INTERNATIONAL JOINT COMMISSION

International Osoyoos Lake Board of Control

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April 18, 2017

Dr. Charles A. Lawson
Secretary, United States Section
International Joint Commission
2000 L Street, NW, Suite 615
Washington, DC 20440

Dr. Camille Mageau
Secretary, Canadian Section
International Joint Commission
234 Laurier Avenue West, 22nd Floor
Ottawa, Ontario K1P 6K6

Transmitted via e-mail to lawsonc@washington.ijc.org and mageauc@ottawa.ijc.org

Dear Drs. Lawson and Mageau:

We hereby submit the Calendar Year 2016 Annual Report of the International Osoyoos Lake Board of Control.

The report sets forth the operation of the control works on Osoyoos Lake under the terms of the Commission's Orders dated December 9, 1982, October 17, 1985, and January 29, 2013.

Respectfully submitted:

For the United States

Cynthia Barton

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Cynthia Barton, PhD
Chair, United States Section
Director, Washington Water Science Center
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Tacoma, Washington

For Canada

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Bruno Tassone
Chair, Canadian Section
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Vancouver, British Columbia

International Osoyoos Lake Board of Control

2016 Annual Report to the International Joint Commission

TABLE OF CONTENTS

Cover photo: View of Zosel Dam (looking upstream) on the Okanogan River, located downstream of Osoyoos Lake (*credit: Gwyn Graham, Environment and Climate Change Canada*).

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International Osoyoos Lake Board of Control

2016 Annual Report to the International Joint Commission

The International Osoyoos Lake Board of Control (Board) was established on September 12, 1946, by the International Joint Commission (IJC or Commission) to carry out the provisions of the Commission's Order of Approval. In 2016, the Board operated under the authority of the Commission's Supplementary Order dated January 29, 2013.

To fulfill its mandate, the Board's efforts are focused on water-level management issues related to the operation of Zosel Dam, located on the Okanagan (Canadian spelling)/Okanogan (U.S. spelling) River about 1.6 mi (2.6 km) downstream from the outlet of Osoyoos Lake, a water body that straddles the international boundary between Canada and the United States (Figure 1). Zosel Dam is owned by Washington State, which is referred to as the Applicant in the IJC Orders and this annual report. The dam is operated by the Oroville-Tonasket Irrigation District under authority of the Washington State Department of Ecology.

ACTIVITIES OF THE BOARD IN 2016

Board membership in 2016 remained unchanged from 2015, when (in September 2015), the Board expanded through an addition of 4 new Board members from the Okanaga(o)gan region, from a total of six to ten members with equal representation from Canada and the U.S.

In 2016, the Board continued holding quarterly conference calls as initiated in 2015; summaries of these calls are posted on the Board's public website (http://ijc.org/en_/iolbc).

The Board conducted an overview of the work plan, including core activities, noting the importance of ensuring that information on Okanagan lake operations is reaching key stakeholders and the related aspects of coordination with both First Nations/Tribes and key stakeholders. Board discussion pointed to the importance of explaining abnormal hydrologic trends to the public to help offset expectation of normal seasonal water level conditions on the lake.

The Board received followed up from the applicant (Washington State Department of Ecology) that it was satisfied with the Board's position on the issue of ramping rates (rate of water level changes) on Osoyoos Lake as outlined in a previous Board letter to the applicant. The applicant indicated that the new IJC rule curve (introduced in 2013) had already removed some of the ramping rate challenges by prescribing a more gradual rise and fall of water levels on Osoyoos Lake.

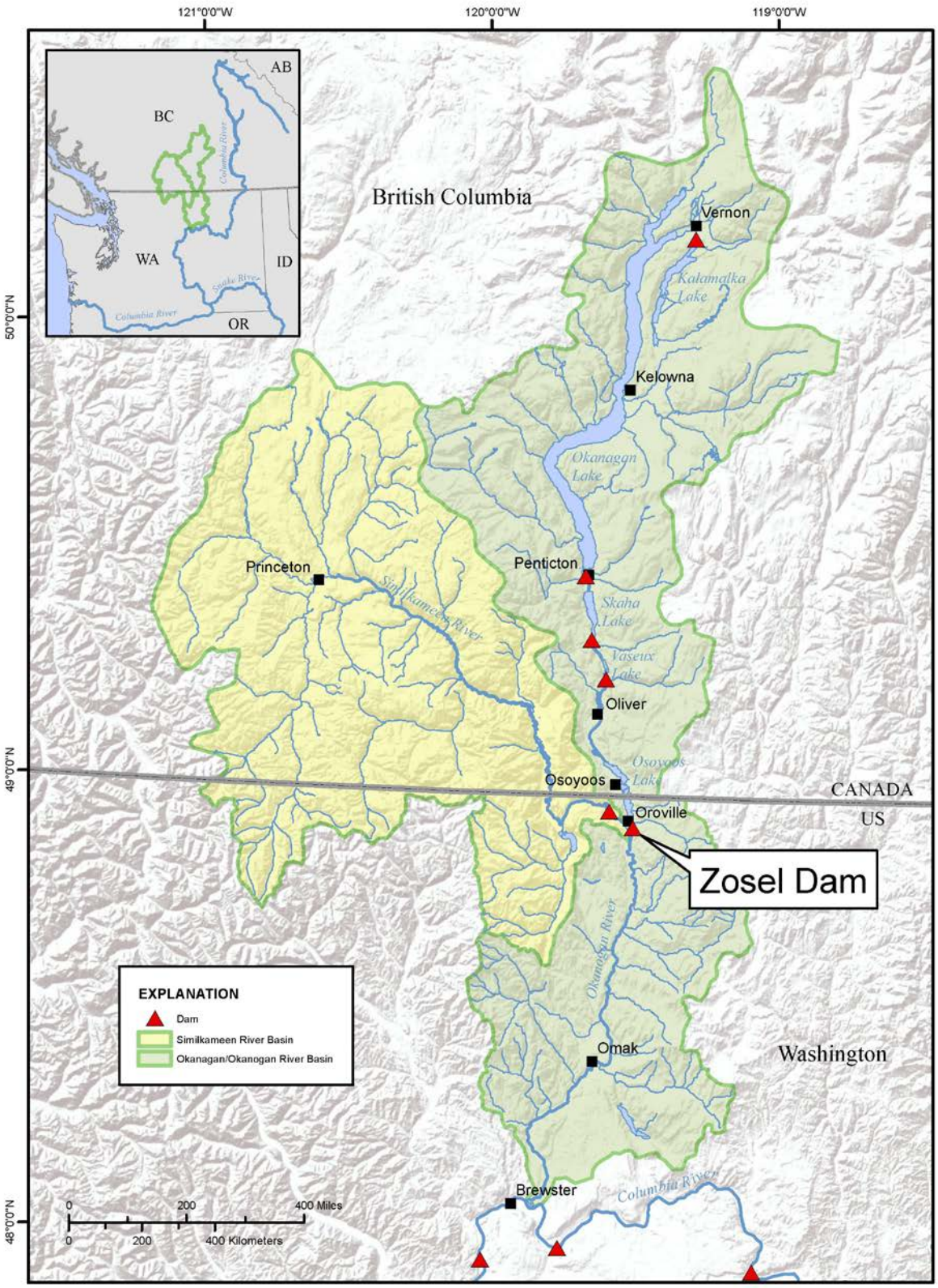

Figure 1 - Location of the Okanagan / Okanogan and Similkameen watersheds.

