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**INTERNATIONAL OSOYOOS LAKE BOARD OF CONTROL**  
**Annual Report**  
**for**  
**CALENDAR YEAR 2000**

The International Osoyoos Lake Board of Control was established on February 12, 1986, by the International Joint Commission to carry out the provisions of the Commission's Order of Approval dated December 9, 1982, and the Supplementary Order of Approval dated October 17, 1985.

**1) ACTIVITIES OF THE BOARD**

On April 11, 2000, the Board advised Mr. Keith Phillips of the Washington State Department of Ecology (WADOE) by letter that current forecasts indicated drought conditions would not be met this year. The Northwest River Forecast Center's April to July volume forecast was for 1.14 million acre feet of runoff for the Similkameen River. The Canadian River Forecast Centre's forecast for the Okanagan River and for Okanagan Lake levels also indicated that drought conditions would not be met. Because of lower than anticipated inflow in the Okanagan River, the WADOE was unable to obtain a minimum lake level of 911.0 feet by April 1 as required by the Orders. A minimum lake level of 911.0 feet was not obtained until April 8. The difficulty in increasing lake levels to 911.0 feet by April 1 was compounded by WADOE's requirement to maintain at least 100 cubic feet per second outflow through Zosel Dam for fish.

The Board met with representatives of the IJC on July 11, 2000, in Vancouver, British Columbia. In that meeting, the IJC noted that in accordance with Condition 4 of the 1985 Order, the present IJC Orders on Osoyoos Lake will terminate on July 31, 2012, unless renewed. The IJC directed the Board to begin planning for Order renewal. The Board received a letter from the IJC dated October 13, 2000, requesting that the Board develop a list of components of a work plan that would lead to consideration of renewal of the Orders.

A formal meeting of the Board was held on September 26, 2000, in Oroville, Washington. A public meeting followed the meeting of the Board on the same date.

## 2) OPERATION AND MAINTENANCE OF ZOSEL DAM

### a. Osoyoos Lake Elevations

The authorized range of normal operating elevations, 909.0 to 911.5 feet, is shown by the blue area in appendix I. The gray area in appendix I shows the authorized range of elevations, 910.5 to 913.0 feet, that may be used to manage storage from April 1 to October 31 if drought conditions are declared by the Board in accordance with conditions 7 and 8.

Condition 9 of the Orders of Approval recognizes that backwater from high flow in the Similkameen River and (or) excessive flow in the Okanogan River can cause Osoyoos Lake levels to rise above the authorized range.

The level of Osoyoos Lake was within the levels authorized in the Order of Approval all year, except as previously noted for the first week of April, and with the exception of one instantaneous value recorded above 911.50 ft, at 911.51 feet on September 8.

The maximum instantaneous elevation on Osoyoos Lake occurred on September 8 at 911.51 feet.

The maximum daily mean elevation occurred on August 5 at 911.45 ft.

The maximum instantaneous discharge of the Okanogan River at Oroville occurred on May 11 and was 2,160 cubic feet per second.

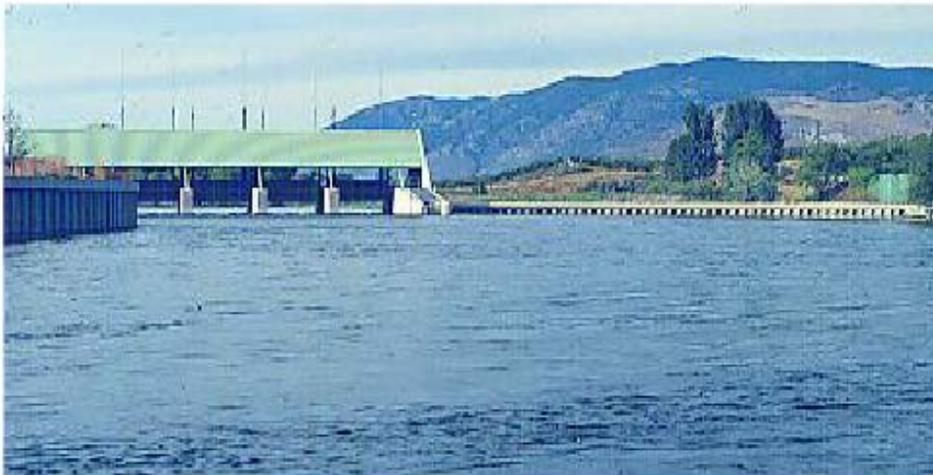
Recorded lake elevations for water years 1998-2000 are shown in appendix I.

