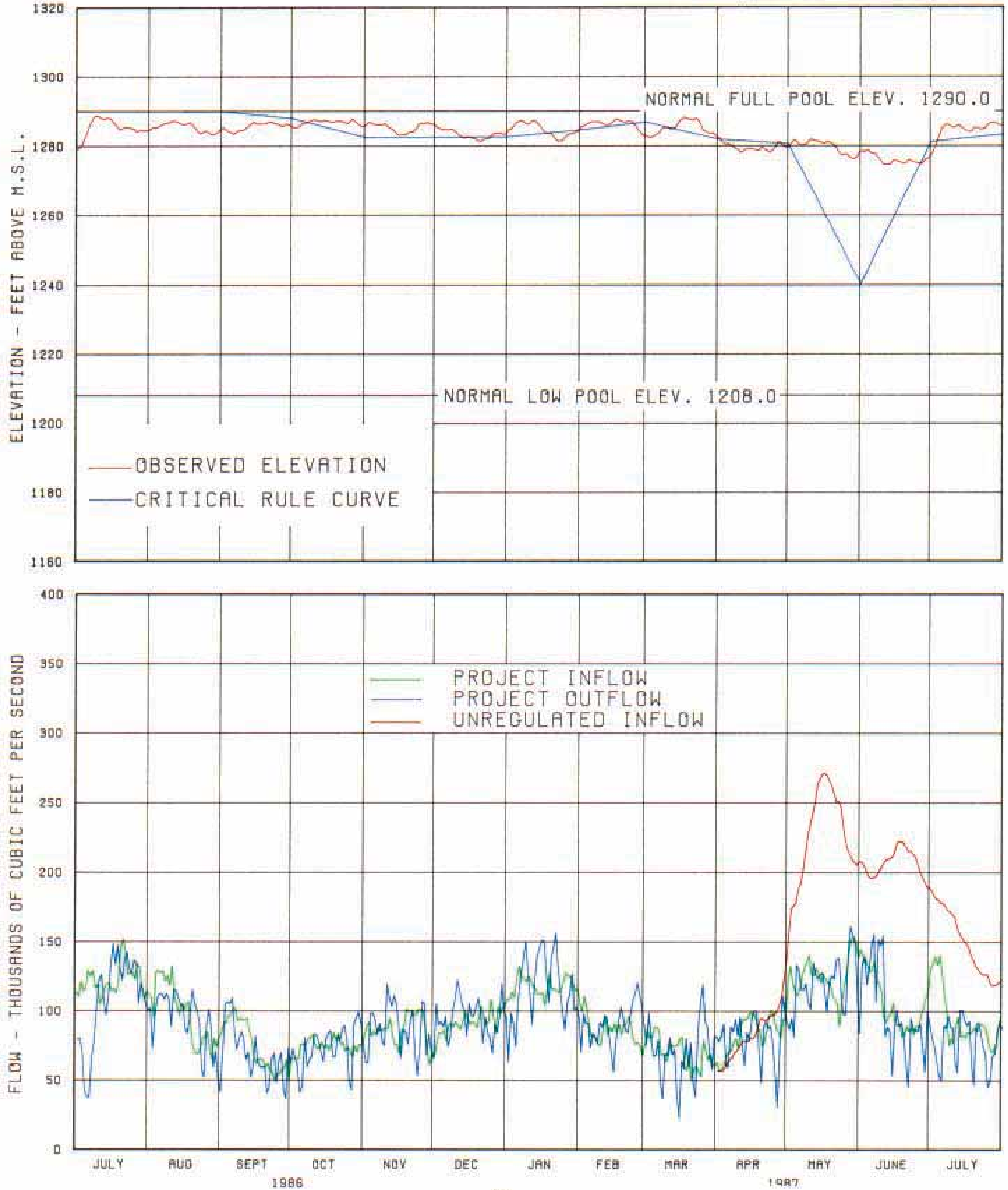


Chart 14

Columbia River at The Dalles
1 April 1986 - 31 April 1987

