

# ***Compilation of Project Hydrologic Data***

## ***Preparation of Hydrologic Database and Hydrologic Statistics in Support of Relicensing Studies***

***Boundary Hydroelectric Project (FERC No. 2144)***



***Prepared for:***  
**Seattle City Light**  
**Seattle, Washington**

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## TABLE OF CONTENTS

<b>1</b>	<b>Introduction.....</b>	<b>1-1</b>
<b>2</b>	<b>Development of Hourly Hydrologic Database.....</b>	<b>2-1</b>
	2.1. Available Data .....	2-1
	2.2. Standardization of Data .....	2-3
	2.3. Missing Data.....	2-3
	2.4. Anomalies in Data .....	2-4
	2.5. Data Synthesis .....	2-10
	2.6. Description of Hourly Hydrologic Database .....	2-16
<b>3</b>	<b>Basin Hydrology.....</b>	<b>3-1</b>
	3.1. Long-Term Trends.....	3-1
	3.2. Impacts of Upstream Projects.....	3-4
	3.3. Tributaries to the Pend Oreille River.....	3-5
<b>4</b>	<b>Boundary Reservoir.....</b>	<b>4-1</b>
	4.1. Inflows to Boundary Reservoir.....	4-1
	4.2. Water Surface Elevations in Boundary Reservoir.....	4-12
	4.3. Ramping Rates.....	4-27
<b>5</b>	<b>Downstream Reach.....</b>	<b>5-1</b>
	5.1. Inflows to Seven Mile Reservoir.....	5-1
	5.2. Water Surface Elevations in Seven Mile Reservoir .....	5-15
	5.3. Ramping Rates.....	5-23
<b>6</b>	<b>References.....</b>	<b>6-1</b>

- APPENDIX A: Daily Maximum and Minimum Water Surface Elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay, 1987 through 2005
- APPENDIX B: Monthly and Annual Frequency of Exceedance of Hourly Stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005
- APPENDIX C: Monthly and Annual Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005
- APPENDIX D: Monthly and Annual Frequency of Exceedance of Daily Maximum Ramping Rates in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005
- APPENDIX E: Hourly Total Flow Release from Boundary Dam to the Pend Oreille River, 1987 through 2005
- APPENDIX F: Monthly and Annual Flow Duration in Pend Oreille River based on Total Hourly Inflow to Boundary Reservoir and Total Hourly Flow Release from Boundary Dam, 1987 to 2005
- APPENDIX G: Monthly and Annual Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on Total Inflow to Boundary Reservoir and Total Flow Release from Boundary Dam, 1987 to 2005
- APPENDIX H: Monthly and Annual Frequency of Exceedance of Hourly Stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005
- APPENDIX I: Monthly and Annual Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005
- APPENDIX J: Monthly and Annual Frequency of Exceedance of Daily Maximum Ramping Rates in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005
- APPENDIX K: Boundary Reservoir Storage/Elevation Curves

**FIGURES**

**Figure 1-1.** Pend Oreille River Basin in Washington, Idaho, Montana, and British Columbia..... 1-3

**Figure 1-2.** Pend Oreille River upstream from Boundary Dam (not including portions of the basin in Canada) (USGS 2007). ..... 1-4

**Figure 1-3.** Pend Oreille River from Albeni Falls Dam to the confluence with the Columbia River and location of major dams. .... 1-5

**Figure 1-4.** Monthly average daily maximum and minimum temperatures, and monthly average daily precipitation in Newport, Washington. .... 1-6

**Figure 1-5.** Locations of major dams within Pend Oreille River Basin. .... 1-8

**Figure 1-6.** Tributaries to Boundary Reservoir between Box Canyon Dam and Boundary Dam. .... 1-9

**Figure 2-1.** Hourly flows in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500), and hourly water levels in Boundary Forebay, and the USGS primary and auxiliary gages in the Pend Oreille River below Box Canyon Dam, September 8 to 21, 1989. .... 2-6

**Figure 2-2.** Hourly water surface elevations and hourly change in water surface elevation in Pend Oreille River in Seven Mile Forebay, and hourly flow releases from Boundary Dam and from Seven Mile Dam to the Pend Oreille River, November 4 to 7, 1991. .... 2-8

**Figure 2-3.** Hourly water surface elevations in Boundary Tailwater, raw and adjusted data, May 18 to June 17, 1991. .... 2-9

**Figure 2-4.** Hourly water surface elevations in Boundary Tailwater, raw and adjusted data, May 4 to June 29, 1997. .... 2-9

**Figure 2-5.** Seasonal adjustment factor used to synthesize flows in Sullivan Creek above Outlet Creek (USGS Gage No. 12396900) based on flows in Boundary Creek Idaho (USGS Gage No. 12321500) and flows in Salmo River, British Columbia (Water Survey of Canada Gage No. 08NE074). ..... 2-12

**Figure 2-6.** Approximate water surface elevation in Pend Oreille River below Box Canyon Dam, estimated from flow release from Box Canyon Dam, and water surface elevation in Boundary Forebay. Water surface elevations estimated from this figure would be most accurate under steady-state conditions. .... 2-13

**Figure 2-7.** Observed and approximate synthesized hourly stage hydrographs, Pend Oreille River below Box Canyon Dam, USGS Primary Gage No. 12396500, September 21 to 27, 1990. .... 2-14

**Figure 2-8.** Approximate water surface elevation in Boundary Tailwater, estimated from flow release from Boundary Dam, and water surface elevation in Seven Mile Forebay. Water surface elevations estimated from this figure would be most accurate under steady-state conditions..... 2-15

**Figure 2-9.** Observed and approximate synthesized hourly stage hydrographs, Boundary Tailwater March 15 to 20, 1988..... 2-16

**Figure 3-1.** Historical trends in long-term basin hydrology for the Pend Oreille River in the vicinity of Boundary Dam, as determined from the cumulative departure from long-term average flow. .... 3-2

**Figure 3-2.** Flow duration for Pend Oreille River in the vicinity of Boundary Dam, derived from average annual flows from Calendar Year 1913 through 2006. Percent exceedance of average annual flows from 1987 through 2005 are shown, based on their ranking within the 94-year period extending from 1913 through 2006. .... 3-2

**Figure 3-3.** Maximum and minimum average monthly flows for Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) for January through December, based on 1953 through 2005, and on 1987 through 2005. .... 3-3

**Figure 3-4.** Median monthly flows in Pend Oreille River below Box Canyon Dam under unimpaired and regulated conditions, Calendar Years 1971 through 2000. .... 3-4

**Figure 3-5.** Median monthly flows in Sullivan Creek near the confluence with the Pend Oreille River, Water Years 1960 through 1968, 1995 through 2003, and 2005..... 3-6

**Figure 3-6.** Median monthly flows in Sullivan Creek above Outlet Creek, Water Years 1960 through 1972, and 1995 through 2003. .... 3-6

**Figure 3-7.** Median monthly flows in the Salmo River near the confluence with the Pend Oreille River, Calendar Years 1950 through 2006. .... 3-7

**Figure 4-1.** Monthly 10% exceedance, median, and 90% exceedance flows for total inflow to Boundary Reservoir (flow releases from Box Canyon Dam plus tributary inflows), derived from 19 years of hourly flows from Calendar Year 1987 through 2005. .... 4-11

**Figure 4-2.** Monthly 10% exceedance, median, and 90% exceedance frequencies for daily change in total inflow to Boundary Reservoir (daily maximum minus daily minimum), derived from 19 years of hourly flows from Calendar Year 1987 through 2005..... 4-11

**Figure 4-3.** Median weekly patterns of water surface elevations in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) and Boundary Forebay during June in 1997, 1995, and 1992..... 4-13

**Figure 4-4.** Median weekly patterns of water surface elevations in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) and Boundary Forebay during August in 1997, 2004, and 1994..... 4-15

**Figure 4-5.** Median weekly patterns of water surface elevations in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) and Boundary Forebay during October in 1990, 1996, and 2002. .... 4-16

**Figure 4-6.** Monthly water surface elevations in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005..... 4-23

**Figure 4-7.** Monthly patterns of daily water surface elevation fluctuations in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005..... 4-25

**Figure 4-8.** Comparison of daily water surface elevation fluctuations (daily maximum minus daily minimum) in Boundary Forebay and in the Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam with daily average inflows to Boundary Reservoir, 1987 through 2005..... 4-26

**Figure 4-9.** Monthly patterns of daily maximum ramping rates in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005. .... 4-28

**Figure 5-1.** Pend Oreille River extending from Boundary Dam to confluence with the Columbia River..... 5-2

**Figure 5-2.** Monthly 10% exceedance, median, and 90% exceedance flows for total flow release from Boundary Dam to the Pend Oreille River, derived from 19 years of hourly flows from Calendar Year 1987 through 2005..... 5-4

**Figure 5-3.** Monthly 10% exceedance, median, and 90% exceedance frequencies for daily change in total flow release from Boundary Dam to the Pend Oreille River (daily maximum minus daily minimum), derived from 19 years of hourly flows from Calendar Year 1987 through 2005..... 5-4

**Figure 5-4.** Median weekly patterns of hourly total flow releases and hourly spill from Boundary Dam to the Pend Oreille River June in 1997, 1995, and 1992. .... 5-11

**Figure 5-5.** Median weekly patterns of hourly total flow releases and hourly spill from Boundary Dam to the Pend Oreille River August in 1997, 2004, and 1988. .... 5-13

**Figure 5-6.** Median weekly patterns of hourly total flow releases and hourly spill from Boundary Dam to the Pend Oreille River October in 1990, 1996, and 2002..... 5-14

**Figure 5-7.** Monthly water surface elevations in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005..... 5-21

**Figure 5-8.** Monthly patterns of daily water surface elevation fluctuations in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005. .... 5-22

**Figure 5-9.** Monthly patterns of daily maximum ramping rates in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005. .... 5-24

## TABLES

<b>Table 1-1.</b>	Drainage areas of tributaries to Boundary Dam between Box Canyon Dam and Boundary Dam. ....	1-8
<b>Table 4-1.</b>	Average monthly and annual flows in Pend Oreille River below Box Canyon Dam, USGS Gage No. 12396500, 1987 to 2005. ....	4-2
<b>Table 4-2.</b>	Average monthly and annual flows in Sweet Creek/Lunch Creek at confluence with Pend Oreille River, 1987 to 2005.....	4-3
<b>Table 4-3.</b>	Average monthly and annual flows in Sullivan Creek at confluence with Pend Oreille River, 1987 to 2005. ....	4-4
<b>Table 4-4.</b>	Average monthly and annual flows in all tributaries combined to the Pend Oreille River between Box Canyon Dam and Boundary Dam, 1987 to 2005. ....	4-5
<b>Table 4-5.</b>	Average monthly and annual flows inflow to Boundary Reservoir, 1987 to 2005, calculated from the sum of all inflows. ....	4-6
<b>Table 4-6.</b>	Average monthly and annual flows inflow to Boundary Reservoir, 1987 to 2005, calculated from outflow plus change in reservoir storage. ....	4-8
<b>Table 4-7.</b>	Monthly and annual maximum, minimum, and average hourly inflows to Boundary Reservoir, January 1987 to December 2006. ....	4-9
<b>Table 4-8.</b>	Monthly and annual maximum, minimum, and average hourly water surface elevations in Boundary Reservoir Forebay, January 1987 to December 2006.....	4-18
<b>Table 4-9.</b>	Monthly and annual maximum, minimum, and average water surface elevations in Pend Oreille River below Box Canyon Dam (USGS Primary Gage No. 12396500) January 1987 to December 2006.....	4-20
<b>Table 5-1.</b>	Average monthly and annual total flow release from Boundary Dam to Pend Oreille River, 1987 to 2005. ....	5-3
<b>Table 5-2.</b>	Average monthly and annual spill from Boundary Dam to Pend Oreille River, 1987 to 2005. ....	5-6
<b>Table 5-3.</b>	Average monthly and annual flows in the Salmo River near the confluence with the Pend Oreille River, 1987 to 2005.....	5-7
<b>Table 5-4.</b>	Average monthly and annual total inflow to Seven Mile Reservoir, 1987 to 2005. ....	5-8
<b>Table 5-5.</b>	Monthly and annual maximum, minimum, and average inflows to Seven Mile Reservoir, January 1987 to December 2006. ....	5-9

**Table 5-6.** Monthly and annual maximum, minimum, and average water surface elevations in Boundary Tailwater, January 1987 to December 2006..... 5-16

**Table 5-7.** Monthly and annual maximum, minimum, and average water surface elevations in Seven Mile Forebay, January 1987 to December 2006..... 5-18

## **Boundary Hydroelectric Project**

### **Preparation of Hydrologic Database and Hydrologic Statistics in Support of Relicensing Studies**

#### **Boundary Hydroelectric Project (FERC No. 2144)**

## **1 INTRODUCTION**

The Boundary Project (Project), owned and operated by Seattle City Light (SCL), was constructed in the mid-1960s and operates under a license administered by the Federal Energy Regulatory Commission (FERC). The present license for the Project expires on September 30, 2011, and in accordance with FERC regulations, SCL must file its application for a new license no later than September 30, 2009. For the relicensing of the Project, SCL is utilizing the FERC Integrated Licensing Process (ILP) to provide the framework for its consultation with agencies, tribes, and other stakeholders (“relicensing participants” or “participants”) during the period leading up to the filing of the license application. The ILP is designed to improve coordination among FERC, the licensee, and relicensing participants during this pre-filing period.

The ILP effort was formally initiated by SCL in May 2006, when the Pre-Application Document (PAD) and accompanying Notice of Intent (NOI) were filed with the FERC. Proposed Study Plans (PSPs) and Revised Study Plans (RSPs) have been developed to address relevant issues identified in cultural, recreational, terrestrial, fish and aquatics, and water quality resource areas. These studies have been initiated and will continue until April 2009 when a Preliminary License Proposal (PLP) will be filed.

Resource analyses conducted as part of relicensing activities require that an hourly record of flow and reservoir water surface elevations be available to describe current Project effects and support assessment of potential operations scenarios. The hydrologic record will be used by multiple disciplines; therefore, a common dataset was developed to ensure consistency among technical workgroups. The hydrologic record must pass a rigorous quality assurance procedure to ensure that potential errors are identified and corrected before the data are distributed for widespread use. Missing data points must also be carefully synthesized and any aberrations in recorded data identified and corrected.

This report describes the hydrologic dataset used to support ongoing relicensing studies. The record of hourly flows between 1987 and 2005 was used to describe current operations. This report includes a variety of hydrologic statistics used to describe the 19-year period (Calendar Years 1987 through 2005) of hourly records. In addition, average daily flow records between 1912 and 2004 were reviewed to characterize the hydrologic nature of this 19-year record.

In a general sense, hydrology is a multidisciplinary science that may include: meteorological information such as solar radiation, air temperature, humidity, and wind speed and direction; precipitation records of rain, snow, and snowpack; surface water and ground water flow; evaporation and transpiration; and erosion and sediment yield. Some of these components of

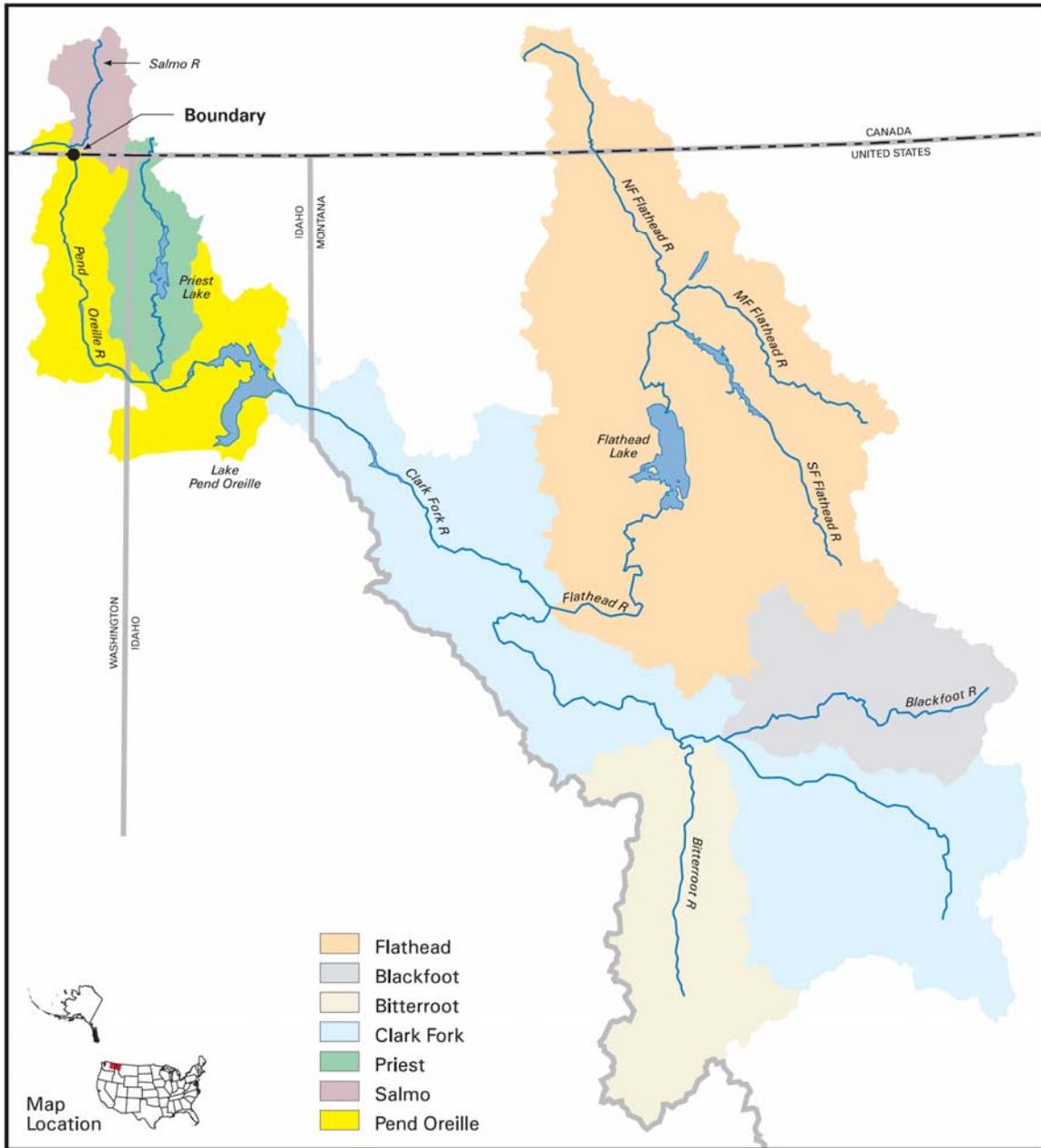
hydrology would be important if were necessary to synthesize flow records from meteorological and precipitation records. However, that approach is not required to develop hydrologic data needed to support resource studies for this Project. The primary focus of the hydrologic database reported and discussed herein is on hourly flow and water surface elevations from various locations upstream and downstream from Boundary Dam. Some meteorological and precipitation information is discussed in this introductory section to generally describe conditions near the Project.

All water surface elevations reported herein are with respect to the North American Vertical Datum of 1988 (NAVD 88) since the U.S. Geological Survey (USGS) is gradually changing to this new vertical datum on a state-by-state basis, followed in parentheses by the National Geodetic Vertical Datum of 1929 (NGVD 29) since the current license exhibits are in this datum.

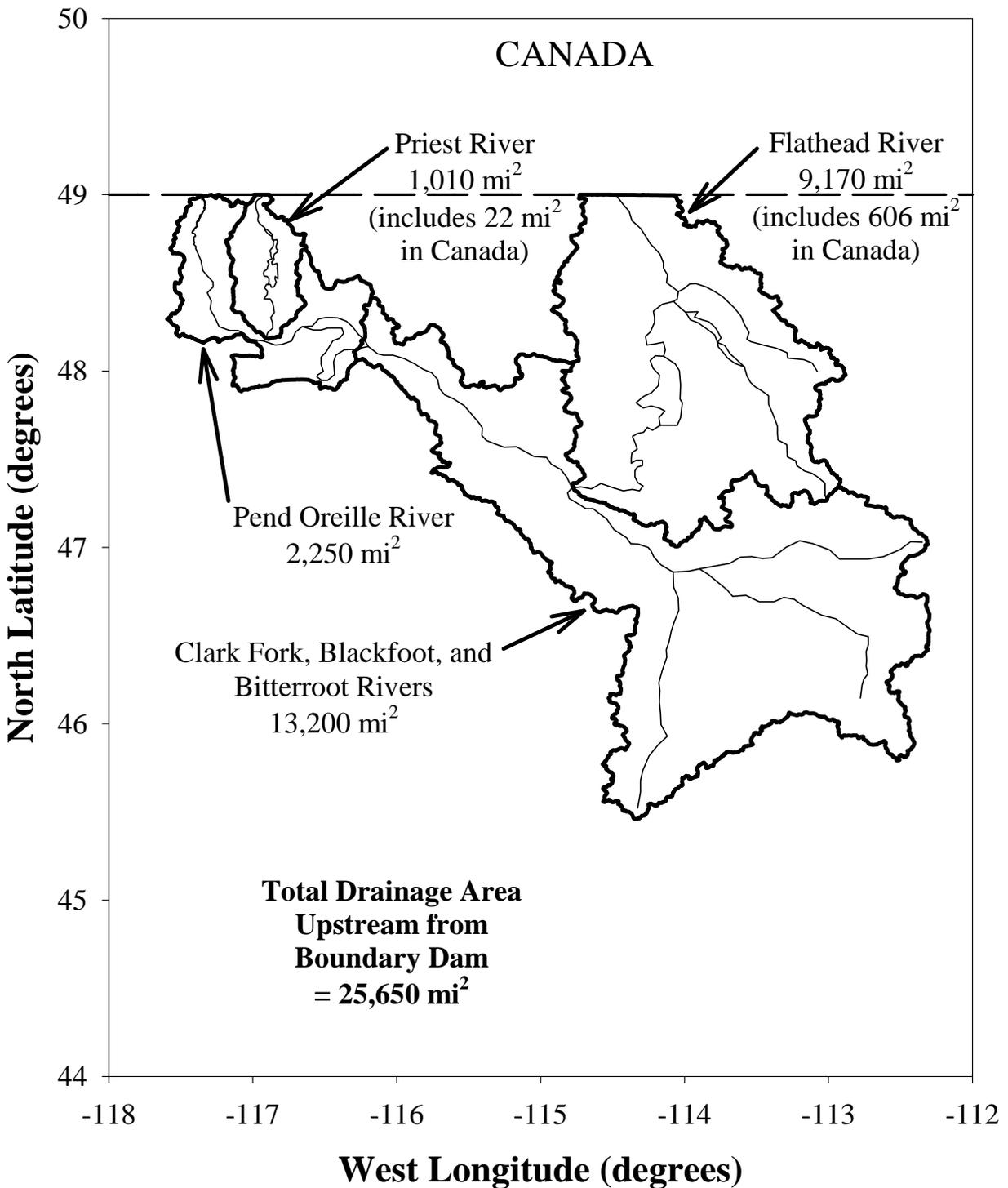
With a total drainage area of 26,260 square miles (including 25,090 square miles in the United States and 1,170 square miles in Canada), the Pend Oreille River is one of the two main tributaries to the Columbia River (Figure 1-1), contributing approximately 10 percent of the Columbia River's flow on an annual basis (Muckleston 2003). The eastern boundary of the Pend Oreille River basin lies along the continental divide and extends from Canada to approximately Butte, Montana. The major tributaries to the Pend Oreille River include the Blackfoot, Bitterroot, Flathead, and Clark Fork rivers. The Blackfoot and Bitterroot rivers flow in to the Clark Fork River near Missoula, Montana. Further downstream, the Flathead River flows into the Clark Fork River, which then flows from Montana across northern Idaho into Lake Pend Oreille. The Pend Oreille River begins at the outlet of Lake Pend Oreille. The Priest River flows into the Pend Oreille River, which then flows into Washington, where it heads north into Canada for its last 16 miles, joining the Columbia River at Waneta, in British Columbia. The Pend Oreille River proper is approximately 120 miles long from its head at the outlet of Lake Pend Oreille to its confluence with the Columbia River. The total drainage area of the Pend Oreille River upstream from Boundary Dam is 25,650 square miles (Figure 1-2).

The Project is set within the heavily forested Selkirk Mountains, and the surrounding topography is rugged. The mountains in the Project vicinity reach 6,830 feet in elevation with intervening valleys ranging in elevation from 2,000 to 2,400 feet. The major topographic features at the site have been imposed by glacial erosion and deposition above elevation 2,000 feet and by stream erosion below that level. Boundary Dam itself is located in a narrow section of the river canyon. The isolated pyramidal rock mass that houses the Project's underground power plant rises abruptly from a wide section of the stream some 500 feet downstream from the dam (Schilling 1966).

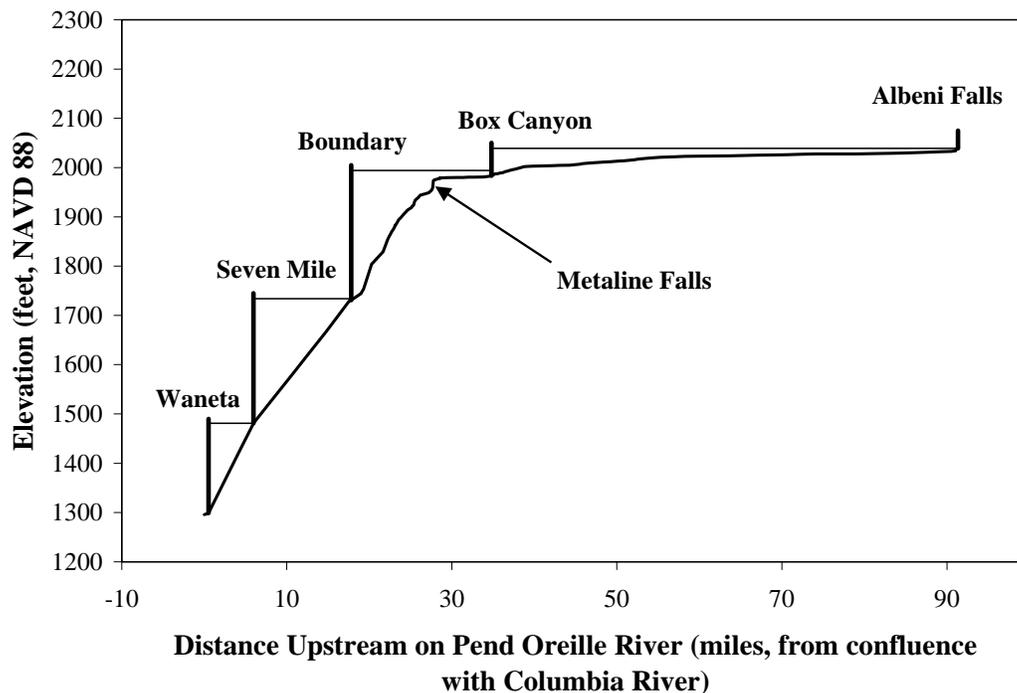
In the Project vicinity, the Pend Oreille River flows through a valley of varying width and steepness. The gradient of the river channel (stream bed) is relatively flat from Albeni Falls (Project River Mile 88 or RM 88, where tailwater elevation at mean low flow is 2,039.03 feet NAVD 88, or 2,035 feet NGVD 29) to Metaline Falls (RM 25, where elevation of the channel is approximately 1,979.03 feet NAVD 88, or 1,975 feet NGVD 29), as shown in Figure 1-3, and this portion of the river flows through a relatively wide, deep valley. From Metaline Falls downstream, the river flows through a deep, narrow gorge with steep canyon walls for most of its length to its confluence with the Columbia River (RM 0, at about elevation 1,294.03 feet NAVD 88, or 1,290 feet NGVD 29).



**Figure 1-1.** Pend Oreille River Basin in Washington, Idaho, Montana, and British Columbia.



**Figure 1-2.** Pend Oreille River upstream from Boundary Dam (not including portions of the basin in Canada) (USGS 2007).



**Figure 1-3.** Pend Oreille River from Albeni Falls Dam to the confluence with the Columbia River and location of major dams.

Within the Pend Oreille River valley, mean annual precipitation is approximately 27 inches. December and January account for about 25–35 percent of the annual precipitation, whereas July and August account for only 6 percent. On average, the daily rainfall exceeds 0.1 inches 29.7 days each year, and the daily snowfall exceeds 1.0 inches 73.1 days each year. Winters are typically cold, and the snowpack normally covers all but the lowest elevations continuously from November through May (ENTRIX 2001).

Seasonal patterns of temperature and precipitation were derived from long-term records of meteorological data collected in Newport, Washington (1927 through 2007 [Western Region Climate Center 2007]). The wettest months (November through February) coincide with the coldest months of the year (Figure 1-4). Much of the precipitation that falls during this period is stored in the snowpack at higher elevations, and subsequently released when temperatures warm up during the spring.

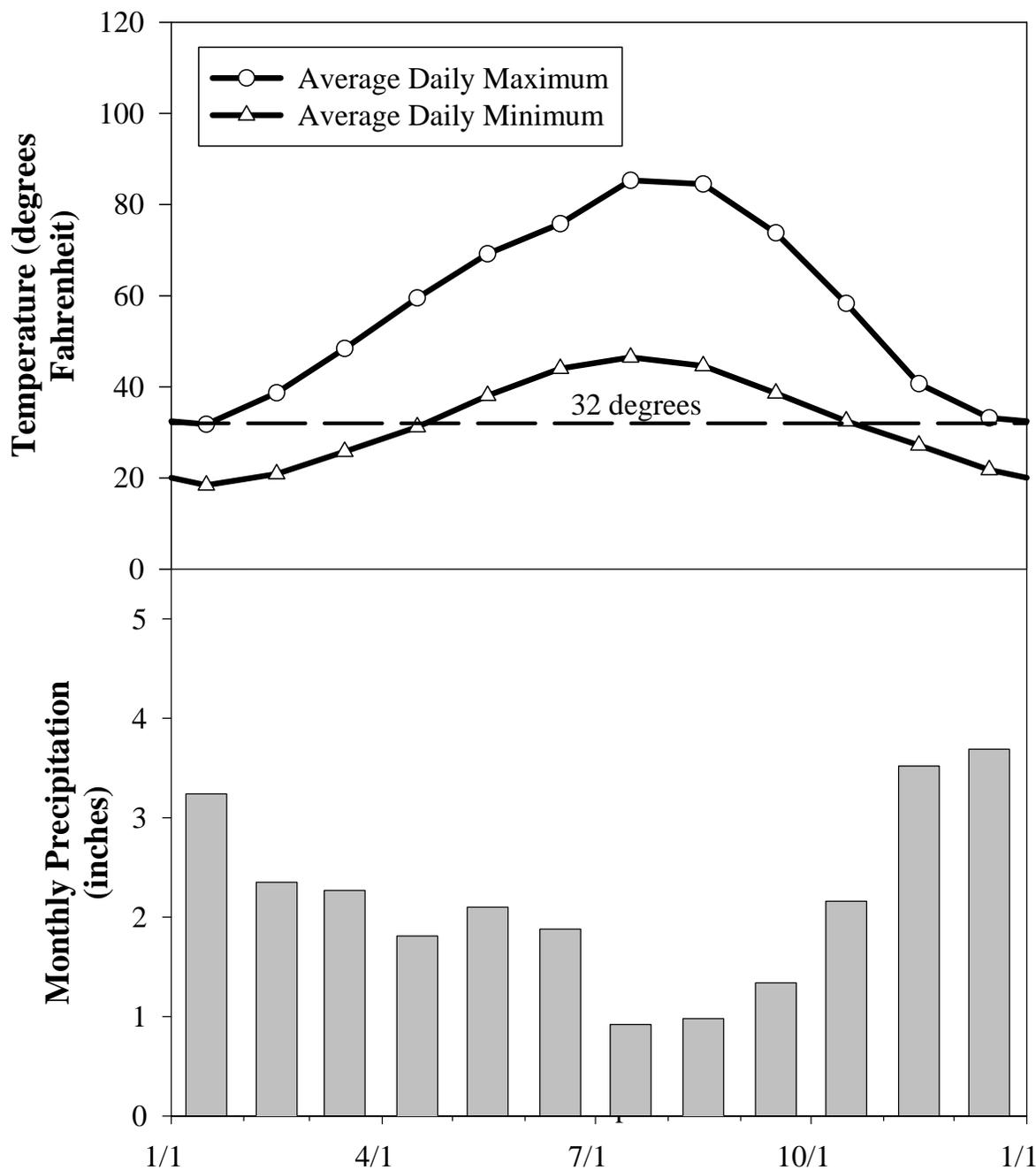


Figure 1-4. Monthly average daily maximum and minimum temperatures, and monthly average daily precipitation in Newport, Washington.

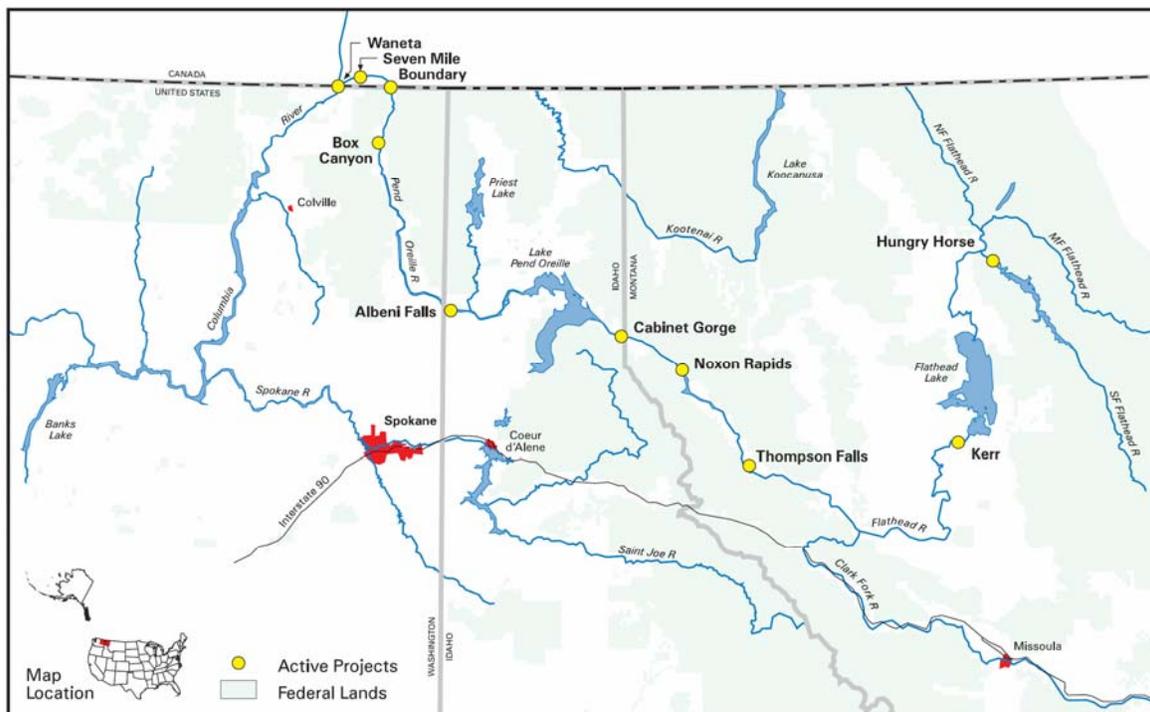
Boundary Dam is one of eleven dams on the mainstem and major tributaries within the Pend Oreille River basin. The dams and corresponding locations (RM upstream of the Columbia River) are as follows:

- Hungry Horse (South Fork Flathead River) — RM 390.3
- Kerr Project (Flathead River) — RM 318.0
- Thompson Falls (Clark Fork River) — RM 208.0
- Noxon Rapids (Clark Fork River) — RM 169.7
- Cabinet Gorge (Clark Fork River) — RM 149.9
- Priest Lake (Priest River) — RM 139.0
- Albeni Falls (Pend Oreille River) — RM 90.1
- Box Canyon (Pend Oreille River) — RM 34.5
- Boundary (Pend Oreille River) — RM 17.0
- Seven Mile (Pend Oreille River) — RM 6.0
- Waneta (Pend Oreille River) — RM 0.5

Significant storage reservoirs within the basin include Hungry Horse Reservoir and Flathead Lake in Montana, and Lake Pend Oreille in Idaho, as shown in Figure 1-5. Other projects along the mainstem upstream from the Boundary Project include the Box Canyon Project, immediately upstream, the Albeni Falls Project, the Cabinet Gorge Development and Noxon Rapids Development of the Clark Fork Project in Idaho and Montana, and the Thompson Falls Project in Montana. Downstream of Boundary Dam, the Pend Oreille River flows past the Seven Mile and Waneta dams, both in Canada, before entering the Columbia River. Potential influence on flows by individual projects is greater during low flow periods and for those reservoirs having significant storage capacity (Enserch 1994). In addition to the dams listed above, the Sullivan Creek Hydroelectric Project dam is located on Sullivan Creek (a tributary to Boundary Reservoir).

A total of 27 tributaries enter Boundary Reservoir, 14 of which are named. The named tributaries, shown in Figure 1-6 are Everett, Flume, Pewee, Lime, Linton, Lost, Lunch/Sweet, Pocahontas, Three Mile, Sand, Slate, Sullivan, Whiskey, and Wolf creeks. Drainage areas of all of the named tributaries to Boundary Reservoir between Box Canyon Dam and Boundary Dam are listed in Table 1-1. The total drainage area of the Pend Oreille River between Box Canyon Dam and Boundary Dam is 268.3 square miles. The largest tributary is Sullivan Creek with a drainage area of 140.9 square miles (about 53% of the total drainage between Box Canyon and Boundary dams).

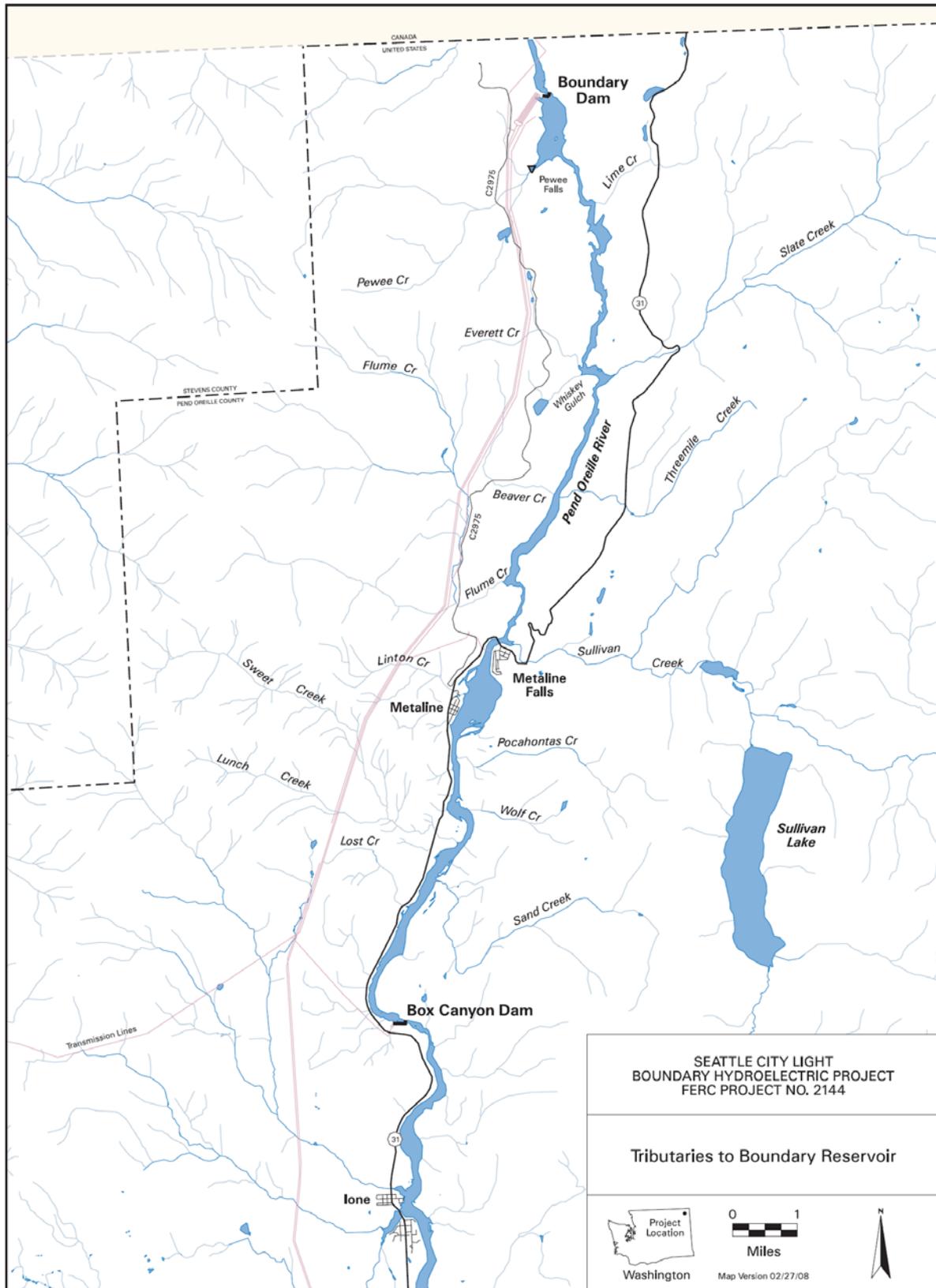
With the exception of Sullivan Creek, which has water storage at Mill Pond and Sullivan Lake, discharge patterns for these tributaries are unregulated, with peak flows generally occurring from May through June and minimum flows occurring in September. Sullivan Creek, the largest of the tributaries draining into Boundary Reservoir, is the only tributary in which discharge is known to be regularly monitored.