Data on Osoyoos Lake levels and relevant river flows are summarized in appendix II and depicted in the hydrographs in appendix III.

To increase public understanding of the hydraulic relationships affecting the levels of Osoyoos Lake, an explanatory page was added to the Board's web site. This is attached as appendix IV.

**b. Zosel Dam**

The Oroville-Tonasket Irrigation District operated Zosel Dam under authority from the State of Washington, Department of Ecology.



**Zosel Dam Outlet – looking north**

**3) IMPROVEMENTS TO THE OKANOGAN RIVER CHANNEL**

Condition 4 of the IJC Order of Approval (December 9, 1982), and subsequently revised by the Supplementary Order of Approval (October 17, 1985), calls for the applicant (State of Washington Department of Ecology) to "...take all measures to ensure that the flow capacity of the Okanogan River, upstream and downstream from the control structure, enables the control structure to pass at least 2,500 cubic feet per second when the elevation of Osoyoos Lake is 913.0 feet USCGS and there is no appreciable backwater effect from the Similkameen River."

The Board obtained confirmation from the State of Washington regarding the capacities of the Okanogan River Channel. Hydrologic conditions in 1997, 1998, and 1999 demonstrated that water is able to be moved out of the lake, through the outlet channel, and past the dam at a rate

greater than 2,500 cubic feet per second with the lake at an elevation less than 913.0 feet and no appreciable backwater effect from the Similkameen River.

Tonasket Creek enters a bypass reach of the outlet channel that was designed to accept the creek's sediment load deposits. The Tonasket Creek alluvial fan has not impaired the capacity of the main outlet channel to perform according to requirements of Condition 4.