The Board discussed a potential project for installation of a webcam at Zosel Dam. The key purpose of providing visual real-time observation of flow conditions was identified but funding sources are uncertain at present. The Board also discussed the potential for additional water level monitoring (gauge stations) at Zosel Dam (forebay and tailrace) to provide data toward further development of an operational hydraulic model for Zosel dam (with assistance of the US Army Corps of Engineers) but again, with uncertain funding at this time.

The Board reviewed information on potential plans by the Okanogan Public Utility District (OPUD) to renovate and reactivate the Enloe Dam site, a run-of-river hydro-electric project. Enloe Dam is located on the Similkameen River in Washington State, above the confluence with the Okanogan River. While it's still not clear at this time if this proposal will prove to be economically feasible enough to proceed, the Board agreed that there would be no effect of the project on Zosel Dam or the Conditions of the IJC Order.

The Board discussed interests on the U.S. side of the watershed with regard to sediment transport processes and concerns along Tonasket Creek. While there was no immediate implication to the IJC Orders for Osoyoos Lake, the Board will continue to follow this issue due to potential for sediment deposition in the Okanogan River Channel and related implications for channel capacity.

Work continues on the documentary film that will highlight collaborative transboundary water management in the Okanagan/Okanogan Basin. A film trailer was presented during the annual Board meeting and made available on the IJC's website. The Board contributed information on suggested target audiences at the request of the production team (Ascent Films), to assist with editing decisions and eventual communication of the final product. Editing of the film has started and a rough cut is expected by mid- to late-May 2017 with a September 2017 time frame for final delivery. There is no budget yet for distribution.

In 2016, Special maintenance projects were undertaken at Zosel Dam. A contractor was hired to repair the gate setting system due to wear, damage and preventative maintenance needs. Some of this work will be ongoing next March (2017). In collaboration with the Columbia River Inter-Tribal Fisheries Commission (CRIFC), pit tag counters were installed at the dam to count the number of fish passing through the dam, using a floating system (Biomark fish counters) which John Arterburn (Confederated Tribes of the Colville Reservation) helps to operate/maintain. This system showed good Sockeye return numbers in 2016. Estimated survival (return) rate of 82.6% (215,975 counted at Wells dam and 178,306 counted at Zosel Dam). Fish went quickly in Osoyoos Lake and up the Okanogan River (an estimated 50,000 were caught by the Osoyoos Lake fishery).

The Board held its annual meeting on September 20, 2016 in Oroville (WA), which included presentations on water supply forecasting methodology by Katherine Rowden (Service Hydrologist for the National Weather Service – Spokane, WA) and Shaun Reimer (BC FLNRO – Water Resources Engineer, Penticton, BC). Katherine Rowden presented on the water supply forecast methodology employed by the National Weather Service, with a focus on the Okanogan region of Washington State. Short-term deterministic (10-day) forecasts are used for flood watch and flood warning purposes (some low-flow forecasting as well), while seasonal ensemble forecasts are used to provide seasonal probabilistic water supply forecasts, using a data record that extends back to 1948. The outcome distribution represents uncertainty and the Apr-Sept forecast period (period of interest) is presented for ranges of 50%, 30/70%, and 10/90%.

The public meeting of the Board was held September 20, 2016, in Oroville (WA) and featured a presentation by Al Josephy (WA Dept. Ecology) on the management of in-stream and out-of-stream water uses in the Okana(o)gan watershed. An additional presentation on cooperative water management between British Columbia and Washington State was provided by Brian Symonds (Canadian Board member). The details of these presentations are provided in the meetings minutes, posted to the Board's public website.

Shaun Reimer provided an overview of the water supply forecast methodology in British Columbia, with a focus on the Okanagan. The BC River Forecast Centre provides Shaun with the volumetric river forecast that he uses for operational planning. The system is currently in transition to a new model/methodology. There is a 15x relationship in water levels between Okanagan Lake and Osoyoos Lake (1 cm storage on Okanagan Lake translates to 15 cm storage on Osoyoos Lake). The forecasted inflows trigger variable lake targets; the months of April to July are a critical period. There can be poor comparison of forecasts to actuals due to limitations of the current method to account for the early snowmelt effect (using the Principle Component Analysis- Statistical model developed 1984 and updated by Summit Environmental in 1999). The weakness is in antecedent conditions, meaning that early snowmelt equals higher lake levels, which skews the forecast with an abnormally high lake level. The current methodology employed by BC will be transitioning to an ensemble streamflow prediction model (ESP) – probabilistic method (developed by Watersmith research –Kelowna, BC) known as RAVEN (already in use by BCHydro).

Figure 2 –Representative IJC Commissioners, IOLBC members and the representative Applicant at Zosel Dam, September 21, 2016. From left to right: Glen Davidson (Board member, Canada), Al Josephy (aka "the Applicant" WA Dept. of Ecology), Anna Warwick Sears (Board member, Canada), Mark Colosimo (IJC U.S. Engineering Advisor), Ford Waterstrat (Board member, U.S.),David Fay (IJC Canadian Engineering Advisor), Richard Morgan (IJC Commissioner, Canada), Bruno Tassone (Board Co-Chair, Canada), Rich Moy (IJC Commissioner, U.S.), Kris Kauffman (Board member, U.S.), Brian Symonds (Board member, Canada), John Arterburn (Board member, U.S.), Gwyn Graham (Board Secretary, Canada), Col. John Buck (Board member, U.S), Jay O'Brien (Zosel Dam operations, OTID), Sue McKortoff (Board member, Canada), Sara Marxen (US Army Corps of Engineers). Missing: Cindi Barton (Board Co-Chair, U.S.). Photograph by Marijke Van Heeswijk (Board Secretary, U.S.).

The Board presented progress reports during the semi-annual IJC meetings on April 19 in Washington, DC, and October 26 in Ottawa, ON. The April meeting was attended in person by the chairs of the Canadian and U.S. sections of the Board and the secretary of the U.S. section. The October meeting was attended in person by the chair of the U.S. section of the Board, a Canadian Board member. Other Board members and the U.S. and Canadian Board secretary participated remotely via teleconference. Participants in the October meeting also took part in the International Watershed Initiative workshop following the Board appearances.

Throughout the year, the Board posted a number of announcements on the Board's section of the IJC website.