**Figure 1-5.** Locations of major dams within Pend Oreille River Basin.

**Table 1-1.** Drainage areas of tributaries to Boundary Dam between Box Canyon Dam and Boundary Dam.

Tributary	Drainage Area (mi <sup>2</sup> )	Percent of Total
Sullivan Creek	142.0	52.9%
Slate Creek	31.9	11.9%
Flume Creek	18.7	7.0%
Sweet Creek/Lunch Creek	11.3	4.2%
Pewee Creek	10.2	3.8%
Sand Creek	7.7	2.9%
Lime Creek	4.3	1.6%
Threemile Creek	4.1	1.5%
Pocahontas Creek	3.1	1.2%
Linton Creek	2.6	1.0%
Everett Creek	2.2	0.8%
Beaver Creek	1.9	0.7%
Wolf Creek	1.7	0.6%
Lost Creek	1.2	0.4%
Whiskey Gulch	0.7	0.3%
Thirteen unnamed tributaries plus hillslope drainage	24.7	9.2%
<b>Total</b>	<b>268.3</b>	<b>100.0%</b>



**Figure 1-6.** Tributaries to Boundary Reservoir between Box Canyon Dam and Boundary Dam.

Between Boundary Dam and the confluence with the Columbia River, the Pend Oreille River gains an additional 610 square miles of drainage area. The Salmo River in British Columbia, with a drainage area of 475 square miles, accounts for 77 percent of the downstream gain. The Salmo River is an unregulated, gaged tributary to the Pend Oreille River with a long record of gaged flows (Calendar Years 1950 through 2006).

Boundary Dam, situated in a narrow canyon and founded on interbedded limestone and dolomite of the Metaline Limestone formation, is a variable-radius concrete arch dam with a total height of 360 feet above the lowest part of the foundation and a structural height of 340 feet. The dam structure varies in thickness from 8 feet at the crest to 32 feet at the base. The dam has a crest length of 508 feet and a total length, including the spillways, of 740 feet. The dam impounds the Pend Oreille River to a normal high-water level at elevation 1,994.03 feet NAVD 88 (or 1990 feet NGVD 29), as measured in the forebay.

The Pend Oreille River in the tailwater of Boundary Dam is at approximately elevation 1,733.04 feet NAVD 88 (or 1729 feet NGVD 29), so the impoundment provides approximately 261 feet of gross head for power purposes. There are two spillways fitted with radial gates, one on each abutment. Each spillway is 50 feet wide and controlled by a radial gate 45 feet high. The two radial gate spillways have a combined total maximum capacity of 108,000 cfs at reservoir elevation 1,994.03 feet NAVD 88 (or 1900 feet NGVD 29). The spillways are equipped with an air bubbler system to prevent the formation of ice at the gates.

Seven low-level sluices through the dam under a head of 190 feet provide 252,000 cfs of the total 360,000 cfs discharge capacity of the dam at reservoir elevation 1,994.03 feet NAVD 88 (or 1900 feet NGVD 29). The sluices are steel-plate lined, including the entrance transitions that incorporate a surface against which the maintenance bulkhead seals. The sluice gates are fixed-wheel gates, 17 feet wide by 21 feet high, operated by cable hoists located on a hoist deck along the downstream face of the dam at elevation 1,864.03 feet NAVD 88 (or 1860 feet NGVD 29). A sluice maintenance bulkhead, 35 feet wide by 57 feet high, can be moved into position on the upstream face of the dam over a sluice entrance and utilized for dewatering the sluices for maintenance purposes. In addition, there is one bascule-type (hinged-leaf) skimmer gate, 26 feet wide by 9 feet high, adjacent to the left spillway originally designed to permit passage of debris from the reservoir.

Boundary Reservoir extends 17.5 miles upstream from the dam. The reservoir occupies a canyon that is relatively wide for approximately the first mile upstream of the dam then tapers to a narrow gorge and remains narrow up to Metaline Falls. Upstream of Metaline Falls, the reservoir widens and becomes shallower for the rest of its length to Box Canyon Dam.

Metaline Falls is a geological feature that geographically divides Boundary Reservoir into two distinct reaches: an upstream reach that extends from Box Canyon Dam to Metaline Falls; and a downstream reach that extends from Metaline Falls to Boundary Dam. The gradient of the upstream reach is much less than the gradient of the downstream reach, as shown in Figure 1-3. Furthermore, the Pend Oreille River must pass through a bedrock-controlled constriction located at Metaline Falls.

To account for storage in Boundary Reservoir, it is convenient to divide the reservoir into the two reaches separated by Metaline Falls. The water surface elevation in the upstream reach (from Box Canyon Dam to Metaline Falls) is typically higher than the water surface elevation in the downstream reach (from Metaline Falls to Boundary Dam) as further discussed in Section 4.

Boundary Reservoir has a small active storage capacity (41,000 acre-feet) relative to the average daily river flow (52,000 acre-feet). As a result, instream flow releases to the Pend Oreille River from Boundary Dam on annual, seasonal, and monthly time intervals are largely controlled by the amount of water delivered from upstream projects such as the Albeni Falls and Hungry Horse.

The reservoir has relatively little active storage (about 41,000 acre-feet) within the maximum drawdown of 40 feet (active storage from elevation 1,994.03 feet NAVD 88 (1,990 feet NGVD 29) to elevation 1,954.03 feet NAVD 88 (1,950 feet NGVD 29) authorized under the current license. During the summer recreation season (approximately Memorial Day weekend through Labor Day weekend), SCL voluntarily restricts the water surface fluctuations to a 10-foot range between elevations 1,984.03 feet NAVD 88 (1,980 feet NGVD 29) and 1,994.03 feet NAVD 88 (1,990 feet NGVD 29) to facilitate reservoir access and related recreational activities during daytime hours. For the remainder of the year, the water surface may fluctuate between elevations 1,994.03 feet NAVD 88 (1,990 feet NGVD 29) and 1,974.03 feet NAVD 88 (1,970 feet NGVD 29). Storage between elevation 1,974.03 feet NAVD 88 (1,970 feet NGVD 29) and elevation 1,954.03 feet NAVD 88 (1,950 feet NGVD 29) is reserved for extreme system load requirements. Flood storage is not provided, and other than the operating goals noted above, there are no seasonal or minimum flow requirements.

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## 2 DEVELOPMENT OF HOURLY HYDROLOGIC DATABASE

### 2.1. Available Data

Sources of available hydrologic data for Boundary Project include the U.S. Geological Survey (USGS), Seattle City Light, BC Hydro, the Water Survey of Canada, and the U.S. National Weather Service. Data were obtained and reviewed for two primary purposes: to characterize basin hydrology; and to develop a standardized database for resource evaluations during the relicensing process. Hydrologic data were reviewed to identify missing gaps and anomalies. Missing data were synthesized and anomalies were adjusted to ensure overall consistency.

Although Boundary Project has been operating since 1967, operation of the Project changed in 1986 when two larger turbine units were added to the original array of four smaller turbine units. Thus, the period since 1986 is considered representative of current operations. The period extending from Calendar Year 1987 through 2005 was selected for development of the standardized hydrologic database for resource evaluations during the relicensing process.

Hydrologic summary statistics have been developed from hourly records from this 19-year period from Calendar Year 1987 through 2005, and these statistics are reported herein. Although records from 2006 are no longer considered provisional, they were not included in this report because their inclusion would not significantly alter the results reported in this report, which were derived from 19 years of hourly records.

Types of hydrologic records obtained included flow (hourly, daily, monthly, and annual), and water surface elevation (hourly). Records from Calendar Year 1987 through 2005 were used to characterize the selected study period for resource evaluations while records outside of this 19-year period were used to describe basin hydrology. The following specific hydrologic data were obtained:

- **U.S. Geological Survey**
  - Pend Oreille River below Albeni Falls Dam (Gage No. 12395500)
    - Average monthly flows for the 30-year period extending from Calendar Year 1971 through 2000
  - Pend Oreille River below Box Canyon Dam (Gage No. 12396500)
    - Average monthly flows for the 53-year period from Calendar Year 1953 through 2005
    - Hourly flows for the 19-year period from Calendar Year 1987 through 2005

- Hourly water surface elevations for the primary gage from Calendar Year 1987 through 2005
- Hourly water surface elevations for the auxiliary gage from Calendar Year 1987 through 2005.
  
- Sullivan Creek above Outlet Creek (Gage No. 12396900):
  - Daily flows from April 24, 1994 to September 30, 2003.
  
- Sullivan Creek near confluence with Pend Oreille River (Gage No. 12398000):
  - Average monthly flows from Water Year 1954 through 1968, and from 1995 through 2003, and daily flows from April 24, 1994 to September 30, 2005, and from July 1, 2004 to September 30, 2005.
  
- Pend Oreille River just upstream from current location of Boundary Dam (Gage No. 12398500)
  - Average annual flows from Calendar Year 1913 through 1963
  
- Pend Oreille River below Boundary Dam (Gage No. 12398600):
  - Average annual flows from Calendar Year 1913 through 2006
  
- **Seattle City Light**
  - Hourly flow releases from Boundary Dam to Pend Oreille River from Calendar Years 1987 through 2005
  - Hourly water surface elevations in Boundary Forebay from Calendar Years 1987 through 2005
  - Hourly water surface elevations from Boundary Tailwater
  - Boundary Reservoir elevation/storage curve, based on original bathymetry and based on topographic and bathymetric surveys conducted from 2005 through 2007.
  
- **BC Hydro**
  - Hourly flow releases from Seven Mile Dam to Pend Oreille River from Calendar Years 1987 through 2005

- Hourly water surface elevations in Seven Mile Forebay from Calendar Years 1987 through 2005
- **Water Survey of Canada**
  - Salmo River near confluence with Pend Oreille River (Gage No. 08NE074) – daily flows from Calendar Years 1950 through 2006.
- **U.S. National Weather Service**
  - Pend Oreille River below Albeni Falls Dam – estimates of unimpaired monthly average flows from Calendar Years 1971 through 2000.

## 2.2. Standardization of Data

All hydrologic records were converted to a standard system of units (English), and all water surface elevations were converted to a common datum, the North American Vertical Datum of 1988 (NAVD 88). Hydrologic records obtained from Canadian sources (BC Hydro and Water Survey of Canada) were converted from metric to English units using conversion factors adopted by the U.S. National Institute of Standards and Technology (1995).

Elevation records obtained from sources in the United States in the vicinity of Boundary Project were converted from the National Geodetic Vertical Datum of 1929 (NGVD 29) to NAVD 88 by adding 4.03 feet. Elevation records obtained from Canadian sources were converted from the Canadian Geodetic Vertical Datum of 1928 (CGVD 28) to NAVD 88 by adding 4.00 feet.

## 2.3. Missing Data

There were a few gaps of missing data in the list of hydrologic data sources described in Section 2.1. These gaps of missing data consisted of the following:

- Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) – hourly flows and water surface elevations for both the primary and auxiliary gages were missing during the following periods:

- January 1, 1987 through September 30, 1987
  - September 24, 1990 through October 10, 1990
  - June 4, 1992 through June 10, 1992
  - January 31, 1996 through February 6, 1996
  - December 17, 1996 through January 10, 1997
  - December 3, 1997 through February 5, 1998
  - February 9, 1998 through February 23, 1998
- Pend Oreille River below Boundary Dam (Gage No. 12398600) – average annual flows were missing from 1995 and 1996.
  - Boundary Tailwater hourly water surface elevations – January 1, 1987 through March 18, 1988.

Missing hourly flows and water surface elevations from the Pend Oreille River below Box Canyon Dam were synthesized using methods described in Section 2.4. The missing annual flows from the Pend Oreille River below Boundary Dam were the result of missing daily flows from October 1, 1995 through September 30, 1996 in the USGS database. These missing daily flows were determined from hourly flows provided by SCL, and the missing annual average flows from 1995 and 1996 were calculated from daily flows from those two years. Missing Boundary Tailwater hourly water surface elevations were synthesized using methods described in Section 2.4.

## 2.4. Anomalies in Data

As would be expected with 19 years of hourly measurements (166,560 hours) of flow and water surface elevations at various locations in the Pend Oreille River, some anomalies were found in the raw data. These erroneous data were identified, and then adjusted to be consistent with measurements at neighboring locations.

Anomalies in flow measurements were identified by comparing daily flows measured in the Pend Oreille River below Box Canyon Dam, below Boundary Dam, and below Seven Mile Dam. Potential discrepancies were identified when flow differences exceeded the capacity of each project to alter daily flows, after accounting for tributary inflow. The following discrepancies were found:

1. The daily flow derived from SCL hourly outflows from Boundary Reservoir was much lower than daily flows obtained from other sources on September 11, 1987.
2. The daily flow derived from BC Hydro hourly outflows from Seven Mile Reservoir was much lower than daily flows obtained from other sources on April 12, 1989.

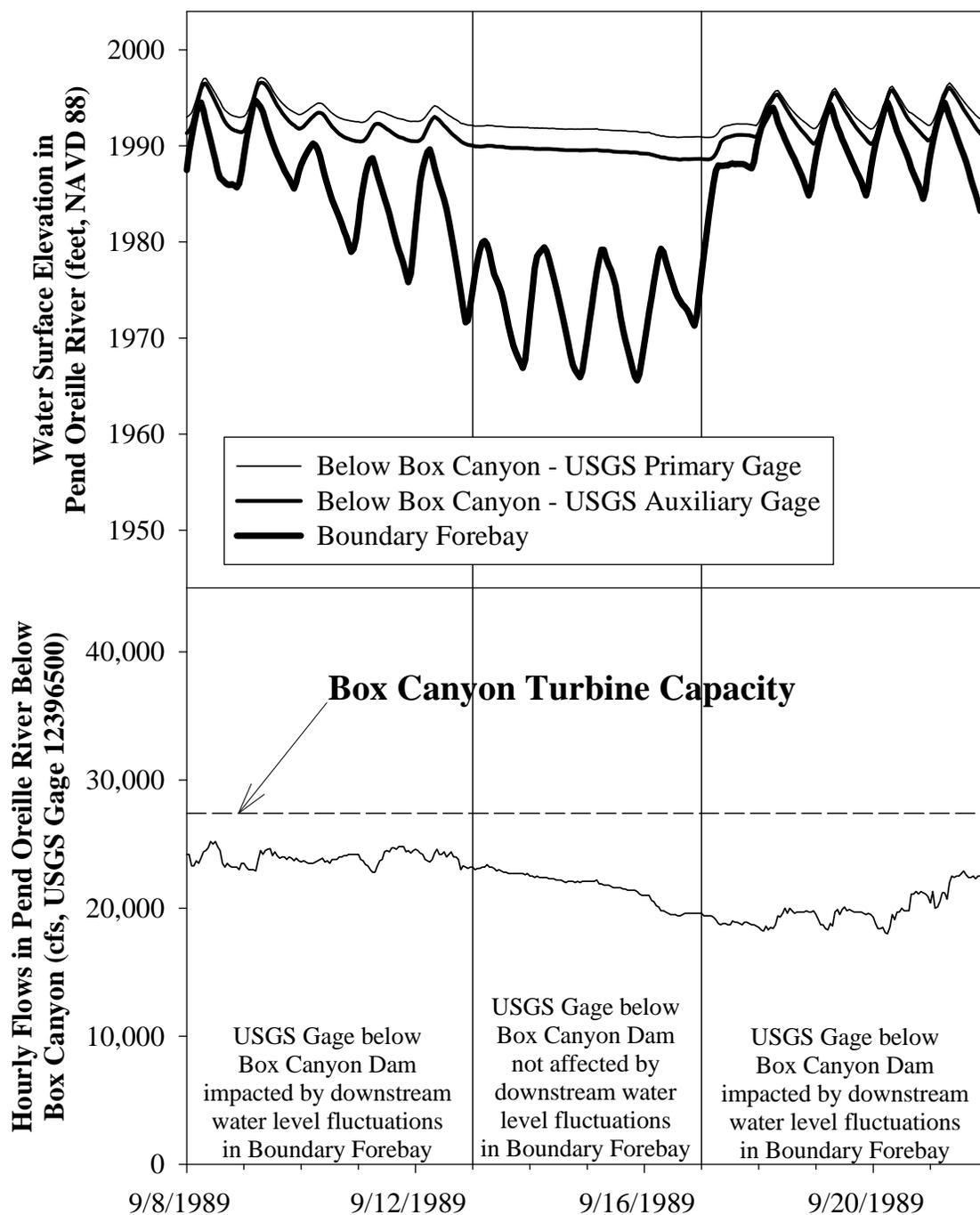
3. The daily flow derived from BC Hydro hourly outflows from Seven Mile Reservoir was much lower than daily flows obtained from other sources on May 11, 1989.
4. Daily flows derived from SCL hourly inflows to and outflows from Boundary Reservoir were much higher than daily flows obtained from other sources on March 30 and 31, 1990.
5. The daily flow derived from BC Hydro hourly outflows from Seven Mile Reservoir was much higher than daily flows obtained from other sources on April 3, 1995.
6. The daily flow derived from BC Hydro hourly outflows from Seven Mile Reservoir was much lower than daily flows obtained from other sources on March 29, 2000.

To correct these anomalies, hourly outflows from Boundary Reservoir were adjusted by SCL for September 11, 1987, and for March 30 and 31, 1990, and incorporated into the hydrologic database. BC Hydro hourly outflows for April 12, 1989, May 11, 1989, April 3, 1995, and March 29, 2000 were estimated, and incorporated into the hydrologic database. These flows were determined by first estimating the average daily flows for those particular days, using the daily flows released from Boundary Project as a guide and by accounting for tributary inflow (Salmo River). The schedule of hourly flows within each day was then patterned after the hourly flows released on the preceding and following days.

The US Geological Survey uses a two-gage system to measure flow in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) because the water levels in the Pend Oreille River below Box Canyon Dam depends on both the flow releases from Box Canyon Dam to the Pend Oreille River and downstream water levels in Boundary Forebay. Water levels are measured by the USGS at a primary gage located 1,000 feet downstream from Box Canyon Powerplant, and at an auxiliary gage located 4,700 feet further downstream (1.2 miles downstream from Box Canyon Dam).

Hourly flow records at the USGS Gage in the Pend Oreille River below Box Canyon Dam exhibit fluctuations within each day. Hourly flow records obtained from the USGS typically show a peak flow around 5:00PM and reach a minimum flow shortly after midnight. These patterns can be seen in Figure 2-1, which shows hourly flows from the USGS Gage on the Pend Oreille River below Box Canyon Dam, and hourly water levels in Boundary Forebay, and at the primary and auxiliary gages in the Pend Oreille River below Box Canyon Dam from September 8 to 21, 1989.

As illustrated in Figure 2-1, from September 8 to 12, 1989, and from September 17 to 21, 1989, water level fluctuations in Boundary Forebay caused the water levels at the primary and auxiliary gages to fluctuate, and hourly flow fluctuations can be seen in the reported hourly flow measurement. From September 13 to September 16, 1989, the water levels in Boundary Forebay dropped to a level where the Pend Oreille River below Box Canyon Dam was not affected by water level fluctuations in Boundary Forebay. The reported hourly flows during this period do not display the typical apparent fluctuations that occur when the water levels in Boundary Forebay are fluctuating at higher levels.



**Figure 2-1.** Hourly flows in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500), and hourly water levels in Boundary Forebay, and the USGS primary and auxiliary gages in the Pend Oreille River below Box Canyon Dam, September 8 to 21, 1989.

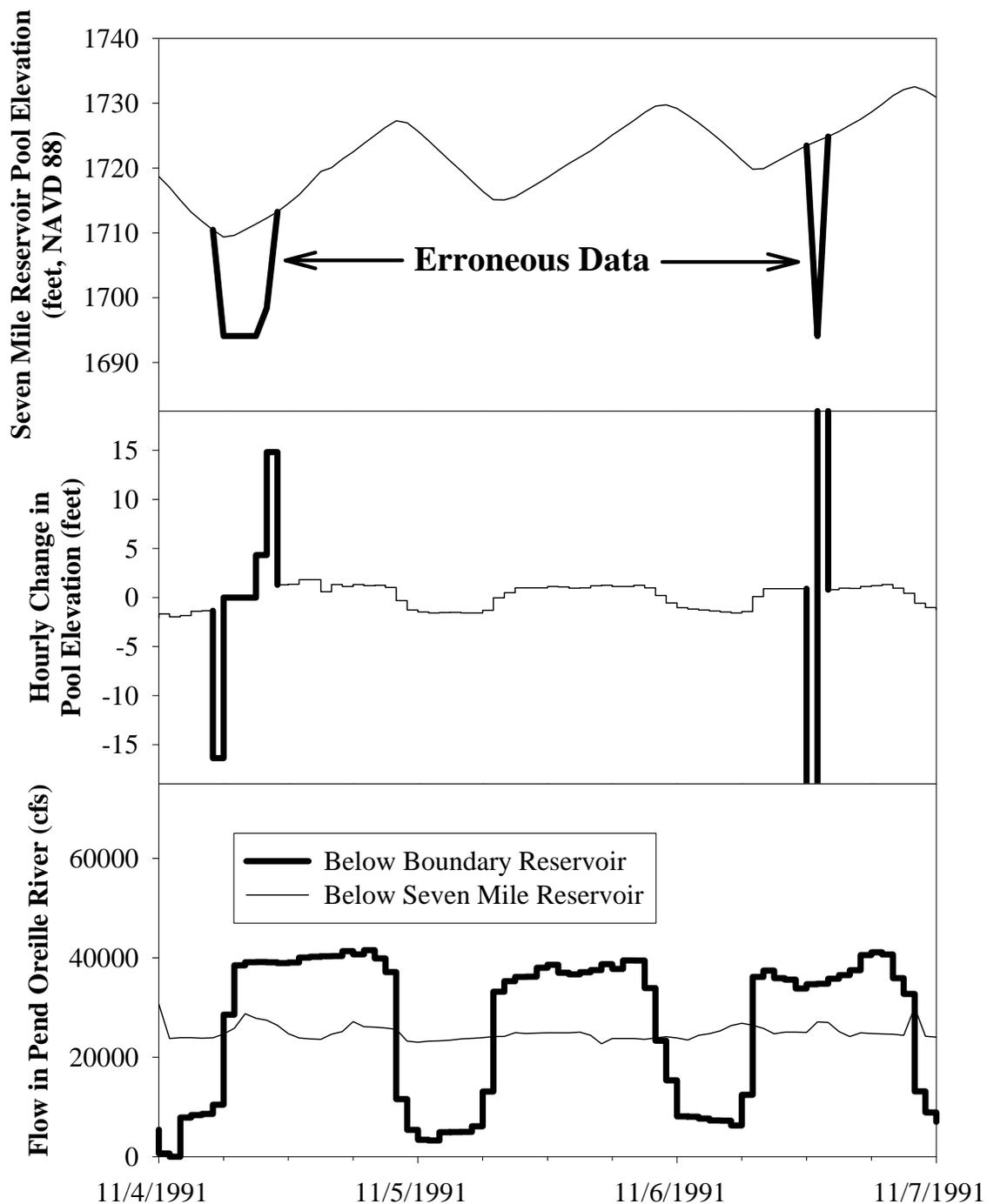
The results shown in Figure 2-1 suggest that the hourly flow hydrograph for the Pend Oreille River below Box Canyon (USGS Gage No. 12396500) may be smoother than reported by the USGS. The USGS uses a two-gage system to measure the flows in the Pend Oreille River below Box Canyon Dam. The water surface elevation is measured at two locations: a Primary gage located 1,000 feet downstream from Box Canyon Dam; and an Auxiliary gage located 1.2 miles downstream from Box Canyon Dam. Two gages are used to account for the backwater effect from the water surface elevation in Boundary Forebay on the water surface elevation just downstream from Box Canyon Dam. This method would be most accurate if the water surface elevation in Boundary Forebay were steady. However, it would be less accurate if the water surface elevation in Boundary Forebay were fluctuating on an hourly basis.

To adjust for these anomalies, a “smoothed” hydrograph of hourly flows was calculated for the Pend Oreille River below Box Canyon Dam, consistent with the reported daily flows at that gage. For sake of completeness, both the “unsmoothed” and the “smoothed” hourly flows are included in the hydrologic database.

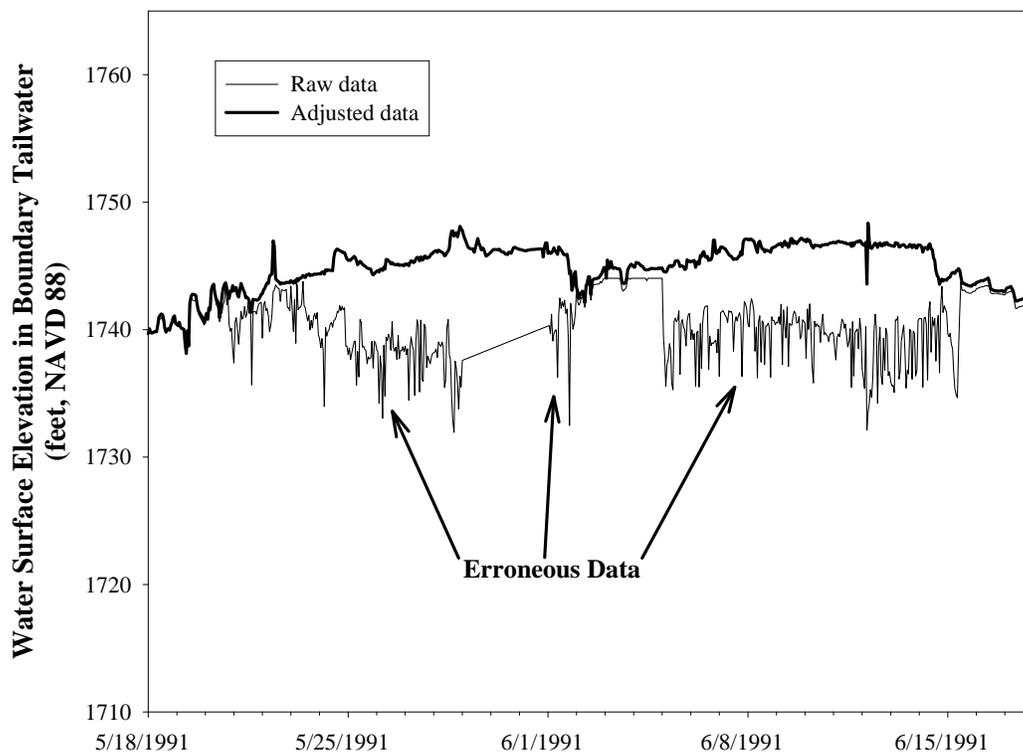
Hourly water surface elevations measured by BC Hydro in Seven Mile Forebay were reviewed, and a total of 63 anomalies were identified over the 19-year period from Calendar Year 1987 through 2005. An example of a couple of these errors is illustrated in Figure 2-2. These anomalies were adjusted to provide a more realistic pattern of hourly water surface fluctuations.

Erroneous hourly water surface elevations were also found in Boundary Tailwater, most notably from May 20 to June 15, 1991, and from May 6 to June 27, 1991, as shown in Figures 2-3 and 2-4, respectively. Anomalous hourly water surface elevations in Boundary Tailwater were adjusted using methods described in Section 2.4.

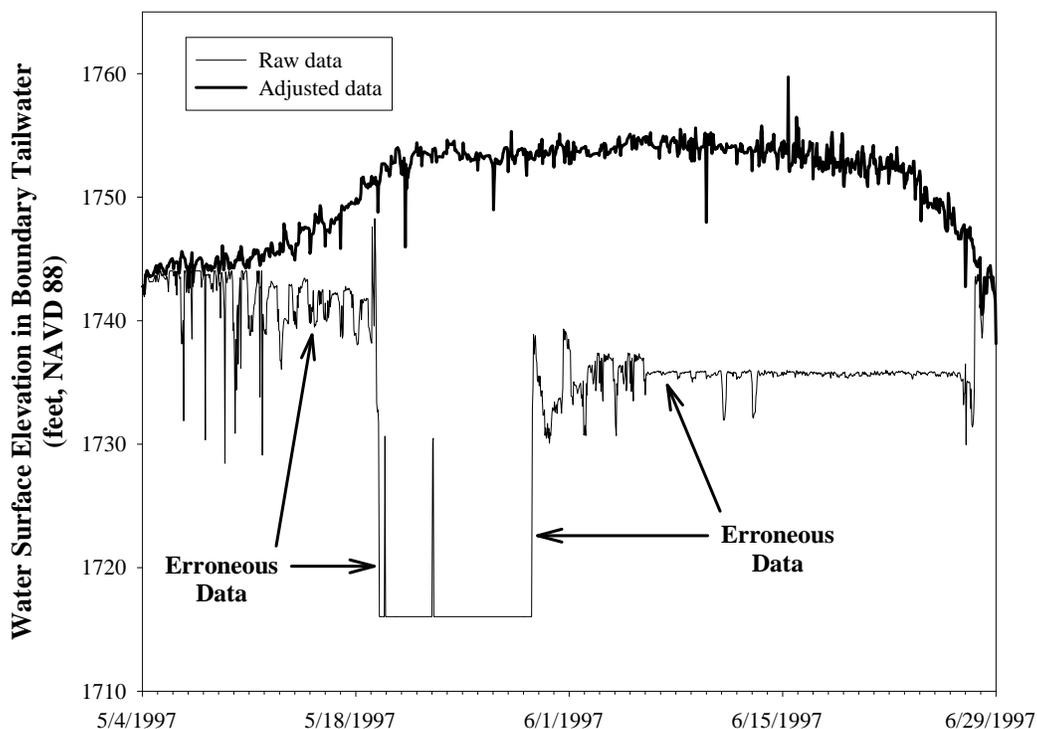
Hourly water surface elevations in the Pend Oreille River were checked to ensure that water surface elevations at downstream locations did not exceed water surface elevations at upstream locations. In particular, water surface elevations in Boundary Forebay were reviewed to ensure that they did not exceed water surface elevations in the Pend Oreille River below Box Canyon Dam, and water surface elevations in Seven Mile Forebay were evaluated to ensure that they did not exceed water surface elevations in Boundary Tailwater.



**Figure 2-2.** Hourly water surface elevations and hourly change in water surface elevation in Pend Oreille River in Seven Mile Forebay, and hourly flow releases from Boundary Dam and from Seven Mile Dam to the Pend Oreille River, November 4 to 7, 1991.



**Figure 2-3.** Hourly water surface elevations in Boundary Tailwater, raw and adjusted data, May 18 to June 17, 1991.



**Figure 2-4.** Hourly water surface elevations in Boundary Tailwater, raw and adjusted data, May 4 to June 29, 1997.

## 2.5. Data Synthesis

The total inflow to Boundary Reservoir consists of the flows released from Box Canyon Dam plus the sum of all inflows from the Boundary Reservoir tributaries listed in Table 1-1. The only gaged tributary to the Pend Oreille River is Sullivan Creek (USGS Gage No. 12398000).

One possible way to estimate the total inflow from ungaged tributaries to Boundary Reservoir would be to subtract the flow releases from Box Canyon Dam and the change in reservoir storage from the flow releases from Boundary Dam. However, this approach would often result in negative calculated tributary inflows to Boundary Reservoir because the flow releases from Box Canyon Dam and Boundary Dam are very large compared to the tributary inflows. Small (percentage-wise) errors in the flow releases from Box Canyon Dam and Boundary Dam can lead to calculated negative flows when the difference between these two large flows of similar magnitude is determined.

Therefore, an alternate method was used to estimate the tributary inflows to Boundary Reservoir. As previously mentioned, Sullivan Creek was the only gaged tributary during the selected study period (January 1987 to December 2005). Flow measurements are available at the following two locations on Sullivan Creek:

1. ***Sullivan Creek above Outlet Creek (USGS Gage No. 12396900)***, drainage area of 70.2 square miles, flow records available from April 24, 1994 through September 30, 2003.
2. ***Sullivan Creek near confluence with Pend Oreille River (USGS Gage No. 12398000)***, drainage area of 142 square miles, flow records available from April 24, 1994 through September 30, 2003, and from July 1, 2004 through September 30, 2005.

Flows in Sullivan Creek above Outlet Creek are unregulated, and can thus be used to estimate flows in ungaged tributaries to the Pend Oreille River between Box Canyon Dam and Boundary Dam. Flows in Sullivan Creek near the confluence with the Pend Oreille River are regulated to store up to 31,000 acre-feet during the spring (March through June) for subsequent release during the fall (October through December).

The flow record in Sullivan Creek above Outlet Creek was extended to cover the entire study period (January 1987 through December 2005) by synthesizing missing flows, using relationships derived from a nearby reference gage. In a previous study (FERC 1998), flow records from Boundary Creek, Idaho (USGS Gage No. 12321500) were used to synthesize missing flows in Sullivan above Outlet Creek.

In this study, the following two sites were considered for a reference gage to synthesize flows in Sullivan Creek above Outlet Creek:

1. **Boundary Creek, Idaho (USGS Gage No. 12321500)**, drainage area of 97 square miles, located in Kootenay River Basin.
2. **Salmo River near confluence with Pend Oreille River (Water Survey of Canada Gage No. 08NE074)**, drainage area of 475 square miles.

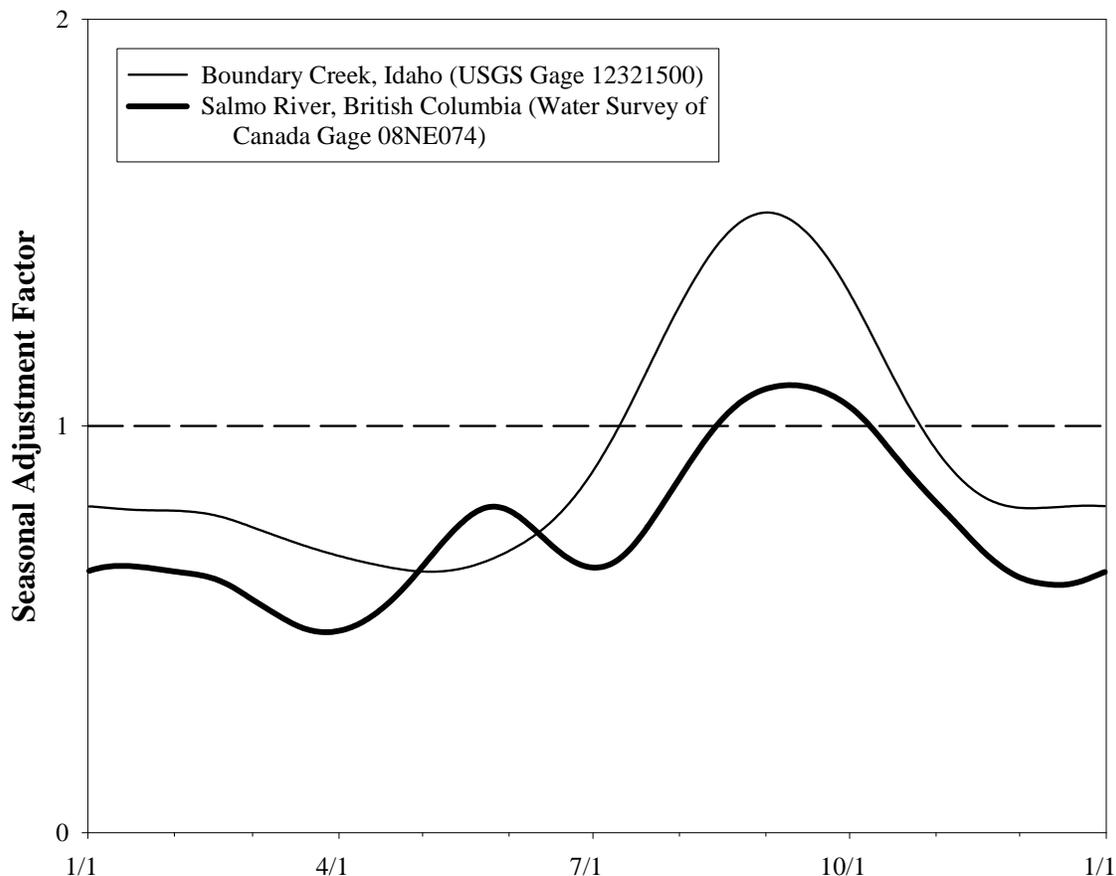
The drainage area in Boundary Creek, Idaho (97 square miles) is a closer match to the drainage area of Sullivan Creek above Outlet Creek (70.2 square miles) than the drainage area of the Salmo River (475 square miles). However, Boundary Creek is located in the Kootenay River Basin, while the Salmo River is located in the Pend Oreille River Basin. Flow records from Boundary Creek and the Salmo River were compared with flow records from Sullivan Creek above Outlet Creek for Calendar Years 1995 through 2002. It was found that flow records in Sullivan Creek above Outlet Creek could be estimated by multiplying concurrent flows from the reference gage by the drainage area ratio and a seasonal adjustment factor as shown in Figure 2-5.

When the seasonal adjustment factor (shown in Figure 2-5) is less than one, it means that the unit runoff (flow per square mile) in Sullivan Creek above Outlet Creek is less than the corresponding unit runoff at the reference gage. When the seasonal adjustment factor is greater than one, as it is for both reference gages during the summer, it means that the unit runoff in Sullivan Creek is greater than the corresponding unit runoff at the reference gage.

The percent (%) difference between observed and predicted flows in Sullivan Creek above Outlet Creek was calculated for the predictions from both reference gages. The quadratic mean (root mean square or RMS) of these percentage differences was considerably smaller for the predictions based on the Salmo River than the predictions based on Boundary Creek (34% versus 60%). Consequently, the Salmo River was selected as the reference gage to synthesize missing flows in Sullivan Creek below Outlet Creek.

The average flow in Sullivan Creek near the confluence with the Pend Oreille River from 1995 through 2002 was 275 cfs, while the average flow in Sullivan Creek above Outlet Creek was 130 cfs. The ratio of these two flows is 2.11 and is very similar to the drainage area ratio of 2.02. This suggests that a simple drainage area ratio can be used to estimate flows at ungaged, unimpaired tributaries between Box Canyon Dam and Boundary Dam from the flows in Sullivan Creek above Outlet Creek.

The long-term average monthly flow in August in the Salmo River is about 21 percent of the long-term average annual flow at the same location. In contrast, the long-term average monthly flow in August in Sullivan Creek above Outlet Creek is 31 percent of the long-term average annual flow. The relatively high base flow in Sullivan Creek suggests that ungaged tributaries to the Pend Oreille River between Box Canyon Dam and Boundary Dam may be spring-fed, consistent with qualitative observations during the summer low flow period (Hilgert 2007).