**Mouth of Tonasket Creek – looking south to Zosel Dam**

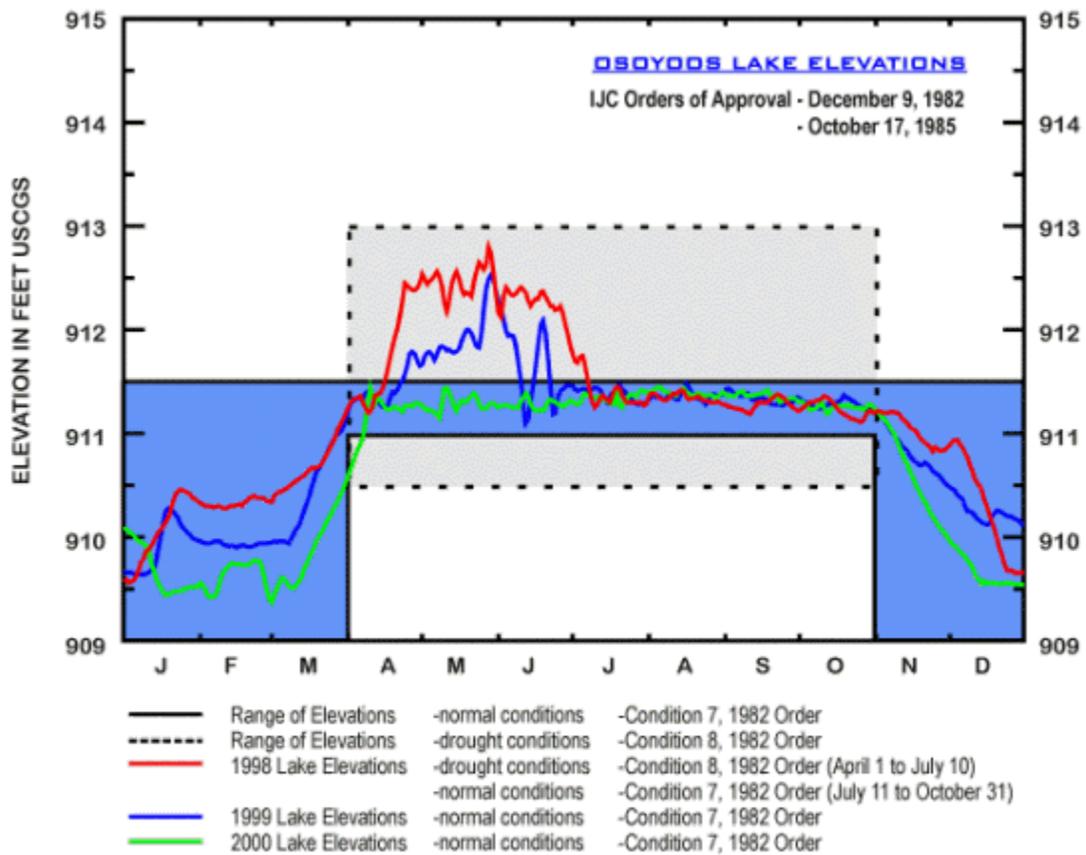
#### **4) PUBLIC MEETING COMMENTS**

A public meeting was held in Oroville, WA., on September 26, 2000. Presentations were made on Osoyoos Lake, Zosel Dam and the Orders of Approval, 2000 hydrologic conditions, and Zosel Dam operations. Attendance was 22, of which 10 were from the general public.



**Ray Smith, Chief, Spokane Field Office, USGS, at Okanogan River near Oroville gaging station.**

# APPENDIX I



## APPENDIX II.-- OSOYOOS LAKE LEVELS, INFLOWS, AND OUTFLOWS

A. International gaging stations in operation throughout the year:

(1) For Stage Records

Osoyoos Lake near Oroville, Washington  
Okanogan River at Oroville, Washington (auxiliary gage)

(2) For Discharge Records

Okanogan River near Oliver, British Columbia  
Okanogan River near Oroville, Washington (base gage)  
Similkameen River near Nighthawk, Washington

(3) Reports

Monthly summary reports of stage and discharge data were forwarded to the International Joint Commission and to the Board of Control members.

B. Compliance with the lake levels specified in the Orders of Approval is measured at the station "Osoyoos Lake near Oroville," where elevations are expressed in terms of USCGS datum.

C. Osoyoos Lake

Maximum daily mean elevation	277.810 meters – August 5 (911.45 feet)
Maximum instantaneous elevation	277.828 meters - September 8 (911.51 feet)
Minimum instantaneous elevation	277.167 meters - March 1 (909.34 feet)
Lake elevation at time of peak flow for Okanogan River at Oroville	277.807 meters – May 11 (911.44 feet)

D. Okanogan River at Oroville

Maximum instantaneous discharge	61.2 cms - May 11 (2,160 cfs)
Maximum daily mean discharge	59.7 cms - May 12 (2,110cfs)
Annual mean discharge	20.4 cms (722 cfs)