HYDROLOGIC CONDITIONS IN 2016

Drought Criteria

Condition 8 of the Commission's Supplementary Order of Approval dated January 29, 2013, provides three criteria for declaring a year of drought (table 1). In a year when the Board has declared a drought, the Osoyoos Lake level may be managed within a wider range from April through October as compared to non-drought years. (Drought year water-level ranges are discussed in the section "Osoyoos Lake Levels.") Drought conditions were not in effect in 2015, as indicated by the forecasted values for the drought criteria in Table 1. On July 28, however, the IJC approved a Condition 10 variance at the recommendation of the Board that gave the Applicant permission to follow the drought rule curve for the remainder of 2015 in recognition of unusual hydrologic conditions in the basin.

Table 1 – Summary of drought criteria and forecast and actual values in 2016. The Board declares a drought if condition 8(a) and either condition 8(b i) or 8(b ii) are met (ac-ft, acre-feet; ft, feet)

Criteria for declaring a drought	2016 Value forecasted in (a) Early April (b) Early May	Drought criterion met?	Actual 2016 value
Condition 8(a) - Volume of flow in the Similkameen River at Nighthawk, WA, for the period April through July as calculated or forecasted by U.S. authorities is less than 1 million ac-ft	(a) 1,039,000 ac-ft (b) 831,000 ac-ft	(a) No (b) Yes	1,298,043 ac-ft
Condition 8(b i) - Net inflow to Okanagan Lake for the period April through July as calculated or forecasted by Canadian authorities is less than 195,000 ac-ft	(a) 396,000 ac-ft (b) 316,200 ac-ft	(a) No (b) No	489,754 ac-ft
Condition 8(b ii) - Level of Okanagan Lake in June or July is less than or is forecasted by Canadian authorities to be less than 1,122.6 ft (Canadian Geodetic Survey Datum)	(a) >1,126.6 ft (b) 1,123.3 ft	(a) No (b) No	1123.71 ft

Unusual Hydrologic Conditions in the Basin

During the winter of 2015-16, precipitation amounts were slightly about normal but early onset of above average temperatures resulted in early melt, such that snowpack was well below average by May 2016 (Figure 3). Early and rapid snowmelt resulted in an earlier timing of peak water levels than normal. Okana(o)gan hydrology was also influenced by significant rain through the June-July period. The effect on inflows to Osoyoos Lake was modulated by storage operations on Okanagan Lake. There was an overall below-average discharge on Similkameen River, despite an above-average peak discharge (freshet), which occurred slightly earlier than normal (Figure 4). The Similkameen River is an unregulated tributary to the Okanogan River whose confluence with the Okanogan River is downstream from Zosel Dam (Figure 1). Summer period discharge for the Similkameen River was close to record low, despite the benefit of rainfall during the June-July period. This was identified as significant, since Similkameen River flow is typically an important water supply source for the Okanogan region during the summer period. Inflows to Okanagan Lake ramped up earlier than usual in 2016 and water levels were above normal (Figure 5).

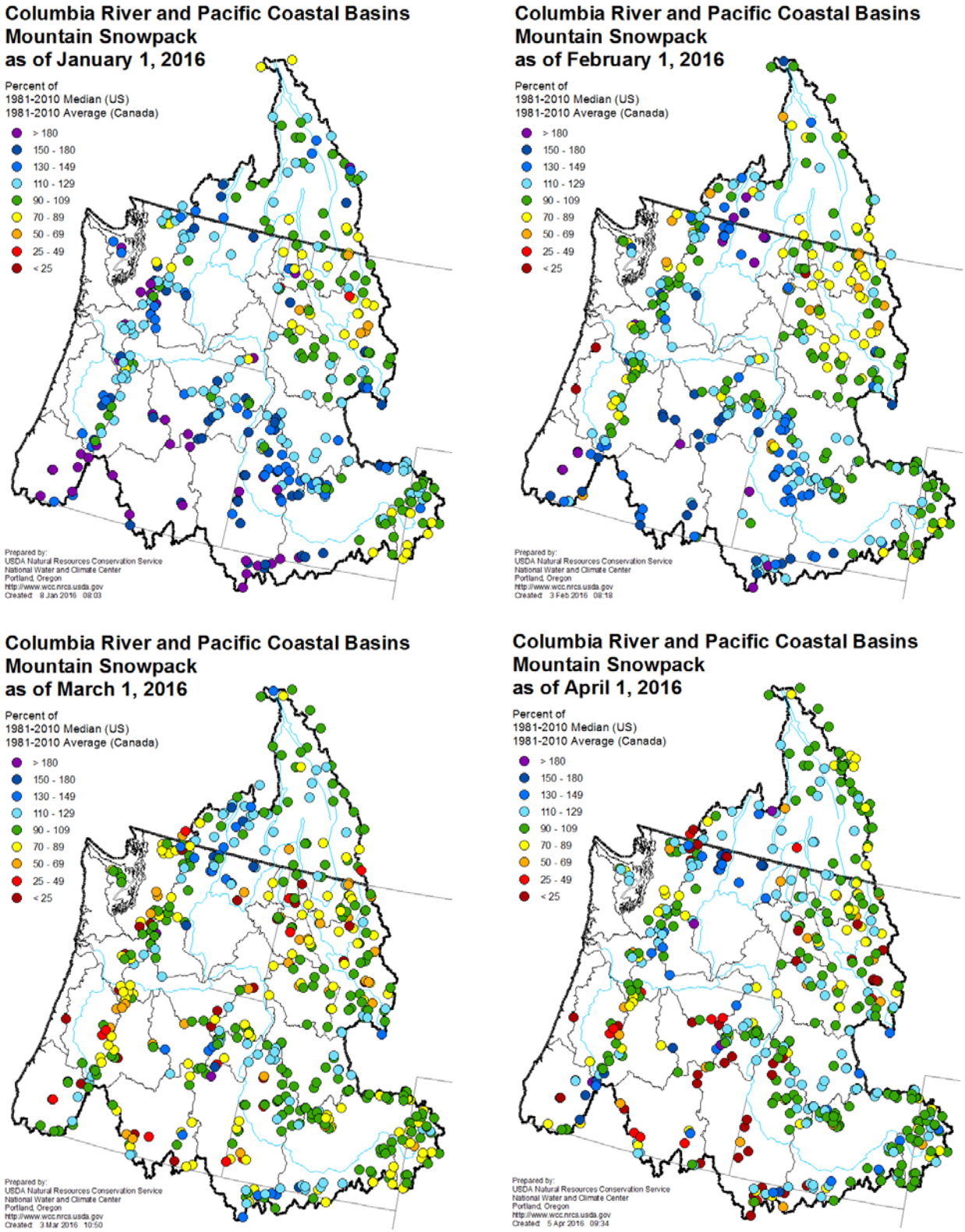

Figure 3 – Mountain snowpack conditions in the general area of the Okanagan/Okanogan and Similkameen River Basins (area inside purple oval outline) and the Columbia River and US Pacific Coastal Basins from Jan to Apr 2016 (US Dept. of Agriculture, Natural Resources and Conservation Service, 2016).