**Figure 2-5.** Seasonal adjustment factor used to synthesize flows in Sullivan Creek above Outlet Creek (USGS Gage No. 12396900) based on flows in Boundary Creek Idaho (USGS Gage No. 12321500) and flows in Salmo River, British Columbia (Water Survey of Canada Gage No. 08NE074).

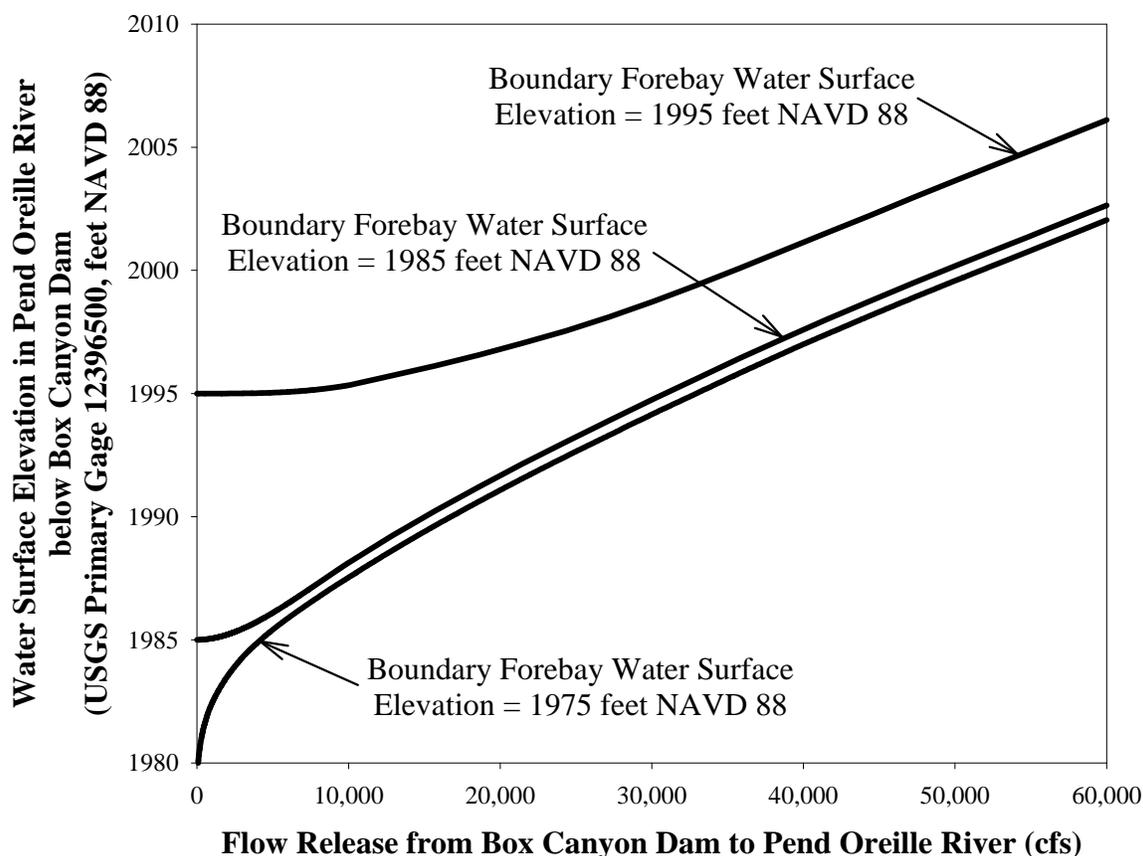
The flow record in Sullivan Creek near the confluence with the Pend Oreille River was also extended and data gaps filled in by first estimating the unimpaired flows at that location by multiplying the corresponding flows in Sullivan Creek above Outlet Creek by the ratio of average flows of 2.11 between the two locations. The unimpaired flows were then modified to account for up to 31,000 acre-feet stored in April through June for subsequent release in October through December.

As mentioned in Section 2.3, hourly flows and water surface elevations were missing from the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) for several periods between 1987 and 2005. Hourly flows were synthesized by estimating a continuous pattern of hourly flows, consistent with the reported daily flows at that gage.

Missing hourly water surface elevations were estimated by deriving a relationship between water surface elevation in the Pend Oreille River below Box Canyon Dam, and combined effect of flow release from Box Canyon Dam and water surface elevation in Boundary Forebay.

The daily maximum water surface elevation in the Pend Oreille River below Box Canyon Dam was determined for each day from 1987 through 2005 from available data. The corresponding hourly flow release from Box Canyon Dam, and daily maximum water surface elevation in Boundary Forebay were also determined.

It was found that the water surface elevation in the Pend Oreille River below Box Canyon Dam can be estimated from the hourly flow release from Box Canyon Dam and the water surface elevation in Boundary Forebay, using the curves illustrated in Figure 2-6. The relationships illustrated in Figure 2-6 are approximate, and would be most accurate under steady-state conditions. A more accurate determination of water surface elevations in the Pend Oreille River below Box Canyon Dam will be developed using an unsteady flow routing model as part of other relicensing efforts.

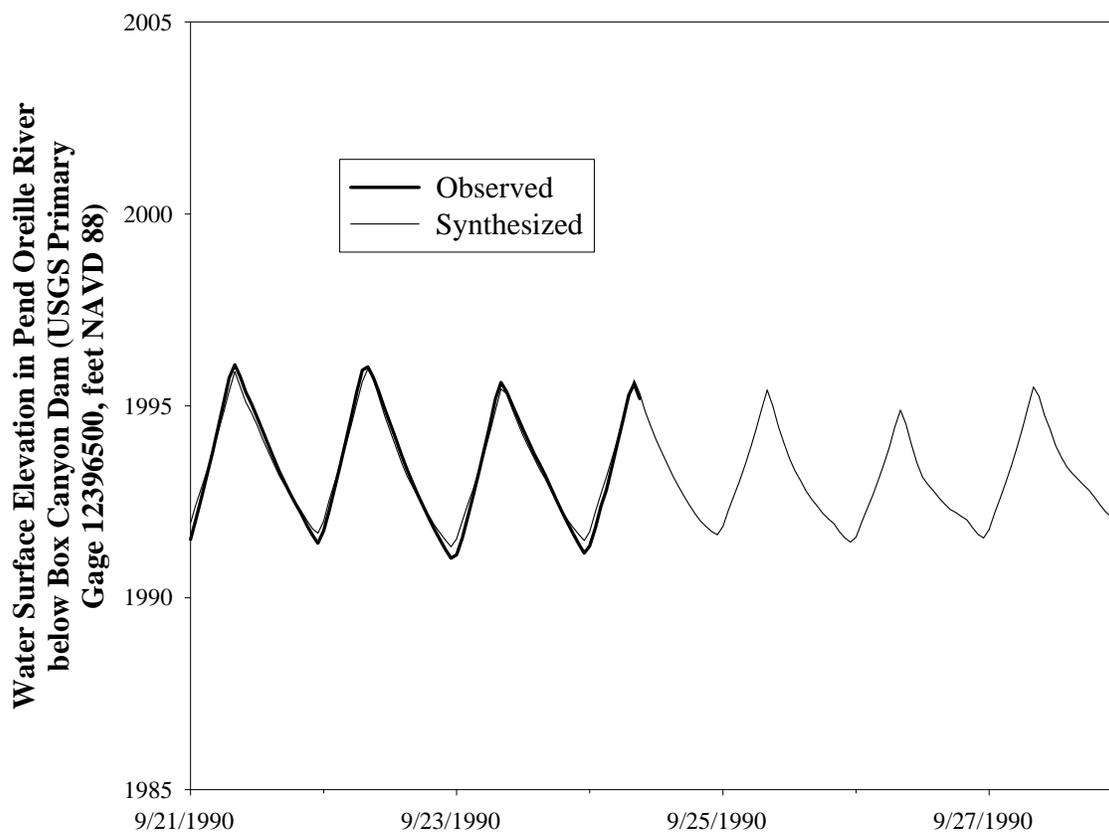


**Figure 2-6.** Approximate water surface elevation in Pend Oreille River below Box Canyon Dam, estimated from flow release from Box Canyon Dam, and water surface elevation in Boundary Forebay. Water surface elevations estimated from this figure would be most accurate under steady-state conditions.

The relationships illustrated in Figure 2-6 were used to synthesize water surface elevations in the Pend Oreille River below Box Canyon Dam to fill in the missing data gaps identified in Section 2.3. An example of the synthesized stage hydrograph is shown in Figure 2-7 for the period from September 21 to 27, 1990. There is good agreement between the observed and synthesized

hydrographs from September 21 to 23, 1990. The synthesized stage hydrograph was used to fill in the missing data gap after September 23, 1990.

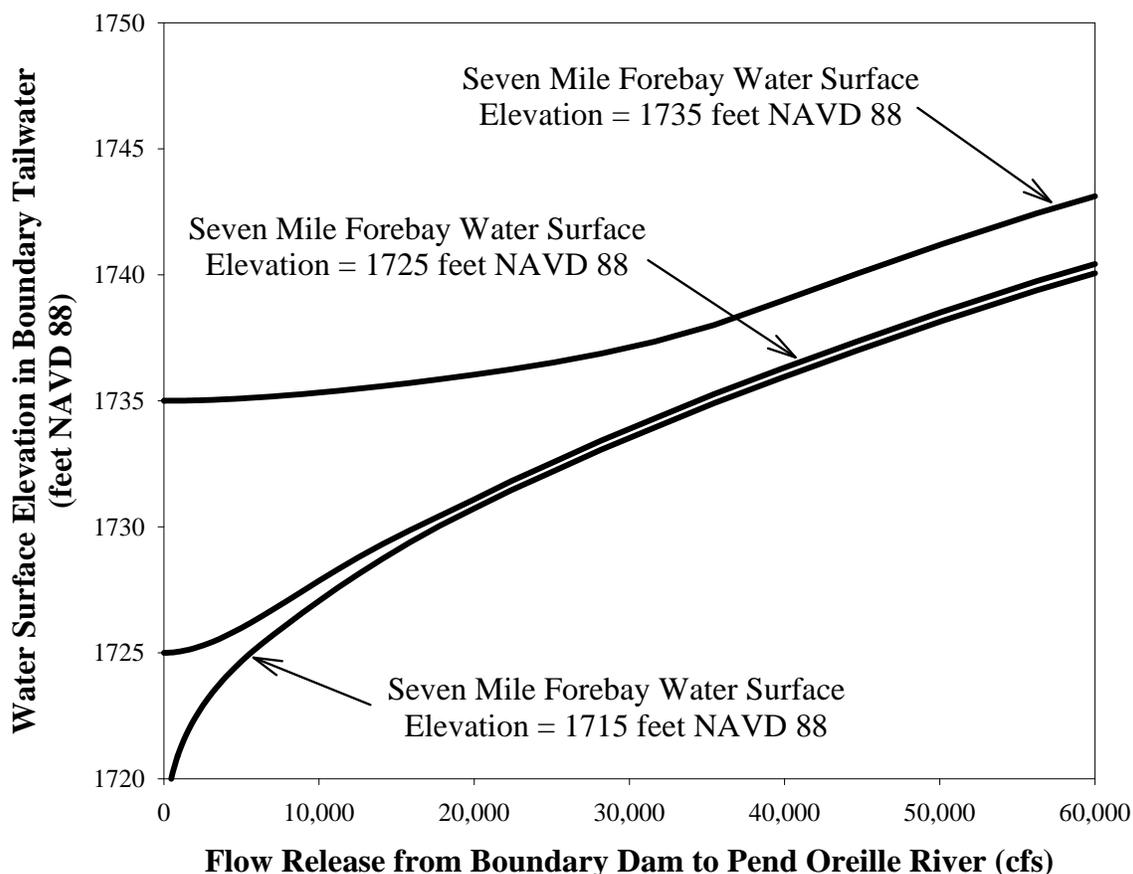
A similar process was used to synthesize water surface elevations in Boundary Tailwater to fill in missing data gaps identified in Section 2.3. The daily maximum water surface elevation in the Boundary Tailwater was determined for each day from 1998 through 2005 from available data, a period when no major anomalies in hourly water surface elevations were found at this location. The corresponding hourly flow release from Boundary Dam, and the corresponding hourly water surface elevation in Seven Mile Forebay were also determined.



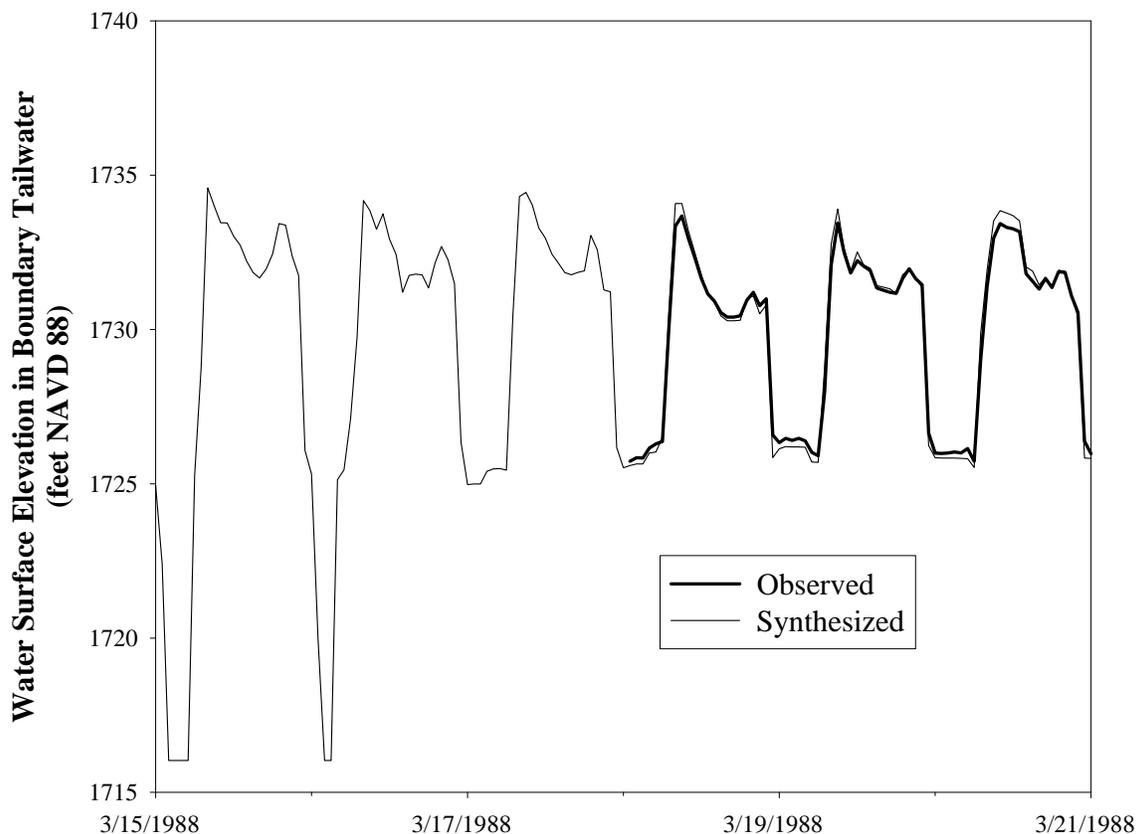
**Figure 2-7.** Observed and approximate synthesized hourly stage hydrographs, Pend Oreille River below Box Canyon Dam, USGS Primary Gage No. 12396500, September 21 to 27, 1990.

It was found that the water surface elevation in Boundary Tailwater can be estimated from the hourly flow release from Boundary Dam and the water surface elevation in Seven Mile Forebay, using the curves illustrated in Figure 2-8. The relationships illustrated in Figure 2-8 are approximate, and would be most accurate under steady-state conditions. A more accurate determination of water surface elevations in Boundary Tailwater will be developed using an unsteady flow routing model for resource evaluations.

The relationships illustrated in Figure 2-8 were used to synthesize water surface elevations in Boundary Tailwater to fill in the missing data gaps identified in Section 2.3. An example of the synthesized stage hydrograph is shown in Figure 2-9 for the period from March 15 to 20, 1988. There is good agreement between the observed and synthesized hydrographs from March 18 to 20, 1988. The synthesized stage hydrograph was used to fill in the missing data gap prior to March 18, 1988. The relationships shown in Figure 2-9 were also used to adjust the erroneous water surface elevations in Boundary Tailwater in 1991 and in 1997, shown in Figures 2-3 and 2-4, respectively.



**Figure 2-8.** Approximate water surface elevation in Boundary Tailwater, estimated from flow release from Boundary Dam, and water surface elevation in Seven Mile Forebay. Water surface elevations estimated from this figure would be most accurate under steady-state conditions.



**Figure 2-9.** Observed and approximate synthesized hourly stage hydrographs, Boundary Tailwater March 15 to 20, 1988.

## 2.6. Description of Hourly Hydrologic Database

After reviewing available hourly data, adjusting anomalies, and filling in data gaps, a Project hourly hydrologic database was developed. The database includes hourly water surface elevations at various locations in the Pend Oreille River upstream and downstream from the Project, and hourly flows at various locations in the Pend Oreille River and its tributaries upstream and downstream from the Project from 1987 through 2005. An inventory of the hourly hydrologic data is provided in the section.

Hourly water surface elevations are provided for the 19-year period from Calendar Year 1987 through 2005 at the following locations in the Pend Oreille River:

- Below Box Canyon Dam at USGS Primary Gage No. 12396500
- Below Box Canyon Dam at USGS Auxiliary Gage No. 12396500
- Boundary Forebay
- Boundary Tailwater
- Seven Mile Forebay.

Hourly flows are provided for the 19-year period from Calendar Year 1987 through 2005 at the following locations in the Pend Oreille River:

- Below Box Canyon Dam at USGS Gage No. 12396500 – both “unsmoothed” and “smoothed”
- Below Boundary Dam – total release and spill
- Below Seven Mile Dam – total release.

Hourly flows are provided for the 19-year period from Calendar Year 1987 through 2005 at the following tributaries of the Pend Oreille River between Box Canyon Dam and Seven Mile Dam:

- Sullivan Creek
- Slate Creek
- Flume Creek
- Sweet Creek/Lunch Creek
- Pewee Creek
- Sand Creek
- Lime Creek
- Threemile Creek
- Pocahontas Creek
- Linton Creek
- Everett Creek
- Beaver Creek
- Wolf Creek
- Lost Creek
- Whiskey Gulch
- Thirteen unnamed tributaries plus hillslope drainage between Box Canyon Dam and Boundary Dam
- Salmo River

Summary statistics were derived from this database, and the results of these analyses are reported in Sections 4 and 5.

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### 3 BASIN HYDROLOGY

#### 3.1. Long-Term Trends

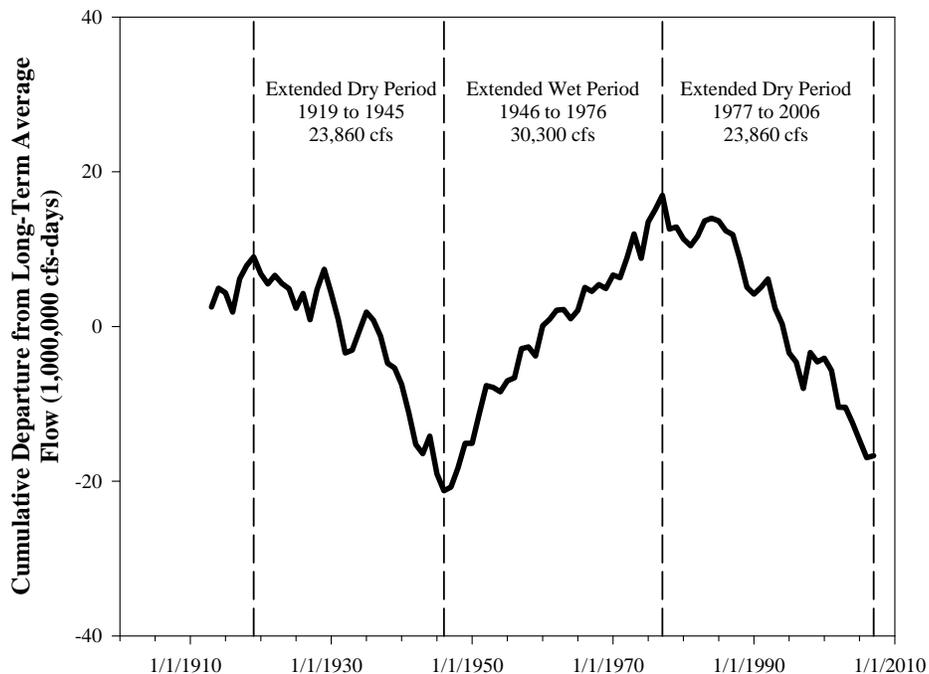
Long-term flow records are available from the USGS for the Pend Oreille River in the vicinity of Boundary Dam from Calendar Year 1913 through 2006. Prior to 1964, flows were measured by the USGS in the Pend Oreille River just upstream from the present location of Boundary Dam (Gage No. 12398500) from Calendar Year 1913 through 1963. When Boundary Dam was constructed, SCL assumed responsibility for measuring river flows and reported these data to the USGS (Gage No. 12398600). Flows have been measured in the vicinity of Boundary Dam from Calendar Year 1913 through 2006, with one year of overlap between the two gages.

Average annual flows from this 94-year period of record were analyzed to determine historical trends in basin hydrology. The long-term average flow during this period was 26,370 cfs. The cumulative departure from this long-term average was determined with the results shown in Figure 3-1. An extended dry period was observed from 1919 through 1945 (average flow of 23,860 cfs), followed by an extended wet period from 1946 through 1976 (average flow of 30,300 cfs), followed by another extended dry period from 1977 through 2006 (average flow of 23,860 cfs). The durations of these extended periods were remarkably similar, ranging from 27 to 31 years. The period adopted for Boundary relicensing studies (1987 through 2005) is within the current extended dry period (average flow is about 10% less than the long-term average).

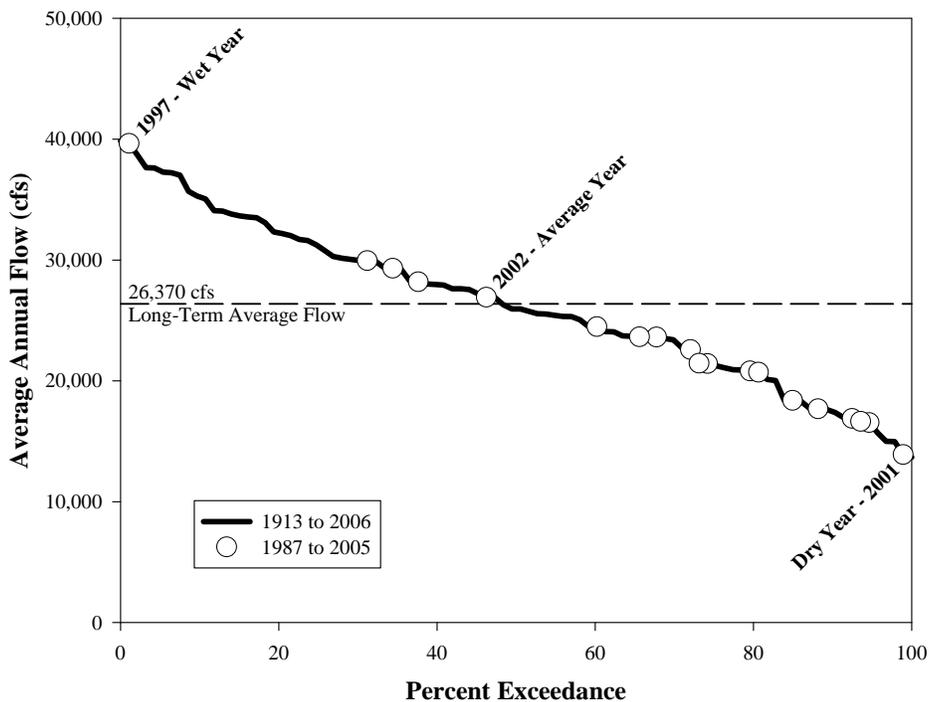
The alternating sequence of wet and dry periods shown in Figure 3-1 correspond with alternating periods of cool and warm temperatures in the Pacific Ocean, referred to as Pacific Decadal Oscillations (Mantua and Hare 2002). The periods with cool temperatures in the Pacific Ocean correspond with wet periods in the Pend Oreille River, while the periods with warm temperatures in the Pacific Ocean correspond with dry periods in the Pend Oreille River.

A flow duration curve was derived from the 94-years of average annual flow extending from 1913 through 2006, with the results shown in Figure 3-2. The relative ranking of each of the average annual flows from 1987 through 2005 was determined within the longer 94-year time period. These results are also illustrated in Figure 3-2. Most of the average annual flows from 1987 through 2005 (fourteen out of nineteen), had an exceedance frequency greater than the long-term median, consistent with the coincidence of this period with the recent extended dry period.

Although the period from 1987 through 2005 is somewhat drier than the long-term average, it does capture the long-term range of variability of basin hydrology. The average annual flow from 1997 ranks as the second wettest year during the 94-year period, while the average annual flow from 2001 ranks as the second driest year during the long-term record. The average annual flow from 2002 is similar to both the median and the long-term average from the 94-year period. Thus, Calendar Years 1997, 2001, and 2002 may be considered representative wet, dry, and average years, respectively, based on average annual flows.



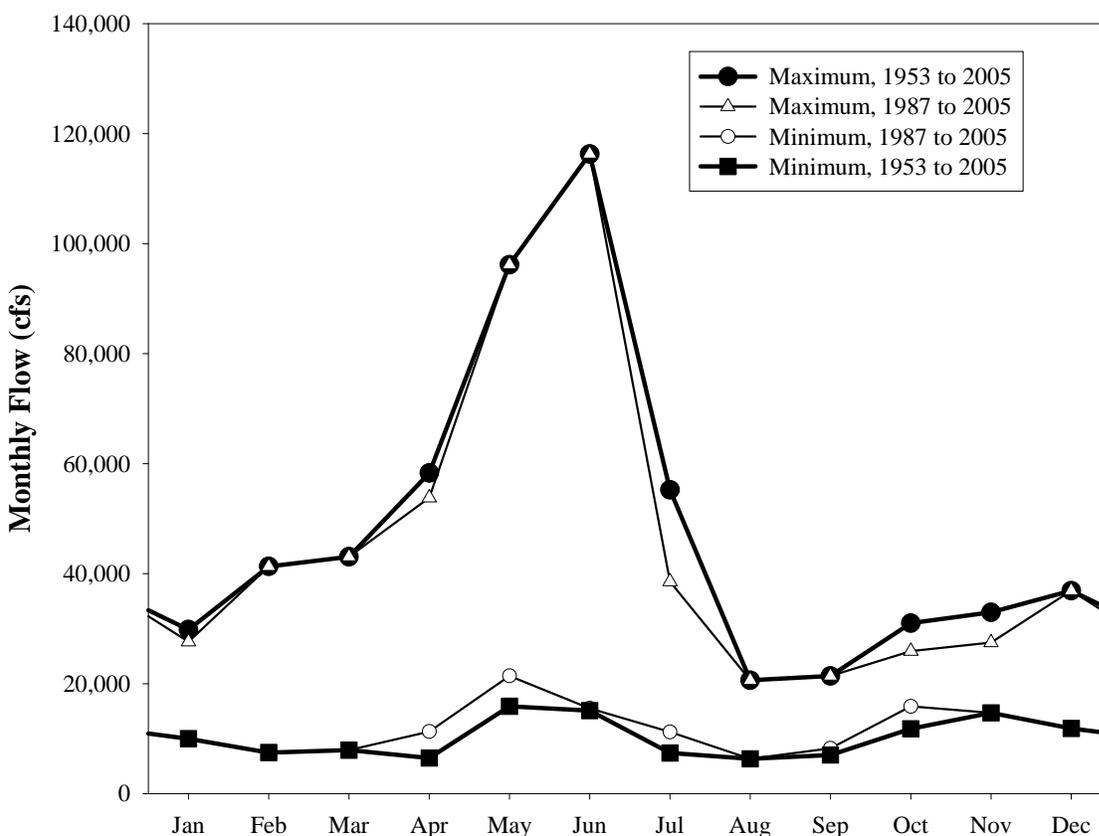
**Figure 3-1.** Historical trends in long-term basin hydrology for the Pend Oreille River in the vicinity of Boundary Dam, as determined from the cumulative departure from long-term average flow.



**Figure 3-2.** Flow duration for Pend Oreille River in the vicinity of Boundary Dam, derived from average annual flows from Calendar Year 1913 through 2006. Percent exceedance of average annual flows from 1987 through 2005 is shown, based on their ranking within the 94-year period extending from 1913 through 2006.

An alternate method of selecting representative wet, dry, and average years would be to look at the seasonal pattern of monthly flows in each calendar year. From this perspective, 1997 and 2001 would still be considered representative wet and dry years, respectively. However, the pattern of monthly flows in 2002 includes both wet and dry months and few months that are similar to average monthly flows from Calendar Year 1987 through 2005. The seasonal pattern of monthly flows in Calendar Year 1998 is very similar to the seasonal pattern of average monthly flows from Calendar Year 1987 through 2005. However, the average flow in 1987 was lower than the long-term annual average flow. The seasonal pattern of monthly flows in 1999 is similar to the seasonal pattern of average monthly flows from 1987 through 2005 and the average annual flow in 1999 is also similar to the long-term average flow.

Average monthly flows for the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) from Calendar Year 1953 through 2005 were examined to determine whether the period from 1987 through 2005 is representative of longer-term basin hydrology. Monthly flows since 1953 were used for this assessment, because the three largest upstream storage projects (Hungry Horse, Kerr, and Albeni Falls) have all been operating since 1953. Maximum and minimum monthly flows from January through December were determined for both time periods, 1953 through 2005 and 1987 through 2005. Results of these analyses are shown in Figure 3-3.

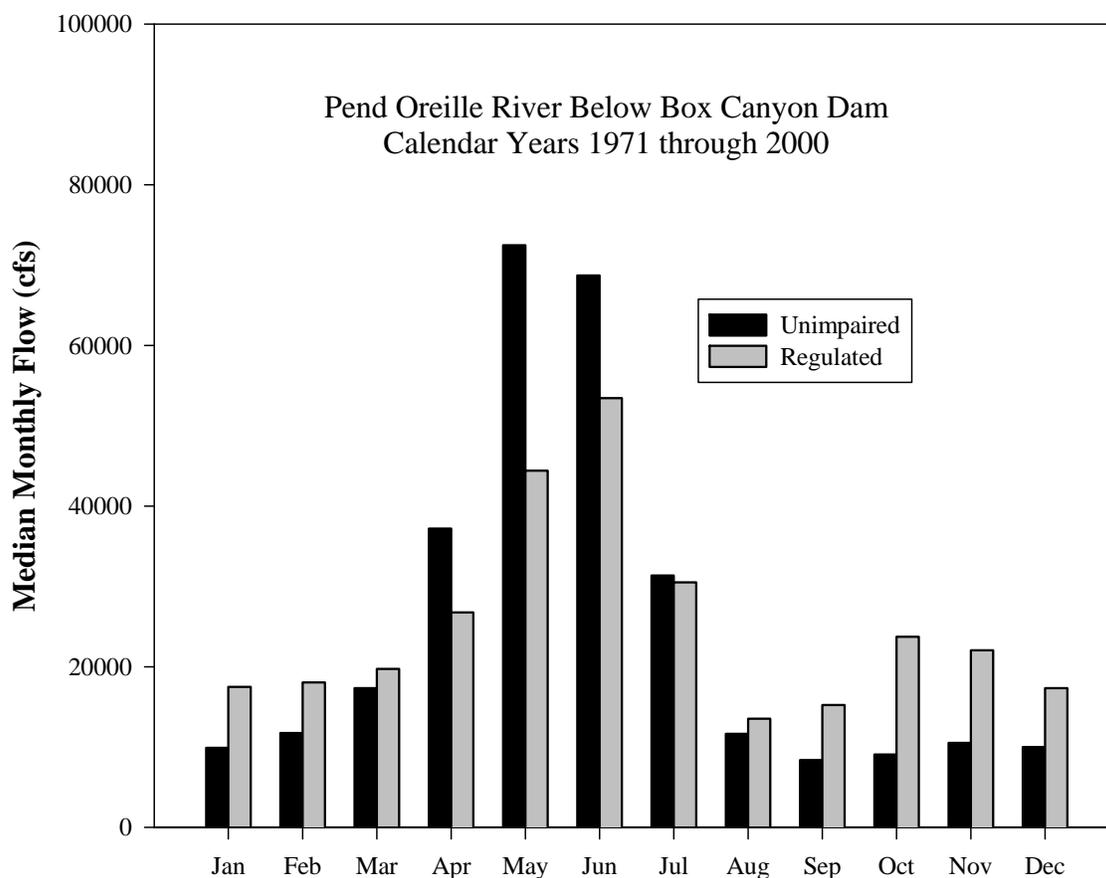


**Figure 3-3.** Maximum and minimum average monthly flows for Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) for January through December, based on 1953 through 2005, and on 1987 through 2005.

The shorter period (1987 through 2005) does contain the wettest month, June 1997 (average flow of 116,300 cfs), when compared with the longer period (1953 through 2005). The shorter period also contains the driest month, August 1988 (average flow of 6,340 cfs) when compared with the longer period. However, some months do not have a similar range of variability when compared with the longer period of record, i.e., April, May, July, and October.

### 3.2. Impacts of Upstream Projects

The influence of projects upstream from Boundary Dam is illustrated in Figure 3-4. Median monthly unimpaired flows in the Pend Oreille River below Box Canyon Dam are compared with regulated flows based on Calendar Years 1971 through 2000. Unimpaired conditions represent the flow regime that would occur if there were no upstream storage. The unimpaired flows typically exceed the regulated flows from May through July as water is stored in upstream projects. Regulated flows typically are greater than unimpaired flows from August through April as stored water is released from upstream projects.



**Figure 3-4.** Median monthly flows in Pend Oreille River below Box Canyon Dam under unimpaired and regulated conditions, Calendar Years 1971 through 2000.

The unimpaired hydrograph has two peaks: a primary peak in May resulting from spring snowmelt; and a secondary peak in October as precipitation starts to increase prior to winter freezing. The unimpaired hydrograph also has two lows: a primary low in September following three consecutive months of low precipitation; and a secondary low in January during the coldest month of the year.

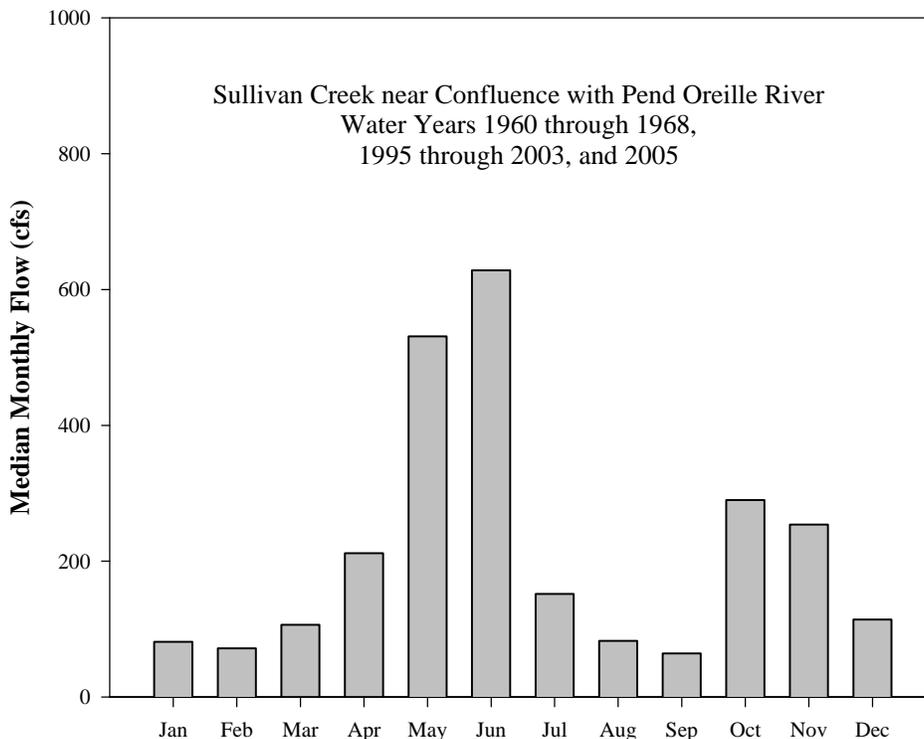
The regulated hydrograph also has two peaks and two lows. However, the magnitude of the primary peak is smaller under regulated conditions than it would be under unimpaired conditions, as would be expected with storage in upstream projects. Similarly the magnitude of the primary low is greater under regulated conditions than it would be under unimpaired conditions. The timing of the regulated hydrograph also differs from the unimpaired hydrograph. The primary peak is shifted from May to June under regulated conditions, and the primary low is shifted from September to August under regulated conditions.

### **3.3. Tributaries to the Pend Oreille River**

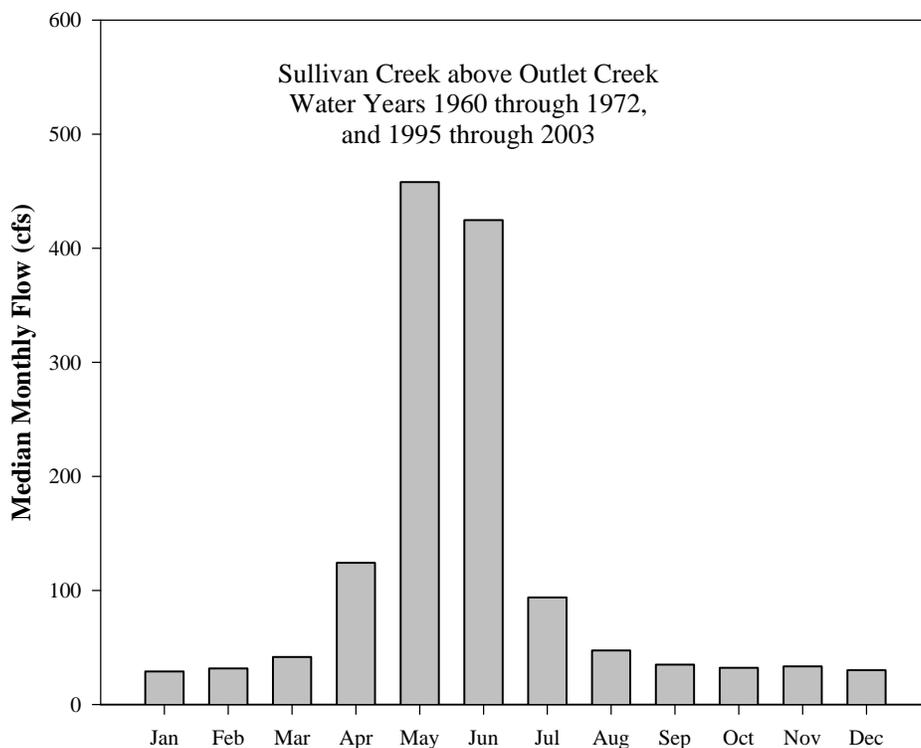
Median monthly flows in Sullivan Creek near the confluence with the Pend Oreille River are shown in Figure 3-5 for Water Years 1960 through 1968, 1995 through 2003, and 2005. Sullivan Creek is regulated to store some of the spring runoff from April through July for subsequent release in October and November. Other tributaries to the Pend Oreille River between Box Canyon Dam and Boundary Dam would not follow a similar seasonal pattern because they are unregulated.

Median monthly flows in Sullivan Creek above Outlet Creek are shown in Figure 3-6 for Water Years 1960 through 1972, and 1995 through 2003. Sullivan Creek is unregulated at this location, and flow records from this gage can be used as a template for estimating flows in ungaged tributaries of the Pend Oreille River between Box Canyon Dam and Boundary Dam, as was discussed in Section 2.5.