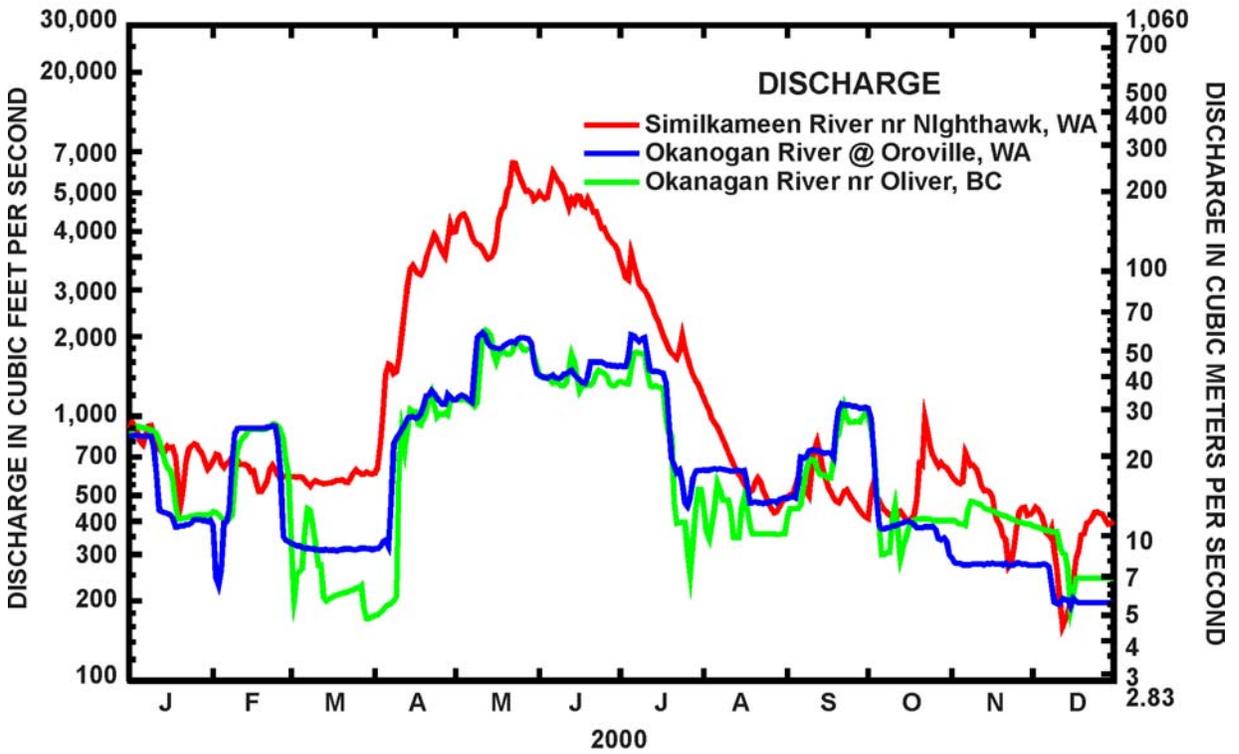
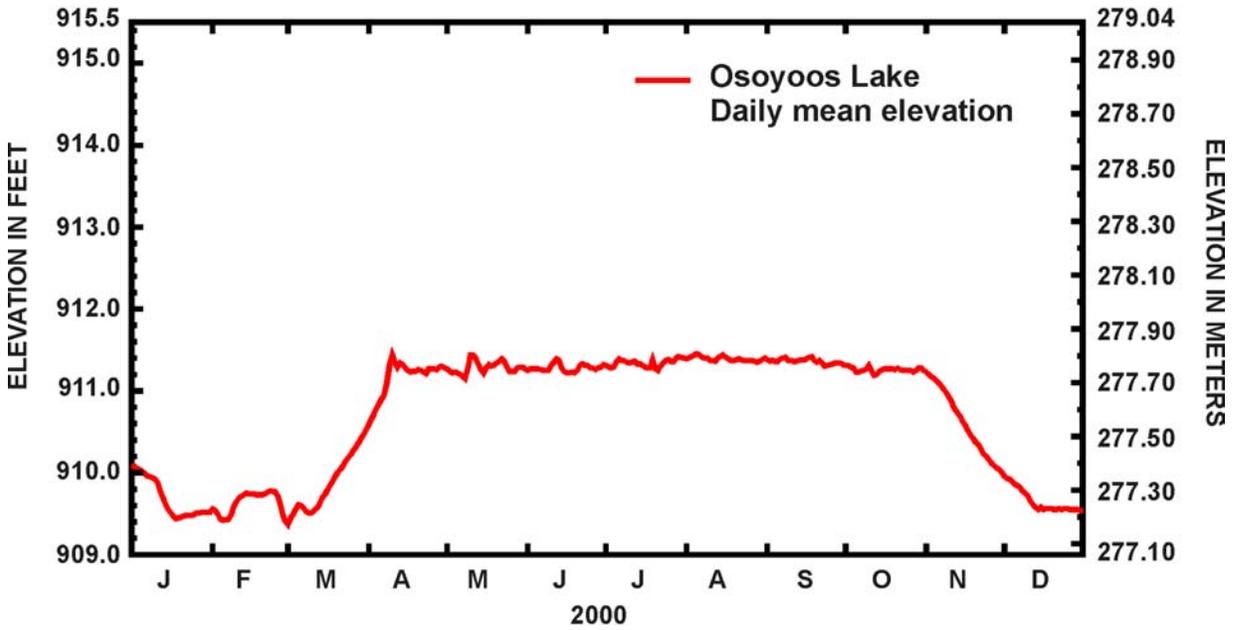
The annual mean discharge was 103 percent of the 58-year average of 704 cfs.

E. Similkameen River near Nighthawk

Maximum instantaneous discharge	282 cms – May 22 (9,960 cfs)
Maximum daily mean discharge	257 cms – May 22 (9,080 cfs)

High river discharges and stages created backwater conditions for the Okanogan River at Oroville gaging station from May 17 to June 21.

APPENDIX III



## **APPENDIX IV**

### **Natural Factors Affecting the Level of Osoyoos Lake**

#### **Background**

Osoyoos Lake is operated under conditions prescribed by the International Joint Commission (IJC) and Figure 1 shows the ranges within which Osoyoos Lake should operate. In normal summers, Osoyoos Lake is maintained between elevations 911 and 911.5 whenever possible. When drought conditions are deemed to have occurred, through regulation of the outflow through Zosel Dam, Osoyoos Lake can be deliberately raised to elevation 913 ft. In non-drought years, however, due to natural flows during the spring and early summer, levels in excess of the normal upper limit of 911.5 feet may occur. This document explains the circumstances that can cause this.