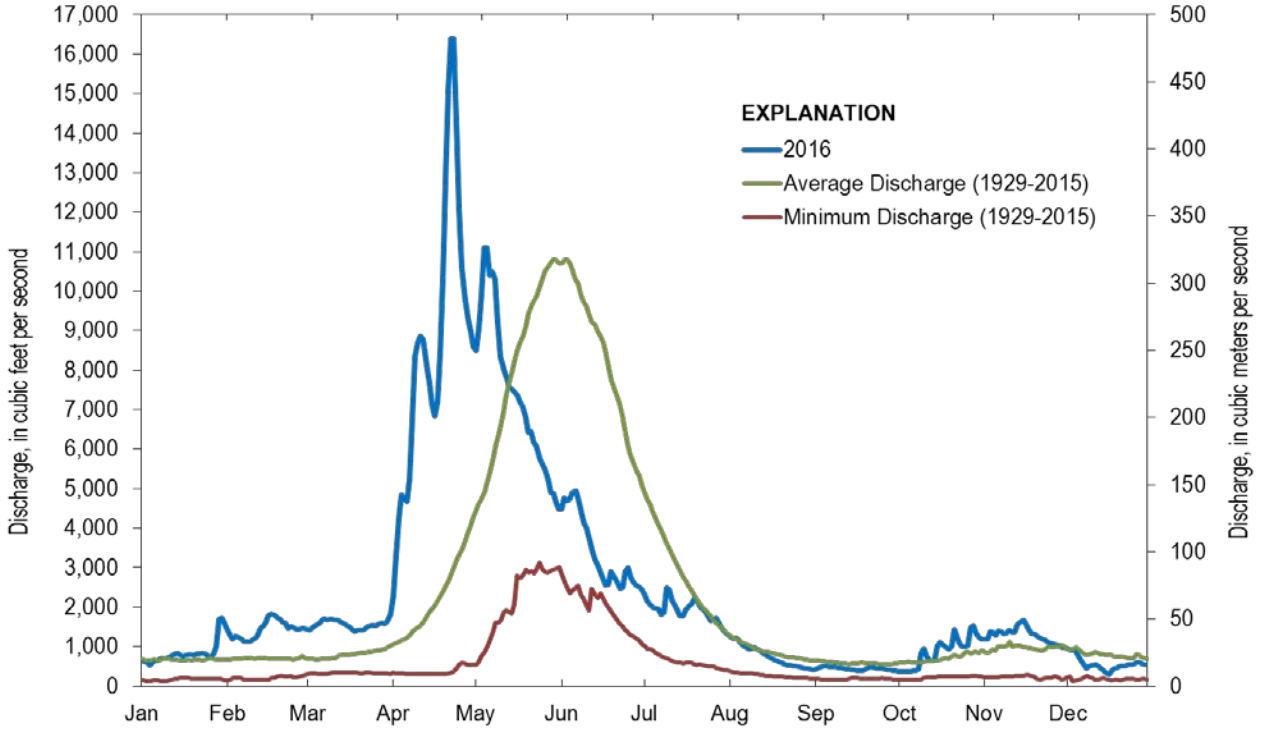

Figure 4 – Long-term average, minimum, and 2016 streamflow discharge in the Similkameen River at Nighthawk, Washington (US Geological Survey, 2016)

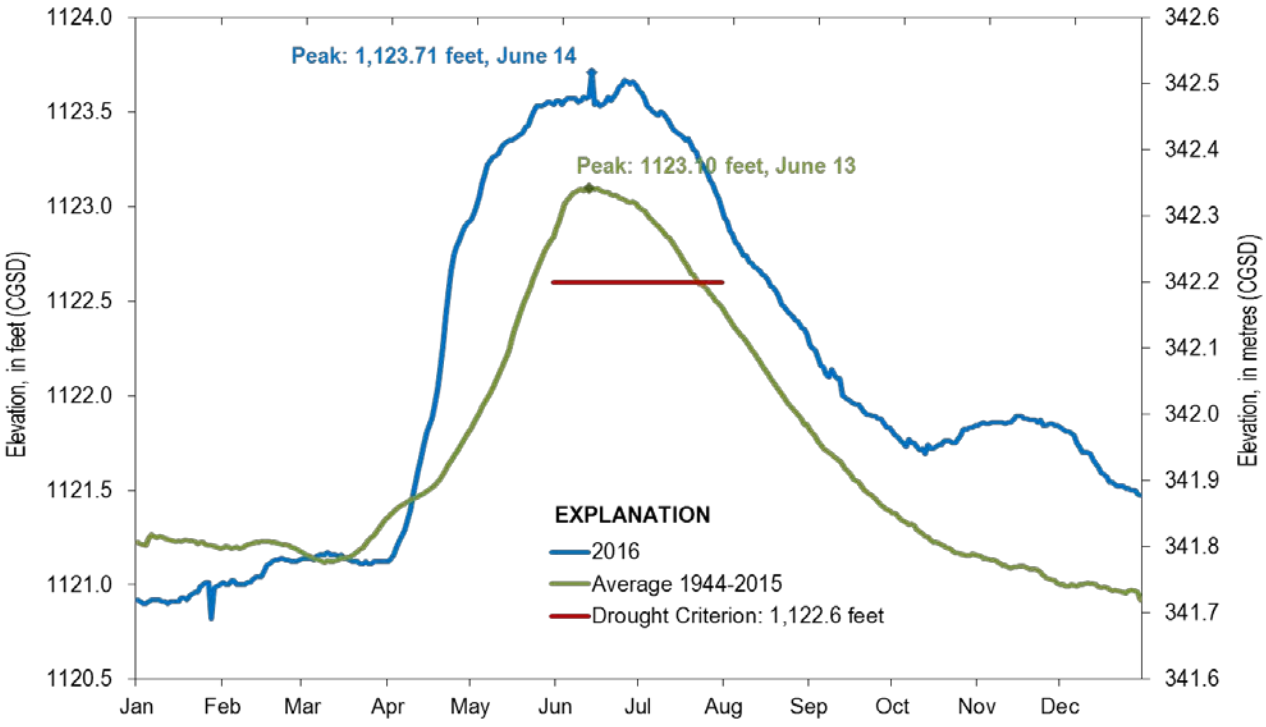

Figure 5 – Long-term average and 2016 Okanagan Lake water-surface levels (Water Survey of Canada, Environment and Climate Change Canada, 2016)

The above-normal snowpack and early spring runoff conditions resulted in an early peak to net-inflow to Okanagan Lake. Early onset of net negative inflow conditions were offset by rainfall events in June and July (Figure 6). (Net inflow is defined as the volume of water released at the dam at the outlet of Okanagan Lake plus the change in volume of water stored in Okanagan Lake, where positive change represents an increase in volume of water stored and negative change represents a decrease.)