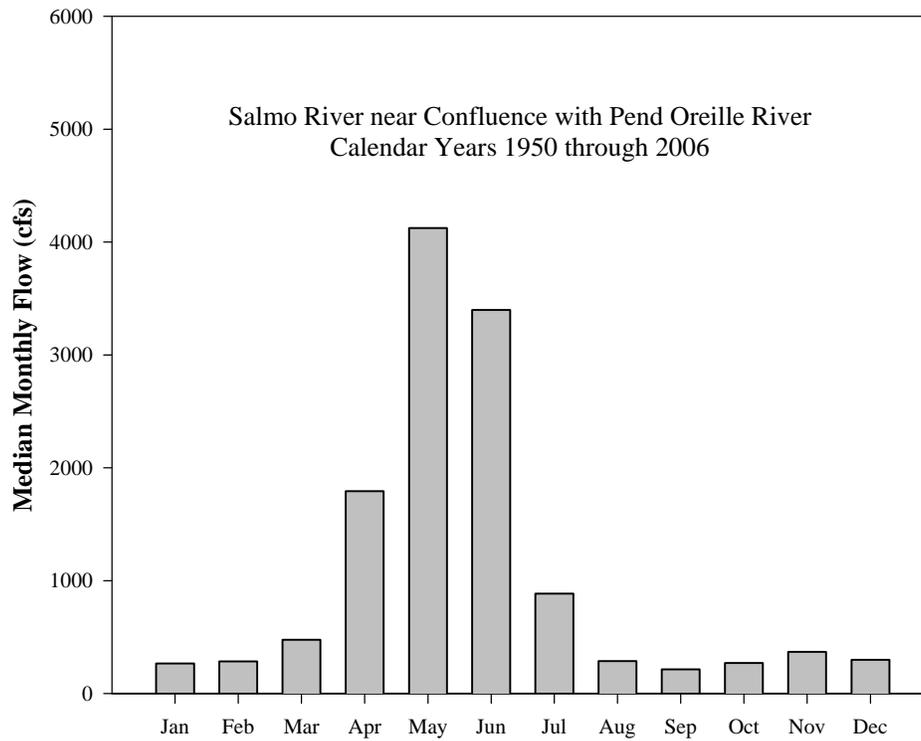
Median monthly flows in the Salmo River are shown in Figure 3-7 for Calendar Years 1950 through 2006. The seasonal hydrograph of the Salmo River follows a similar pattern to the unregulated hydrograph of the Pend Oreille River. Flow records from the Salmo River were used as a template for estimating flows in Sullivan Creek during periods when there were no measurements by the USGS at Gage No. 12396900, as described in Section 2.5.



**Figure 3-5.** Median monthly flows in Sullivan Creek near the confluence with the Pend Oreille River, Water Years 1960 through 1968, 1995 through 2003, and 2005.



**Figure 3-6.** Median monthly flows in Sullivan Creek above Outlet Creek, Water Years 1960 through 1972, and 1995 through 2003.



**Figure 3-7.** Median monthly flows in the Salmo River near the confluence with the Pend Oreille River, Calendar Years 1950 through 2006.

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## 4 BOUNDARY RESERVOIR

### 4.1. Inflows to Boundary Reservoir

The total average inflow to Boundary Reservoir over the duration of the selected study period (1987 to 2005) is estimated to be 24,100 cfs. Of this total, about 98.1% comes from flow releases from Box Canyon Dam to the Pend Oreille River, 1.0% comes from Sullivan Creek (the largest tributary to the Pend Oreille River between Box Canyon Dam and Boundary Dam), and 0.9% comes from additional smaller tributaries, listed in Table 1-1.

Average monthly and annual flows in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) from January 1987 to December 2005 are summarized in Table 4-1. Monthly flows ranged from a minimum of 6,300 cfs in August 1988 to a maximum of 116,300 cfs in June 1997. Annual flows ranged from a minimum of 13,400 cfs in 2001 to a maximum of 40,400 cfs in 1997.

The drainage areas of Sweet Creek/Lunch Creek and Sullivan Creek above Outlet Creek are 11.3 and 70.2 square miles, respectively. The ratio of 11.3 divided by 70.2 was used to estimate flows in Sweet Creek/Lunch Creek from flows in Sullivan Creek above Outlet Creek. Results of these calculations are shown in Table 4-2. Monthly flows ranged from a minimum of 1.9 cfs in February 1993 to a maximum of 126.4 cfs in May 1997. Annual flows ranged from a minimum of 8.8 cfs in 2001 to a maximum of 30.5 cfs in 1997.

Average monthly flows in Sullivan Creek near the confluence with the Pend Oreille River are shown in Table 4-3. Monthly flows ranged from a minimum of 25 cfs in February 1993 to a maximum of 1,590 cfs in June 1999. Annual flows ranged from a minimum of 110 cfs in 2001 to a maximum of 409 cfs in 1997.

The sum of the flow of all tributaries combined to the Pend Oreille River between Box Canyon Dam and Boundary Dam was calculated, with the results shown in Table 4-4. Monthly flows ranged from a minimum of 47 cfs in February 1993 to a maximum of 2,811 cfs in May 1997. Annual flows ranged from a minimum of 208 cfs in 2001 to a maximum of 751 cfs in 1997. The average flow over the 19-year period from 1987 through 2005 was 447 cfs, equivalent to a 1.9% increase to the flows in the Pend Oreille River passing Box Canyon Dam (23,700 cfs, as shown in Table 4-1).

The sum of the flows released from Box Canyon Dam to the Pend Oreille River (reported in Table 4-1) and the total combined flow of all tributaries to the Pend Oreille River between Box Canyon Dam and Boundary Dam (Table 4-4) represents the total inflow to Boundary Reservoir. These total inflows are shown in Table 4-5. Monthly flows ranged from a minimum of 6,400 cfs in August 1988 to a maximum of 118,800 cfs in June 1997. Annual flows ranged from a minimum of 13,600 cfs in 2001 to a maximum of 41,200 cfs in 1997.

Total inflow to Boundary Reservoir was also estimated from the sum of total outflow from Boundary Reservoir plus the change in reservoir storage using a reservoir storage/elevation curve derived from topographic and bathymetric surveys performed from 2005 through 2007. This was done as a QA/QC check on the flows derived from releases from Box Canyon plus tributary

**Table 4-1.** Average monthly and annual flows in Pend Oreille River below Box Canyon Dam, USGS Gage No. 12396500, 1987 to 2005.

Year	Average Monthly and Annual Flow in Pend Oreille River Below Box Canyon Dam, USGS Gage No. 12396500 (cfs)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	14,400	15,600	15,600	24,400	32,600	19,000	12,100	11,000	17,300	22,700	18,600	14,700	18,200
1988	10,000	12,300	18,800	26,900	27,700	21,600	11,600	6,300	10,200	20,300	21,000	13,800	16,700
1989	11,800	11,700	17,500	28,900	46,000	41,400	21,300	16,400	21,400	23,700	26,000	23,300	24,200
1990	22,700	22,100	19,700	38,300	45,000	69,100	31,400	13,900	16,500	25,900	27,500	20,700	29,400
1991	22,400	26,300	26,700	31,800	54,000	66,200	38,500	13,300	16,700	25,600	22,000	17,400	30,100
1992	15,200	13,300	16,900	19,200	21,400	15,500	13,500	10,200	14,800	25,400	19,700	12,500	16,500
1993	17,500	11,100	14,700	21,400	35,800	32,000	29,600	14,700	18,100	24,300	19,200	19,000	21,500
1994	18,500	14,900	16,400	20,300	24,600	25,900	11,200	7,600	10,300	19,000	20,200	12,900	16,800
1995	13,900	17,600	27,200	22,700	28,600	51,600	28,000	12,400	13,900	24,200	25,000	36,900	25,200
1996	27,600	41,300	43,100	53,800	67,500	74,700	31,900	18,400	15,300	20,300	18,400	18,400	35,800
1997	23,900	22,800	33,200	46,100	96,200	116,300	38,000	20,600	20,300	23,800	23,700	19,700	40,400
1998	17,000	13,800	18,200	25,100	37,800	52,900	32,200	15,400	15,100	17,600	18,700	16,500	23,400
1999	17,000	16,400	22,100	31,100	43,800	67,200	35,200	15,700	13,800	17,600	23,100	23,200	27,200
2000	17,700	15,000	18,700	35,000	43,600	37,000	20,300	9,800	12,200	18,700	16,300	13,300	21,500
2001	11,800	7,500	7,900	11,300	26,000	23,200	12,700	7,500	8,200	18,000	14,700	11,900	13,400
2002	16,600	16,300	17,800	28,600	45,200	80,500	36,900	13,900	11,900	15,900	14,800	16,100	26,200
2003	11,200	17,100	21,200	33,900	40,800	44,900	17,700	10,100	9,900	17,300	20,100	14,900	21,600
2004	11,700	13,600	17,900	19,900	34,300	36,200	22,700	13,600	19,100	23,300	16,900	20,700	20,900
2005	17,700	15,600	13,000	21,100	37,800	46,500	22,000	12,300	9,600	18,200	20,600	15,000	20,800
<b>Maximum</b>	<i>27,600</i>	<i>41,300</i>	<i>43,100</i>	<i>53,800</i>	<i>96,200</i>	<i>116,300</i>	<i>38,500</i>	<i>20,600</i>	<i>21,400</i>	<i>25,900</i>	<i>27,500</i>	<i>36,900</i>	<i>40,400</i>
<b>Average</b>	<i>16,800</i>	<i>17,100</i>	<i>20,300</i>	<i>28,400</i>	<i>41,500</i>	<i>48,500</i>	<i>24,600</i>	<i>12,800</i>	<i>14,500</i>	<i>21,100</i>	<i>20,300</i>	<i>17,900</i>	<i>23,700</i>
<b>Minimum</b>	<i>10,000</i>	<i>7,500</i>	<i>7,900</i>	<i>11,300</i>	<i>21,400</i>	<i>15,500</i>	<i>11,200</i>	<i>6,300</i>	<i>8,200</i>	<i>15,900</i>	<i>14,700</i>	<i>11,900</i>	<i>13,400</i>

**Table 4-2.** Average monthly and annual flows in Sweet Creek/Lunch Creek at confluence with Pend Oreille River, 1987 to 2005.

Year	Average Monthly and Annual Flow in Sweet Creek/Lunch Creek at Confluence with Pend Oreille River (cfs)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	3.8	3.4	15.2	30.1	64.7	21.8	8.2	5.7	4.1	3.1	2.6	3.3	13.9
1988	2.1	2.0	4.0	35.5	62.5	36.7	8.0	4.1	4.8	6.7	9.2	4.1	15.0
1989	4.2	3.0	4.3	31.0	70.6	47.3	8.3	7.8	5.5	4.5	11.8	8.1	17.2
1990	5.7	4.2	6.5	40.3	63.7	81.8	19.7	8.1	5.5	5.0	14.4	7.1	21.8
1991	5.3	11.4	7.0	27.8	80.9	69.8	31.3	10.9	6.0	3.5	3.1	2.7	21.7
1992	2.9	5.6	10.9	29.5	57.0	20.3	8.6	5.0	4.9	4.3	3.5	2.1	12.9
1993	2.1	1.9	4.1	18.6	89.6	27.8	19.3	11.9	6.9	4.7	2.9	2.7	16.2
1994	2.8	2.6	5.8	40.9	64.8	30.8	10.9	5.5	4.3	3.8	3.5	3.3	15.0
1995	3.7	5.0	13.7	18.7	76.6	51.1	12.2	6.6	4.4	6.5	10.9	16.2	18.9
1996	9.2	11.0	10.5	37.8	80.3	71.7	15.0	8.0	5.2	4.9	5.0	4.0	21.9
1997	5.0	4.9	15.2	31.7	126.4	99.8	24.9	10.2	13.6	13.1	12.8	7.8	30.5
1998	6.4	6.7	11.2	33.4	97.3	42.3	16.8	9.0	6.1	5.2	6.0	6.1	20.6
1999	5.7	5.3	7.4	24.2	82.9	106.3	37.8	11.1	7.2	6.4	11.9	8.6	26.3
2000	6.5	5.6	6.1	38.8	88.9	67.3	16.7	7.8	6.0	5.1	4.2	3.8	21.4
2001	3.3	3.0	3.7	6.7	34.0	21.4	9.5	6.2	3.9	3.5	5.2	4.4	8.8
2002	6.2	5.6	6.7	24.5	74.2	76.6	13.6	6.5	5.3	4.4	4.4	4.5	19.4
2003	4.3	4.8	9.3	25.7	61.0	58.2	11.8	6.0	4.3	5.8	4.5	3.1	16.6
2004	2.8	2.9	7.2	34.2	61.3	40.2	10.6	7.8	16.5	10.7	11.2	11.1	18.1
2005	8.7	10.3	9.2	24.6	59.6	36.6	13.2	6.0	4.8	9.1	6.3	4.4	16.1
<b>Maximum</b>	9.2	11.4	15.2	40.9	126.4	106.3	37.8	11.9	16.5	13.1	14.4	16.2	30.5
<b>Average</b>	5.0	5.0	8.0	29.0	73.0	53.0	16.0	8.0	6.0	6.0	7.0	6.0	19.0
<b>Minimum</b>	2.1	1.9	3.7	6.7	34.0	20.3	8.0	4.1	3.9	3.1	2.6	2.1	8.8

**Table 4-3.** Average monthly and annual flows in Sullivan Creek at confluence with Pend Oreille River, 1987 to 2005.

Year	Average Monthly and Annual Flow in Sullivan Creek at Confluence with Pend Oreille River (cfs)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	50	45	199	257	553	212	108	75	54	289	232	107	183
1988	28	27	52	303	534	422	106	53	63	334	317	122	197
1989	55	40	56	265	603	579	109	103	72	308	346	178	227
1990	75	55	86	344	544	1,042	259	106	73	313	377	167	287
1991	69	149	93	237	691	909	411	143	79	294	239	99	285
1992	38	74	144	251	487	174	112	65	64	304	245	71	169
1993	28	25	54	159	765	356	253	156	91	310	237	99	213
1994	37	34	76	353	531	357	108	61	54	228	304	58	184
1995	48	71	191	179	690	628	134	70	50	187	460	401	260
1996	120	142	161	404	814	858	195	84	63	184	262	177	288
1997	88	68	156	313	1,398	1,392	307	124	147	310	378	214	409
1998	91	91	148	320	1,055	499	147	94	64	201	341	144	267
1999	81	76	119	230	759	1,590	630	183	129	329	259	139	377
2000	77	76	106	360	710	826	183	81	68	290	222	100	258
2001	44	36	42	66	266	189	92	54	43	92	299	92	110
2002	98	79	85	220	597	794	180	76	61	349	198	71	234
2003	65	72	168	244	485	520	101	64	56	322	258	106	205
2004	37	39	94	292	523	456	102	87	86	288	254	170	203
2005	160	137	132	212	418	240	133	86	85	365	283	124	198
<b>Maximum</b>	<i>160</i>	<i>149</i>	<i>199</i>	<i>404</i>	<i>1,398</i>	<i>1,590</i>	<i>630</i>	<i>183</i>	<i>147</i>	<i>365</i>	<i>460</i>	<i>401</i>	<i>409</i>
<b>Average</b>	<i>68</i>	<i>70</i>	<i>114</i>	<i>264</i>	<i>654</i>	<i>634</i>	<i>193</i>	<i>93</i>	<i>74</i>	<i>279</i>	<i>290</i>	<i>139</i>	<i>240</i>
<b>Minimum</b>	<i>28</i>	<i>25</i>	<i>42</i>	<i>66</i>	<i>266</i>	<i>174</i>	<i>92</i>	<i>53</i>	<i>43</i>	<i>92</i>	<i>198</i>	<i>58</i>	<i>110</i>

**Table 4-4.** Average monthly and annual flows in all tributaries combined to the Pend Oreille River between Box Canyon Dam and Boundary Dam, 1987 to 2005.

Year	Average Monthly and Annual Flow of All Tributaries Combined to the Pend Oreille River Between Box Canyon Dam and Boundary Dam (cfs)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	93	84	369	593	1,276	456	200	139	100	324	261	144	338
1988	52	49	96	700	1,233	832	195	99	117	409	420	168	364
1989	101	74	104	611	1,392	1,107	202	190	133	358	478	269	419
1990	138	102	159	795	1,256	1,956	479	197	134	369	538	246	531
1991	129	276	171	548	1,594	1,689	761	265	145	333	274	129	527
1992	69	137	266	581	1,124	401	208	121	119	351	285	95	314
1993	52	47	99	366	1,766	667	468	288	168	363	270	129	393
1994	69	63	141	810	1,256	701	230	123	102	270	343	95	351
1995	89	127	345	387	1,546	1,199	270	144	99	260	581	582	471
1996	224	265	279	826	1,712	1,658	363	173	122	238	317	221	532
1997	144	122	326	667	2,811	2,508	586	238	300	456	520	301	751
1998	162	166	273	694	2,143	972	336	194	132	259	408	212	498
1999	144	135	201	501	1,685	2,778	1,052	307	209	400	392	235	671
2000	149	138	175	794	1,703	1,579	370	169	135	347	269	142	497
2001	80	70	84	140	647	428	199	123	86	131	356	140	208
2002	168	142	160	495	1,426	1,650	332	148	120	398	246	120	451
2003	113	125	272	531	1,167	1,170	233	131	103	387	307	140	391
2004	69	71	174	674	1,208	906	221	174	270	408	379	295	404
2005	256	252	234	487	1,084	649	280	153	138	466	353	173	378
<b>Maximum</b>	256	276	369	826	2,811	2,778	1,052	307	300	466	581	582	751
<b>Average</b>	121	129	207	589	1,475	1,227	368	178	144	344	368	202	447
<b>Minimum</b>	52	47	84	140	647	401	195	99	86	131	246	95	208

**Table 4-5.** Average monthly and annual flows inflow to Boundary Reservoir, 1987 to 2005, calculated from the sum of all inflows.

Year	Average Monthly and Annual Flow into Boundary Reservoir (cfs, calculated from the sum of all inflows)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	14,500	15,700	16,000	25,000	33,900	19,500	12,300	11,100	17,400	23,000	18,900	14,800	18,500
1988	10,100	12,300	18,900	27,600	28,900	22,400	11,800	6,400	10,300	20,700	21,400	14,000	17,100
1989	11,900	11,800	17,600	29,500	47,400	42,500	21,500	16,600	21,500	24,100	26,500	23,600	24,600
1990	22,800	22,200	19,900	39,100	46,300	71,100	31,900	14,100	16,600	26,300	28,000	20,900	29,900
1991	22,500	26,600	26,900	32,300	55,600	67,900	39,300	13,600	16,800	25,900	22,300	17,500	30,600
1992	15,300	13,400	17,200	19,800	22,500	15,900	13,700	10,300	14,900	25,800	20,000	12,600	16,800
1993	17,600	11,100	14,800	21,800	37,600	32,700	30,100	15,000	18,300	24,700	19,500	19,100	21,900
1994	18,600	15,000	16,500	21,100	25,900	26,600	11,400	7,700	10,400	19,300	20,500	13,000	17,200
1995	14,000	17,700	27,500	23,100	30,100	52,800	28,300	12,500	14,000	24,500	25,600	37,500	25,700
1996	27,800	41,600	43,400	54,600	69,200	76,400	32,300	18,600	15,400	20,500	18,700	18,600	36,300
1997	24,000	22,900	33,500	46,800	99,000	118,800	38,600	20,800	20,600	24,300	24,200	20,000	41,200
1998	17,200	14,000	18,500	25,800	39,900	53,900	32,500	15,600	15,200	17,900	19,100	16,700	23,900
1999	17,100	16,500	22,300	31,600	45,500	70,000	36,300	16,000	14,000	18,000	23,500	23,400	27,900
2000	17,800	15,100	18,900	35,800	45,300	38,600	20,700	10,000	12,300	19,000	16,600	13,400	22,000
2001	11,900	7,600	8,000	11,400	26,600	23,600	12,900	7,600	8,300	18,100	15,100	12,000	13,600
2002	16,800	16,400	18,000	29,100	46,600	82,100	37,200	14,000	12,000	16,300	15,000	16,200	26,700
2003	11,300	17,200	21,500	34,400	42,000	46,100	17,900	10,200	10,000	17,700	20,400	15,000	22,000
2004	11,800	13,700	18,100	20,600	35,500	37,100	22,900	13,800	19,400	23,700	17,300	21,000	21,300
2005	18,000	15,900	13,200	21,600	38,900	47,100	22,300	12,500	9,700	18,700	21,000	15,200	21,200
<i>Maximum</i>	<i>27,800</i>	<i>41,600</i>	<i>43,400</i>	<i>54,600</i>	<i>99,000</i>	<i>118,800</i>	<i>39,300</i>	<i>20,800</i>	<i>21,500</i>	<i>26,300</i>	<i>28,000</i>	<i>37,500</i>	<i>41,200</i>
<i>Average</i>	<i>16,900</i>	<i>17,200</i>	<i>20,600</i>	<i>29,000</i>	<i>43,000</i>	<i>49,700</i>	<i>24,900</i>	<i>13,000</i>	<i>14,600</i>	<i>21,500</i>	<i>20,700</i>	<i>18,100</i>	<i>24,100</i>
<i>Minimum</i>	<i>10,100</i>	<i>7,600</i>	<i>8,000</i>	<i>11,400</i>	<i>22,500</i>	<i>15,900</i>	<i>11,400</i>	<i>6,400</i>	<i>8,300</i>	<i>16,300</i>	<i>15,000</i>	<i>12,000</i>	<i>13,600</i>

inflows. Total outflow from Boundary Reservoir is determined from discharge from the Powerplant plus spill flows. Powerplant discharge flows are estimated from power generation through each of the six units combined with gross head (difference between forebay and tailwater elevations). Spill flows are determined from gate opening combined with forebay water surface elevations.

Total inflows to Boundary Reservoir were calculated from the sum of total outflow from Boundary Reservoir plus the change in reservoir storage, based on the storage/elevation curve shown in Appendix K. Results of these calculations are shown in Table 4-6. The flows shown in Tables 4-5 and 4-6 should represent the same quantity, the total inflow to Boundary Reservoir. However, they were derived by two different methods, using data from different sources. The flows are generally consistent with each other. In almost all of the months, there is less than 10 percent difference between flows. However, there is more than 10 percent difference between flows for the months of August and September 1994, and November 1995.

The total inflow to Boundary Reservoir, derived from the sum of flow releases from Box Canyon Dam and all tributaries between Box Canyon Dam and Boundary Dam, was used for further statistical evaluations in this study. Monthly and annual maximum, minimum, and average hourly inflows to Boundary Reservoir are shown in Table 4-7 for January 1987 through December 2005. The minimum hourly inflow (3,100 cfs) occurred in August 1988, and the maximum hourly inflow (137,900 cfs) occurred in June 1997.

Monthly and annual flow duration frequencies were determined for total inflow to Boundary Reservoir using hourly flows from Calendar Years 1987 through 2005. Flow duration frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix F.

Flows reported on a monthly basis in Appendix F range from 4,300 cfs (90% exceedance level in August 1988) to 135,900 cfs (10% exceedance level in June 1997). Flows reported on an annual basis in Appendix F range from 6,700 cfs (90% exceedance level in 1988 and 2001) to 111,500 cfs (10% exceedance level in 1997). Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance flows are 43,100, 29,700, 19,500, 13,400, and 10,700 cfs, respectively.

A summary of the results reported in Appendix F is illustrated in Figure 4-1. Monthly flows based on the total inflow to Boundary Reservoir at 10%, 50%, and 90% exceedance levels are shown in Figure 4-1. Peak inflows typically occur in June, while lowest inflows typically occur in August.

Maximum daily change (Daily maximum minus daily minimum) of total inflow to Boundary Reservoir was calculated for each day over the 19-year period from Calendar Year 1987 through 2005. A monthly and annual frequency analysis (based on the number days a given flow change is equaled or exceeded) was performed on these daily flow changes, with the results reported in Appendix G. A general summary of the results reported in Appendix G is illustrated in Figure 4-2. As would be expected, peak daily flow changes typically occur in June, the month when outflows from Albeni Falls Dam (Lake Pend Oreille outlet) and Box Canyon Dam typically peak.

**Table 4-6.** Average monthly and annual flows inflow to Boundary Reservoir, 1987 to 2005, calculated from outflow plus change in reservoir storage.

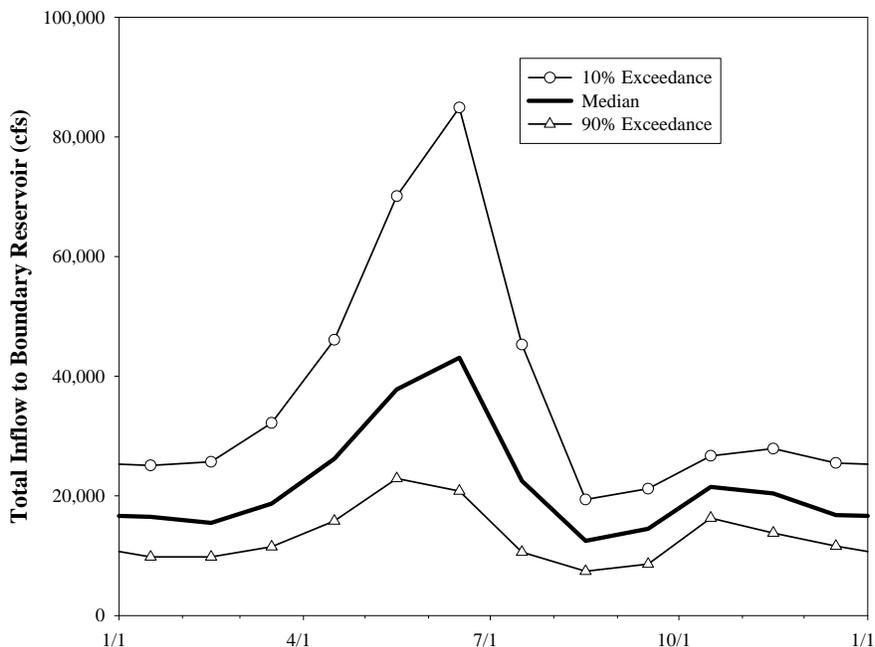
Year	Average Monthly and Annual Flow into Boundary Reservoir (cfs, calculated from outflow plus change in reservoir storage)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	14,600	15,600	15,700	25,200	34,100	19,200	12,000	10,900	17,300	22,900	18,900	14,700	18,400
1988	10,200	12,900	18,800	27,400	28,300	21,800	11,400	6,200	9,900	20,400	21,000	13,800	16,800
1989	11,700	11,900	18,100	30,000	47,500	41,500	21,200	16,500	20,800	23,700	26,200	23,100	24,400
1990	22,200	21,900	19,400	38,900	45,800	68,400	31,200	13,700	15,900	25,800	27,700	20,800	29,300
1991	21,900	26,300	26,900	32,400	55,000	67,200	39,000	13,200	16,400	25,500	22,200	17,100	30,200
1992	14,700	12,800	16,500	19,300	22,200	16,000	14,200	10,300	15,100	25,400	19,600	12,200	16,500
1993	17,100	10,500	14,200	21,100	36,500	32,100	29,200	14,100	17,400	23,900	19,300	18,900	21,300
1994	18,400	14,600	16,000	20,400	24,500	25,900	10,900	6,200	9,300	19,000	20,200	12,600	16,500
1995	13,500	17,200	27,400	22,800	29,500	50,900	28,400	11,800	13,700	24,500	28,700	38,000	25,600
1996	28,200	42,500	44,400	55,700	68,800	78,600	32,200	18,400	15,600	20,800	19,200	18,700	36,800
1997	24,600	22,600	33,200	47,400	99,100	116,300	38,500	20,100	19,700	23,200	23,400	20,000	40,700
1998	16,900	13,700	17,500	24,500	37,900	54,000	33,000	15,600	15,300	18,200	19,700	17,300	23,700
1999	17,800	17,300	23,400	32,800	45,500	67,700	36,400	16,300	14,200	18,500	24,100	24,200	28,200
2000	18,400	15,800	19,600	36,800	46,000	39,400	21,600	10,400	12,700	19,300	17,000	14,300	22,600
2001	12,500	8,000	8,500	12,000	26,100	23,500	13,100	7,700	8,200	18,400	15,700	12,400	13,900
2002	17,200	16,800	18,200	29,000	46,300	84,300	37,400	14,700	12,500	15,900	14,900	16,000	26,900
2003	10,700	16,900	21,300	34,300	41,100	44,700	17,400	9,500	9,500	17,400	20,300	14,800	21,500
2004	11,700	13,600	17,700	20,000	34,400	36,300	22,500	13,300	18,700	23,400	17,100	20,800	20,800
2005	17,800	15,800	13,200	21,500	38,100	45,900	21,800	12,000	9,000	18,300	20,400	14,700	20,700
<b>Maximum</b>	28,200	42,500	44,400	55,700	99,100	116,300	39,000	20,100	20,800	25,800	28,700	38,000	40,700
<b>Average</b>	16,800	17,200	20,500	29,000	42,500	49,100	24,800	12,700	14,300	21,300	20,800	18,100	23,900
<b>Minimum</b>	10,200	8,000	8,500	12,000	22,200	16,000	10,900	6,200	8,200	15,900	14,900	12,200	13,900

**Table 4-7.** Monthly and annual maximum, minimum, and average hourly inflows to Boundary Reservoir, January 1987 to December 2006.

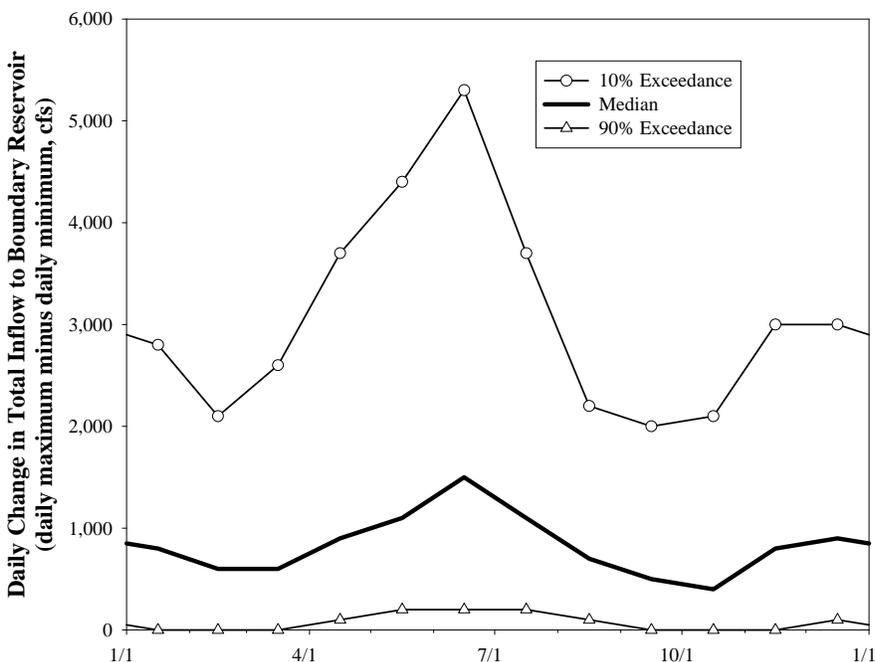
		Monthly and Annual Maximum, Average, and Minimum Inflow to Boundary Reservoir												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	Maximum	21,000	21,800	23,600	32,000	44,100	26,100	21,700	16,200	25,600	26,800	26,000	21,900	44,100
	Average	14,500	15,700	15,900	25,000	33,900	19,400	12,300	11,200	17,400	23,000	18,900	14,800	18,500
	Minimum	7,900	7,800	5,800	17,300	22,300	11,500	8,000	8,500	12,600	11,900	11,300	5,600	5,600
1988	Maximum	18,400	22,200	22,800	39,100	49,500	31,700	16,700	14,900	18,700	42,400	27,800	18,000	49,500
	Average	10,000	12,400	18,800	27,600	29,000	22,500	11,800	6,400	10,300	20,800	21,400	14,000	17,100
	Minimum	5,400	3,400	16,100	17,400	20,600	8,500	7,000	3,100	4,600	7,100	16,000	5,400	3,100
1989	Maximum	17,800	14,800	20,800	45,900	61,700	57,500	26,700	27,200	25,300	25,800	32,500	28,900	61,700
	Average	11,900	11,700	17,600	29,500	47,400	42,500	21,500	16,600	21,500	24,100	26,500	23,600	24,600
	Minimum	8,900	8,500	11,600	18,500	34,400	25,200	16,100	13,100	17,200	20,100	15,400	18,600	8,500
1990	Maximum	28,800	28,300	26,100	55,100	66,800	83,000	58,400	26,200	20,600	30,300	31,700	30,500	83,000
	Average	22,800	22,200	19,800	39,100	46,300	71,100	31,800	14,100	16,700	26,300	28,000	21,000	29,900
	Minimum	5,500	13,700	14,700	26,000	37,400	55,800	17,900	10,300	12,000	19,800	23,600	11,400	5,500
1991	Maximum	26,800	30,400	32,300	41,700	86,900	85,400	64,900	21,900	21,900	28,800	28,500	21,000	86,900
	Average	22,500	26,600	26,900	32,400	55,600	67,900	39,300	13,500	16,900	26,000	22,300	17,600	30,600
	Minimum	17,800	20,000	13,900	13,900	37,400	40,600	18,100	7,400	9,000	21,300	12,900	14,500	7,400
1992	Maximum	23,500	16,500	19,200	29,500	31,200	24,400	18,800	14,200	20,800	28,200	33,100	19,800	33,100
	Average	15,300	13,400	17,200	19,800	22,500	15,900	13,700	10,300	14,900	25,800	20,000	12,600	16,800
	Minimum	5,900	5,900	12,300	13,100	9,000	8,400	8,300	6,000	8,000	16,500	11,200	8,200	5,900
1993	Maximum	21,700	14,300	20,700	28,900	55,300	52,800	44,700	28,000	24,800	25,500	25,500	23,000	55,300
	Average	17,600	11,100	14,800	21,800	37,600	32,700	30,100	15,000	18,300	24,600	19,500	19,100	21,900
	Minimum	11,600	9,100	9,900	18,400	13,500	22,500	22,600	12,600	13,100	21,200	14,600	13,200	9,100
1994	Maximum	23,300	17,800	22,000	33,900	30,900	32,700	23,000	11,800	12,400	22,000	28,400	22,300	33,900
	Average	18,600	15,000	16,500	21,100	25,800	26,600	11,400	7,700	10,400	19,300	20,500	13,000	17,200
	Minimum	17,000	12,100	9,800	12,000	18,000	17,000	5,600	5,500	6,100	9,700	13,000	8,700	5,500
1995	Maximum	17,700	27,600	34,000	33,000	41,700	65,900	44,400	17,100	19,400	31,600	30,400	49,300	65,900
	Average	14,000	17,700	27,500	23,000	30,100	52,800	28,300	12,500	14,000	24,500	25,600	37,500	25,700
	Minimum	7,300	9,000	19,600	17,600	20,900	38,600	15,100	9,200	8,200	16,300	20,300	22,000	7,300
1996	Maximum	31,900	55,700	48,400	68,700	88,300	93,400	53,100	26,700	19,000	27,900	22,800	24,700	93,400
	Average	27,800	41,600	43,400	54,600	69,200	76,400	32,300	18,500	15,400	20,600	18,700	18,600	36,300
	Minimum	22,200	16,200	38,000	34,200	46,400	49,100	14,200	13,100	12,000	12,100	16,100	12,700	12,000

**Table 4-7.** Monthly and annual maximum, minimum, and average hourly inflows to Boundary Reservoir, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Inflow to Boundary Reservoir												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1997	Maximum	38,700	26,700	51,800	77,000	133,300	137,900	58,100	25,600	25,000	26,000	27,400	24,300	137,900
	Average	24,100	22,900	33,500	46,800	99,000	118,800	38,600	20,900	20,600	24,200	24,200	20,000	41,100
	Minimum	15,300	17,400	19,900	33,200	68,000	46,900	22,500	10,100	17,500	22,000	17,600	14,100	10,100
1998	Maximum	21,200	16,400	30,700	35,200	73,300	76,000	54,800	25,700	19,200	22,400	24,000	25,900	76,000
	Average	17,100	14,000	18,500	25,800	39,900	53,800	32,600	15,600	15,200	17,900	19,100	16,700	23,900
	Minimum	13,500	10,000	13,600	14,500	28,000	39,900	16,700	8,300	8,300	11,700	14,700	8,000	8,000
1999	Maximum	22,600	20,800	32,300	56,500	78,800	80,100	70,100	21,700	20,200	23,000	29,300	28,000	80,100
	Average	17,200	16,600	22,300	31,600	45,500	70,000	36,300	16,000	14,000	18,000	23,500	23,500	27,900
	Minimum	12,500	14,500	16,400	19,900	29,900	61,700	17,900	10,700	8,800	9,000	14,900	17,800	8,800
2000	Maximum	21,000	20,200	24,500	53,200	53,600	51,700	34,300	15,900	17,300	25,500	26,200	23,600	53,600
	Average	17,900	15,200	18,900	35,800	45,300	38,500	20,600	10,000	12,300	19,100	16,600	13,500	22,000
	Minimum	13,900	12,000	13,800	20,200	32,600	26,400	12,700	7,200	7,200	16,300	9,300	9,600	7,200
2001	Maximum	14,100	10,900	10,600	26,600	30,900	29,800	21,800	9,500	11,000	20,900	22,300	17,700	30,900
	Average	11,800	7,500	8,000	11,400	26,600	23,700	12,900	7,600	8,300	18,100	15,000	12,000	13,600
	Minimum	9,100	5,800	5,700	10,200	17,100	21,400	8,100	5,600	6,100	11,100	7,700	8,300	5,600
2002	Maximum	27,300	20,400	24,300	50,000	82,100	95,600	79,800	19,500	13,800	18,200	19,100	21,100	95,600
	Average	16,800	16,400	18,000	29,100	46,700	82,100	37,200	14,100	12,000	16,300	15,100	16,200	26,700
	Minimum	9,700	13,500	13,600	15,400	29,800	66,800	16,600	10,600	8,900	10,600	12,200	12,500	8,900
2003	Maximum	17,700	25,300	33,400	46,000	60,800	71,000	27,000	13,700	13,200	22,600	29,100	18,500	71,000
	Average	11,300	17,200	21,400	34,400	42,000	46,000	17,900	10,300	10,000	17,700	20,400	15,000	21,900
	Minimum	7,700	13,900	11,100	23,900	32,600	27,200	11,100	6,300	6,100	12,700	13,000	12,700	6,100
2004	Maximum	18,600	16,200	24,200	24,300	51,100	51,300	38,400	21,800	27,100	27,100	25,600	26,600	51,300
	Average	11,800	13,700	18,100	20,600	35,600	37,100	22,900	13,800	19,400	23,700	17,300	21,000	21,300
	Minimum	8,300	11,000	13,900	16,400	22,200	28,800	13,800	10,900	11,900	20,600	12,900	16,100	8,300
2005	Maximum	27,200	23,000	20,000	37,400	54,700	73,200	36,100	16,800	16,100	23,600	29,300	23,600	73,200
	Average	18,000	15,800	13,200	21,600	38,800	47,100	22,300	12,500	9,700	18,700	20,900	15,200	21,200
	Minimum	12,100	13,700	7,800	15,000	26,600	31,800	13,300	9,400	5,200	14,600	12,500	11,900	5,200
1987 to 2005	Maximum	38,700	55,700	51,800	77,000	133,300	137,900	79,800	28,000	27,100	42,400	33,100	49,300	137,900
	Average	16,900	17,200	20,500	29,000	43,000	49,700	24,900	13,000	14,600	21,500	20,700	18,200	24,100
	Minimum	5,400	3,400	5,700	10,200	9,000	8,400	5,600	3,100	4,600	7,100	7,700	5,400	3,100



**Figure 4-1.** Monthly 10% exceedance, median, and 90% exceedance flows for total inflow to Boundary Reservoir (flow releases from Box Canyon Dam plus tributary inflows), derived from 19 years of hourly flows from Calendar Year 1987 through 2005.