In a natural lake (i.e. one with no artificial controls such as a dam at its outlet), the level of the lake is generally controlled by the inflow and the geometry of the outlet. The lake level determines the outflow. In a natural system, a lake will always adjust its level in an attempt to balance inflow and outflow. When the inflow exceeds the outflow, the level of the lake will rise to provide the additional energy, or head, necessary to increase the outflow. Conversely, if the inflow is less than the outflow, the lake level will drop and outflow will decrease. If inflow remains constant, the lake will find the level required to produce outflow equal to inflow.

When there is a dam at the lake outlet, such as Zosel Dam for Osoyoos Lake, outflow can be controlled by opening or closing gates in the dam. Obviously, if it is controlled such that outflow is less than inflow, the lake will rise, and vice-versa.

In the case of Osoyoos Lake there is another complication. The Similkameen River, with a mean annual flow 3.5 times greater than that of the Okanogan River, joins the Okanogan just below Zosel Dam. Because the land at the confluence is flat, high water levels in the Similkameen River effectively impede or block the flow out of the Okanogan River and Osoyoos Lake. With extreme high water in the Similkameen River, flow in the Okanogan River may reverse and flow upstream into Osoyoos Lake. This is a natural phenomenon that would occur whether there was a dam at the outlet of Osoyoos Lake or not.

## **Control of Osoyoos Lake Levels during non-drought years**

The following is a summary of the various conditions that can occur in Osoyoos Lake during the period April through October in a year in which runoff is average or greater.

### **1. Normal inflow to the lake, normal flow in the Similkameen River**

*Osoyoos Lake inflows less than 2,000 cubic feet per second (  $\text{ft}^3/\text{s}$ ) (57  $\text{m}^3/\text{s}$ ), and Similkameen River flow less than 10,000  $\text{ft}^3/\text{s}$  (283  $\text{m}^3/\text{s}$ ).*

Under these conditions there is no outflow restriction downstream from Zosel Dam due to the Similkameen River and the gates are operated to maintain the level of Osoyoos Lake between 911.0 and 911.5 feet as required by the IJC. There is relatively little difference between the water level at the lake and at the dam (Figure 2).

### **2. High inflow to the lake, normal flow in the Similkameen River**

*Osoyoos Lake inflows greater than 2,000 cfs (57  $\text{m}^3/\text{s}$ ), and Similkameen River flow less than 10,000  $\text{ft}^3/\text{s}$  (283  $\text{m}^3/\text{s}$ ).*

Although there is no restriction downstream from Zosel Dam from the Similkameen River, high inflow may cause the level of Osoyoos Lake to exceed 911.5 feet. Under the terms of the IJC Order of Approval, the gates at Zosel Dam are to be fully opened whenever the level of Osoyoos Lake exceeds 911.5 feet, unless a drought has been declared. During high inflows, the level of Osoyoos Lake will rise to provide enough head to force water out of the lake. For example, at an inflow of about 3,000  $\text{ft}^3/\text{s}$  (85  $\text{m}^3/\text{s}$ ), the lake would have to rise to about 913 feet for the outflow to balance the inflow. Inflows are unlikely to exceed 3,700  $\text{ft}^3/\text{s}$  (105  $\text{m}^3/\text{s}$ ) which would be associated with a lake level of about 913.5 feet (Figure 3). However, it should be noted that lake levels greater than 913 feet are likely to occur more frequently due to the conditions outlined in the following paragraph.

### **3. Outflow Restricted by Similkameen River flows**

*Flows in the Similkameen greater than 10,000  $\text{ft}^3/\text{s}$  (283  $\text{m}^3/\text{s}$ ).*

The Similkameen River is a natural river with no controls. Its peak flows can be more than ten times as great as those in the Okanogan River leaving Zosel Dam.

The relationship is complex, but, in general, when the flow of the Similkameen River as measured at Nighthawk exceeds about 10,000  $\text{ft}^3/\text{s}$  (283  $\text{m}^3/\text{s}$ ), the Similkameen River level becomes high enough to restrict outflow in the Okanogan River. The greater the flow in the Similkameen, the

greater is this blocking effect. (Figure 4). If the outflow is restricted to less than the Osoyoos Lake inflow, the lake level will rise. Under certain circumstances it is possible for the level of the Similkameen River to exceed the water levels at Zosel Dam with the result that the water in the Okanogan River flows upstream into the lake (Figure 5). This reverse flow only occurs relatively rarely, the last occurrence being in 1976.