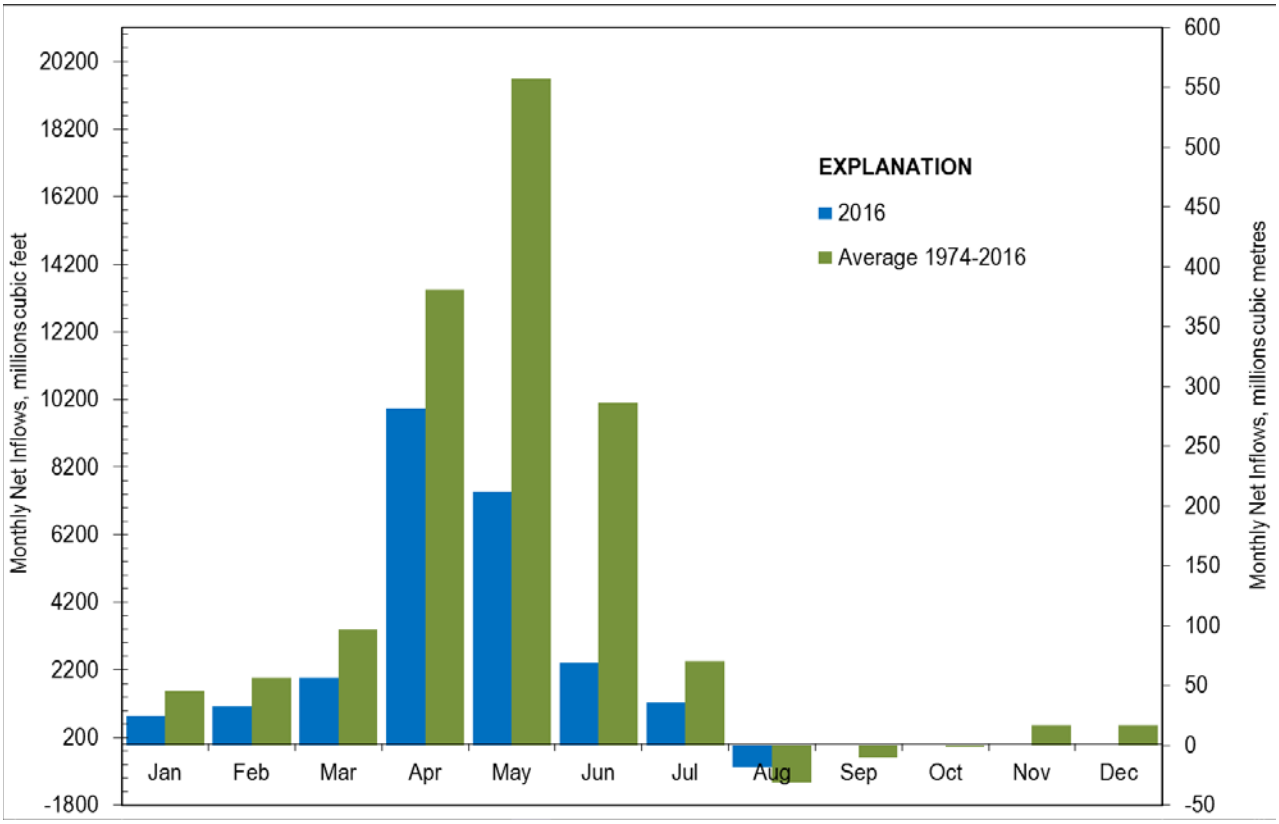

Figure 6 – Monthly net inflow to Okanagan Lake in 2016, January through August, and on average during 1974-2016, January through December (British Columbia Ministry of Forests, Lands and Natural Resource Operations, written communication, 2017)

Early peak discharge conditions associated with freshet were observed in early May on the Okanagan River and Okanogan Rivers. Both the Okanagan River (Figure 7) and Okanogan River (Figure 8) discharge conditions, however, were not as bad in 2016 as in 2015.

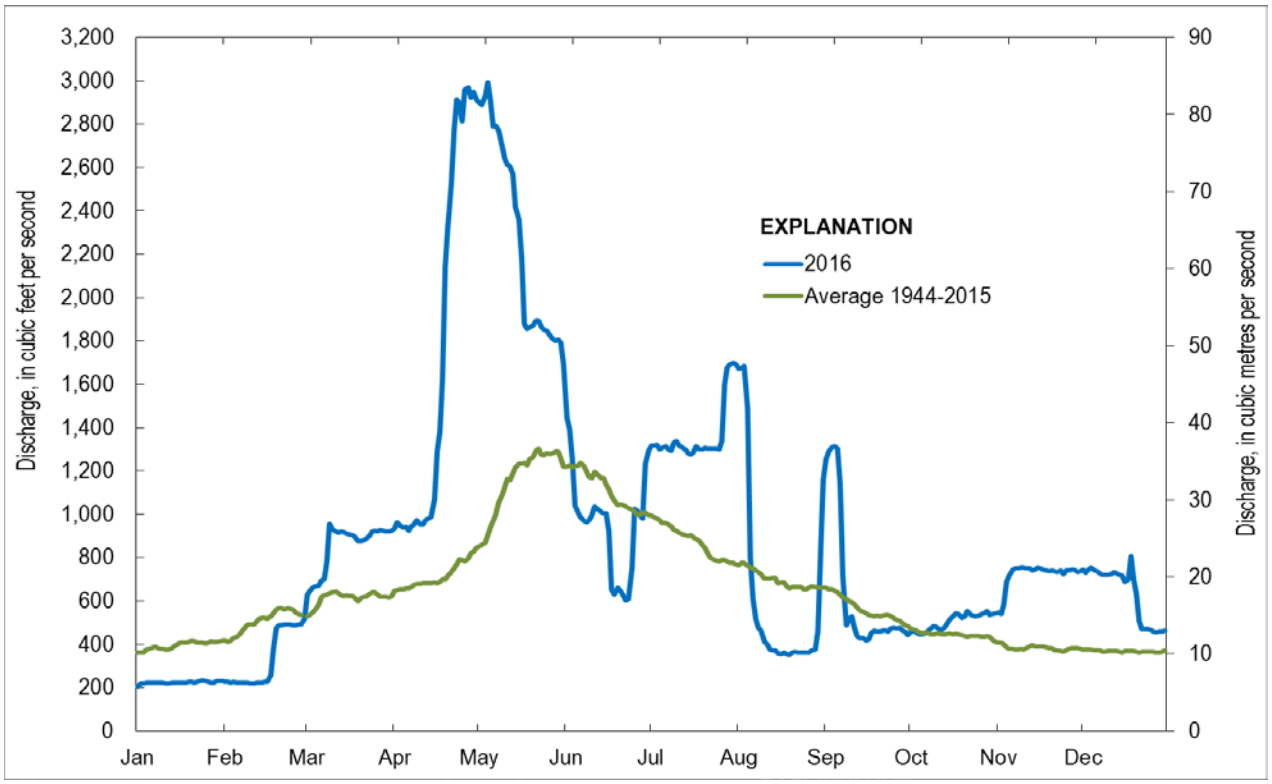

Figure 7 - Long-term average and 2016 streamflow discharge in the Okanagan River at Oliver, British Columbia (Water Survey of Canada, Environment and Climate Change Canada, 2016)