**Figure 4-2.** Monthly 10% exceedance, median, and 90% exceedance frequencies for daily change in total inflow to Boundary Reservoir (daily maximum minus daily minimum), derived from 19 years of hourly flows from Calendar Year 1987 through 2005.

## 4.2. Water Surface Elevations in Boundary Reservoir

Hourly water surface elevations in Boundary Reservoir were measured at the upstream and downstream ends of the reservoir at USGS Gage No. 12396500) and by SCL in Boundary Forebay, respectively. All water surface elevations reported herein are with respect to the North American Vertical Datum of 1988 (NAVD 88), followed in parentheses by equivalent water surface elevations with respect to the National Geodetic Vertical Datum of 1929 (NGVD 29).

A complete set of hourly water surface elevations for Boundary Reservoir Forebay was obtained from SCL for the entire 19-year study period (1987 through 2005). Hourly water surface elevations in Boundary Reservoir Forebay in 1987 and 1988 were synthesized by SCL to be consistent with measured end-of-day elevations. Hourly water surface elevations in Boundary Forebay for the remaining 17 years (1989 to 2005) were based on hourly measurements.

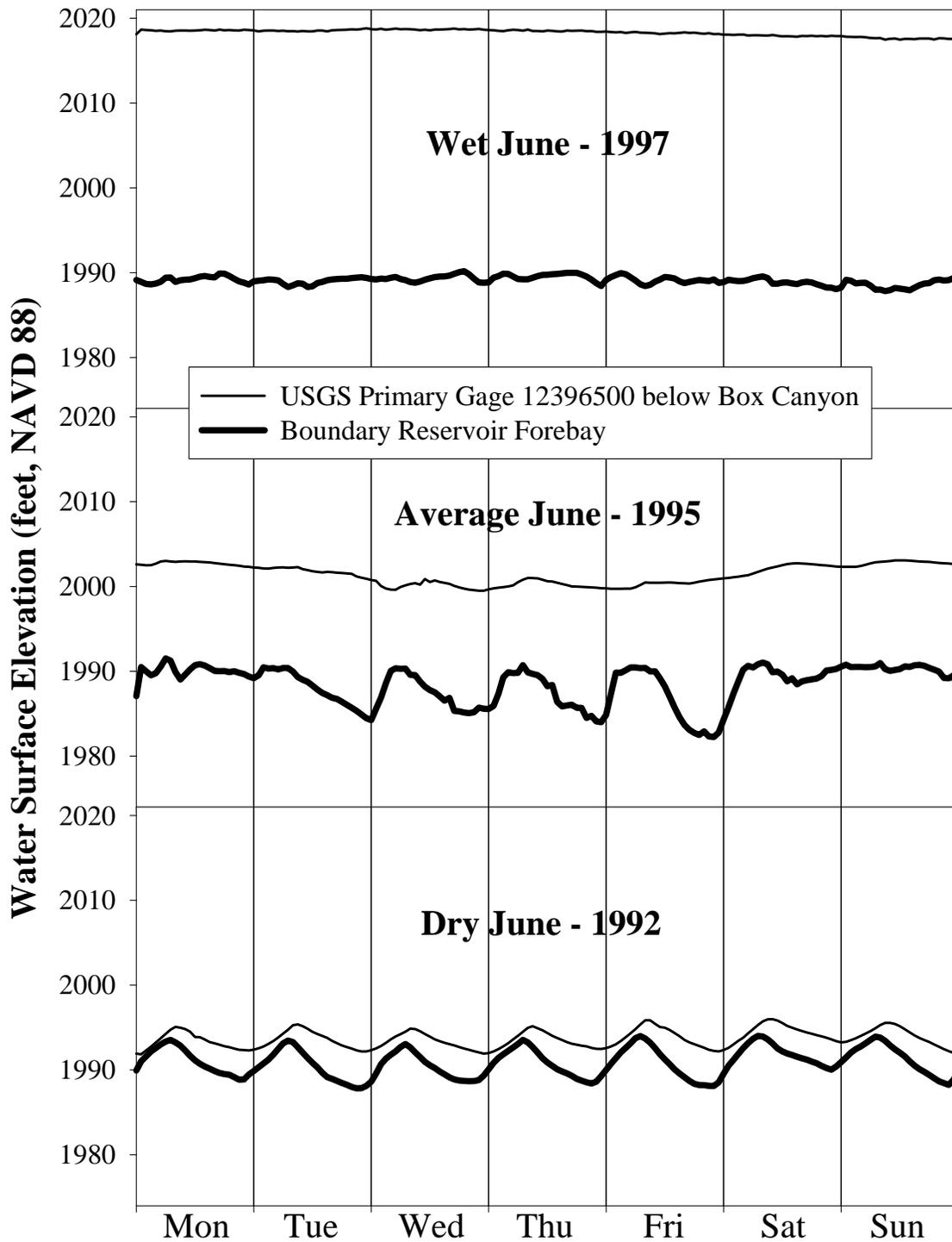
Hourly USGS records for the Pend Oreille River below Box Canyon (USGS Gage No. 12396500) were missing from January 1, 1987 to September 30, 1987, from December 17, 1996 through January 10, 1997, and from December 15, 1997 through February 5, 1998. Hourly water surface elevations were synthesized to fill in these missing data gaps to be consistent with reported daily flows in the Pend Oreille River below Box Canyon Dam and water surface elevations in Boundary Reservoir Forebay.

Water surface elevations in Boundary Reservoir fluctuate in response to inflow variations, project operations, and wind-induced waves. These fluctuations propagate upstream through the reservoir where they arrive with a reduced amplitude at Box Canyon Reservoir. To gain an understanding of how the water surface elevations change, the median monthly water surface elevation for each hour of the week was determined for selected representative months from 1987 through 2004.

During the month of June, flows were highest in 1997 and lowest in 1992 over the 19-year study period. In 1995, the flows in June were close to the 19-year average for that month. Thus, 1997, 1995, and 1992 were selected for wet, average, and dry conditions in June. The median weekly patterns of hourly water surface elevations were determined in June for these 3 years. Results of these analyses are shown in Figure 4-3.

During June 1997, the average monthly inflow to Boundary Reservoir was 118,800 cfs (from Table 4-5). Under these high flow conditions for the month of June, the resultant water surface elevations in the Pend Oreille River were relatively constant on a weekly basis at both the upstream and downstream ends of the reservoir, as shown in Figure 4-3.

During June 1995, the average monthly inflow to Boundary Reservoir was 52,800 cfs (from Table 4-5). Under these average flow conditions for the month of June, daily fluctuations in water surface elevations in Boundary Forebay occurred from Tuesday through Saturday, and relatively constant water surface elevations occurred on Sunday and Monday. Fluctuations in water surface elevations in the Pend Oreille River immediately below Box Canyon Dam were almost undetectable.



**Figure 4-3.** Median weekly patterns of water surface elevations in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) and Boundary Forebay during June in 1997, 1995, and 1992.

During June 1992, the average monthly inflow to Boundary Reservoir was 15,900 cfs (from Table 4-5). Under these low flow conditions for the month of June, daily fluctuations in water surface elevations in Boundary Forebay occurred on all days of the week from Monday through Sunday. Fluctuations in water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with reduced amplitudes.

The median weekly patterns of hourly water surface elevations for wet, average, and dry conditions in August were determined for 1997, 2004, and 1994, respectively. Results of these analyses are shown in Figure 4-4.

During August 1997, the average monthly inflow to Boundary Reservoir was 20,800 cfs (from Table 4-5). Under these high flow conditions for the month of August, daily fluctuations in water surface elevations in Boundary Forebay on all days of the week from Monday through Sunday. Fluctuations in water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with reduced amplitudes.

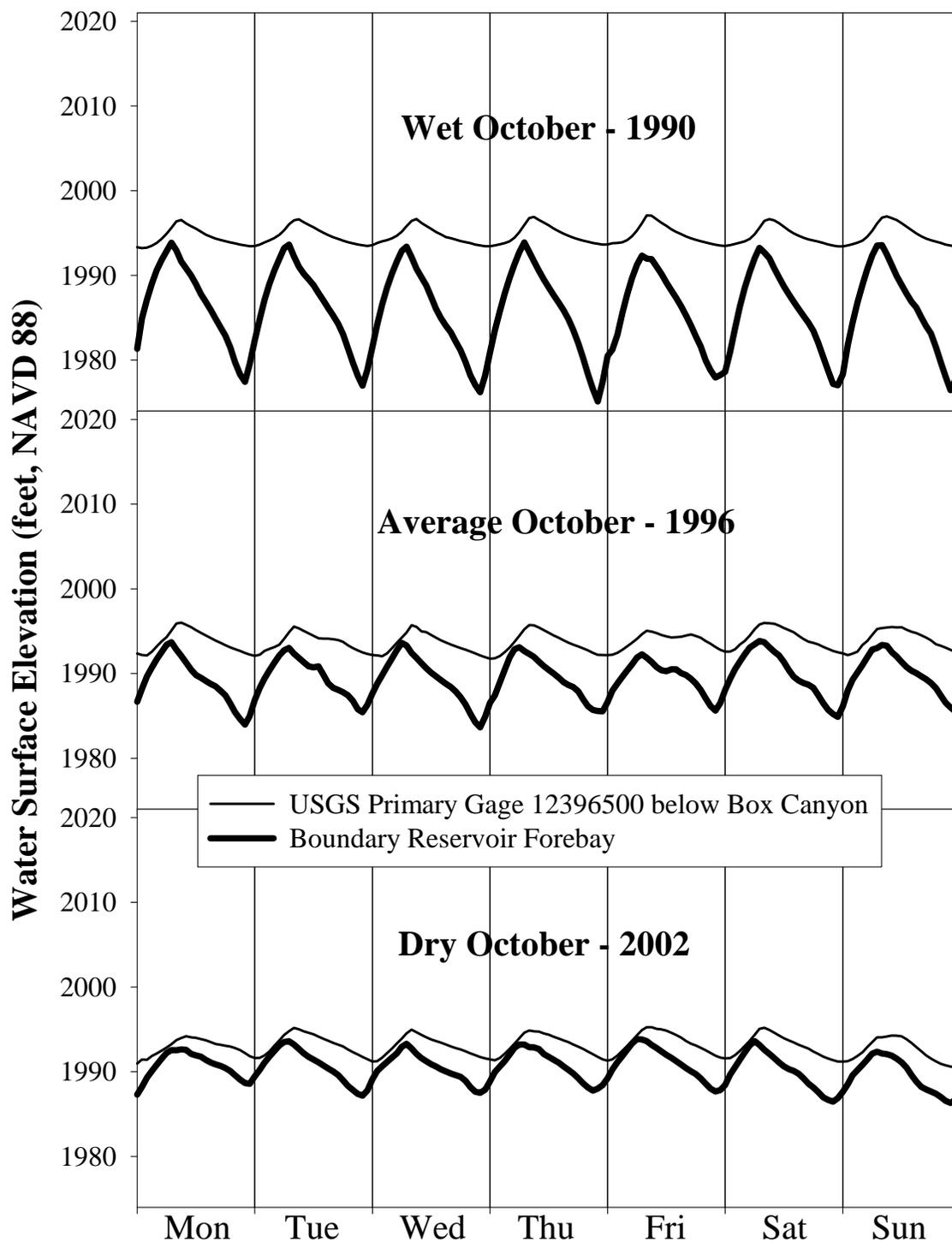
During August 2004, the average monthly inflow to Boundary Reservoir was 13,800 cfs (from Table 4-5). Under these average flow conditions for the month of August, daily fluctuations in water surface elevations in Boundary Forebay occurred on all days of the week from Monday through Sunday. The highest water surface elevations occurred on Monday and the lowest elevations occurred on Friday. Fluctuations in water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with reduced amplitudes.

During August 1994, the average monthly inflow to Boundary Reservoir was 7,700 cfs (from Table 4-5). Under these low flow conditions for the month of August, the water surface elevations in Boundary Forebay fluctuated from Monday through Saturday, and the reservoir was refilled on Sunday. The amplitudes of water surface fluctuations under these low flow conditions in August 1994 were lower than they were in August 1997 and August 2004. Fluctuations in water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with amplitudes of almost the same magnitude of the fluctuations in Boundary Reservoir.

The median weekly patterns of hourly water surface elevations for wet, average, and dry conditions in October were determined for 1990, 1996, and 2002, respectively. Results of these analyses are shown in Figure 4-5.

During October 1990, the average monthly inflow to Boundary Reservoir was 26,300 cfs (from Table 4-5). Under these high flow conditions for the month of October, daily fluctuations in water surface elevations in Boundary Forebay occurred on all days of the week from Monday through Sunday. The magnitude of daily fluctuations was almost 20 feet, much higher than they were for other months examined in Figures 4-3, 4-4, and 4-5. Fluctuations in water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with a much smaller amplitude.





**Figure 4-5.** Median weekly patterns of water surface elevations in the Pend Oreille River below Box Canyon Dam (USGS Gage No. 12396500) and Boundary Forebay during October in 1990, 1996, and 2002.

During October 1996, the average monthly inflow to Boundary Reservoir was 20,500 cfs (from Table 4-5). Under these average flow conditions for the month of October, daily fluctuations in water surface elevations in Boundary Forebay occurred on all days of the week from Monday through Sunday. Water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with reduced amplitudes.

During October 2002, the average monthly inflow to Boundary Reservoir was 16,300 cfs (from Table 4-5). Under these low flow conditions for the month of October, daily fluctuations in water surface elevations in Boundary Forebay occurred on all days of the week from Monday through Sunday. Water surface elevations in the Pend Oreille River below Box Canyon Dam followed a similar pattern with reduced amplitudes.

Daily maximum, average, and minimum water surface elevations were derived from the hourly water surface elevations in the Pend Oreille River below Box Canyon Dam and in Boundary Forebay. The resultant stage hydrographs are shown on plots in Appendix A for each of the 19 Calendar Years from 1987 through 2005. From these plots, it is readily apparent that water surface elevations in Boundary Forebay are bound on the upper end by maximum normal pool elevation 1994.03 feet NAVD 88 (1990 feet NGVD 29), and that water surface elevations in the Pend Oreille River below Box Canyon are bound on the lower end by the water surface elevation in Boundary Forebay, as well as a flow-related stage associated with the stage/discharge relationship at that location.

Monthly and annual maximum, minimum, and average water surface elevations in Boundary Reservoir Forebay are shown in Table 4-8 for January 1987 through December 2005. The minimum hourly water surface elevation (1956.83 feet NAVD 88 or 1952.40 feet NGVD 29) occurred in December 1995 (Figure A-9), and the maximum hourly water surface elevation (1995.37 feet NAVD 88 or 1991.34 feet NGVD 29) occurred in September 1987 (Figure A-1). The minimum monthly average water surface elevation (1983.10 feet NAVD 88 or 1979.07 feet NGVD 29) occurred in September 1989, and the maximum monthly average water surface elevation (1991.81 feet NAVD 88 or 1987.78 feet NGVD 29) occurred in February 2001. The minimum annual average water surface elevation (1986.99 feet NAVD 88 or 1982.96 feet NGVD 29) occurred in 2004, and the maximum annual average water surface elevation (1990.91 feet NAVD 88 or 1986.88 feet NGVD 29) occurred in 1998.

Monthly and annual maximum, minimum and average water surface elevations in the Pend Oreille River below Box Canyon Dam (USGS Primary Gage No. 12396500) are shown in Table 4-9 for January 1987 through December 2005. The minimum hourly water surface elevation (1985.76 feet NAVD 88 or 1981.73 feet NGVD 29) occurred in August 1988 (Figure A-2), and the maximum hourly water surface elevation (2019.68 feet NAVD 88 or 2015.65 feet NGVD 29) occurred in June 1997 (Figure A-11). The minimum monthly average water surface elevation (1989.58 feet NAVD 88 or 1985.55 feet NGVD 29) occurred in September 2003, and the maximum monthly average water surface elevation (2016.20 feet NAVD 88 or 2012.17 feet NGVD 29) occurred in June 1997. The minimum annual average water surface elevation (1992.44 feet NAVD 88 or 1988.41 feet NGVD 29) occurred in 2001, and the maximum annual average water surface elevation (1998.82 feet NAVD 88 or 1994.79 feet NGVD 29) occurred in 1997. Not surprisingly, the timing of the maximum hourly, monthly average, and annual average water surface elevations coincided with the timing of the maximum hourly, monthly average, and annual average flows.

**Table 4-8.** Monthly and annual maximum, minimum, and average hourly water surface elevations in Boundary Reservoir Forebay, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Boundary Forebay (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	Maximum	1995.13	1994.71	1994.77	1994.44	1992.29	1994.66	1994.25	1994.40	1995.37	1994.86	1994.59	1994.78	1995.37
	Average	1990.34	1989.46	1989.86	1987.98	1986.42	1990.46	1990.11	1989.53	1990.02	1989.69	1990.91	1990.40	1989.60
	Minimum	1985.18	1981.95	1980.49	1978.16	1979.36	1985.57	1984.91	1985.04	1984.21	1976.23	1984.94	1979.37	1976.23
1988	Maximum	1995.25	1994.87	1994.86	1994.82	1994.69	1994.58	1994.62	1994.72	1994.22	1995.01	1994.57	1994.87	1995.25
	Average	1989.83	1991.45	1989.81	1986.68	1988.22	1988.55	1989.63	1990.13	1988.16	1988.71	1988.36	1989.75	1989.11
	Minimum	1982.23	1987.68	1981.36	1973.68	1968.20	1978.88	1984.87	1983.63	1976.95	1975.55	1972.33	1982.07	1968.20
1989	Maximum	1994.89	1994.28	1995.11	1995.29	1994.32	1994.73	1995.17	1994.57	1994.67	1994.63	1994.51	1994.73	1995.29
	Average	1989.33	1991.45	1989.10	1986.97	1989.08	1990.71	1989.36	1989.80	1983.10	1987.90	1987.90	1986.97	1988.46
	Minimum	1977.04	1982.20	1981.07	1973.40	1972.99	1983.48	1980.35	1984.30	1959.29	1969.23	1975.01	1967.40	1959.29
1990	Maximum	1994.52	1994.85	1994.91	1994.90	1994.13	1992.52	1995.03	1994.62	1994.60	1994.39	1994.42	1994.92	1995.03
	Average	1986.77	1987.53	1988.76	1987.49	1989.36	1990.96	1989.03	1990.69	1990.01	1985.71	1985.73	1988.81	1988.41
	Minimum	1970.21	1972.55	1975.48	1974.73	1977.33	1989.08	1974.33	1980.20	1982.41	1971.86	1971.15	1975.80	1970.21
1991	Maximum	1994.86	1994.50	1993.84	1994.72	1993.40	1993.43	1994.81	1994.58	1994.55	1995.25	1994.77	1994.64	1995.25
	Average	1987.53	1986.55	1987.60	1986.91	1989.14	1989.58	1989.94	1990.43	1988.66	1986.42	1988.40	1990.71	1988.51
	Minimum	1971.65	1971.60	1973.16	1969.35	1982.03	1981.58	1981.25	1984.32	1977.38	1973.80	1973.82	1982.41	1969.35
1992	Maximum	1994.53	1994.57	1994.36	1994.95	1994.27	1994.53	1994.44	1994.57	1994.74	1994.49	1994.64	1994.76	1994.95
	Average	1991.22	1991.73	1991.70	1989.04	1989.89	1990.72	1989.79	1991.22	1990.02	1987.31	1988.20	1990.56	1990.11
	Minimum	1983.84	1986.52	1987.28	1974.51	1980.64	1984.17	1983.61	1986.11	1981.87	1973.70	1974.20	1983.01	1973.70
1993	Maximum	1994.69	1994.68	1994.77	1994.67	1994.42	1994.75	1994.43	1994.70	1994.57	1994.57	1994.46	1994.65	1994.77
	Average	1989.54	1991.27	1990.79	1988.87	1987.92	1988.62	1989.51	1990.33	1988.68	1986.10	1989.14	1989.74	1989.20
	Minimum	1981.07	1985.41	1982.12	1975.80	1977.52	1978.77	1981.65	1980.47	1976.16	1972.26	1976.06	1977.99	1972.26
1994	Maximum	1994.59	1994.48	1994.52	1994.47	1994.62	1994.45	1994.95	1994.36	1994.48	1994.52	1994.85	1994.58	1994.95
	Average	1990.66	1989.83	1990.66	1989.40	1987.30	1987.12	1989.72	1991.14	1991.37	1989.17	1988.30	1990.16	1989.58
	Minimum	1983.24	1981.83	1981.06	1978.80	1970.72	1976.14	1982.33	1985.36	1984.77	1976.31	1973.25	1977.96	1970.72
1995	Maximum	1994.83	1994.49	1994.80	1994.68	1994.56	1994.15	1994.63	1994.66	1994.67	1994.85	1994.21	1994.39	1994.85
	Average	1990.45	1991.03	1990.78	1986.76	1986.77	1988.41	1988.57	1990.08	1990.06	1987.59	1988.53	1988.30	1988.93
	Minimum	1981.38	1979.77	1984.81	1971.32	1970.20	1976.37	1979.13	1979.67	1982.78	1977.07	1968.60	1956.83	1956.83
1996	Maximum	1994.31	1994.47	1993.78	1993.89	1994.05	1994.21	1994.94	1994.56	1994.51	1994.30	1994.58	1994.35	1994.94
	Average	1988.31	1989.71	1990.85	1991.62	1990.79	1991.04	1989.61	1988.91	1990.09	1989.12	1989.34	1990.36	1989.97
	Minimum	1973.53	1979.65	1985.84	1987.25	1982.16	1983.38	1980.01	1980.17	1981.65	1977.88	1977.41	1979.84	1973.53

**Table 4-8.** Monthly and annual maximum, minimum, and average hourly water surface elevations in Boundary Reservoir Forebay, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Boundary Forebay (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1997	Maximum	1994.82	1994.38	1994.35	1994.41	1993.34	1991.95	1994.23	1994.44	1994.21	1994.88	1994.60	1994.83	1994.88
	Average	1990.54	1989.89	1989.77	1990.46	1990.17	1989.19	1989.74	1990.02	1989.92	1987.76	1988.93	1989.71	1989.67
	Minimum	1982.93	1983.28	1977.04	1980.57	1984.37	1983.76	1983.45	1984.00	1983.95	1977.04	1980.53	1980.43	1977.04
1998	Maximum	1994.65	1994.56	1994.59	1994.28	1994.57	1993.96	1994.28	1994.43	1994.06	1994.30	1994.36	1994.43	1994.65
	Average	1990.67	1990.92	1990.87	1989.66	1990.15	1991.25	1989.72	1991.52	1990.91	1990.13	1991.29	1991.46	1990.71
	Minimum	1984.09	1984.09	1981.41	1980.52	1981.51	1987.90	1982.68	1986.75	1984.69	1983.61	1984.37	1984.50	1980.52
1999	Maximum	1994.49	1994.49	1994.34	1994.27	1993.96	1993.11	1994.71	1994.36	1994.01	1994.23	1994.46	1994.27	1994.71
	Average	1990.86	1990.99	1990.42	1989.98	1987.75	1990.64	1990.56	1990.02	1988.05	1987.87	1988.28	1988.22	1989.46
	Minimum	1984.26	1983.18	1981.64	1984.11	1969.32	1987.05	1982.00	1984.16	1974.23	1976.88	1975.28	1974.55	1969.32
2000	Maximum	1993.64	1993.92	1994.13	1993.94	1994.53	1994.55	1994.19	1994.20	1994.11	1993.93	1994.26	1994.19	1994.55
	Average	1987.10	1988.15	1987.96	1987.31	1988.94	1988.54	1989.67	1990.58	1989.30	1987.60	1988.87	1990.29	1988.69
	Minimum	1976.02	1976.58	1975.47	1973.44	1975.47	1977.44	1981.45	1983.68	1979.61	1975.79	1974.15	1977.41	1973.44
2001	Maximum	1994.02	1994.11	1994.31	1994.04	1994.05	1993.74	1994.08	1993.86	1993.88	1994.51	1994.35	1994.40	1994.51
	Average	1989.87	1991.81	1991.05	1990.50	1984.33	1986.80	1989.70	1990.00	1988.02	1989.77	1989.96	1990.61	1989.35
	Minimum	1980.32	1987.93	1984.77	1983.19	1963.34	1978.18	1978.82	1985.08	1977.16	1976.77	1980.01	1978.68	1963.34
2002	Maximum	1994.50	1993.75	1994.27	1994.78	1994.06	1991.46	1993.94	1994.05	1994.02	1994.32	1994.22	1994.10	1994.78
	Average	1989.01	1988.57	1987.69	1987.21	1988.80	1989.18	1988.89	1990.57	1990.97	1990.31	1990.40	1989.35	1989.25
	Minimum	1978.14	1976.49	1975.95	1975.21	1974.70	1987.30	1982.23	1983.96	1984.41	1983.44	1982.13	1977.39	1974.70
2003	Maximum	1994.19	1994.43	1994.02	1993.65	1994.69	1994.22	1994.29	1993.50	1992.48	1993.57	1993.90	1993.38	1994.69
	Average	1989.41	1988.37	1988.04	1985.46	1986.45	1989.81	1989.23	1989.95	1986.63	1988.99	1988.54	1986.45	1988.12
	Minimum	1981.95	1975.42	1979.50	1974.31	1972.57	1982.00	1982.20	1985.78	1974.59	1982.04	1976.37	1974.31	1972.57
2004	Maximum	1994.08	1994.48	1994.12	1993.45	1993.88	1994.02	1993.87	1994.29	1993.99	1993.13	1993.89	1993.45	1994.48
	Average	1987.36	1988.18	1987.07	1985.65	1985.52	1988.24	1988.70	1989.18	1986.94	1984.61	1987.34	1985.22	1986.99
	Minimum	1974.35	1974.80	1974.35	1975.12	1973.85	1981.82	1982.00	1982.08	1973.59	1974.41	1975.46	1972.26	1972.26
2005	Maximum	1993.68	1993.81	1994.23	1993.98	1994.09	1994.00	1994.18	1993.63	1993.71	1993.47	1994.02	1993.55	1994.23
	Average	1985.90	1985.55	1988.22	1986.64	1984.78	1988.41	1989.42	1989.54	1989.40	1987.32	1986.51	1987.26	1987.43
	Minimum	1974.79	1974.19	1974.63	1975.35	1974.36	1982.35	1982.52	1983.92	1980.75	1975.44	1976.40	1974.36	1974.19
1987 to 2005	Maximum	1995.25	1994.87	1995.11	1995.29	1994.69	1994.75	1995.17	1994.72	1995.37	1995.25	1994.85	1994.92	1995.37
	Average	1989.19	1989.60	1989.53	1988.14	1987.99	1989.38	1989.52	1990.19	1988.96	1988.00	1988.68	1989.18	1989.03
	Minimum	1970.21	1971.60	1973.16	1969.35	1963.34	1976.14	1974.33	1979.67	1959.29	1969.23	1968.60	1956.83	1956.83

**Table 4-9.** Monthly and annual maximum, minimum, and average water surface elevations in Pend Oreille River below Box Canyon Dam (USGS Primary Gage No. 12396500) January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Pend Oreille River below Box Canyon Dam (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	Maximum	1996.50	1996.47	1997.12	1997.53	1999.87	1997.04	1995.80	1995.34	1996.83	1997.37	1996.77	1996.65	1999.87
	Average	1992.81	1992.70	1993.09	1994.81	1996.84	1994.00	1992.13	1991.49	1993.46	1994.47	1993.71	1992.58	1993.51
	Minimum	1988.95	1987.70	1988.55	1991.12	1993.88	1990.15	1988.76	1988.54	1990.60	1989.48	1989.78	1988.02	1987.70
1988	Maximum	1995.43	1995.98	1997.03	2000.34	2001.29	1997.92	1995.89	1994.87	1995.76	2002.06	1997.49	1995.89	2002.06
	Average	1991.16	1992.92	1993.35	1995.00	1995.84	1993.85	1991.59	1990.78	1990.52	1993.58	1993.67	1992.09	1992.85
	Minimum	1987.88	1989.33	1990.56	1990.75	1992.60	1986.58	1987.52	1985.76	1986.51	1987.79	1990.03	1987.79	1985.76
1989	Maximum	1995.87	1995.42	1996.59	2000.86	2004.96	2003.71	1998.16	1997.71	1997.10	1997.28	1998.54	1997.34	2004.96
	Average	1991.41	1992.81	1992.99	1995.66	2000.64	1999.66	1994.10	1992.92	1993.02	1994.24	1994.90	1993.89	1994.69
	Minimum	1987.26	1987.92	1989.60	1991.14	1995.88	1994.35	1990.05	1990.07	1989.15	1991.08	1991.69	1990.90	1987.26
1990	Maximum	1997.45	1997.50	1997.22	2003.39	2005.48	2008.89	2005.72	1997.23	1996.45	1998.05	1997.78	1997.86	2008.89
	Average	1993.81	1993.69	1993.36	1998.12	2000.30	2006.20	1996.70	1993.09	1993.24	1994.69	1994.88	1993.94	1996.00
	Minimum	1988.04	1989.86	1990.06	1993.21	1996.83	2003.19	1990.98	1989.40	1989.91	1992.29	1992.26	1987.89	1987.89
1991	Maximum	1997.62	1997.77	1998.44	2000.34	2010.72	2009.89	2005.41	1996.01	1996.28	1997.40	1997.36	1996.11	2010.72
	Average	1994.15	1994.65	1994.84	1996.27	2002.30	2005.41	1998.67	1992.61	1992.61	1994.55	1993.89	1993.48	1996.12
	Minimum	1991.10	1991.57	1990.75	1990.58	1997.22	1997.67	1990.67	1988.82	1988.68	1990.54	1988.93	1990.70	1988.68
1992	Maximum	1996.53	1996.44	1996.47	1997.60	1997.64	1996.85	1996.37	1995.92	1996.02	1997.46	1999.42	1995.61	1999.42
	Average	1993.33	1993.20	1993.90	1993.59	1994.48	1993.58	1992.48	1992.55	1992.77	1994.61	1993.24	1992.30	1993.34
	Minimum	1988.77	1989.57	1989.99	1989.31	1988.61	1989.19	1988.90	1987.83	1987.51	1990.22	1989.52	1989.35	1987.51
1993	Maximum	1996.49	1995.27	1996.43	1997.03	2002.68	2002.34	2000.73	1997.77	1997.07	1997.18	1997.09	1996.58	2002.68
	Average	1993.74	1992.42	1992.97	1993.83	1997.51	1996.73	1996.33	1992.82	1992.89	1993.96	1993.50	1993.66	1994.22
	Minimum	1990.12	1989.40	1989.55	1991.10	1989.85	1992.50	1991.80	1989.01	1989.28	1991.64	1990.39	1989.37	1989.01
1994	Maximum	1997.17	1995.65	1996.37	1998.73	1997.91	1998.35	1996.40	1995.20	1995.27	1996.49	1997.32	1996.52	1998.73
	Average	1993.86	1992.53	1993.32	1993.79	1994.45	1995.05	1991.86	1991.91	1992.60	1993.53	1993.56	1992.25	1993.23
	Minimum	1991.03	1989.40	1988.40	1988.62	1990.81	1991.18	1987.81	1987.25	1988.95	1990.87	1989.88	1988.44	1987.25
1995	Maximum	1996.30	1997.67	1998.76	1997.91	1999.17	2006.42	2000.01	1995.88	1996.14	1997.82	1997.77	2002.00	2006.42
	Average	1992.67	1993.94	1996.28	1993.68	1995.56	2001.75	1995.85	1992.20	1992.51	1994.34	1995.50	1998.19	1995.21
	Minimum	1988.35	1989.25	1993.80	1990.94	1991.61	1997.27	1990.34	1988.36	1987.70	1989.98	1992.04	1992.30	1987.70
1996	Maximum	1997.97	2003.51	2002.44	2006.39	2011.11	2012.69	2002.63	1996.58	1996.01	1997.45	1998.33	1998.03	2012.69
	Average	1995.58	1999.50	2000.25	2003.01	2006.11	2008.18	1996.88	1993.36	1992.85	1993.84	1993.61	1993.96	1998.07
	Minimum	1993.13	1990.84	1997.65	1997.16	2000.10	2000.29	1989.30	1990.11	1989.87	1988.16	1990.33	1990.74	1988.16

**Table 4-9.** Monthly and annual maximum, minimum, and average water surface elevations in Pend Oreille River below Box Canyon Dam (USGS Primary Gage No. 12396500) January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Pend Oreille River below Box Canyon Dam (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1997	Maximum	1999.24	1997.28	2002.59	2009.05	2018.72	2019.68	2004.00	1997.41	1997.23	1997.37	1997.34	1996.91	2019.68
	Average	1995.40	1994.51	1997.15	2000.82	2012.53	2016.20	1998.57	1994.11	1993.89	1994.11	1994.46	1993.98	1998.82
	Minimum	1992.03	1992.27	1992.10	1995.93	2005.92	2000.57	1993.05	1988.06	1990.65	1991.89	1990.88	1991.17	1988.06
1998	Maximum	1996.73	1995.72	1997.99	1998.38	2006.29	2007.47	2003.70	1997.69	1996.02	1996.15	1996.52	1997.42	2007.47
	Average	1993.71	1993.01	1993.95	1995.09	1998.50	2002.79	1997.31	1993.95	1993.42	1993.50	1994.38	1993.94	1995.30
	Minimum	1991.00	1990.45	1991.08	1991.12	1994.40	1999.04	1991.12	1990.35	1989.14	1991.16	1992.09	1989.17	1989.14
1999	Maximum	1996.62	1996.42	1997.68	2004.91	2008.15	2008.51	2006.19	1996.92	1996.38	1996.72	1997.77	1997.42	2008.51
	Average	1993.72	1993.60	1994.86	1996.97	1999.65	2005.81	1998.33	1993.19	1991.75	1992.62	1994.49	1994.42	1995.79
	Minimum	1990.57	1990.94	1991.62	1992.40	1994.16	2003.33	1992.14	1989.86	1988.30	1988.11	1991.02	1991.26	1988.11
2000	Maximum	1995.68	1995.74	1996.40	2002.57	2003.11	2002.70	1998.97	1995.66	1994.96	1996.59	1995.71	1997.02	2003.11
	Average	1992.30	1991.79	1992.97	1997.39	2000.23	1998.49	1994.33	1992.14	1991.88	1992.76	1992.99	1992.67	1994.17
	Minimum	1989.63	1989.25	1990.09	1991.77	1995.43	1993.52	1990.32	1988.00	1988.97	1990.43	1989.63	1988.85	1988.00
2001	Maximum	1995.10	1994.88	1994.96	1995.89	1997.54	1996.60	1995.82	1994.43	1994.51	1996.14	1996.44	1995.29	1997.54
	Average	1992.05	1992.51	1991.99	1992.33	1994.44	1993.90	1992.32	1990.96	1990.05	1993.52	1992.78	1992.50	1992.44
	Minimum	1988.72	1989.04	1988.08	1988.39	1990.28	1991.85	1988.10	1986.98	1986.22	1990.85	1986.96	1989.13	1986.22
2002	Maximum	1996.08	1995.67	1996.32	2002.59	2008.77	2011.50	2008.50	1995.98	1995.19	1995.64	1995.41	1996.31	2011.50
	Average	1992.84	1992.39	1992.51	1995.32	2000.05	2008.77	1997.95	1993.02	1992.71	1992.98	1992.74	1992.55	1995.32
	Minimum	1988.51	1989.13	1989.10	1990.01	1994.64	2004.49	1991.53	1989.88	1989.31	1989.88	1989.95	1989.21	1988.51
2003	Maximum	1995.62	1996.75	1997.37	2000.49	2004.08	2007.14	1997.10	1994.77	1993.42	1995.54	1997.51	1994.78	2007.14
	Average	1991.22	1992.25	1993.32	1996.49	1998.64	2000.21	1993.01	1991.43	1989.58	1992.66	1993.20	1991.00	1993.58
	Minimum	1987.42	1989.06	1988.20	1992.36	1990.70	1993.75	1989.18	1987.84	1986.54	1990.27	1988.99	1989.14	1986.54
2004	Maximum	1995.06	1995.74	1996.53	1995.82	2000.25	2000.61	1999.47	1995.95	1995.71	1995.64	1995.42	1996.14	2000.61
	Average	1990.53	1991.33	1992.17	1992.29	1996.72	1997.68	1994.05	1991.78	1992.79	1993.16	1991.87	1992.53	1993.08
	Minimum	1987.84	1988.25	1990.06	1989.81	1991.66	1994.47	1989.62	1988.59	1988.12	1991.23	1988.78	1989.42	1987.84
2005	Maximum	1995.59	1994.77	1995.61	1997.78	2000.97	2008.11	1999.17	1994.78	1994.13	1995.89	1996.52	1995.27	2008.11
	Average	1991.76	1990.87	1991.19	1993.10	1997.60	2000.15	1994.17	1991.63	1990.83	1992.25	1992.52	1991.34	1993.12
	Minimum	1988.74	1989.10	1987.19	1990.15	1993.24	1995.83	1989.34	1988.02	1986.54	1989.28	1988.59	1988.22	1986.54
1987 to 2005	Maximum	1999.24	2003.51	2002.59	2009.05	2018.72	2019.68	2008.50	1997.77	1997.23	2002.06	1999.42	2002.00	2019.68
	Average	1992.95	1993.19	1993.92	1995.66	1999.07	2000.97	1995.09	1992.42	1992.28	1993.65	1993.68	1993.22	1994.68
	Minimum	1987.26	1987.70	1987.19	1988.39	1988.61	1986.58	1987.52	1985.76	1986.22	1987.79	1986.96	1987.79	1985.76

Monthly and annual stage duration frequencies were determined for the Pend Oreille River in Boundary Forebay and at the USGS Primary Gage No. 12396500 below Box Canyon Dam for Calendar Years 1987 through 2005. Stage exceedance frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix B.

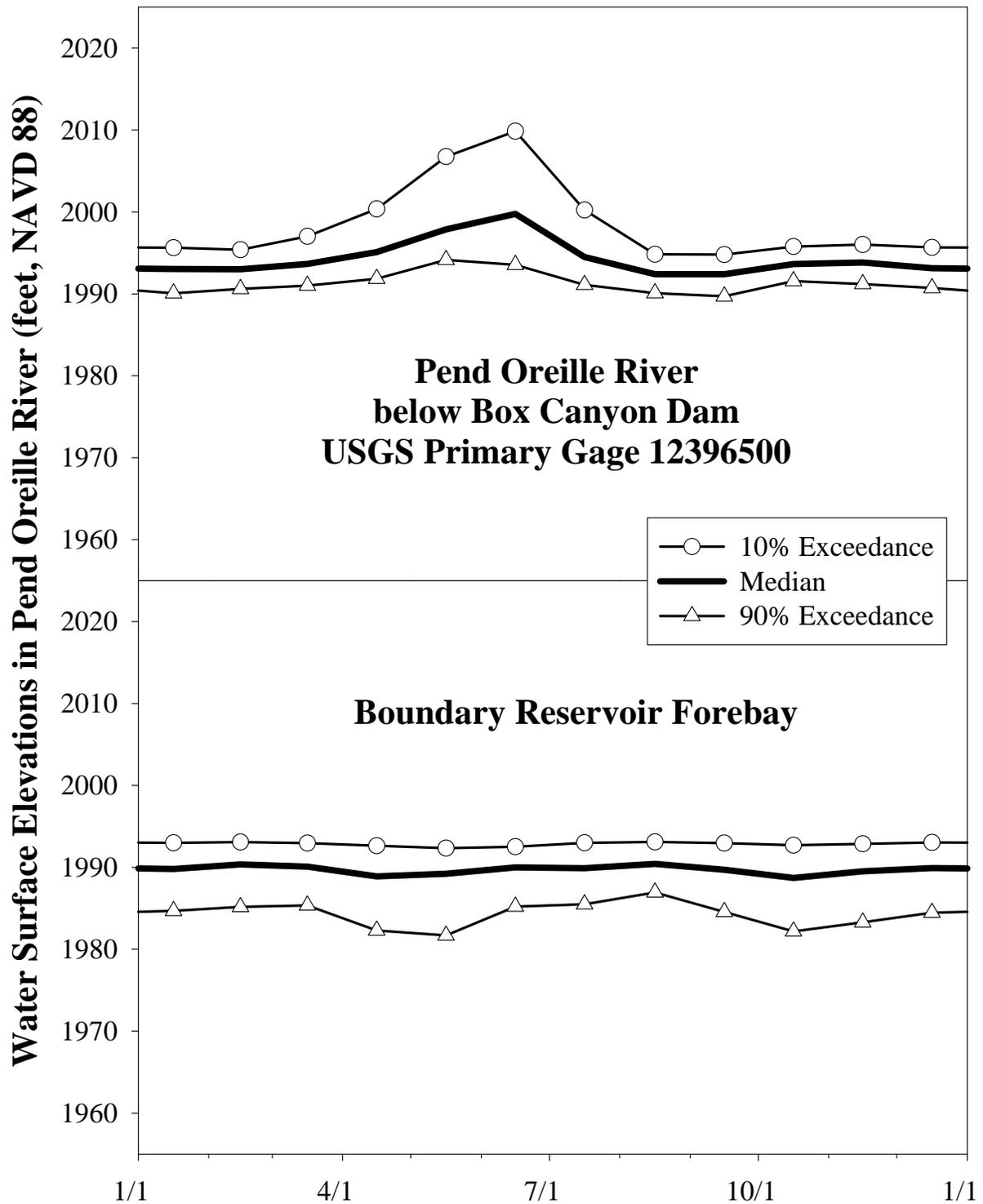
Water surface elevations reported on a monthly basis in Appendix B range from 1969.06 feet NAVD 88 (90% exceedance level in September 1989, equivalent to 1965.03 feet NGVD 29) to 1993.81 feet NAVD 88 (10% exceedance level in February 1992, equivalent to 1989.78 feet NGVD 29) in the results reported for Boundary Forebay, while comparable water surface elevations at the USGS Primary Gage No. 12396500 below Box Canyon Dam range from 1987.10 feet NAVD 88 (90% exceedance level in September 2003, equivalent to 1983.07 feet NGVD 29) to 2019.44 feet NAVD 88 (10% exceedance level in June 1977, equivalent to 2015.41 feet NGVD 29).