### **What can be done?**

*High Osoyoos Lake levels (other than during a drought) are a natural phenomenon caused by hydrologic factors and the natural physical layout of the area. As a result, little can be done to reduce Osoyoos Lake levels when high flows occur. Two commonly suggested remedies are:*

#### **1. Reduce flows into Osoyoos Lake**

When high Similkameen River flows occur, every effort is made to reduce Okanogan River flows into Osoyoos Lake to reduce both the rate of rise and peak lake levels. However, flows greater than 10,000 ft<sup>3</sup>/s (283 m<sup>3</sup>/s) in the Similkameen can be continuous for several weeks in high runoff years - which also tend to be high runoff years in the Okanagan basin in Canada. This makes it impractical to cut flows in the Okanagan River for an extended period.

#### **2. Lower the level of Osoyoos Lake in anticipation of high flow in the Similkameen River**

Osoyoos Lake cannot ameliorate high flood levels because the storage volume available in the lake is very small compared with the total flow volume into the lake. At low Osoyoos Lake levels, the outflow capacity is also low. The lake level can rise by several inches per day if there is a large difference between inflow and outflow. Thus, any benefit of lowering the lake level in advance would be lost in only a few days once inflows increased and/or outflows were restricted. When there is a large difference between inflow and outflow, the lake would rise rapidly and there would be little or no difference in the peak level attained by the lake nor the duration of high lake levels. Consequently, attempts to hold Osoyoos Lake at a lower level in anticipation of high runoff are of little value.

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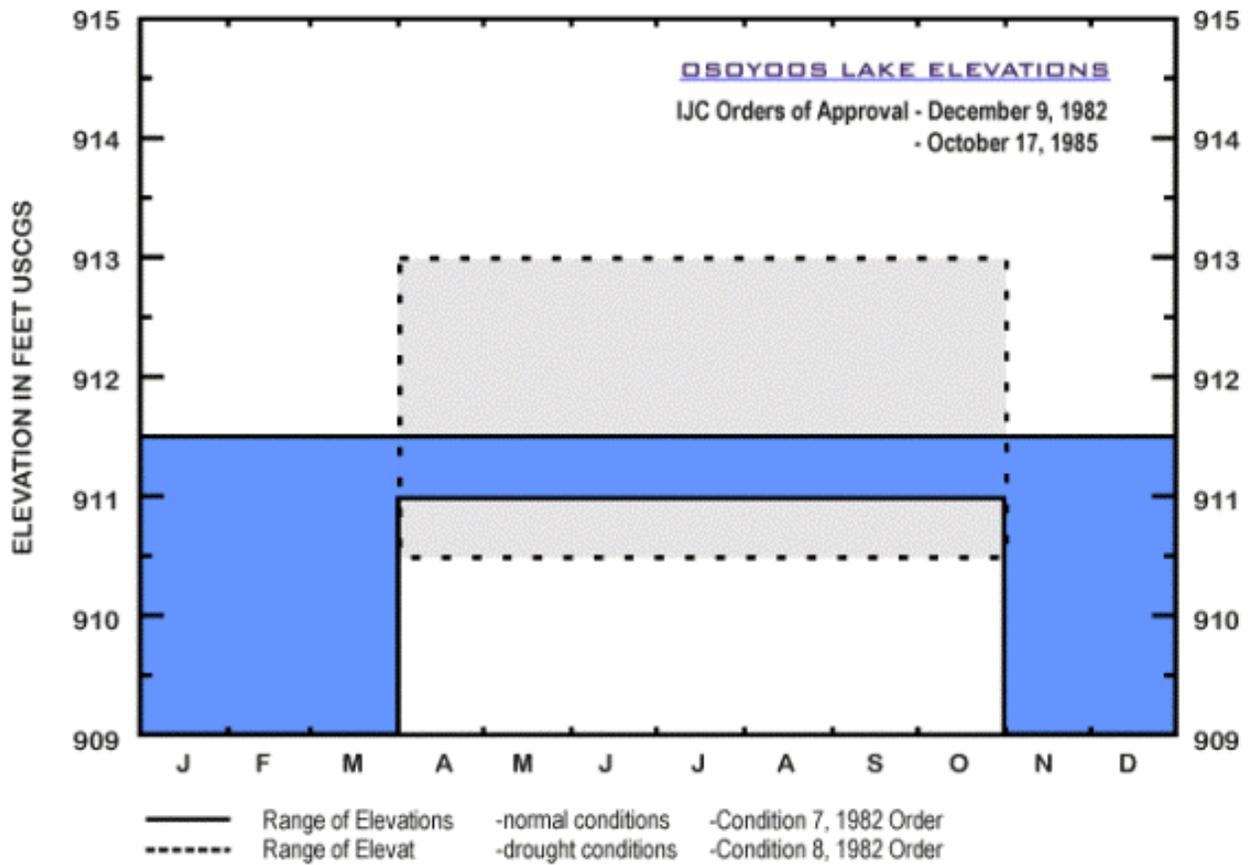
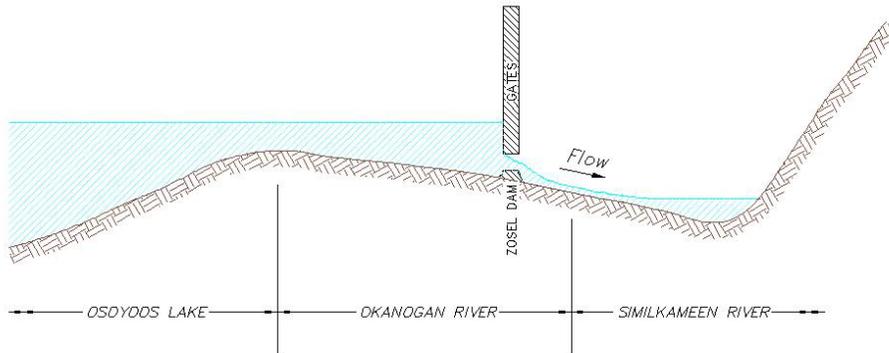