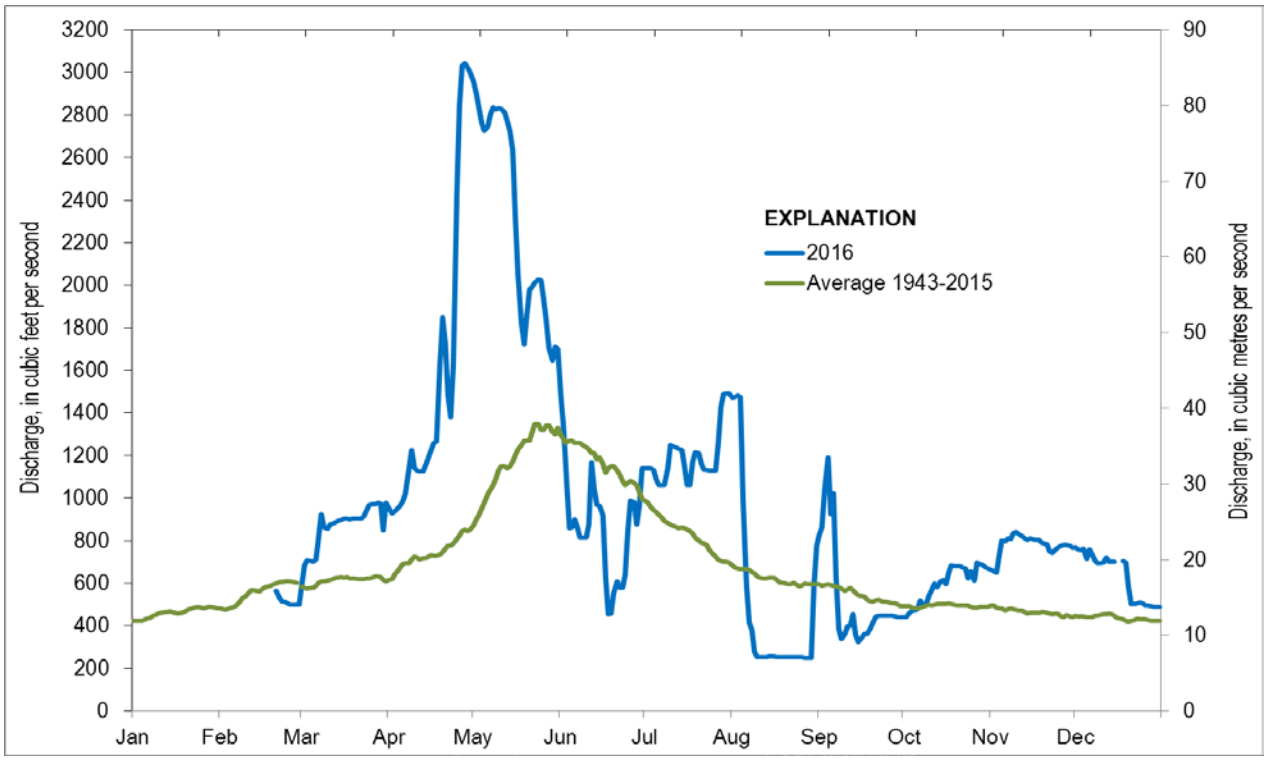

Figure 8 – Long-term average and 2016 streamflow discharge in the Okanogan River at Oroville, Washington (US Geological Survey, 2016)

This year did not require a drought declaration according to IJC Order (drought criteria were not met). High natural inflow into Osoyoos Lake during freshet resulted in a rule curve exceedance (Figure 9), but the operators of Zosel dam maintained maximum discharge through the dam and thus, the applicant was in compliance with the terms of the Order. Water level management on Osoyoos Lake was within the upper and lower bounds of the IJC rule curve and thus there have not been any compliance issues to date.

Osoyoos Lake Levels

Throughout any given year, Osoyoos Lake levels may fluctuate in accordance with criteria specified in the IJC's Supplementary Order of Approval dated January 29, 2013. Lake levels are influenced naturally by discharge in the Okanagan/Okanogan and Similkameen Rivers and by the operation of Zosel Dam (Figure 1).

The gray area in Figure 9 shows the authorized range of normal operating elevations: an upper range of 911.5 ft (277.8 m) on 1 January; 911.5 ft (277.8 m) on 1 March; 912 ft (278.0 m) on 1 May; 912 ft (278.0 m) on 15 September; 911.5 ft (277.8 m) on 1 November and 911.5 ft (277.8 m) on 31 December; and to the extent possible the elevation of Osoyoos Lake does not fall below the NGVD 1929 elevation of 909.0 ft (277.0 m) on 1 January; 909.0 ft (277.0 m) on 31 March; 910.0 ft (277.4 m) on 1 April; 911 ft (277.7 m) on 1 June; 911 ft (277.7 m) on 15 September; 910.0 ft (277.4 m) on 31 October; 909.0 ft (277.0 m) on 1 November and 909.0 ft (277.0 m) on 31 December. Elevation limits are linearly interpolated between dates.

The area between the orange dashed lines in Figure 9 shows the lake elevations authorized by the IJC from April 1 to October 31 if drought criterion 8(a) and either 8(b i) or 8(b ii) in table 1 are declared in effect by the Board. During such conditions, the elevation of Osoyoos Lake may be raised to 912.5 ft (278.1 m) from 1 April to 15 September, after which the lake level shall be decreased to reach an elevation of 911.5 ft (277.8 m) by 1 November. To the extent possible, during the April 1 to October 31 period, the elevation of Osoyoos Lake should not fall below 910.0 ft (277.4 m) on 1 April; 910.5 ft (277.5 m) on 1 June; 910.5 ft (277.5 m) on 15 September; and 910.0 ft (277.4 m) on 31 October. Between dates, elevation limits are linearly interpolated. Condition 9 of the 1982 Order recognizes that backwater from high flow in the Similkameen River and (or) excessive flow in the Okanagan River may cause Osoyoos Lake levels to rise above the authorized range.