Water surface elevations reported on an annual basis in Appendix B range from 1981.11 feet NAVD 88 (90% exceedance level in 2004, equivalent to 1987.08 feet NGVD 29) to 1993.42 feet NAVD 88 (10% exceedance level in 1998, equivalent to 1989.39 feet NGVD 29) in the results reported for Boundary Forebay, while comparable water surface elevations at the USGS Primary Gage No. 12396500 below Box Canyon Dam range from 1989.64 feet NAVD 88 (90% exceedance level in 2005, equivalent to 1985.61 feet NGVD 29) to 2015.12 feet NAVD 88 (10% exceedance level in 1997, equivalent to 2011.09 feet NGVD 29).

Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance stages in the Pend Oreille River in Boundary Forebay are 1992.87, 1992.00, 1989.77, 1986.53, and 1984.27 feet NAVD 88, respectively (equivalent to 1988.84, 1987.97, 1985.74, 1982.50, and 1980.24 feet NGVD 29). Stages with the same long-term frequency of exceedance are 1999.50, 1996.39, 1993.81, 1991.83, and 1990.91 feet NAVD 88, respectively (equivalent to 1994.47, 1992.36, 1989.78, 1987.80, and 1986.88 feet NGVD 29) at the USGS Primary Gage No. 12396500 below Box Canyon Dam.

A summary of the results reported in Appendix B is illustrated in Figure 4-6. Monthly water surface elevations in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels are shown in Figure 4-6. The range of water surface elevations shown for Boundary Forebay is bounded on the upper end by normal maximum pool level. The lower end of the range for Boundary Forebay was lowest in April, May, and October. The seasonal patterns of water surface elevations in the Pend Oreille River at USGS Primary Gage No. 12396500 generally follow the seasonal pattern of monthly flows, with highest water surface elevations in June, corresponding with the month with highest flows.

Daily stage fluctuations (daily maximum minus daily minimum) were calculated from hourly water surface elevations records in Boundary Forebay and in the Pend Oreille River at the USGS Primary Gage No. 12396500 below Box Canyon Dam. Monthly and annual stage fluctuation duration frequencies were determined for the Pend Oreille River in Boundary Forebay and at the USGS Primary Gage No. 12396500 below Box Canyon Dam for Calendar Years 1987 through 2005. Stage fluctuation exceedance frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix C.



**Figure 4-6.** Monthly water surface elevations in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005.

Daily water surface elevation fluctuations reported on an annual basis in Appendix C range from 1.15 feet (90% exceedance level in 1996) to 18.02 (10% exceedance level in 1990) in the results reported for Boundary Forebay, while comparable daily water surface elevation fluctuations at the USGS Primary Gage No. 12396500 below Box Canyon Dam range from 0.42 feet (90% exceedance level in 1996) to 4.80 feet (10% exceedance level in 1992).

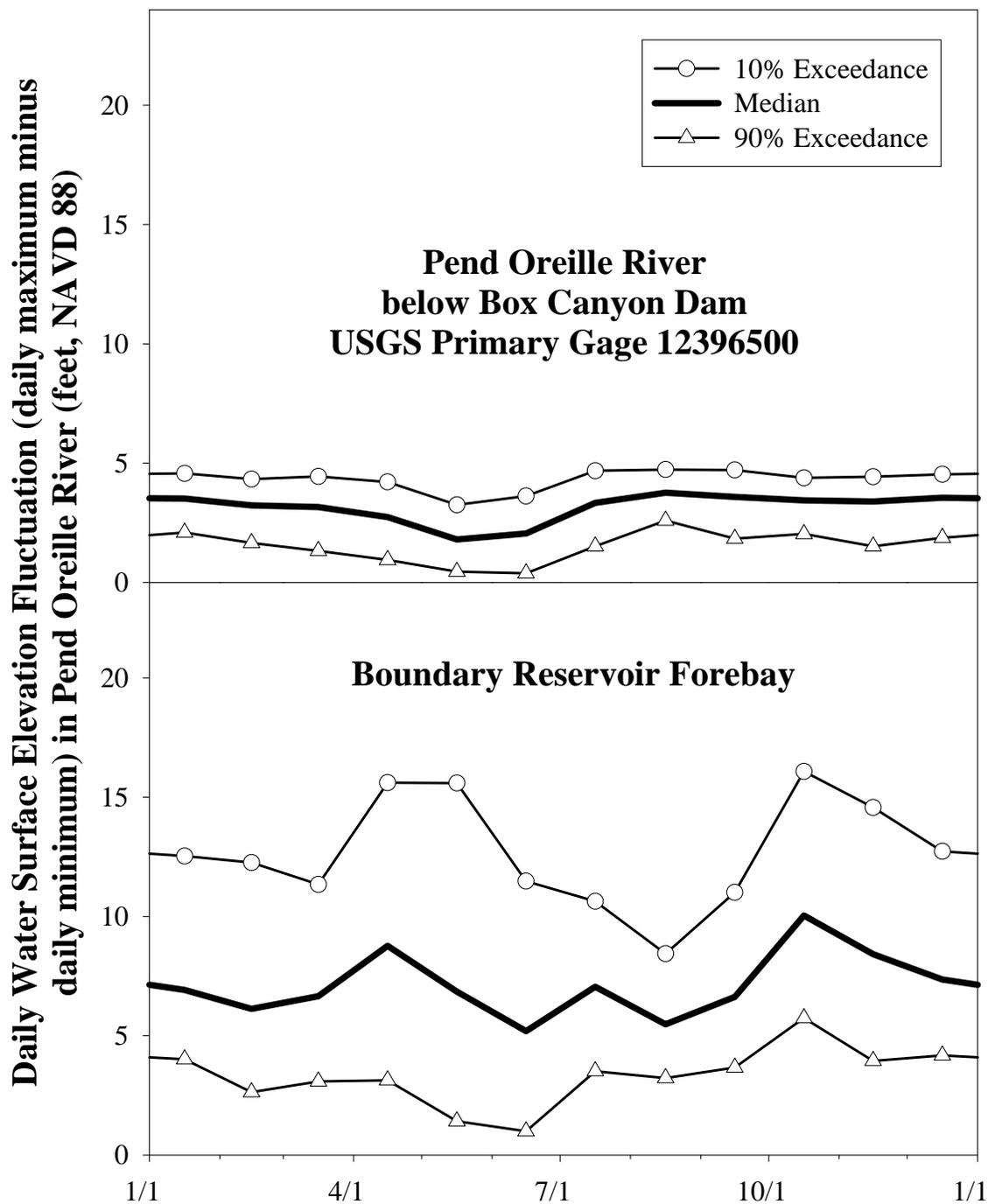
Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance daily stage fluctuations in the Pend Oreille River in Boundary Forebay are 13.09, 10.77, 7.00, 4.27, and 2.93 feet, respectively. Daily stage fluctuations with the same long-term frequency of exceedance are 4.46, 4.08, 3.21, 1.95, and 1.19 feet, respectively at the USGS Primary Gage No. 12396500 below Box Canyon Dam.

A summary of the results reported in Appendix C is illustrated in Figure 4-7. Monthly water surface elevation fluctuations in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels are shown in Figure 4-7. Daily water surface elevation fluctuations reach the highest magnitudes in April, May, and October in Boundary Forebay, consistent with the results shown in Figure 4-7. Daily water surface elevation fluctuations in the Pend Oreille River at USGS Gage No. 12396500 below Box Canyon Dam are smallest in May and June, the months with the highest flows.

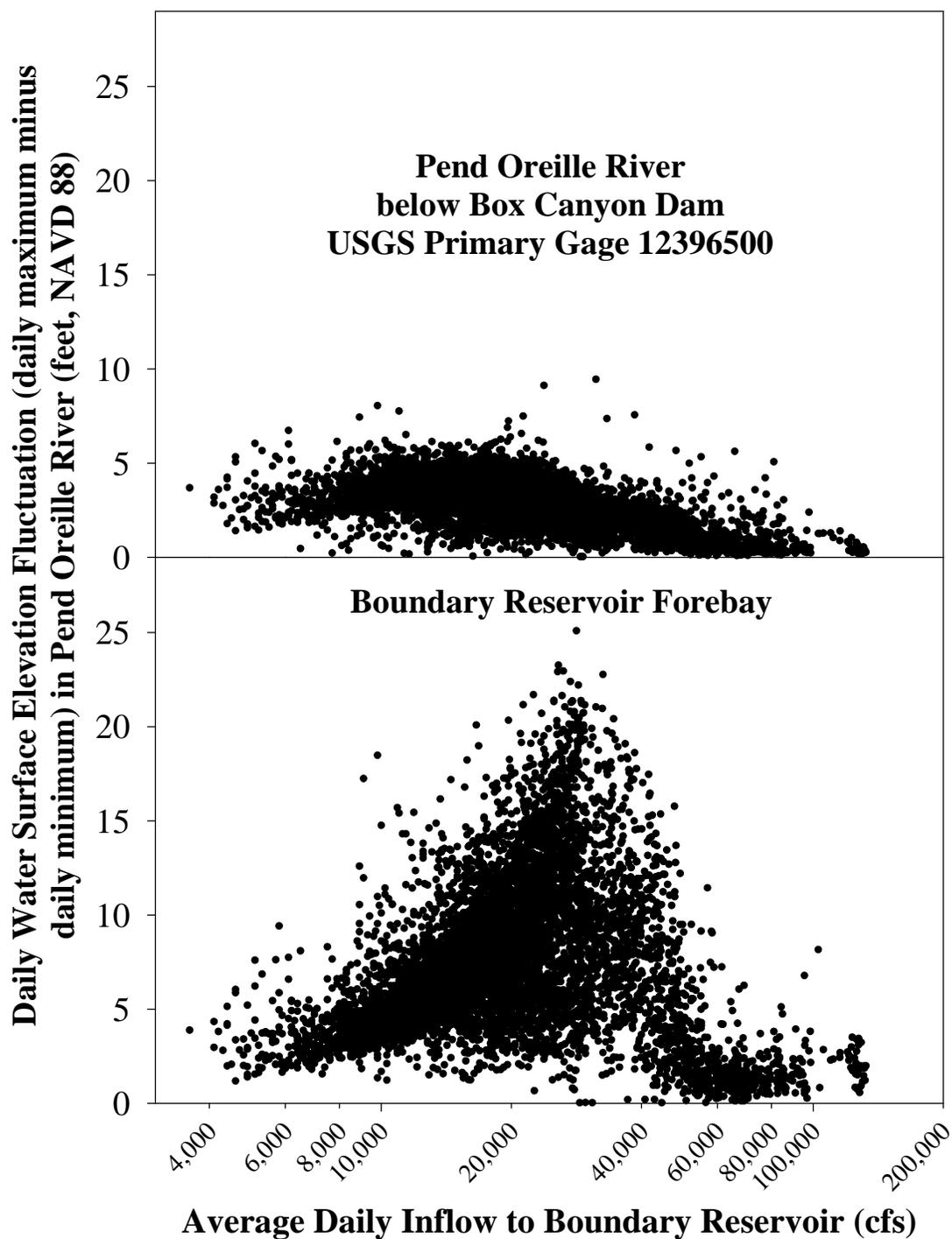
Daily water surface elevation fluctuations (daily maximum minus daily minimum) in Boundary Forebay and in the Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam were compared with daily average inflows to Boundary Reservoir for the 6,940 days from 1987 through 2005. Results of these calculations are shown in Figure 4-8.

The highest daily water surface elevation fluctuations in Boundary Forebay occur when the inflow to Boundary Reservoir is approximately 28,000 cfs. From the results reported in Appendix C, the month with the highest median daily water surface elevation fluctuation in Boundary Forebay was October 1990. The median daily water surface elevation fluctuation for that month was 17.72 feet, and the average inflow to Boundary Reservoir that month was about 26,000 cfs, consistent with the results shown in Figure 4-8.

The highest daily water surface elevation fluctuations in the Pend Oreille River at the USGS Primary Gage No. 12396500 below Box Canyon Dam generally occur when the inflow to Boundary Reservoir ranges from about 10,000 cfs to 20,000 cfs. As flows increase, the backwater from Boundary Forebay has less impact on water surface elevations at the USGS Gage.



**Figure 4-7.** Monthly patterns of daily water surface elevation fluctuations in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005.



**Figure 4-8.** Comparison of daily water surface elevation fluctuations (daily maximum minus daily minimum) in Boundary Forebay and in the Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam with daily average inflows to Boundary Reservoir, 1987 through 2005.

### 4.3. Ramping Rates

Hourly ramping rates were calculated for falling stages in Boundary Forebay and in the Pend Oreille River at the USGS Primary Gage No. 12396500 below Box Canyon for the selected study period (1987 to 2005). The maximum ramping rate was determined for each day during this period. All ramping rate calculations refer to falling stages, ramping rates were not calculated for rising stages.

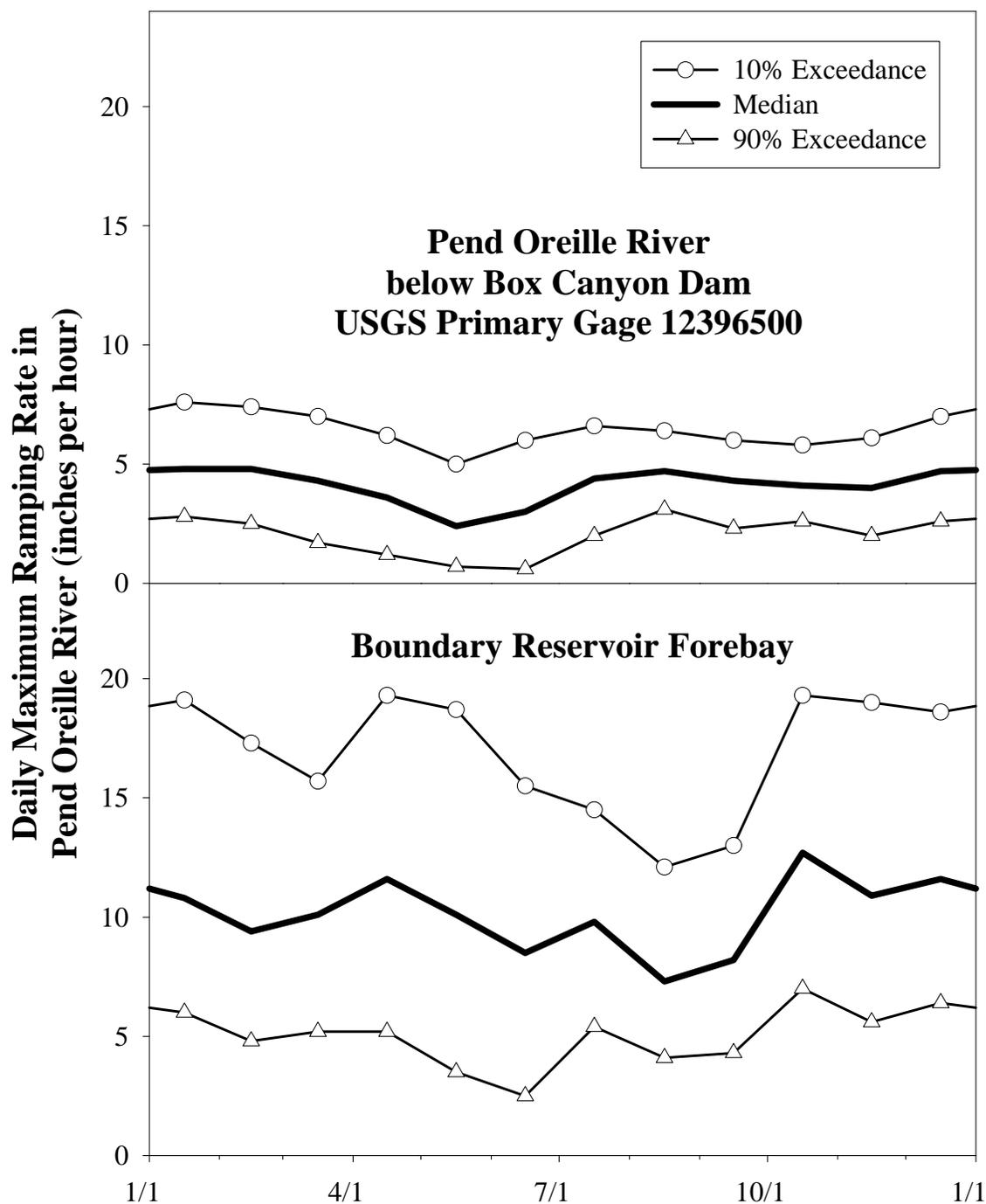
Monthly and annual daily maximum ramping rate frequencies were determined for the Pend Oreille River in Boundary Forebay and at the USGS Primary Gage No. 12396500 below Box Canyon Dam for Calendar Years 1987 through 2005. Daily maximum ramping rate exceedance frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix D.

Daily maximum ramping rates reported on a monthly basis in Appendix D range from zero (90% exceedance level in April 1996) to 30.0 inches per hour (10% exceedance level in February 1991) in the results reported for Boundary Forebay, while comparable daily maximum ramping rates at the USGS Primary Gage No. 12396500 below Box Canyon Dam range from 0.2 (90% exceedance level in June 1995, December 1995, and June 1999) to 16.7 inches per hour (10% exceedance level in September 1989).

Daily maximum ramping rates reported on an annual basis in Appendix D range from 2.5 inches per hour (90% exceedance level in 1996) to 23.6 inches per hour (10% exceedance level in 1990) in the results reported for Boundary Forebay, while comparable daily maximum ramping rates at the USGS Primary Gage No. 12396500 below Box Canyon Dam range from 0.8 inches per hour (90% exceedance level in 1996) to 8.7 inches per hour (10% exceedance level in 1989).

Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance daily maximum ramping rates in the Pend Oreille River in Boundary Forebay are 17.3, 14.5, 10.0, 6.2, and 4.8 inches per hour, respectively. Daily maximum ramping rates with the same long-term frequency of exceedance are 6.6, 5.6, 4.2, 2.6, and 1.7 inches per hour, respectively at the USGS Primary Gage No. 12396500 below Box Canyon Dam.

A summary of the results reported in Appendix D is illustrated in Figure 4-9. Monthly daily maximum ramping rates in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels are shown in Figure 4-9. Daily maximum ramping rates reach the highest magnitudes in April and October in Boundary Forebay. Daily maximum ramping rates in the Pend Oreille River at USGS Gage No. 12396500 below Box Canyon Dam are smallest in May, when flows are generally increasing toward the annual peak in June.



**Figure 4-9.** Monthly patterns of daily maximum ramping rates in Boundary Forebay and in Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005.

## 5 DOWNSTREAM REACH

### 5.1. Inflows to Seven Mile Reservoir

Downstream from Boundary Dam, the Pend Oreille River gains about 570 square miles of additional drainage area between Boundary Dam and Seven Mile Dam. Of this total, the Salmo River, with a drainage area of 475 square miles, accounts for 83 percent of the additional drainage area. The remainder comes from smaller tributaries. The Pend Oreille River extending downstream from Boundary Dam to the confluence with the Columbia River is shown in Figure 5-1.

The Salmo River had an average flow of 1,100 cfs during the selected study period (1987 to 2005). If the flow in the additional downstream tributaries is assumed to be equivalent to the flow in the Salmo River, scaled in proportion to drainage area, then the additional downstream tributaries are assumed to contribute an average flow of 220 cfs.

The total average annual inflow to Seven Mile Reservoir is estimated to be 25,400 cfs. Of this total, releases from Boundary Dam to the Pend Oreille River account for 94.8%; the Salmo River accounts for 4.3%; and the additional downstream tributaries account for 0.9%.

Average monthly and annual total flow releases from Boundary Dam to the Pend Oreille River from 1987 to 2005 are summarized in Table 5-1. Monthly flows ranged from a minimum of 6,100 cfs in August 1988 to a maximum of 116,200 cfs in June 1997. Annual flow ranged from a minimum of 13,900 cfs in 2001 to a maximum of 40,700 cfs in 1997.

Total hourly flow releases from Boundary Dam to the Pend Oreille River are shown on plots in Appendix E for each Calendar Year from 1989 through 2005. Monthly and annual flow duration frequencies were determined for total flow releases from Boundary Dam to the Pend Oreille River using hourly flows from Calendar Years 1987 through 2005. Flow duration frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix F.

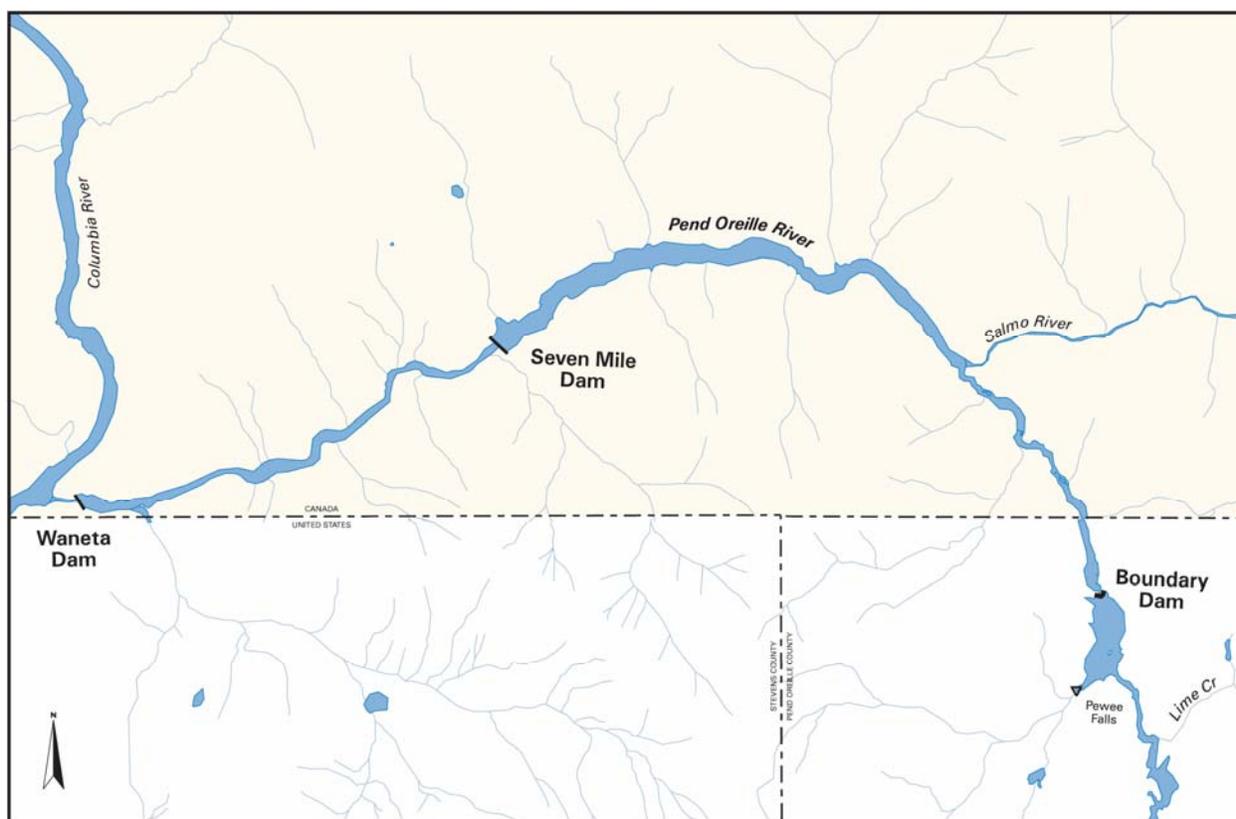
Flows reported on a monthly basis in Appendix F range from zero (90% exceedance level in 150 of the 228 months from 1987 to 2005) to 132,200 cfs (10% exceedance level in June 1997). Flows reported on an annual basis in Appendix F range from zero (90% exceedance level in 16 of the 19 years from 1987 to 2005) to 111,200 cfs (10% exceedance level in 1997). Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance flows are 46,900, 36,600, 22,600, 5,900, and zero, respectively.

A summary of the results reported in Appendix F is illustrated in Figure 5-2. Monthly flows based on the total flow release from Boundary Dam to the Pend Oreille River at 10%, 50%, and 90% exceedance levels are shown in Figure 5-2. Peak inflows typically occur in June, while lowest inflows typically occur in August.

Maximum daily change (daily maximum minus daily minimum) of total flow release from Boundary Dam to the Pend Oreille River was calculated for each day over the 19-year period

from Calendar Year 1987 through 2005. A monthly and annual frequency analysis (based on the number days a given flow change is equaled or exceeded) was performed on these daily flow changes, with the results reported in Appendix G. A general summary of the results reported in Appendix G is illustrated in Figure 5-3. The daily change in flow releases from Boundary Dam (shown in Figure 5-3) is much greater than the daily change in total inflow to Boundary Dam (shown in Figure 4-3).

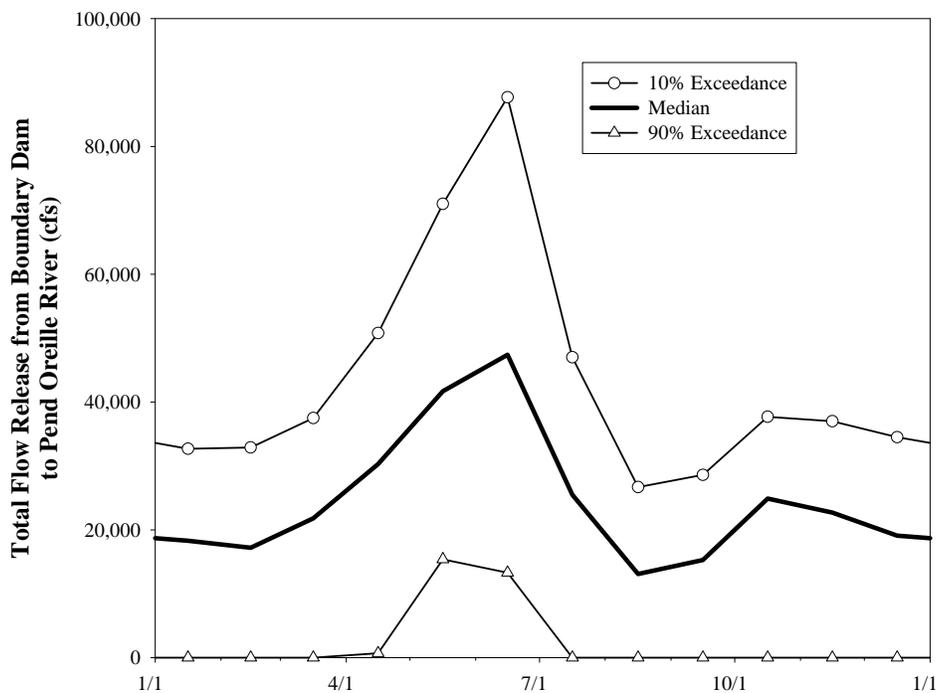
Total releases from Boundary Dam to the Pend Oreille River consist of discharge from the Powerplant plus spill flows. Powerplant discharge flows are estimated from power generation through each of the six units combined with gross head (difference between forebay and tailwater elevations). Spill flows are determined from gate opening combined with forebay water surface elevations.



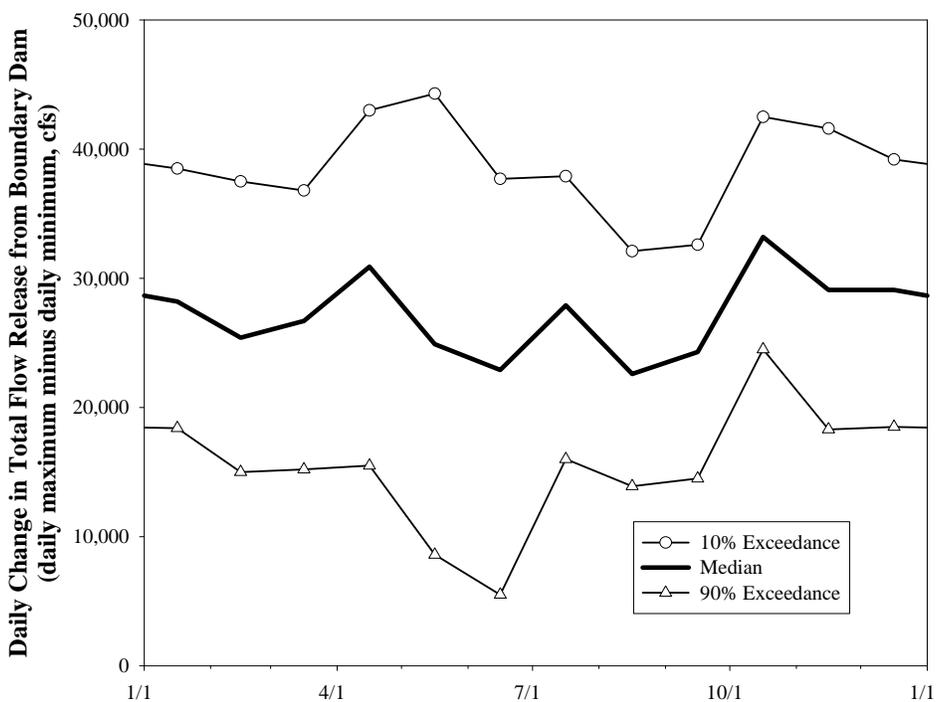
**Figure 5-1.** Pend Oreille River extending from Boundary Dam to confluence with the Columbia River.

**Table 5-1.** Average monthly and annual total flow release from Boundary Dam to Pend Oreille River, 1987 to 2005.

Year	Average Monthly and Annual Total Flow Release from Boundary Dam to Pend Oreille River (cfs)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	14,500	15,700	15,700	25,200	34,100	19,200	12,100	10,800	17,300	23,000	18,800	14,700	18,400
1988	10,200	12,800	18,900	27,300	28,300	21,900	11,400	6,100	10,100	20,300	21,200	13,700	16,800
1989	11,800	11,800	18,200	30,000	47,400	41,500	21,300	16,400	21,200	23,500	26,200	23,100	24,400
1990	22,300	21,600	19,400	38,800	45,900	68,400	31,200	13,600	16,000	26,000	27,500	20,800	29,300
1991	21,900	26,200	26,900	32,300	55,100	67,100	39,100	13,000	16,600	25,600	21,900	17,000	30,200
1992	14,800	12,700	16,500	19,500	22,000	16,100	14,200	10,300	15,100	25,600	19,500	12,100	16,500
1993	17,100	10,500	14,300	21,100	36,400	32,100	29,200	14,000	17,600	23,900	19,300	18,900	21,300
1994	18,400	14,500	16,200	20,300	24,400	26,000	10,700	6,200	9,300	19,200	20,200	12,800	16,500
1995	13,300	17,100	27,500	22,800	29,500	50,900	28,300	11,700	13,700	24,700	28,600	37,900	25,500
1996	28,300	42,300	44,400	55,700	68,800	78,700	32,200	18,500	15,500	20,900	19,100	18,800	36,800
1997	24,600	22,600	33,200	47,400	99,200	116,200	38,600	20,000	19,700	23,400	23,300	20,000	40,700
1998	16,900	13,700	17,500	24,600	37,800	53,900	33,100	15,500	15,300	18,300	19,700	17,200	23,700
1999	17,800	17,200	23,500	32,700	45,500	67,600	36,500	16,200	14,300	18,400	24,200	24,200	28,200
2000	18,400	15,800	19,800	36,700	46,000	39,500	21,400	10,300	12,900	19,300	16,900	14,300	22,600
2001	12,600	7,900	8,600	12,000	26,200	23,500	13,100	7,700	8,200	18,500	15,600	12,500	13,900
2002	17,200	16,700	18,100	29,000	46,400	84,300	37,400	14,700	12,400	16,000	14,800	16,000	26,900
2003	10,700	17,000	21,200	34,300	40,900	44,900	17,300	9,500	9,400	17,400	20,300	14,800	21,500
2004	11,700	13,400	18,000	19,800	34,500	36,300	22,500	13,300	18,800	23,300	17,100	20,900	20,800
2005	17,800	15,700	13,200	21,500	38,100	46,000	21,800	12,000	9,200	18,300	20,400	14,700	20,700
<i>Maximum</i>	<i>28,300</i>	<i>42,300</i>	<i>44,400</i>	<i>55,700</i>	<i>99,200</i>	<i>116,200</i>	<i>39,100</i>	<i>20,000</i>	<i>21,200</i>	<i>26,000</i>	<i>28,600</i>	<i>37,900</i>	<i>40,700</i>
<i>Average</i>	<i>16,900</i>	<i>17,100</i>	<i>20,600</i>	<i>29,000</i>	<i>42,400</i>	<i>49,200</i>	<i>24,800</i>	<i>12,600</i>	<i>14,300</i>	<i>21,300</i>	<i>20,800</i>	<i>18,100</i>	<i>23,900</i>
<i>Minimum</i>	<i>10,200</i>	<i>7,900</i>	<i>8,600</i>	<i>12,000</i>	<i>22,000</i>	<i>16,100</i>	<i>10,700</i>	<i>6,100</i>	<i>8,200</i>	<i>16,000</i>	<i>14,800</i>	<i>12,100</i>	<i>13,900</i>



**Figure 5-2.** Monthly 10% exceedance, median, and 90% exceedance flows for total flow release from Boundary Dam to the Pend Oreille River, derived from 19 years of hourly flows from Calendar Year 1987 through 2005.



**Figure 5-3.** Monthly 10% exceedance, median, and 90% exceedance frequencies for daily change in total flow release from Boundary Dam to the Pend Oreille River (daily maximum minus daily minimum), derived from 19 years of hourly flows from Calendar Year 1987 through 2005.

Average monthly and annual spill flows from Boundary Dam to the Pend Oreille River from 1987 to 2005 are summarized in Table 5-2. Monthly spill flows ranged from a minimum of zero in 187 of the 228 months over the 19-year period, to a maximum of 78,700 cfs in June 1997. Average annual spill flow ranged from a minimum of zero in 7 of the 19 years to a maximum of 11,700 cfs in 1997.

Average monthly and annual flows in the Salmo River near the confluence with the Pend Oreille River from 1987 to 2005 are summarized in Table 5-3. Monthly flows ranged from a minimum 110 cfs in February 2001, to a maximum of 5,940 cfs in May 1997. Annual flow ranged from a minimum of 610 cfs in 2001 to a maximum of 1,710 cfs in 1999.

The total inflow to Seven Mile Reservoir consists of flow releases from Boundary Dam plus tributary inflow between Boundary Dam and Seven Mile Dam. Tributary inflows from ungaged tributaries were estimated from the flows in the Salmo River scaled in proportion to drainage area. Average monthly and annual total inflow to Seven Mile Reservoir, calculated using this procedure are summarized in Table 5-4 for the period extending from 1987 to 2005. Monthly flows ranged from a minimum 6,300 cfs in August 1988, to a maximum of 122,400 cfs in June 1997. Annual flow ranged from a minimum of 14,600 cfs in 2001 to a maximum of 42,700 cfs in 1997.

Monthly and annual maximum, minimum, and average hourly inflows to Seven Mile Reservoir are shown in Table 5-5 for January 1987 through December 2005. The minimum hourly inflow (100 cfs) occurred in 24 of the 228 months from 1987 through 2005, and the maximum hourly inflow (167,600 cfs) occurred in June 1997.

Flow releases from Boundary Dam to the Pend Oreille River may change on an hourly basis. To gain an understanding of how hourly flow releases from Boundary Dam to the Pend Oreille River change, the median monthly total flow release and spill for each hour of the week were determined for selected representative months from 1987 through 2004. Median flows were determined instead of average flows because the number of hours in each month for a particular hour of the week is only 4 or 5. The average flow determined from this small sample size would be biased if the flow for one of those hours were unusually large or small. Consequently median flows were determined for this assessment.

The median weekly patterns of hourly flow releases for wet, average, and dry conditions in June were determined for 1997, 1995, and 1992, respectively. Results of these analyses are shown in Figure 5-4. These months are the same as the months shown in Figure 4-4 (water surface elevations in Boundary Forebay and the Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam).

During June 1997, the average monthly inflow to Boundary Reservoir was 118,800 cfs (from Table 4-5). Under these high flow conditions for the month of June, the resultant total hourly flow release from Boundary Dam to the Pend Oreille River were relatively constant, as shown in Figure 5-4.

**Table 5-2.** Average monthly and annual spill from Boundary Dam to Pend Oreille River, 1987 to 2005.

Year	Average Monthly and Annual Spill from Boundary Dam to Pend Oreille River (cfs)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	100	1,900	400	0	0	0	0	0	0	200
1990	0	0	0	0	1,600	18,900	300	0	0	0	0	0	1,700
1991	0	0	0	0	10,300	17,200	5,400	0	0	0	0	0	2,800
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	2,200	400	0	0	0	0	0	0	200
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	3,300	0	0	0	0	0	2,600	500
1996	1,100	7,300	3,300	13,600	22,900	33,500	2,900	0	0	0	0	0	7,000
1997	0	0	1,600	3,600	53,000	78,700	3,800	0	100	0	0	0	11,700
1998	0	0	0	0	4,100	9,500	600	0	0	0	0	0	1,200
1999	0	0	0	800	4,200	15,100	1,100	0	0	0	0	0	1,700
2000	0	0	0	100	100	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	4,700	31,300	3,200	0	0	0	0	0	3,200
2003	0	0	0	0	300	2,800	0	0	0	0	0	0	300
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	1,700	0	0	0	0	0	0	100
<b>Maximum</b>	1,100	7,300	3,300	13,600	53,000	78,700	5,400	0	100	0	0	2,600	11,700
<b>Average</b>	100	400	300	1,000	5,500	11,200	900	0	0	0	0	100	1,600
<b>Minimum</b>	0	0	0	0	0	0	0	0	0	0	0	0	0

**Table 5-3.** Average monthly and annual flows in the Salmo River near the confluence with the Pend Oreille River, 1987 to 2005.