FIG. 1

### OSOYOOS LAKE / SIMILKAMEEN RIVER RELATIONSHIP

**NORMAL:**

OSOYOOS LAKE INFLOW LESS THAN 2000 cfs (57m<sup>3</sup>/s), approx.  
 SIMILKAMEEN RIVER FLOW LESS THAN 10,000 cfs (283m<sup>3</sup>/s), approx.



**NOTES:**

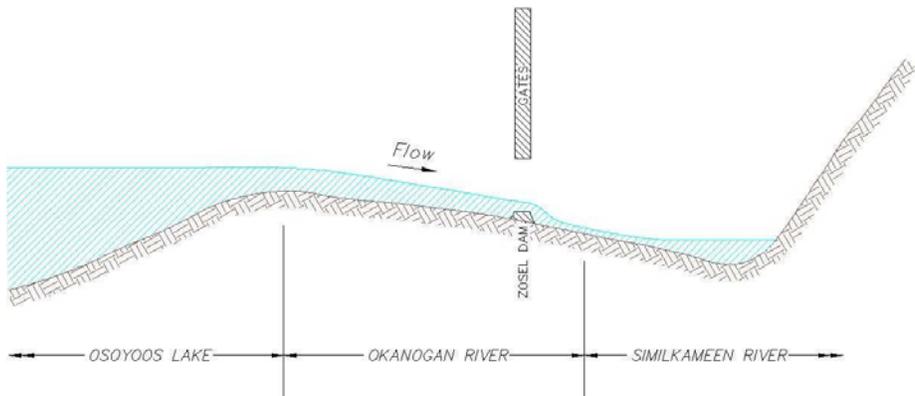
1. NOT TO SCALE, SCHEMATIC ONLY
2. ZOSEL DAM GATES ADJUSTED TO MAINTAIN OUTFLOW EQUAL TO INFLOW
3. OSOYOOS LAKE LEVEL NORMALLY BETWEEN 911.0 AND 911.5 FT. ELEVATION

FIG. 2

### OSOYOOS LAKE / SIMILKAMEEN RIVER RELATIONSHIP

**HIGH INFLOWS TO OSOYOOS LAKE:**

OSOYOOS LAKE INFLOW GREATER THAN 2000 cfs (57m<sup>3</sup>/s), approx.  
 SIMILKAMEEN RIVER FLOW LESS THAN 10,000 cfs (283m<sup>3</sup>/s), approx.