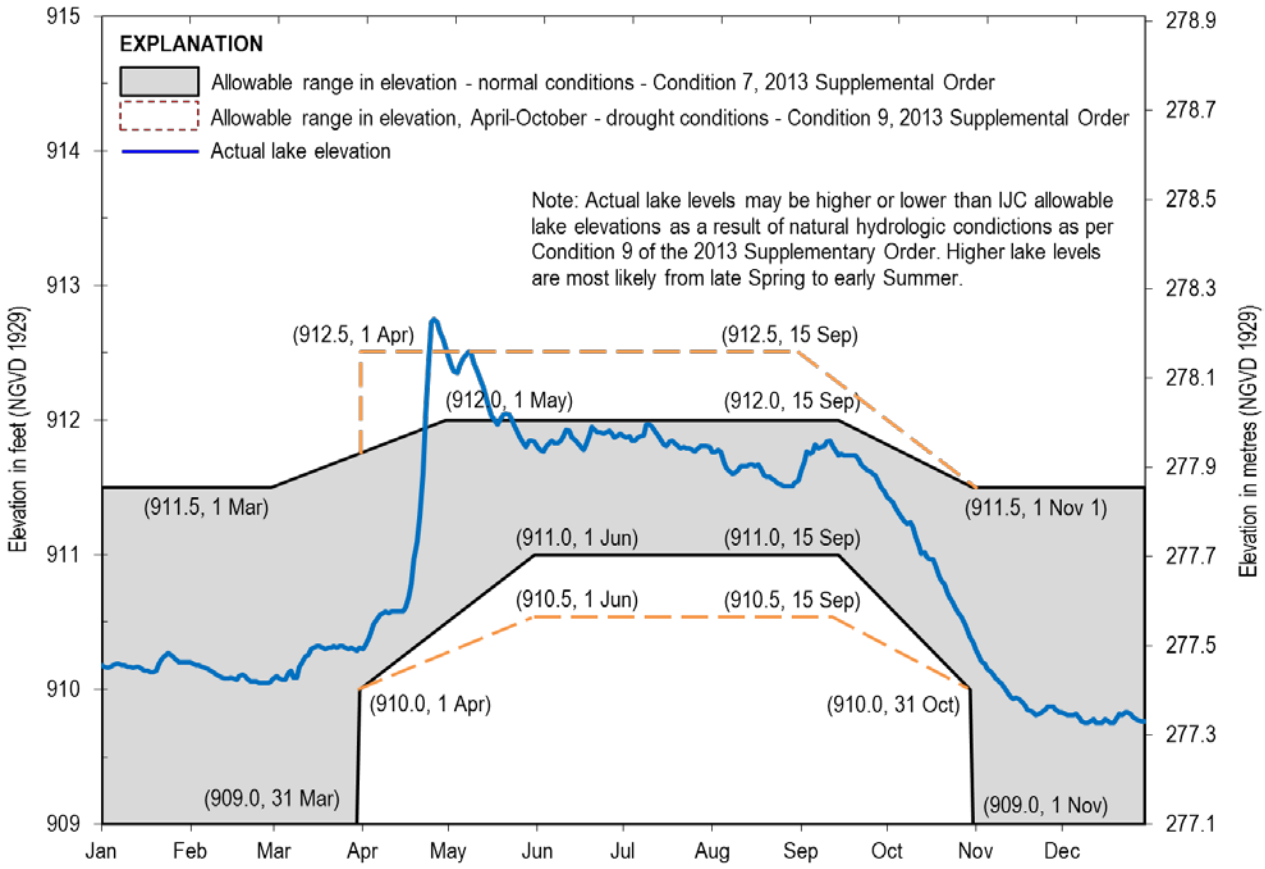

Figure 9 – Allowable Osoyoos Lake elevations per IJC Supplemental Order of Approval dated January 29, 2013, and the actual daily mean lake elevations recorded at USGS Station no. 12439000 in 2016

During 2016, the maximum instantaneous Osoyoos Lake elevation was 912.76 ft (278.21 m), which occurred at 12:45 PDT on April 25. The maximum daily mean elevation occurred April 26 (Figure 9) and was 912.75 ft (278.21 m). The minimum instantaneous elevation was 909.73 ft (277.29 m), which occurred at 15:00 on December 9. The minimum daily mean elevation was 909.75 ft (277.29 m), which occurred on December 9.

While the maximum instantaneous water level exceeded the standard rule curve by 0.76 ft (0.23 m) in late April, it was due to high inflow event during freshet and the applicant maintained compliance with the conditions of the IJC Order during this period by maximizing discharge conditions through Zosel Dam and allowing the lake to return to within the rule curve limits in a timely manner. In 2016, there were no other deviations from the rule curve that was in effect and thus the Applicant was in compliance with the IJC's 2013 Supplementary Order of Approval.

River Discharges

The maximum instantaneous discharge of the Okanogan River at Oroville (downstream from Zosel Dam) occurred on April 28 and was 3,080 cubic feet per second (cfs) (87.2 cubic meters per second [cms]) with a corresponding Osoyoos Lake elevation of 912.66 ft (277.92 m).

The maximum instantaneous discharge of the Similkameen River occurred on April 23 and was 16, 800 cfs (479 cms). The maximum daily mean discharge of 16,400 cfs (464 cms) occurred on April 23. High flow in the Similkameen River created variable backwater at the Okanogan River at Oroville gaging station during the period April 9 to May 24. The annual mean flow in the Similkameen River was 2,433 cfs (68.9 cms) in 2016, which is 105 percent of the 88-year average of 2,307 cfs (65.3 cms). From 1929 through 2016, there were 46 years when the annual mean flow was less than 2,307 cfs (65.3 cms). The smallest annual mean flow of record occurred in 2001, when it was 1,030 cfs (29.2 cms).

Conditions 3 and 4 of the IJC Order of 1982 specify that the flow capacity of the Okanogan River channel between the outlet of Osoyoos Lake up to and including Zosel Dam be at least 2,500 cfs (70.8 cms) when the elevation of Osoyoos Lake is 913.0 ft (278.3 m) and there is no appreciable backwater effect from the Similkameen River. Hydrologic conditions in 2016 did not allow testing of compliance with these conditions because the Osoyoos Lake elevation did not reach 913.0 ft (278.3 m). In 2013, however, hydrologic conditions were such that compliance with these conditions was confirmed. In addition, no significant sediment-input events that may have reduced the channel capacity were observed between 2013 and 2016.

Data on Osoyoos Lake elevation and relevant river flows for 2015 are summarized in the appendix; the river hydrographs for 2016 and 2015 are depicted in Figure 10 and Figure 11, respectively, and demonstrate that discharge in the Similkameen and Okanagan/Okanogan Rivers was significantly greater in 2016 during freshet but that flows were similar between 2016 and 2015 for the remainder of the year.