Year	Average Monthly and Annual Flows in the Salmo River near the confluence with the Pend Oreille River												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	250	230	1,230	2,190	3,700	1,260	480	240	160	140	150	220	860
1988	140	140	320	2,610	3,440	2,120	480	170	190	300	540	280	890
1989	270	210	350	2,240	4,000	2,710	500	320	210	210	710	550	1,030
1990	370	280	540	3,010	3,520	4,780	1,180	340	210	230	880	480	1,320
1991	340	770	570	2,060	4,430	4,070	1,870	470	230	160	190	180	1,280
1992	180	380	900	2,150	3,220	1,170	500	210	190	190	210	140	790
1993	140	130	340	1,370	4,940	1,610	1,110	500	270	210	170	180	920
1994	180	180	480	2,820	3,450	2,370	590	200	150	150	160	190	910
1995	200	460	1,180	1,470	4,220	3,220	710	350	200	610	1,330	1,530	1,290
1996	600	800	890	2,360	3,600	4,180	1,420	360	220	240	290	260	1,270
1997	370	310	1,130	2,120	5,940	5,130	1,480	430	660	870	680	400	1,630
1998	330	420	860	2,600	4,520	1,900	670	330	190	220	340	490	1,070
1999	370	350	780	2,130	4,550	5,930	3,030	770	310	270	1,250	690	1,710
2000	410	370	570	2,560	4,290	3,830	920	240	210	220	180	150	1,160
2001	130	110	210	690	2,940	1,420	410	180	120	150	600	360	610
2002	620	450	480	1,800	4,120	4,370	1,110	270	170	140	180	270	1,170
2003	250	320	920	1,880	3,500	3,400	550	160	140	270	270	210	990
2004	180	200	590	2,570	3,440	2,330	630	320	640	480	670	760	1,070
2005	560	700	750	1,780	3,310	2,150	780	250	180	420	370	300	960
<i>Maximum</i>	<i>620</i>	<i>800</i>	<i>1,230</i>	<i>3,010</i>	<i>5,940</i>	<i>5,930</i>	<i>3,030</i>	<i>770</i>	<i>660</i>	<i>870</i>	<i>1,330</i>	<i>1,530</i>	<i>1,710</i>
<i>Average</i>	<i>310</i>	<i>360</i>	<i>690</i>	<i>2,130</i>	<i>3,950</i>	<i>3,050</i>	<i>970</i>	<i>320</i>	<i>240</i>	<i>290</i>	<i>480</i>	<i>400</i>	<i>1,100</i>
<i>Minimum</i>	<i>130</i>	<i>110</i>	<i>210</i>	<i>690</i>	<i>2,940</i>	<i>1,170</i>	<i>410</i>	<i>160</i>	<i>120</i>	<i>140</i>	<i>150</i>	<i>140</i>	<i>610</i>

**Table 5-4.** Average monthly and annual total inflow to Seven Mile Reservoir, 1987 to 2005.

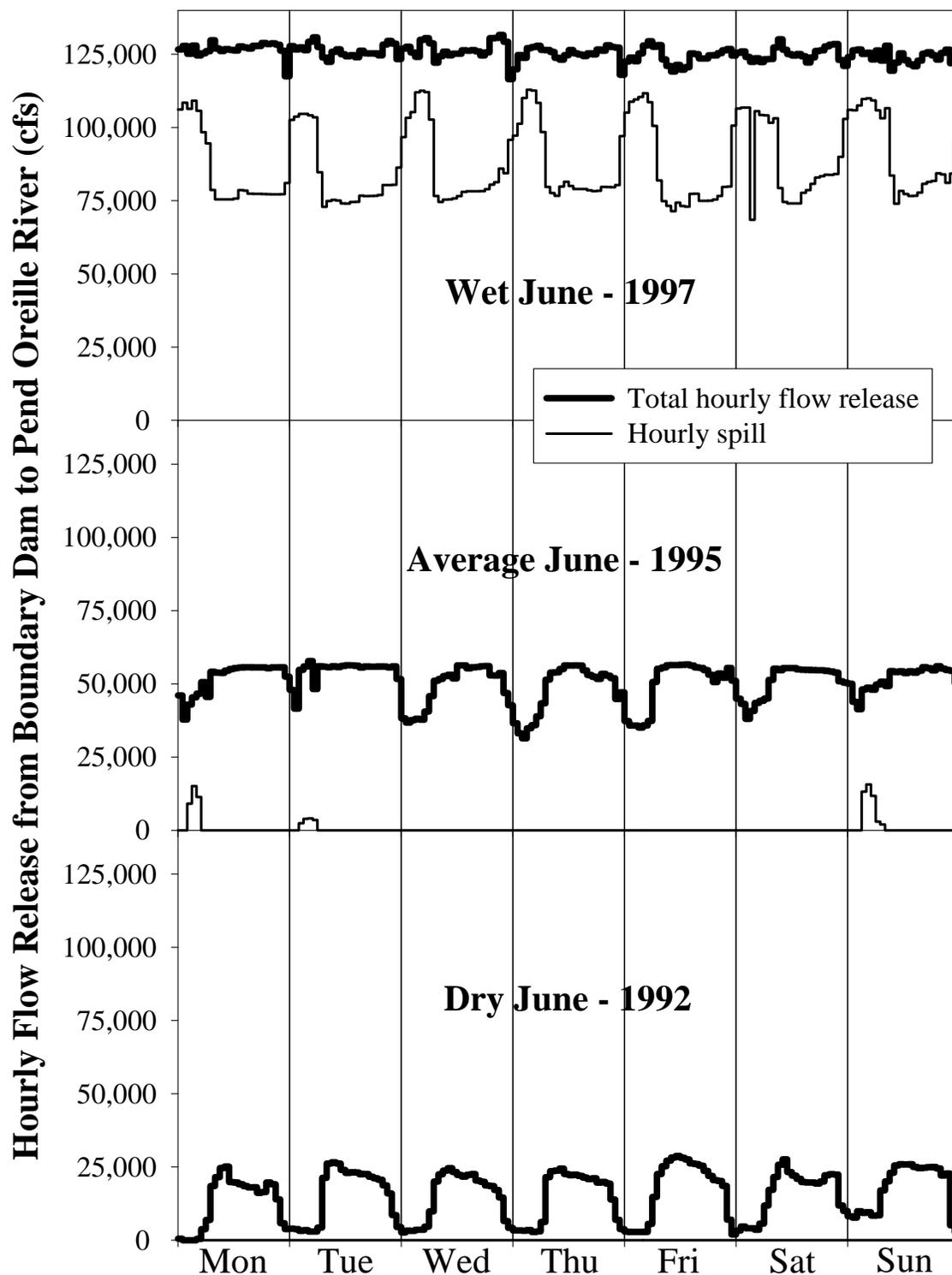
Year	Average Monthly and Annual Total Inflow to Seven Mile Reservoir												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	14,800	16,000	17,200	27,800	38,500	20,700	12,700	11,100	17,500	23,200	19,000	15,000	19,400
1988	10,400	13,000	19,300	30,400	32,400	24,400	12,000	6,300	10,300	20,700	21,800	14,000	17,900
1989	12,100	12,100	18,600	32,700	52,200	44,800	21,900	16,800	21,500	23,800	27,100	23,800	25,600
1990	22,700	21,900	20,000	42,400	50,100	74,100	32,600	14,000	16,300	26,300	28,600	21,400	30,900
1991	22,300	27,100	27,600	34,800	60,400	72,000	41,300	13,600	16,900	25,800	22,100	17,200	31,700
1992	15,000	13,200	17,600	22,100	25,900	17,500	14,800	10,600	15,300	25,800	19,800	12,300	17,400
1993	17,300	10,700	14,700	22,700	42,300	34,000	30,500	14,600	17,900	24,200	19,500	19,100	22,400
1994	18,600	14,700	16,800	23,700	28,500	28,800	11,400	6,400	9,500	19,400	20,400	13,000	17,600
1995	13,500	17,700	28,900	24,600	34,600	54,800	29,200	12,100	13,900	25,400	30,200	39,700	27,000
1996	29,000	43,300	45,500	58,500	73,100	83,700	33,900	18,900	15,800	21,200	19,400	19,100	38,300
1997	25,000	23,000	34,600	49,900	106,300	122,400	40,400	20,500	20,500	24,400	24,100	20,500	42,700
1998	17,300	14,200	18,500	27,700	43,200	56,200	33,900	15,900	15,500	18,600	20,100	17,800	25,000
1999	18,200	17,600	24,400	35,300	51,000	74,700	40,100	17,100	14,700	18,700	25,700	25,000	30,300
2000	18,900	16,200	20,500	39,800	51,100	44,100	22,500	10,600	13,200	19,600	17,100	14,500	24,000
2001	12,800	8,000	8,900	12,800	29,700	25,200	13,600	7,900	8,300	18,700	16,300	12,900	14,600
2002	17,900	17,200	18,700	31,200	51,300	89,500	38,700	15,000	12,600	16,200	15,000	16,300	28,300
2003	11,000	17,400	22,300	36,600	45,100	49,000	18,000	9,700	9,600	17,700	20,600	15,100	22,700
2004	11,900	13,600	18,700	22,900	38,600	39,100	23,300	13,700	19,600	23,900	17,900	21,800	22,100
2005	18,500	16,500	14,100	23,600	42,100	48,600	22,700	12,300	9,400	18,800	20,800	15,100	21,900
<i>Maximum</i>	<i>29,000</i>	<i>43,300</i>	<i>45,500</i>	<i>58,500</i>	<i>106,300</i>	<i>122,400</i>	<i>41,300</i>	<i>20,500</i>	<i>21,500</i>	<i>26,300</i>	<i>30,200</i>	<i>39,700</i>	<i>42,700</i>
<i>Average</i>	<i>17,200</i>	<i>17,500</i>	<i>21,400</i>	<i>31,600</i>	<i>47,200</i>	<i>52,800</i>	<i>26,000</i>	<i>13,000</i>	<i>14,600</i>	<i>21,700</i>	<i>21,300</i>	<i>18,600</i>	<i>25,200</i>
<i>Minimum</i>	<i>10,400</i>	<i>8,000</i>	<i>8,900</i>	<i>12,800</i>	<i>25,900</i>	<i>17,500</i>	<i>11,400</i>	<i>6,300</i>	<i>8,300</i>	<i>16,200</i>	<i>15,000</i>	<i>12,300</i>	<i>14,600</i>

**Table 5-5.** Monthly and annual maximum, minimum, and average inflows to Seven Mile Reservoir, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Inflow to Seven Mile Reservoir												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	Maximum	32,400	34,900	37,000	52,300	60,200	36,400	31,900	25,400	34,700	38,500	35,100	40,400	60,200
	Average	14,800	16,000	17,200	27,800	38,500	20,700	12,700	11,100	17,500	23,200	19,000	14,900	19,500
	Minimum	200	200	300	1,100	14,900	600	400	200	200	200	200	200	200
1988	Maximum	33,400	33,500	39,100	61,500	58,800	49,700	28,600	24,000	32,200	41,900	43,600	34,700	61,500
	Average	10,400	13,000	19,300	30,500	32,500	24,400	12,000	6,300	10,300	20,600	21,800	14,100	17,900
	Minimum	100	100	300	500	10,000	1,100	300	100	100	200	300	200	100
1989	Maximum	41,100	38,400	41,900	62,400	70,800	59,700	45,600	34,200	40,900	44,500	47,100	54,300	70,800
	Average	12,100	12,000	18,600	32,700	52,200	44,700	21,900	16,800	21,500	23,700	27,100	23,800	25,600
	Minimum	300	200	200	600	6,300	11,600	200	200	200	200	300	400	200
1990	Maximum	56,700	55,300	43,000	62,200	88,000	88,800	70,500	41,000	34,200	56,600	56,700	50,300	88,800
	Average	22,700	21,900	20,100	42,400	50,100	74,200	32,600	14,000	16,200	26,300	28,500	21,400	30,800
	Minimum	400	300	300	2,200	16,100	56,900	700	300	200	200	200	400	200
1991	Maximum	54,400	57,800	49,100	60,400	96,100	103,500	86,900	34,800	35,700	50,100	52,900	41,000	103,500
	Average	22,300	27,200	27,600	34,800	60,400	72,000	41,400	13,600	16,800	25,800	22,100	17,200	31,800
	Minimum	300	400	600	800	24,100	23,800	1,000	300	200	200	100	200	100
1992	Maximum	39,000	28,600	34,600	53,100	46,700	37,900	36,500	29,300	34,000	44,200	47,200	37,500	53,100
	Average	15,000	13,200	17,600	22,100	25,900	17,500	14,800	10,500	15,400	25,800	19,700	12,300	17,500
	Minimum	100	400	500	1,100	2,800	700	400	200	200	200	200	100	100
1993	Maximum	38,600	31,500	40,400	50,300	64,000	59,100	49,600	42,100	43,200	46,500	46,500	47,100	64,000
	Average	17,300	10,600	14,700	22,700	42,400	34,100	30,500	14,600	17,900	24,200	19,500	19,200	22,400
	Minimum	100	100	200	800	2,700	1,600	7,800	400	300	200	100	200	100
1994	Maximum	43,100	39,000	35,500	53,400	52,700	53,900	36,400	23,100	24,600	40,300	47,400	39,400	53,900
	Average	18,600	14,700	16,700	23,700	28,600	28,900	11,400	6,400	9,500	19,300	20,400	13,000	17,600
	Minimum	200	200	200	1,500	2,500	1,400	300	200	100	100	100	200	100
1995	Maximum	36,100	46,200	45,900	49,000	62,400	71,200	58,700	35,600	35,400	45,600	58,000	63,200	71,200
	Average	13,500	17,700	28,900	24,600	34,600	54,800	29,200	12,100	14,000	25,500	30,200	39,800	27,100
	Minimum	200	300	9,600	1,400	2,300	19,600	400	300	200	300	2,400	5,100	200
1996	Maximum	58,000	66,800	64,400	82,800	127,300	117,500	70,100	40,700	35,600	46,400	43,100	41,100	127,300
	Average	29,000	43,300	45,500	58,600	73,100	83,700	33,900	19,000	15,800	21,100	19,500	19,100	38,400
	Minimum	600	600	29,000	31,200	42,300	28,400	600	200	200	200	300	300	200

**Table 5-5.** Monthly and annual maximum, minimum, and average inflows to Seven Mile Reservoir, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Inflow to Seven Mile Reservoir												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1997	Maximum	50,200	46,100	64,200	90,000	144,800	167,600	75,400	41,200	36,200	44,800	46,300	40,700	167,600
	Average	25,100	23,000	34,500	49,900	106,300	122,400	40,400	20,600	20,500	24,400	24,100	20,500	42,700
	Minimum	400	6,400	400	17,000	65,700	44,400	4,100	400	300	700	600	400	300
1998	Maximum	36,600	35,600	46,200	60,800	77,300	81,600	66,000	35,700	33,700	36,000	35,000	44,500	81,600
	Average	17,300	14,200	18,600	27,700	43,200	56,200	33,900	15,900	15,500	18,600	20,100	17,800	25,000
	Minimum	200	400	500	1,300	14,700	29,200	400	300	200	200	3,700	400	200
1999	Maximum	36,600	40,300	44,300	71,700	92,800	88,300	73,900	40,900	33,300	37,900	43,000	46,900	92,800
	Average	18,300	17,600	24,400	35,300	50,900	74,800	40,100	17,100	14,700	18,800	25,700	25,000	30,200
	Minimum	400	400	500	6,300	3,700	54,600	1,400	500	300	300	400	600	300
2000	Maximum	42,100	44,400	47,600	62,500	64,100	61,000	45,700	31,800	34,800	44,100	38,200	39,900	64,100
	Average	18,900	16,200	20,500	39,700	51,100	44,100	22,500	10,600	13,200	19,500	17,100	14,500	24,000
	Minimum	400	400	500	900	4,100	5,700	400	200	200	200	200	100	100
2001	Maximum	32,100	28,800	27,700	51,500	53,100	46,300	40,600	19,200	26,800	53,800	36,900	34,600	53,800
	Average	12,700	8,000	8,900	12,800	29,800	25,200	13,600	7,900	8,300	18,700	16,400	12,900	14,600
	Minimum	100	100	100	300	1,700	900	300	200	100	100	200	300	100
2002	Maximum	49,400	36,600	45,800	58,200	94,200	105,600	90,500	32,900	29,400	31,500	32,400	36,200	105,600
	Average	17,900	17,300	18,700	31,100	51,300	89,600	38,700	15,000	12,700	16,100	15,000	16,400	28,300
	Minimum	300	400	500	800	3,200	65,200	500	200	200	100	100	200	100
2003	Maximum	37,500	38,600	47,800	59,800	69,500	79,700	41,700	26,800	24,700	34,800	38,100	34,200	79,700
	Average	11,000	17,400	22,300	36,600	45,100	49,000	18,000	9,700	9,600	17,700	20,600	15,000	22,600
	Minimum	200	300	300	1,500	3,000	7,400	300	100	100	100	300	200	100
2004	Maximum	32,700	32,200	46,400	42,800	58,200	56,400	45,200	36,100	43,800	44,700	38,200	42,500	58,200
	Average	11,900	13,700	18,700	22,900	38,700	39,100	23,300	13,700	19,600	23,900	18,000	21,800	22,100
	Minimum	200	200	300	1,900	3,800	1,800	300	200	400	400	500	600	200
2005	Maximum	44,900	35,500	36,900	52,700	61,000	80,700	49,000	35,200	27,100	41,000	37,600	39,400	80,700
	Average	18,500	16,500	14,100	23,600	42,000	48,600	22,700	12,300	9,400	18,800	20,800	15,100	21,900
	Minimum	300	600	600	1,000	2,700	15,700	500	200	200	200	400	200	200
1987 to 2005	Maximum	58,000	66,800	64,400	90,000	144,800	167,600	90,500	42,100	43,800	56,600	58,000	63,200	167,600
	Average	17,200	17,600	21,400	31,600	47,200	52,800	26,000	13,000	14,700	21,700	21,300	18,600	25,300
	Minimum	100	100	100	300	1,700	600	200	100	100	100	100	100	100



**Figure 5-4.** Median weekly patterns of hourly total flow releases and hourly spill from Boundary Dam to the Pend Oreille River June in 1997, 1995, and 1992.

During June 1995, the average monthly inflow to Boundary Reservoir was 52,800 cfs (from Table 4-5). Under these average flow conditions for the month of June, total hourly flow releases fluctuated between about 40,000 cfs and 56,000 cfs each day. Flow releases were held at the reduced level for a longer duration on Wednesday through Saturday.

During June 1992, the average monthly inflow to Boundary Reservoir was 15,900 cfs (from Table 4-5). Under these low flow conditions for the month of June, total hourly flow releases fluctuated between zero and 25,000 cfs each day of the week.

The median weekly patterns of flow releases for wet, average, and dry conditions in August were determined for 1997, 2004, and 1988, respectively. Results of these analyses are shown in Figure 5-5. These months are the same as the months shown in Figure 4-5 (water surface elevations in Boundary Forebay and the Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam).

During August 1997, the average monthly inflow to Boundary Reservoir was 20,800 cfs (from Table 4-5). Under these high flow conditions for the month of August, total hourly flow releases fluctuated between zero and about 30,000 cfs on all days of the week from Monday through Sunday.

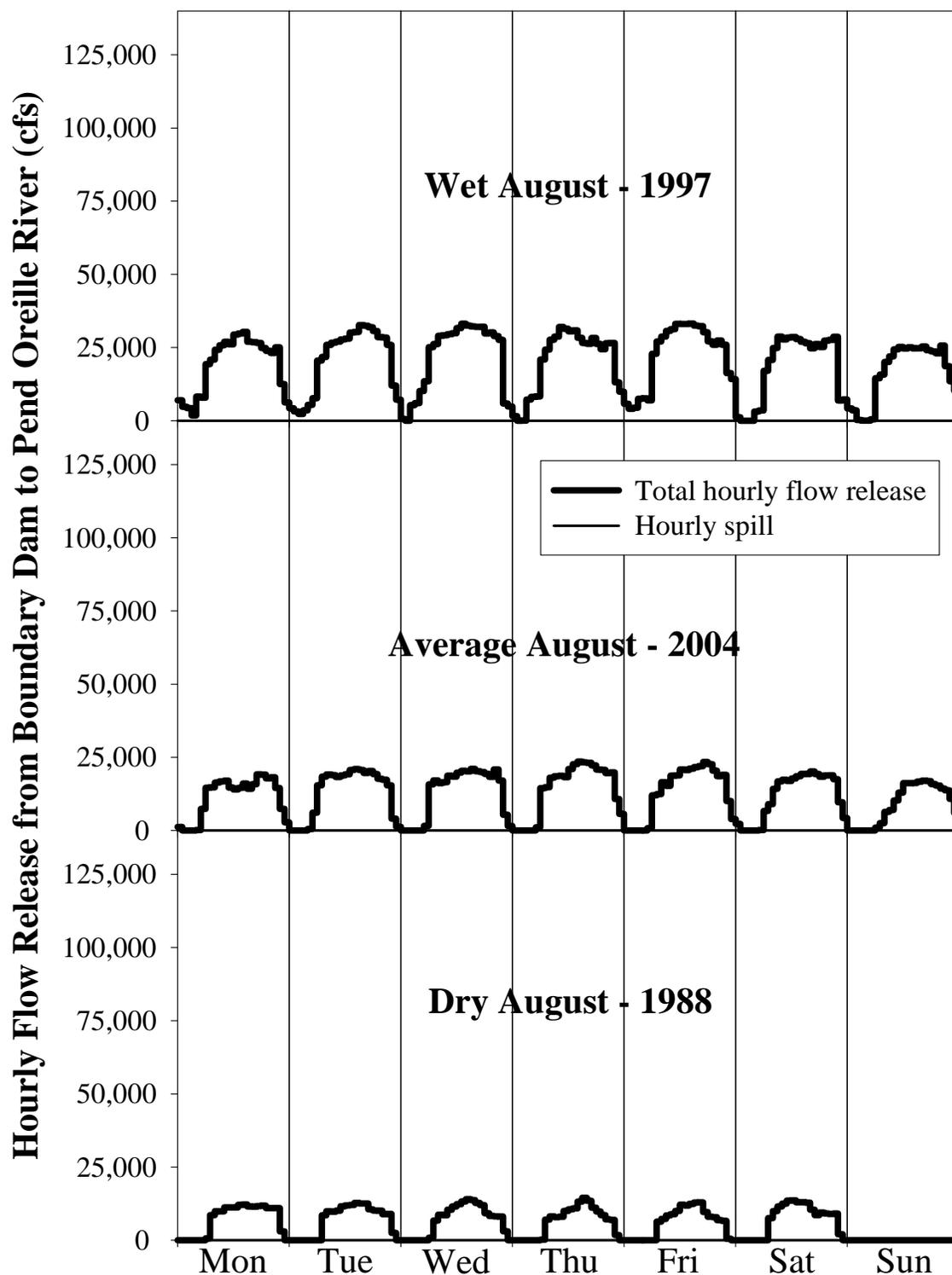
During August 2004, the average monthly inflow to Boundary Reservoir was 13,800 cfs (from Table 4-5). Under these average flow conditions for the month of August, hourly total flow releases fluctuated between zero and about 20,000 cfs on all days of the week from Monday through Sunday.

During August 1994, the average monthly inflow to Boundary Reservoir was 7,700 cfs (from Table 4-5). Under these low flow conditions for the month of August, hourly total flow releases fluctuated between zero and about 10,000 cfs on all days of the week from Monday through Sunday.

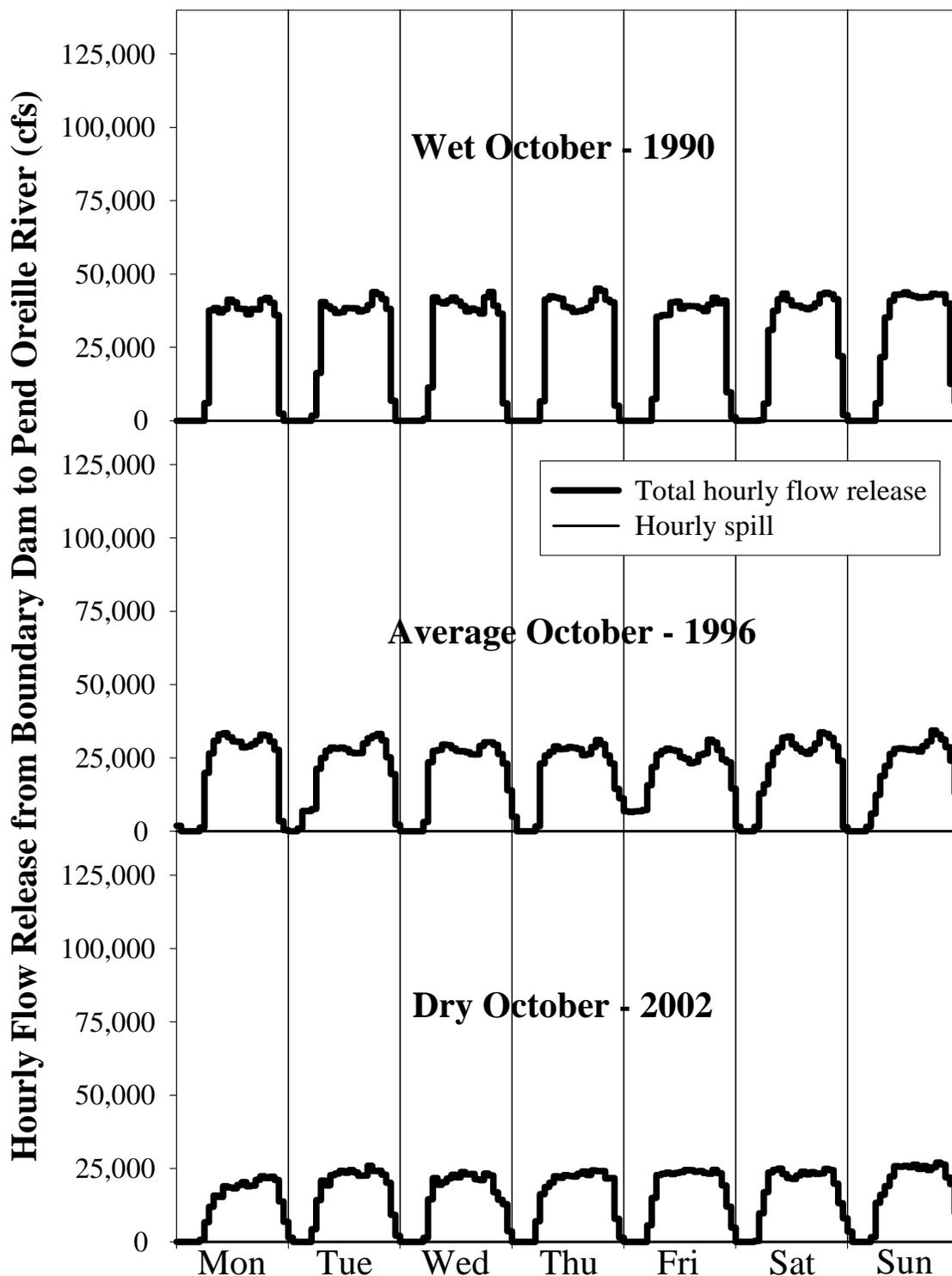
The median weekly patterns of flow releases for wet, average, and dry conditions in October were determined for 1990, 1996, and 2002, respectively. Results of these analyses are shown in Figure 5-6. These months are the same as the months shown in Figure 4-6 (water surface elevations in Boundary Forebay and the Pend Oreille River at USGS Primary Gage No. 12396500 below Box Canyon Dam).

During October 1990, the average monthly inflow to Boundary Reservoir was 26,300 cfs (from Table 4-5). Under these high flow conditions for the month of October, total hourly flow releases fluctuated between zero and about 40,000 cfs on all days of the week from Monday through Sunday.

During October 1996, the average monthly inflow to Boundary Reservoir was 20,500 cfs (from Table 4-5). Under these average flow conditions for the month of October, hourly total flow releases fluctuated between zero and about 32,000 cfs on all days of the week from Monday through Sunday.



**Figure 5-5.** Median weekly patterns of hourly total flow releases and hourly spill from Boundary Dam to the Pend Oreille River August in 1997, 2004, and 1988.



**Figure 5-6.** Median weekly patterns of hourly total flow releases and hourly spill from Boundary Dam to the Pend Oreille River October in 1990, 1996, and 2002.

During October 2002, the average monthly inflow to Boundary Reservoir was 16,300 cfs (from Table 4-5). Under these low flow conditions for the month of October, hourly total flow releases fluctuated between zero and about 25,000 cfs on all days of the week from Monday through Sunday.

## 5.2. Water Surface Elevations in Seven Mile Reservoir

Monthly and annual maximum, minimum and average water surface elevations in Boundary Tailwater are shown in Table 5-6 for January 1987 through December 2005. The minimum hourly water surface elevation (1716.03 feet NAVD 88 or 1712.00 feet NGVD 29) occurred in 15 of the 228 months from 1987 through 2005, and the maximum hourly water surface elevation (1759.73 feet NAVD 88 or 1755.70 feet NGVD 29) occurred in June 1997. The minimum monthly average water surface elevation (1724.96 feet NAVD 88 or 1720.93 feet NGVD 29) occurred in January 1988, and the maximum monthly average water surface elevation (1751.55 feet NAVD 88 or 1747.52 feet NGVD 29) occurred in June 1997. The minimum annual average water surface elevation (1728.66 feet NAVD 88 or 1724.63 feet NGVD 29) occurred in 1987, and the maximum annual average water surface elevation (1736.75 feet NAVD 88 or 1732.72 feet NGVD 29) occurred in 1997.

Monthly and annual maximum, minimum and average water surface elevations in Seven Mile Forebay are shown in Table 5-7 for January 1987 through December 2005. The minimum hourly water surface elevation (1694.00 feet NAVD 88 or 1689.97 feet NGVD 29) occurred in March 1988, and the maximum hourly water surface elevation (1737.25 feet NAVD 88 or 1733.22 feet NGVD 29) occurred in April 1995. The minimum monthly average water surface elevation (1706.53 feet NAVD 88 or 1702.50 feet NGVD 29) occurred in February 1987, and the maximum monthly average water surface elevation (1732.94 feet NAVD 88 or 1728.91 feet NGVD 29) occurred in June 1991. The minimum annual average water surface elevation (1710.96 feet NAVD 88 or 1706.93 feet NGVD 29) occurred in 1987, and the maximum annual average water surface elevation (1729.02 feet NAVD 88 or 1724.99 feet NGVD 29) occurred in 1996.

Monthly and annual stage duration frequencies were determined for the Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay for Calendar Years 1987 through 2005. Stage exceedance frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix H.

**Table 5-6.** Monthly and annual maximum, minimum, and average water surface elevations in Boundary Tailwater, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Boundary Tailwater (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	Maximum	1734.06	1734.70	1734.98	1737.77	1738.67	1734.76	1733.92	1732.22	1734.67	1735.56	1734.77	1735.99	1738.67
	Average	1726.99	1727.33	1727.43	1731.20	1734.34	1729.65	1725.90	1725.15	1728.08	1731.00	1729.56	1727.01	1728.66
	Minimum	1716.03	1716.03	1716.03	1716.03	1728.29	1716.03	1716.03	1716.03	1716.03	1716.03	1716.03	1716.03	1716.03
1988	Maximum	1734.35	1734.37	1735.64	1739.26	1740.48	1740.30	1736.23	1735.56	1736.29	1738.26	1738.32	1736.20	1740.48
	Average	1724.96	1726.82	1729.35	1731.82	1734.08	1734.51	1732.68	1728.79	1731.03	1730.93	1731.43	1731.32	1730.64
	Minimum	1716.03	1716.03	1716.03	1717.24	1726.20	1727.76	1726.64	1716.03	1723.09	1717.48	1718.01	1723.73	1716.03
1989	Maximum	1737.14	1736.94	1737.82	1741.96	1743.92	1741.84	1739.78	1735.73	1737.79	1739.54	1739.52	1740.62	1743.92
	Average	1731.42	1730.95	1731.14	1734.07	1739.75	1737.80	1732.28	1730.37	1731.57	1731.48	1732.05	1730.91	1732.82
	Minimum	1724.68	1723.52	1718.00	1717.86	1728.40	1728.70	1718.14	1717.54	1717.65	1717.67	1717.58	1717.84	1717.54
1990	Maximum	1741.75	1739.90	1737.85	1742.09	1745.81	1746.09	1744.21	1736.04	1737.88	1740.43	1741.25	1739.65	1746.09
	Average	1730.92	1730.30	1730.77	1737.02	1739.29	1743.75	1734.83	1728.87	1731.43	1733.03	1733.13	1731.04	1733.70
	Minimum	1717.85	1717.60	1717.58	1717.87	1729.20	1740.72	1717.60	1717.40	1722.07	1717.90	1717.90	1717.95	1717.40
1991	Maximum	1739.83	1741.13	1740.58	1741.22	1748.11	1748.36	1746.67	1736.14	1736.03	1740.44	1740.72	1736.61	1748.36
	Average	1731.03	1732.25	1733.77	1734.57	1741.18	1743.53	1736.73	1729.84	1730.48	1732.79	1731.20	1730.01	1733.95
	Minimum	1717.95	1717.89	1717.50	1721.03	1733.93	1732.80	1718.29	1717.57	1717.80	1717.84	1717.72	1717.89	1717.50
1992	Maximum	1736.30	1735.36	1735.55	1739.86	1737.03	1737.20	1737.17	1735.69	1737.75	1739.27	1740.08	1737.82	1740.08
	Average	1729.57	1729.76	1731.67	1732.28	1732.40	1732.91	1731.73	1731.88	1732.20	1732.85	1731.92	1731.68	1731.74
	Minimum	1718.02	1721.06	1725.35	1719.75	1723.84	1726.57	1718.79	1721.91	1723.68	1718.59	1718.90	1724.99	1718.02
1993	Maximum	1738.00	1736.10	1737.79	1739.87	1742.54	1741.77	1740.54	1737.54	1743.01	1739.98	1740.11	1739.58	1743.01
	Average	1731.64	1731.65	1732.48	1732.55	1736.93	1735.76	1735.39	1732.35	1730.07	1732.24	1731.06	1731.82	1732.84
	Minimum	1721.21	1726.44	1723.46	1722.22	1718.65	1725.43	1730.28	1725.53	1717.77	1718.07	1718.11	1718.78	1717.77
1994	Maximum	1737.89	1737.29	1737.40	1738.96	1740.33	1738.89	1735.50	1735.11	1735.74	1738.39	1739.83	1736.69	1740.33
	Average	1731.81	1731.72	1732.21	1733.32	1732.24	1732.40	1730.56	1731.31	1731.06	1731.66	1731.84	1730.87	1731.74
	Minimum	1723.45	1723.75	1726.23	1725.34	1717.93	1717.76	1719.81	1726.77	1725.49	1717.67	1720.28	1719.31	1717.67
1995	Maximum	1737.12	1737.78	1739.02	1740.79	1742.36	1743.76	1742.27	1736.69	1737.12	1739.38	1741.18	1743.07	1743.76
	Average	1731.78	1731.65	1734.41	1732.63	1734.91	1740.69	1734.42	1730.43	1731.08	1733.54	1733.92	1737.15	1733.89
	Minimum	1722.97	1718.18	1727.73	1718.37	1722.01	1731.32	1722.67	1719.15	1717.90	1722.71	1722.86	1725.75	1717.90
1996	Maximum	1739.83	1743.73	1742.69	1745.95	1752.71	1751.22	1743.55	1738.68	1736.66	1739.39	1738.86	1737.88	1752.71
	Average	1733.82	1737.53	1739.03	1741.36	1743.84	1745.12	1735.31	1732.22	1730.86	1732.23	1731.74	1731.84	1736.22
	Minimum	1718.46	1719.46	1735.06	1734.64	1737.56	1736.03	1720.42	1719.29	1721.47	1721.75	1722.34	1723.94	1718.46

**Table 5-6.** Monthly and annual maximum, minimum, and average water surface elevations in Boundary Tailwater, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Boundary Tailwater (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1997	Maximum	1740.06	1739.12	1742.64	1746.86	1755.33	1759.73	1744.78	1738.21	1736.61	1738.99	1739.81	1738.14	1759.73
	Average	1733.18	1732.87	1735.97	1738.92	1748.88	1751.55	1736.99	1732.29	1732.27	1732.40	1732.79	1732.80	1736.75
	Minimum	1720.89	1725.94	1718.55	1731.58	1742.16	1737.84	1727.41	1717.49	1717.38	1718.08	1717.46	1719.87	1717.38
1998	Maximum	1737.24	1737.64	1739.26	1740.40	1744.83	1745.17	1743.14	1737.02	1737.29	1737.48	1736.81	1739.38	1745.17
	Average	1729.66	1730.42	1731.09	1732.78	1736.88	1740.97	1735.65	1730.19	1730.29	1731.66	1732.44	1731.19	1732.77
	Minimum	1717.53	1717.52	1718.14	1717.58	1729.63	1734.48	1721.84	1717.39	1717.20	1718.39	1726.27	1717.68	1717.20
1999	Maximum	1737.56	1738.63	1739.11	1742.75	1745.65	1745.66	1743.63	1737.20	1737.11	1738.33	1738.82	1739.02	1745.66
	Average	1732.95	1731.58	1733.00	1734.87	1738.35	1743.31	1736.71	1731.51	1730.78	1731.45	1733.24	1732.67	1734.21
	Minimum	1725.01	1718.97	1723.65	1724.72	1720.12	1740.08	1720.25	1720.39	1722.57	1718.95	1723.35	1717.69	1717.69
2000	Maximum	1738.56	1737.99	1740.06	1742.25	1742.32	1741.69	1737.41	1734.91	1736.01	1737.31	1737.76	1736.93	1742.32
	Average	1730.76	1730.22	1731.75	1736.18	1739.30	1737.52	1731.53	1728.22	1729.56	1731.02	1729.61	1730.41	1732.17
	Minimum	1717.56	1720.10	1717.91	1717.63	1721.29	1717.86	1717.25	1717.12	1717.72	1719.36	1717.53	1719.34	1717.12
2001	Maximum	1735.88	1734.56	1735.32	1738.70	1739.20	1737.84	1737.24	1734.45	1734.37	1739.36	1737.57	1736.00	1739.36
	Average	1730.22	1729.06	1729.33	1729.08	1733.35	1732.34	1728.47	1728.09	1729.03	1731.89	1730.06	1728.84	1729.99
	Minimum	1721.56	1717.91	1717.59	1717.62	1719.07	1717.93	1717.12	1716.93	1720.57	1719.05	1717.18	1717.17	1716.93
2002	Maximum	1740.31	1736.55	1737.86	1741.62	1746.50	1749.27	1747.02	1736.05	1733.68	1735.53	1736.54	1737.40	1749.27
	Average	1729.94	1730.70	1730.79	1734.07	1738.27	1746.30	1735.97	1730.69	1729.05	1730.93	1729.11	1730.78	1733.05
	Minimum	1717.32	1718.17	1717.36	1718.58	1717.97	1742.08	1717.15	1717.53	1716.98	1717.02	1716.98	1717.80	1716.98
2003	Maximum	1737.82	1738.17	1739.52	1741.58	1742.56	1744.57	1737.75	1733.71	1735.11	1736.54	1736.43	1736.10	1744.57
	Average	1728.71	1731.10	1731.28	1735.38	1736.84	1738.30	1732.20	1730.15	1730.25	1731.58	1731.61	1730.17	1732.29
	Minimum	1717.07	1717.14	1717.11	1718.29	1720.39	1726.43	1719.20	1724.03	1719.26	1717.32	1717.31	1719.40	1717.07
2004	Maximum	1736.96	1736.38	1738.19	1737.01	1740.33	1740.31	1737.50	1737.33	1738.73	1738.52	1737.41	1737.99	1740.33
	Average	1728.68	1730.36	1731.17	1731.69	1734.83	1736.01	1732.36	1730.32	1731.01	1733.08	1732.22	1731.78	1731.96
	Minimum	1717.25	1717.47	1720.76	1721.20	1718.34	1726.61	1721.88	1716.93	1719.15	1721.68	1724.91	1718.09	1716.93
2005	Maximum	1738.97	1736.18	1736.51	1740.02	1741.29	1745.54	1739.13	1735.80	1734.41	1738.08	1737.70	1736.16	1745.54
	Average	1730.41	1730.63	1731.47	1733.19	1736.14	1738.11	1733.12	1730.01	1727.22	1732.54	1731.99	1728.85	1731.98
	Minimum	1717.53	1717.42	1722.59	1723.25	1720.78	1728.88	1724.11	1720.42	1717.19	1724.60	1719.70	1717.34	1717.19
1987 to 2005	Maximum	1741.75	1743.73	1742.69	1746.86	1755.33	1759.73	1747.02	1738.68	1743.01	1740.44	1741.25	1743.07	1759.73
	Average	1730.44	1730.89	1732.01	1734.05	1737.46	1738.98	1733.31	1730.14	1730.39	1732.02	1731.63	1731.11	1732.70
	Minimum	1716.03	1716.03	1716.03	1716.03	1717.93	1716.03	1716.03	1716.03	1716.03	1716.03	1716.03	1716.03	1716.03