**NOTES:**

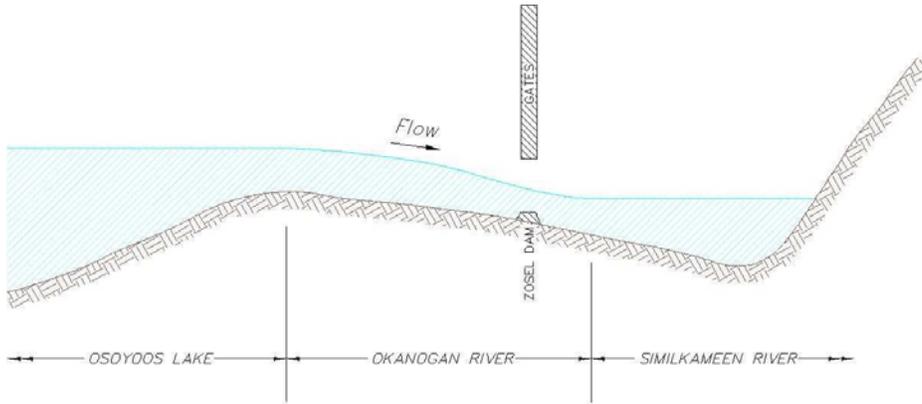
1. NOT TO SCALE, SCHEMATIC ONLY
2. ZOSEL DAM GATES LIFTED ABOVE WATER IF OSOYOOS LAKE ELEVATION ABOVE 911.5 FT.
3. OSOYOOS LAKE RISES UNTIL OUTFLOW EQUALS INFLOW
4. OUTFLOW DETERMINED BY OKANOGAN RIVER CHANNEL GEOMETRY

FIG. 3

### OSOYOOS LAKE / SIMILKAMEEN RIVER RELATIONSHIP

SIMILKAMEEN CAUSES BACKWATER:

OSOYOOS LAKE INFLOW – SEE NOTES  
 SIMILKAMEEN RIVER FLOW GREATER THAN 10,000 cfs (283m<sup>3</sup>/s), approx.



NOTES:

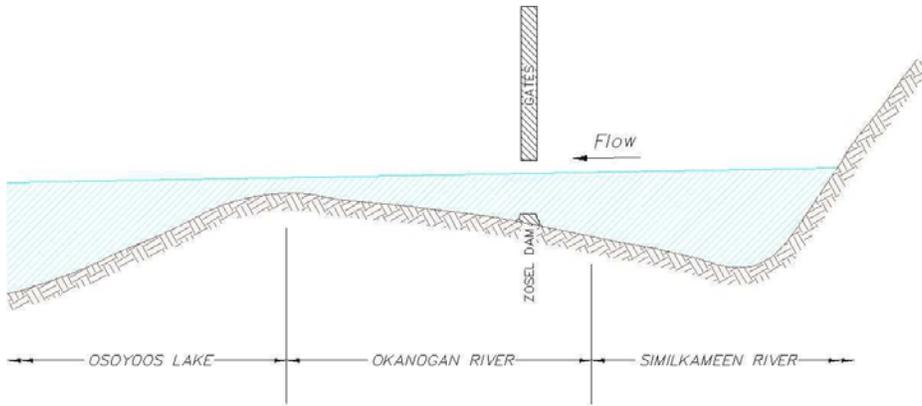
1. NOT TO SCALE, SCHEMATIC ONLY
2. ZOSEL DAM GATES LIFTED ABOVE WATER IF OSOYOOS LAKE ELEVATION ABOVE 911.5 FT.
3. OUTFLOW DETERMINED BY OKANOGAN RIVER CHANNEL GEOMETRY AND LEVEL OF SIMILKAMEEN RIVER
4. OSOYOOS LAKE WILL RISE UNTIL OUTFLOW EQUALS INFLOW

FIG. 4

### OSOYOOS LAKE / SIMILKAMEEN RIVER RELATIONSHIP

REVERSE FLOW:

OSOYOOS LAKE INFLOW – IMMATERIAL  
 SIMILKAMEEN RIVER FLOW GREATER THAN 20,000 cfs (567m<sup>3</sup>/s), approx.



NOTES:

1. NOT TO SCALE, SCHEMATIC ONLY
2. ZOSEL DAM GATES ABOVE WATER.
3. THIS CONDITION OCCURS RELATIVELY RARELY AND ONLY WHEN THE SIMILKAMEEN RIVER HAS RISEN VERY RAPIDLY.

FIG. 5