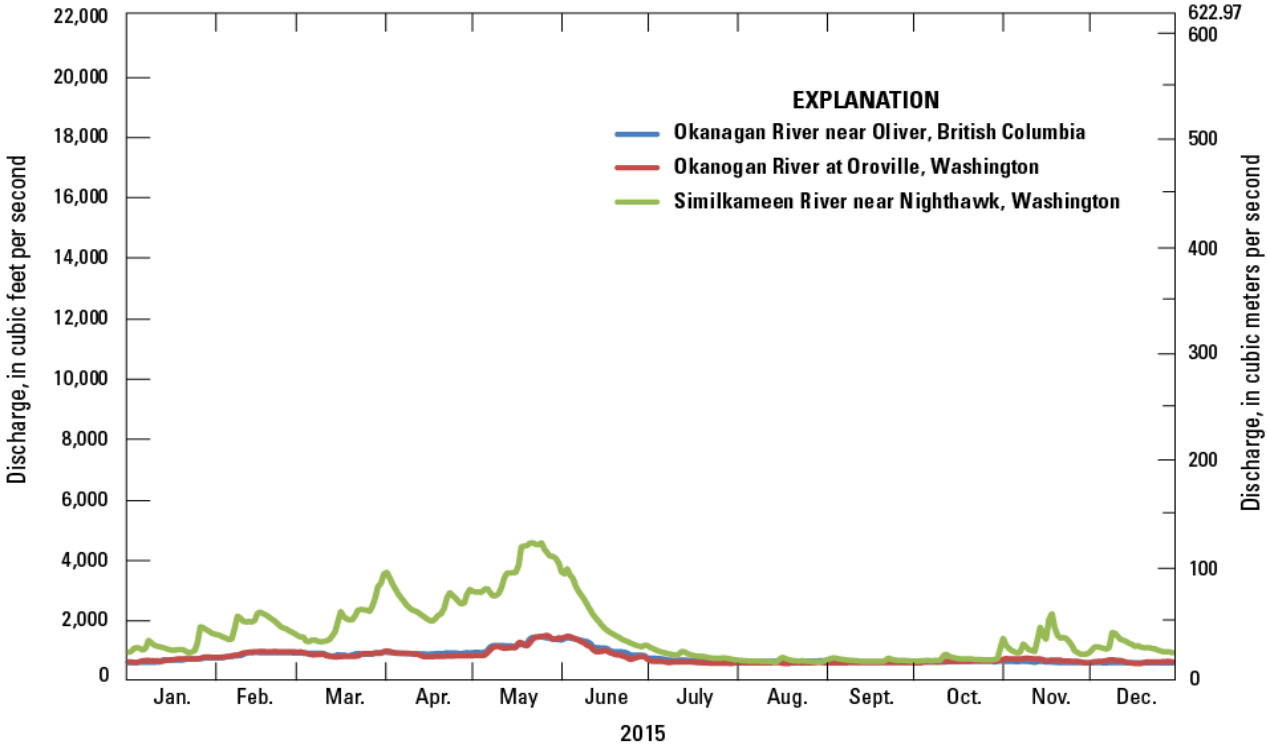

Figure 10 – Hydrographs of daily mean discharge for the Similkameen and Okanagan/Okanogan Rivers, 2015

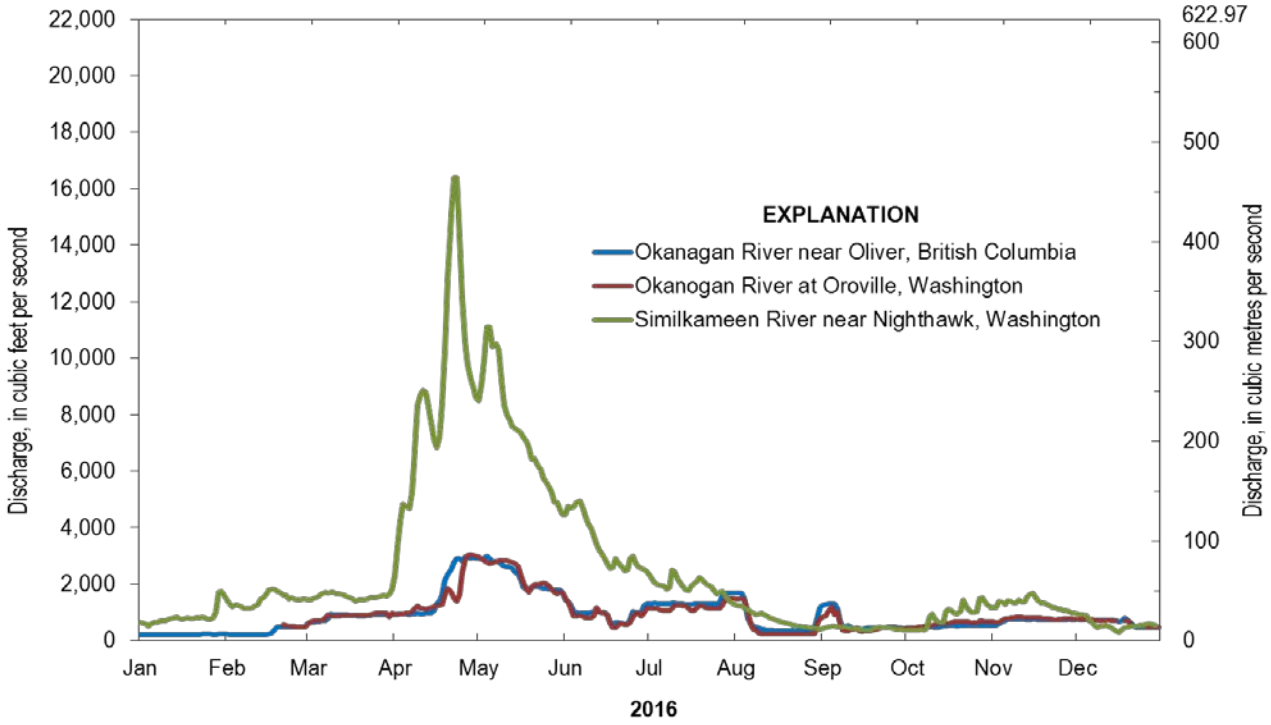

Figure 11 – Hydrographs of daily mean discharge for the Similkameen and Okanagan/Okanogan Rivers, 2016

APPENDIX: OSOYOOS LAKE LEVELS, INFLOWS, AND OUTFLOWS IN 2016

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

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 the U.S. National Geodetic Vertical Datum of 1929 (NGVD 1929).

C. Osoyoos Lake (USGS station no. 12439000)

Maximum instantaneous elevation	912.76 ft (278.21 m) – Apr 25 (also on Apr 26)
Minimum instantaneous elevation	909.73 ft (277.29 m) – Dec 9 (also on Dec 14, 15, 16 and 19)
Maximum daily mean elevation	912.75 ft (278.21 m) – April 26
Minimum daily mean elevation	909.75 ft (277.29 m) – Dec 9 (also on Dec 10, 13, 14, 15, 18 and 19)
Lake elevation at time of peak flow for Okanogan River at Oroville	912.68 ft (278.18 m) – Apr 28

D. Okanogan River at Oroville (USGS station no. 12439500)

Maximum instantaneous discharge	3,080 cfs (87.2 cms) – Apr 28
Minimum instantaneous discharge	231 cfs (6.5 cms) – Jan 19 (also on Jan 20 and 21)
Maximum daily mean discharge	3,040 cfs (86.1 cms) – Apr 28
Minimum daily mean discharge	231 cfs (6.5 cms) – Jan 21
Annual mean discharge	875 cfs (24.8 cms)

The annual mean discharge was 129 percent of the 74-year average of 677 cfs (19.1 cms).

E. Similkameen River near Nighthawk (USGS station no. 12442500)

Maximum instantaneous discharge	16,900 cfs (479 cms) – Apr 23
Minimum instantaneous discharge	238 cfs (6.7 cms) – Dec 16
Maximum daily mean discharge	16,400 cfs (464 cms) – Apr 23, 24
Minimum daily mean discharge	300 cfs (8.5 cms) – Dec 17
Annual mean discharge	2,433 cfs (68.9 cms)

The annual mean discharge was 105 percent of the 88-year average of 2,307 cfs (65.3 cms).

High Similkameen River discharges created variable backwater at the Okanogan River at Oroville gaging station from 11:30 PDT on Apr. 09 until 22:00 PDT on May 24.