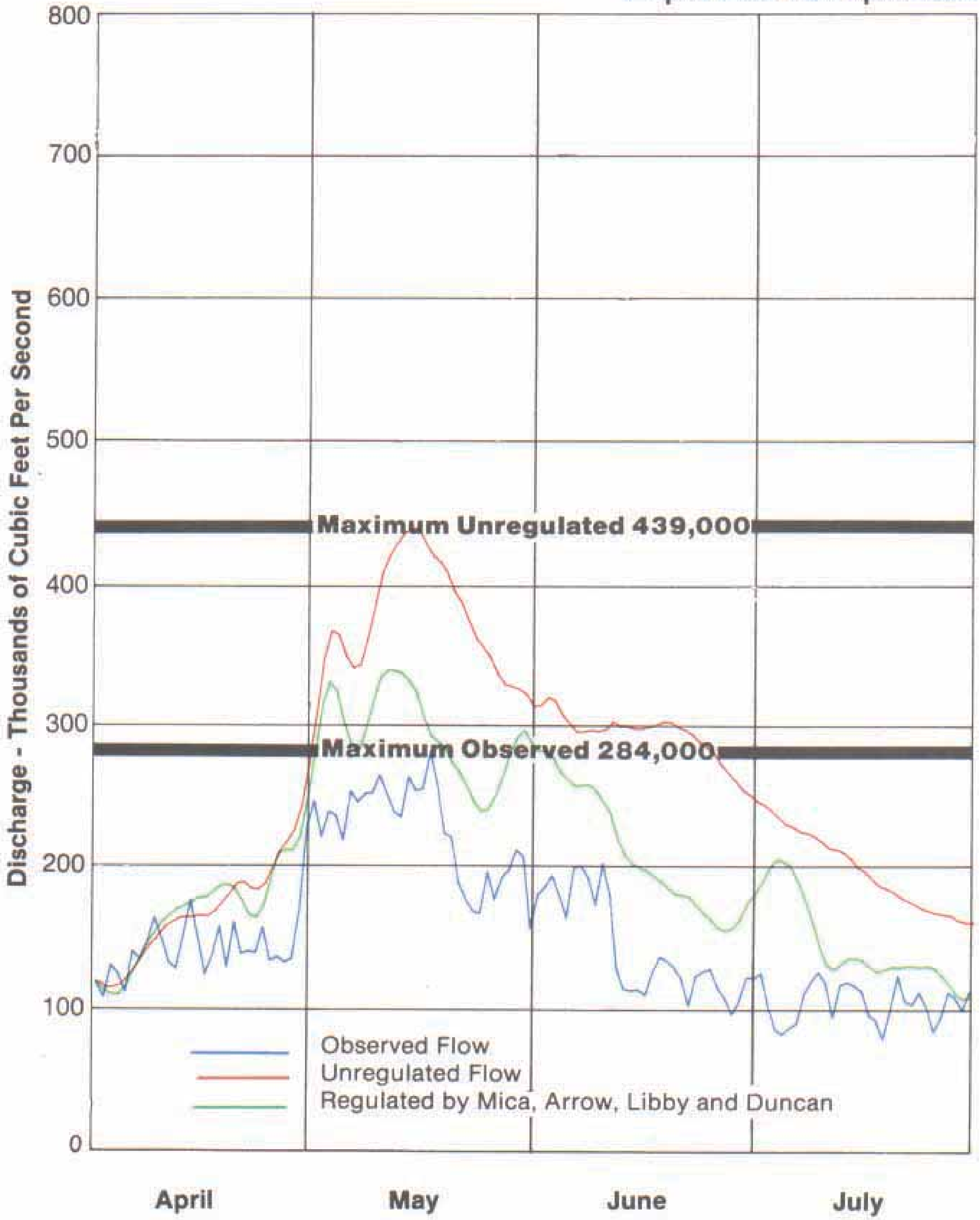


Chart 13

Columbia River at The Dalles
1 July 1986 - 31 July 1987

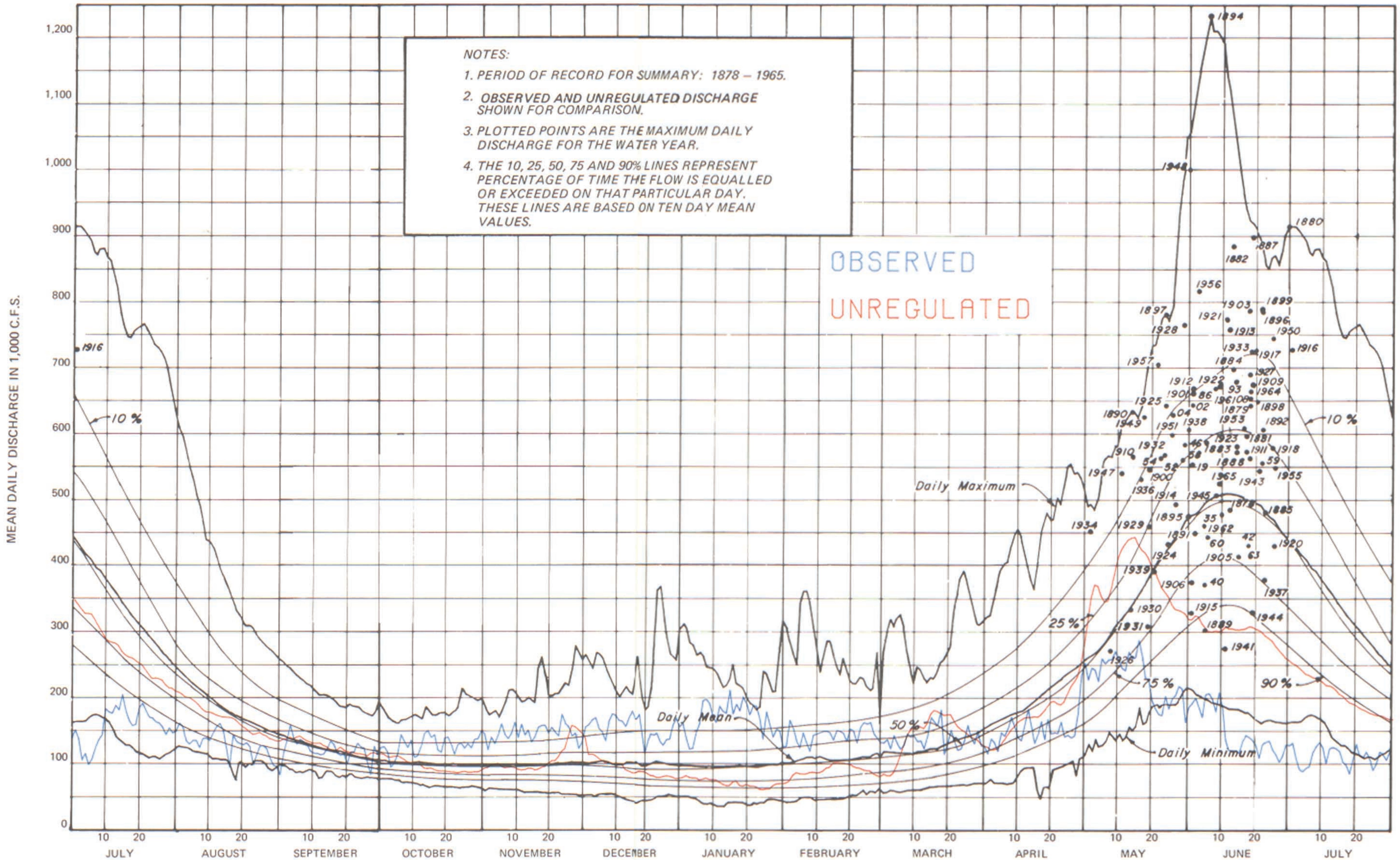


Chart 15

1987 Relative Filling Arrow and Grand Coulee