**Table 5-7.** Monthly and annual maximum, minimum, and average water surface elevations in Seven Mile Forebay, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Seven Mile Forebay (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1987	Maximum	1718.83	1716.73	1718.93	1718.86	1719.03	1718.07	1716.96	1718.07	1718.93	1718.83	1718.57	1718.93	1719.03
	Average	1708.55	1706.53	1710.56	1709.86	1713.51	1710.89	1712.16	1712.89	1712.28	1711.63	1711.56	1710.65	1710.96
	Minimum	1698.69	1698.55	1700.49	1697.70	1700.00	1702.95	1701.18	1700.85	1702.95	1694.09	1700.19	1700.36	1694.09
1988	Maximum	1718.40	1717.94	1718.60	1719.03	1732.84	1733.92	1733.86	1733.10	1732.97	1733.86	1732.64	1732.77	1733.92
	Average	1711.60	1713.31	1709.66	1711.55	1721.14	1731.24	1731.22	1724.24	1728.82	1722.68	1724.15	1728.32	1721.52
	Minimum	1703.02	1705.18	1694.00	1695.14	1702.46	1720.80	1726.64	1694.09	1719.55	1709.64	1713.09	1722.34	1694.00
1989	Maximum	1733.33	1732.77	1733.82	1734.05	1734.25	1734.22	1734.22	1733.04	1732.67	1734.05	1733.79	1733.67	1734.25
	Average	1729.17	1728.86	1725.94	1725.79	1732.10	1729.70	1726.61	1724.92	1723.98	1721.21	1719.94	1720.66	1725.73
	Minimum	1724.28	1723.06	1716.83	1703.84	1719.78	1716.96	1711.87	1707.71	1708.33	1700.33	1701.31	1707.81	1700.33
1990	Maximum	1733.86	1733.30	1734.28	1734.22	1734.25	1734.12	1734.18	1732.61	1734.22	1734.18	1734.22	1734.22	1734.28
	Average	1722.05	1719.93	1722.17	1727.94	1731.75	1732.67	1726.26	1722.40	1727.58	1724.93	1724.40	1723.69	1725.50
	Minimum	1707.02	1703.41	1701.01	1696.19	1722.83	1728.15	1699.44	1704.49	1719.91	1710.00	1708.00	1709.64	1696.19
1991	Maximum	1734.15	1734.15	1734.28	1734.18	1734.25	1734.09	1734.45	1733.40	1732.71	1733.99	1733.66	1729.10	1734.45
	Average	1722.27	1720.96	1724.98	1723.90	1732.63	1732.94	1728.18	1726.08	1724.60	1724.20	1722.16	1722.90	1725.51
	Minimum	1706.85	1698.09	1697.44	1710.86	1727.29	1726.70	1713.55	1708.27	1711.84	1708.17	1709.27	1715.45	1697.44
1992	Maximum	1732.64	1733.17	1732.71	1734.12	1733.82	1733.86	1733.92	1733.72	1734.09	1733.82	1733.72	1733.76	1734.12
	Average	1723.91	1725.65	1728.18	1727.61	1724.73	1730.29	1728.95	1730.27	1729.38	1724.90	1726.48	1729.45	1727.49
	Minimum	1716.89	1710.00	1718.21	1715.88	1715.12	1724.47	1718.21	1721.55	1722.67	1712.73	1716.17	1722.31	1710.00
1993	Maximum	1733.63	1732.77	1733.79	1734.12	1734.64	1734.28	1734.45	1733.89	1734.22	1734.41	1733.99	1734.02	1734.64
	Average	1727.43	1729.93	1730.05	1727.40	1730.50	1727.85	1727.55	1728.09	1722.81	1724.07	1724.66	1726.91	1727.27
	Minimum	1718.93	1724.64	1723.16	1717.55	1713.68	1714.79	1714.99	1719.49	1711.58	1711.97	1708.86	1714.63	1708.86
1994	Maximum	1735.10	1733.07	1733.79	1733.99	1735.63	1732.94	1733.07	1733.86	1733.76	1734.38	1733.46	1734.28	1735.63
	Average	1727.33	1728.62	1729.11	1729.09	1723.65	1721.92	1728.04	1730.44	1729.51	1725.49	1726.05	1727.75	1727.24
	Minimum	1718.60	1722.08	1723.62	1720.67	1708.07	1703.74	1718.17	1726.08	1724.60	1709.18	1716.07	1714.30	1703.74
1995	Maximum	1734.02	1733.27	1736.25	1737.25	1734.28	1734.22	1734.12	1734.05	1734.12	1734.28	1734.02	1734.38	1737.25
	Average	1729.24	1727.15	1728.27	1725.07	1728.00	1732.37	1726.82	1726.99	1727.30	1726.38	1725.72	1729.96	1727.78
	Minimum	1722.34	1713.19	1719.03	1713.55	1716.47	1724.08	1715.65	1717.29	1714.33	1716.37	1716.63	1714.83	1713.19
1996	Maximum	1733.49	1734.25	1734.05	1734.28	1734.22	1733.69	1734.02	1734.12	1733.27	1733.92	1733.76	1732.58	1734.28
	Average	1725.57	1729.01	1732.01	1732.48	1732.49	1731.61	1729.03	1727.80	1727.08	1727.04	1726.95	1727.19	1729.02
	Minimum	1710.79	1716.99	1727.69	1725.72	1729.33	1722.60	1720.17	1718.99	1720.50	1719.52	1720.73	1721.39	1710.79

**Table 5-7.** Monthly and annual maximum, minimum, and average water surface elevations in Seven Mile Forebay, January 1987 to December 2006.

		Monthly and Annual Maximum, Average, and Minimum Water Surface Elevations in Seven Mile Forebay (feet, NAVD 88)												
		January	February	March	April	May	June	July	August	September	October	November	December	Annual
1997	Maximum	1733.76	1734.31	1734.25	1734.05	1734.18	1734.12	1734.41	1734.12	1733.30	1734.12	1734.12	1734.05	1734.41
	Average	1727.29	1727.84	1729.62	1728.30	1732.19	1731.29	1729.23	1726.97	1722.44	1725.38	1725.61	1725.83	1727.67
	Minimum	1719.55	1721.75	1715.71	1707.77	1729.07	1726.80	1713.74	1710.23	1706.13	1712.07	1714.33	1717.68	1706.13
1998	Maximum	1734.02	1734.12	1734.22	1733.66	1734.09	1734.02	1734.12	1733.69	1734.05	1734.15	1734.05	1733.59	1734.22
	Average	1720.90	1726.64	1726.55	1723.02	1728.81	1732.02	1728.18	1724.85	1723.93	1726.40	1728.42	1726.66	1726.35
	Minimum	1701.87	1714.70	1716.70	1698.72	1717.52	1728.44	1715.84	1712.04	1704.98	1714.50	1720.90	1709.34	1698.72
1999	Maximum	1734.15	1734.12	1734.48	1734.12	1733.27	1733.40	1733.56	1733.69	1733.95	1733.99	1733.23	1733.23	1734.48
	Average	1729.89	1727.41	1726.78	1721.60	1727.49	1731.54	1728.06	1726.84	1727.24	1725.82	1727.81	1725.80	1727.19
	Minimum	1722.50	1717.35	1714.66	1701.31	1708.76	1730.02	1710.82	1714.24	1720.08	1717.06	1719.68	1713.97	1701.31
2000	Maximum	1733.10	1731.36	1733.99	1734.25	1734.02	1733.79	1732.38	1732.16	1733.56	1733.79	1733.69	1732.67	1734.25
	Average	1724.69	1725.58	1726.45	1725.45	1731.02	1729.23	1722.97	1723.22	1724.63	1723.59	1720.67	1726.27	1725.32
	Minimum	1706.59	1717.39	1713.25	1695.08	1712.27	1713.15	1710.73	1705.28	1715.02	1714.40	1701.83	1714.01	1695.08
2001	Maximum	1732.81	1732.94	1732.74	1732.67	1733.53	1733.07	1731.95	1732.71	1731.72	1732.67	1733.07	1732.97	1733.53
	Average	1727.30	1726.83	1726.92	1723.94	1724.43	1722.53	1721.64	1725.01	1726.87	1726.96	1725.41	1724.27	1725.16
	Minimum	1720.11	1716.04	1711.81	1713.15	1710.66	1707.38	1711.97	1709.94	1720.20	1712.82	1715.51	1714.43	1707.38
2002	Maximum	1733.76	1733.36	1732.54	1733.93	1734.09	1733.07	1733.86	1733.04	1731.46	1733.20	1733.00	1733.53	1734.09
	Average	1723.27	1725.73	1724.95	1725.02	1726.83	1732.17	1724.29	1726.49	1723.20	1725.39	1722.55	1726.42	1725.52
	Minimum	1709.22	1712.92	1709.48	1708.56	1710.92	1730.51	1704.30	1716.99	1706.26	1703.05	1711.81	1716.24	1703.05
2003	Maximum	1733.20	1733.59	1733.95	1733.40	1733.10	1733.10	1733.56	1733.10	1732.84	1733.49	1732.71	1732.41	1733.95
	Average	1723.51	1725.28	1722.92	1724.79	1724.01	1728.36	1727.79	1727.84	1727.90	1726.23	1725.21	1725.74	1725.80
	Minimum	1705.21	1706.36	1705.94	1707.41	1706.72	1719.62	1716.83	1722.44	1717.09	1713.42	1714.21	1717.48	1705.21
2004	Maximum	1732.94	1732.25	1731.92	1732.92	1732.90	1732.64	1732.74	1732.87	1732.84	1733.07	1733.36	1732.94	1733.36
	Average	1722.86	1726.51	1726.28	1726.49	1723.71	1727.69	1725.87	1726.80	1725.22	1727.50	1728.86	1726.18	1726.16
	Minimum	1704.03	1712.63	1716.66	1718.76	1706.72	1720.96	1715.78	1712.25	1715.58	1717.58	1723.32	1717.58	1704.03
2005	Maximum	1733.33	1732.67	1733.17	1733.53	1732.95	1733.53	1733.66	1733.09	1732.85	1732.92	1733.75	1730.97	1733.75
	Average	1724.11	1725.52	1729.01	1728.06	1726.05	1726.23	1728.23	1726.62	1722.03	1728.80	1726.20	1720.01	1725.91
	Minimum	1708.23	1712.11	1722.31	1712.69	1714.37	1712.14	1717.33	1717.50	1711.30	1720.12	1707.59	1703.40	1703.40
1987 to 2005	Maximum	1735.10	1734.31	1736.25	1737.25	1735.63	1734.28	1734.45	1734.12	1734.22	1734.41	1734.22	1734.38	1737.25
	Average	1723.73	1724.59	1725.28	1724.60	1727.11	1728.55	1726.37	1725.72	1725.10	1724.66	1724.36	1724.98	1725.43
	Minimum	1698.69	1698.09	1694.00	1695.08	1700.00	1702.95	1699.44	1694.09	1702.95	1694.09	1700.19	1700.36	1694.00

Water surface elevations reported on a monthly basis in Appendix H range from 1716.03 feet NAVD 88 (90% exceedance level in 9 of the 228 months from 1987 through 2005, equivalent to 1712.00 feet NGVD 29) to 1754.55 feet NAVD 88 (10% exceedance level in June 1997, equivalent to 1750.52 feet NGVD 29) in the results reported for Boundary Tailwater, while comparable water surface elevations in Seven Mile Forebay range from 1702.20 feet NAVD 88 (90% exceedance level in February 1987, equivalent to 1698.17 feet NGVD 29) to 1733.76 feet NAVD 88 (10% exceedance level in December 1995, equivalent to 1729.73 feet NGVD 29).

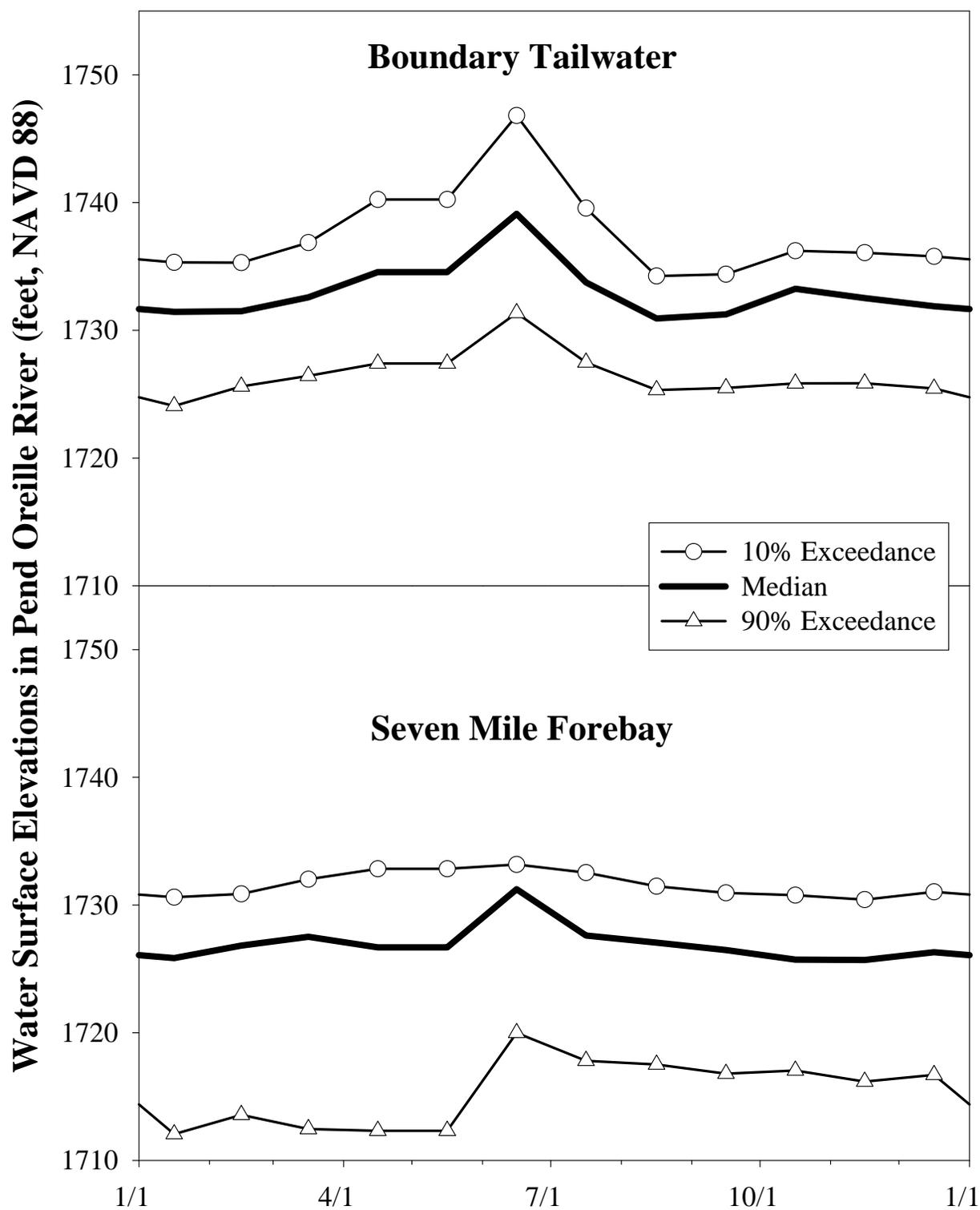
Water surface elevations reported on an annual basis in Appendix H range from 1716.03 feet NAVD 88 (90% exceedance level in 1987, equivalent to 1712.00 feet NGVD 29) to 1750.74 NAVD 88 (10% exceedance level in 1997, equivalent to 1746.71 feet NGVD 29) in the results reported for Boundary Tailwater, while comparable water surface elevations in Seven Mile Forebay range from 1705.44 feet NAVD 88 (90% exceedance level in 1987, equivalent to 1701.41 feet NGVD 29) to 1733.20 feet NAVD 88 (10% exceedance level in 1991, equivalent to 1729.17 feet NGVD 29).

Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance stages in the Pend Oreille River in Boundary Tailwater are 1739.19, 1936.18, 1732.84, 1728.96, and 1726.33 feet NAVD 88, respectively (equivalent to 1735.16, 1732.15, 1728.81, 1724.93, and 1722.30 feet NGVD 29). Stages with the same long-term frequency of exceedance are 1732.28, 1730.80, 1727.00, 1721.02, and 1715.68 feet NAVD 88, respectively (equivalent to 1728.25, 1726.77, 1722.97, 1716.99, and 1711.65 feet NGVD 29) in Seven Mile Forebay.

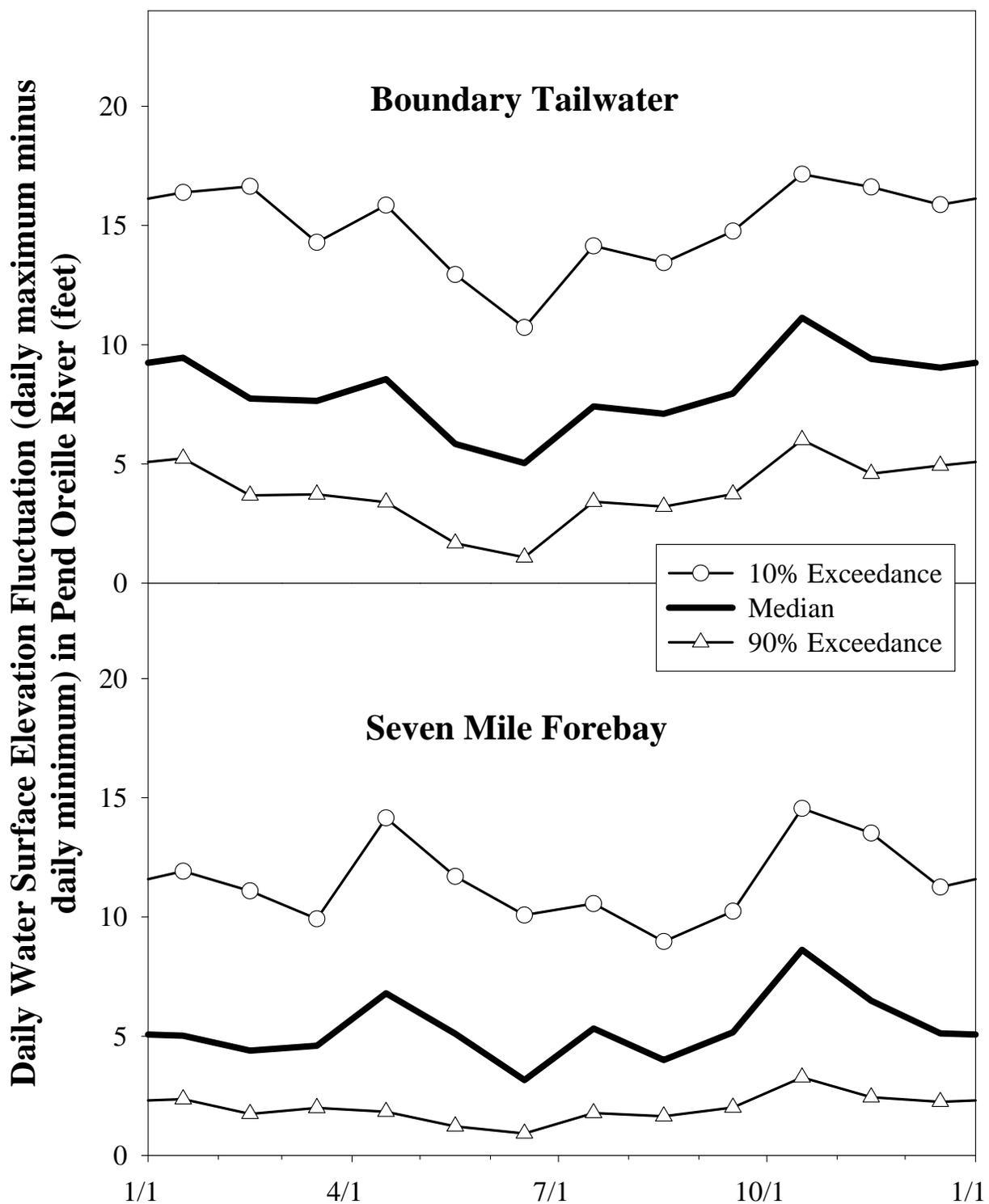
A summary of the results reported in Appendix H is illustrated in Figure 5-7. Monthly water surface elevations in Boundary Tailwater and in Pend Oreille River in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels are shown in Figure 5-7. The seasonal patterns of water surface elevations in Boundary Forebay generally follow the seasonal pattern of monthly flows, with highest water surface elevations in June, corresponding with the month with highest flows. The range of water surface elevations shown for Seven Mile Forebay is bounded on the upper end by normal maximum pool level.

Daily stage fluctuations (daily maximum minus daily minimum) were calculated from hourly water surface elevation records in Boundary Tailwater and in the Seven Mile Forebay. Monthly and annual stage fluctuation exceedance frequencies were determined in Boundary Tailwater and in Seven Mile Forebay for Calendar Years 1987 through 2005. Stage fluctuation exceedance frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in Tables in Appendix I.

A summary of the results reported in Appendix I is illustrated in Figure 5-8. Monthly water surface elevation fluctuations in Boundary Tailwater and in Pend Oreille River in Seven Mile Tailwater at 10%, 50%, and 90% exceedance levels are shown in Figure 5-8. Daily water surface elevation fluctuations in Boundary Tailwater are smallest in June, the month with the highest flows. Daily water surface elevation fluctuations reach the highest magnitudes in April and October in Seven Mile Forebay.



**Figure 5-7.** Monthly water surface elevations in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005.



**Figure 5-8.** Monthly patterns of daily water surface elevation fluctuations in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005.

### 5.3. Ramping Rates

Hourly ramping rates were calculated for falling stages in Boundary Tailwater and in Seven Mile Forebay for the selected study period (1987 to 2005). The maximum ramping rate was determined for each day during this period.

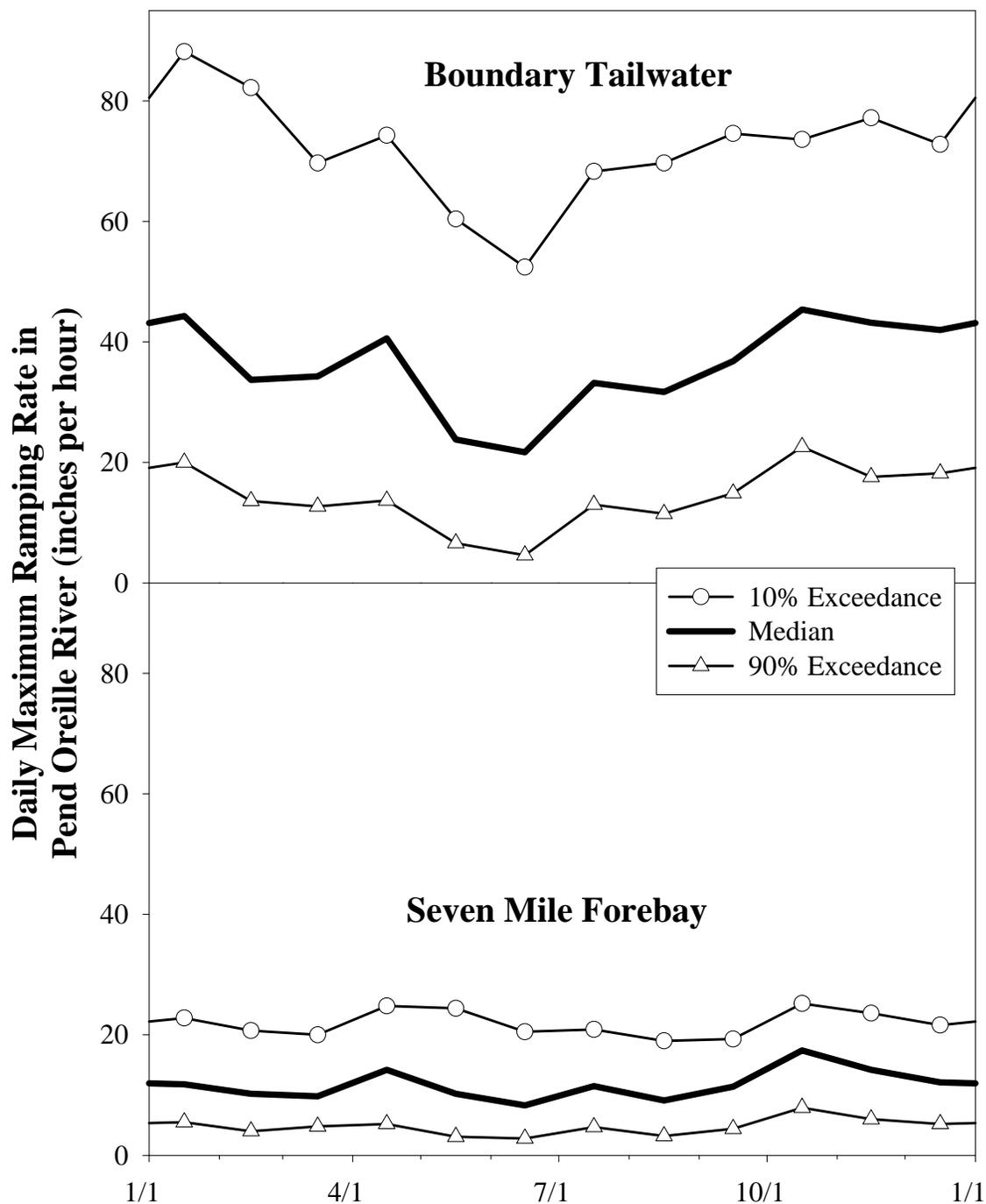
Monthly and annual daily maximum ramping rate frequencies were determined for Boundary Tailwater and at Seven Mile Forebay for Calendar Years 1987 through 2005. Daily maximum ramping rate exceedance frequencies were determined for 10%, 20%, 50% (median), 80%, and 90% levels. Results of these calculations are summarized in tables in Appendix J.

Daily maximum ramping rates reported on a monthly basis in Appendix J range from 1.7 (90% exceedance level in June 1999) to 133 inches per hour (10% exceedance level in February 1987) in the results reported for Boundary Tailwater, while comparable daily maximum ramping rates at Seven Mile Forebay range from 0.3 (90% exceedance level in February 1995) to 36.2 inches per hour (10% exceedance level in February 1991). Ramping rates in Boundary Tailwater were greater than ramping rates in Seven Mile Forebay because ramping rates in Boundary Tailwater were influenced by changes in flow releases from Boundary Dam in addition to changes in water surface elevations in Seven Mile Forebay.

Daily maximum ramping rates reported on an annual basis in Appendix J range from 5.9 inches per hour (90% exceedance level in 1999) to 125 inches per hour (10% exceedance level in 1987) in the results reported for Boundary Tailwater, while comparable daily maximum ramping rates at Seven Mile Forebay range from 3.5 inches per hour (90% exceedance level in 1994) to 25.7 inches per hour (10% exceedance level in 1990).

Over the entire 19-year period of record, the 10%, 20%, 50%, 80%, and 90% exceedance daily maximum ramping rates in Boundary Tailwater are 73.6, 59.8, 36.2, 18.7, and 12.4 inches per hour, respectively. Daily maximum ramping rates with the same long-term frequency of exceedance are 22.4, 18.8, 11.8, 6.4, and 4.3 inches per hour, respectively at in Seven Mile Forebay.

A summary of the results reported in Appendix J is illustrated in Figure 5-9. Monthly daily maximum ramping rates in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels are shown in Figure 5-9. Daily maximum ramping rates in Boundary Tailwater are smallest in June, when flows are generally high. Daily maximum ramping rates reach the highest magnitudes in April and October in Seven Mile Forebay.



**Figure 5-9.** Monthly patterns of daily maximum ramping rates in Boundary Tailwater and in Seven Mile Forebay at 10%, 50%, and 90% exceedance levels, derived from 19 years of hourly records, 1987 through 2005.

## 6 REFERENCES

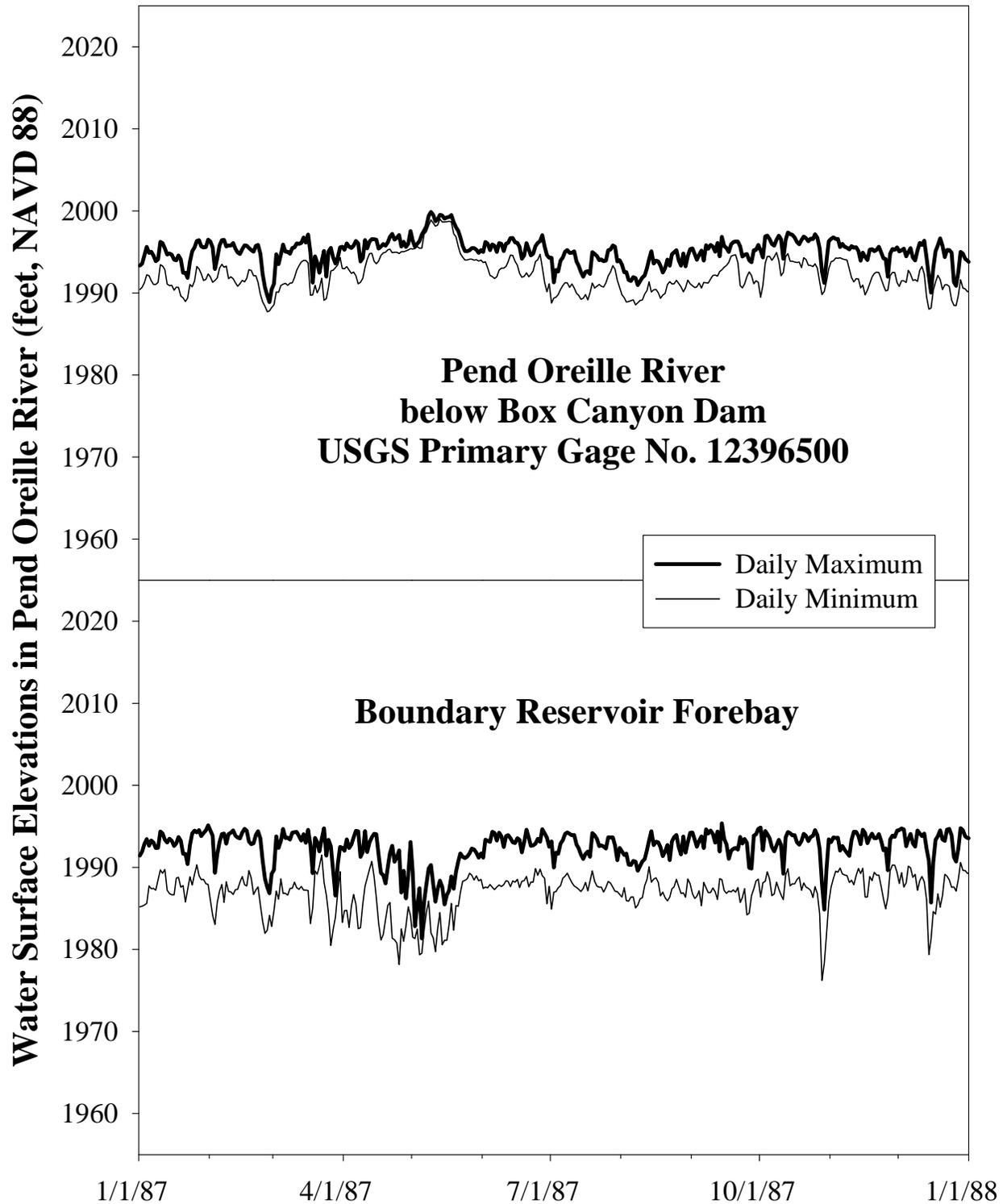
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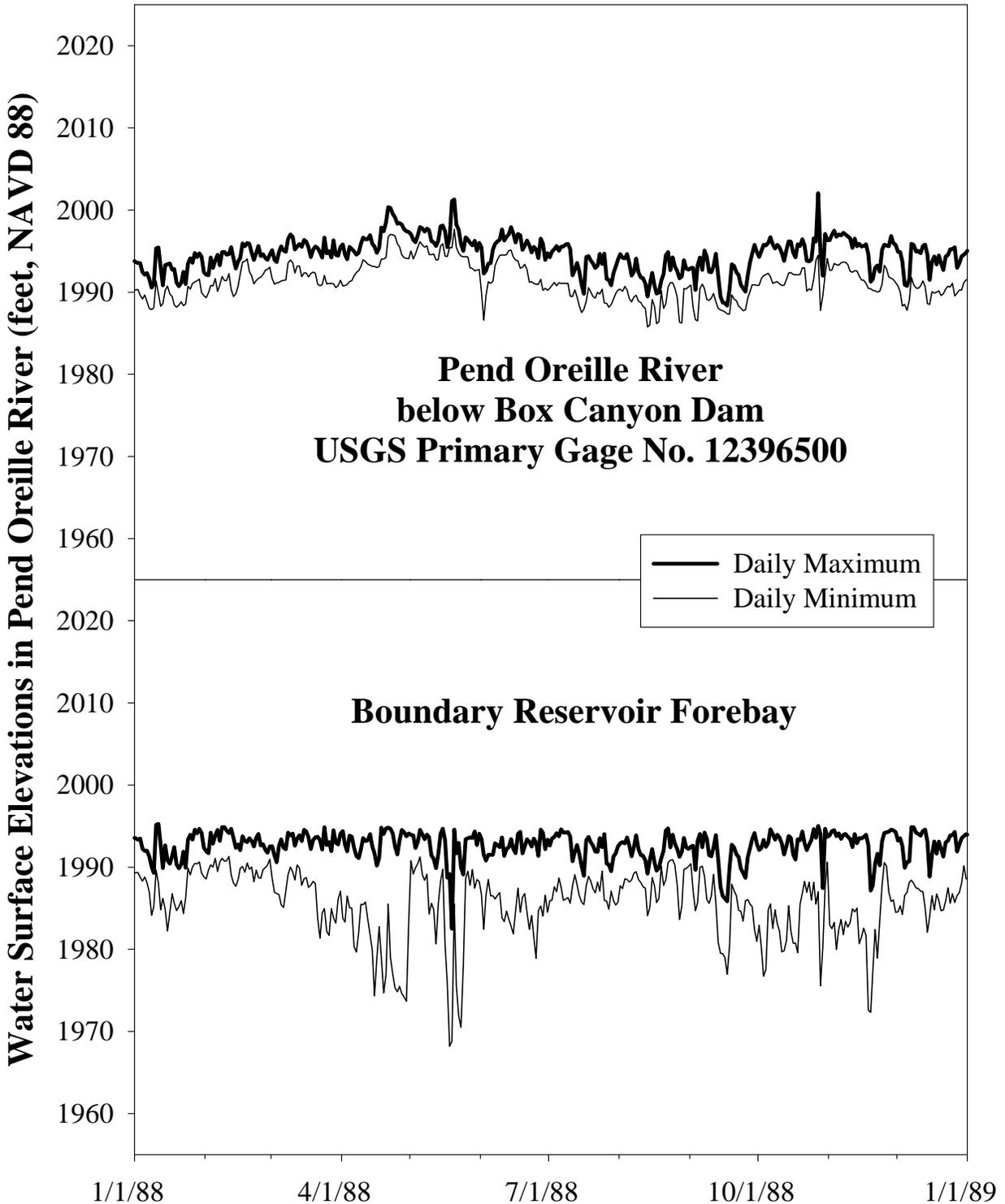
## **Appendix A**

### **Daily Maximum and Minimum Water Surface Elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay, 1987 through 2005**

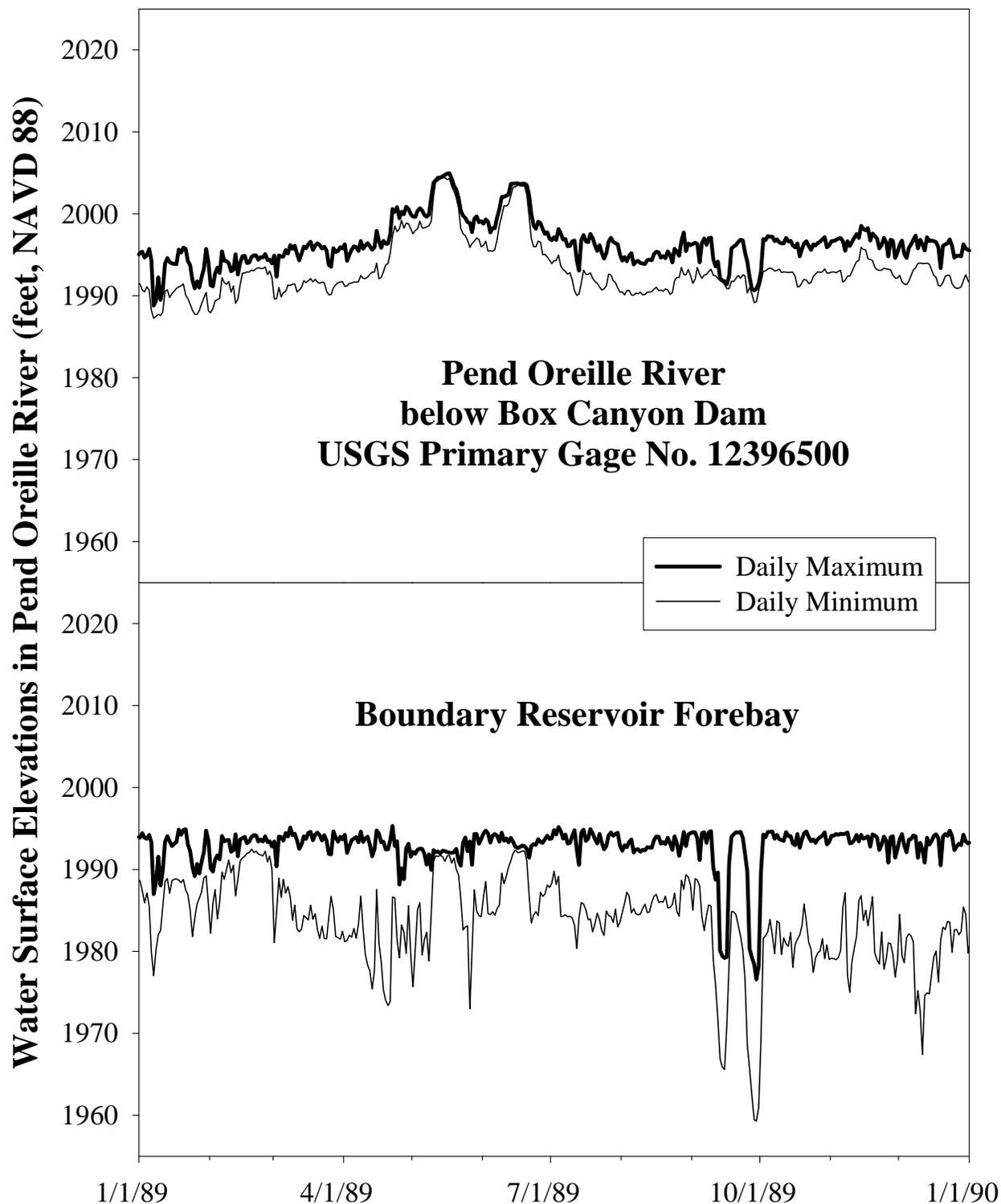
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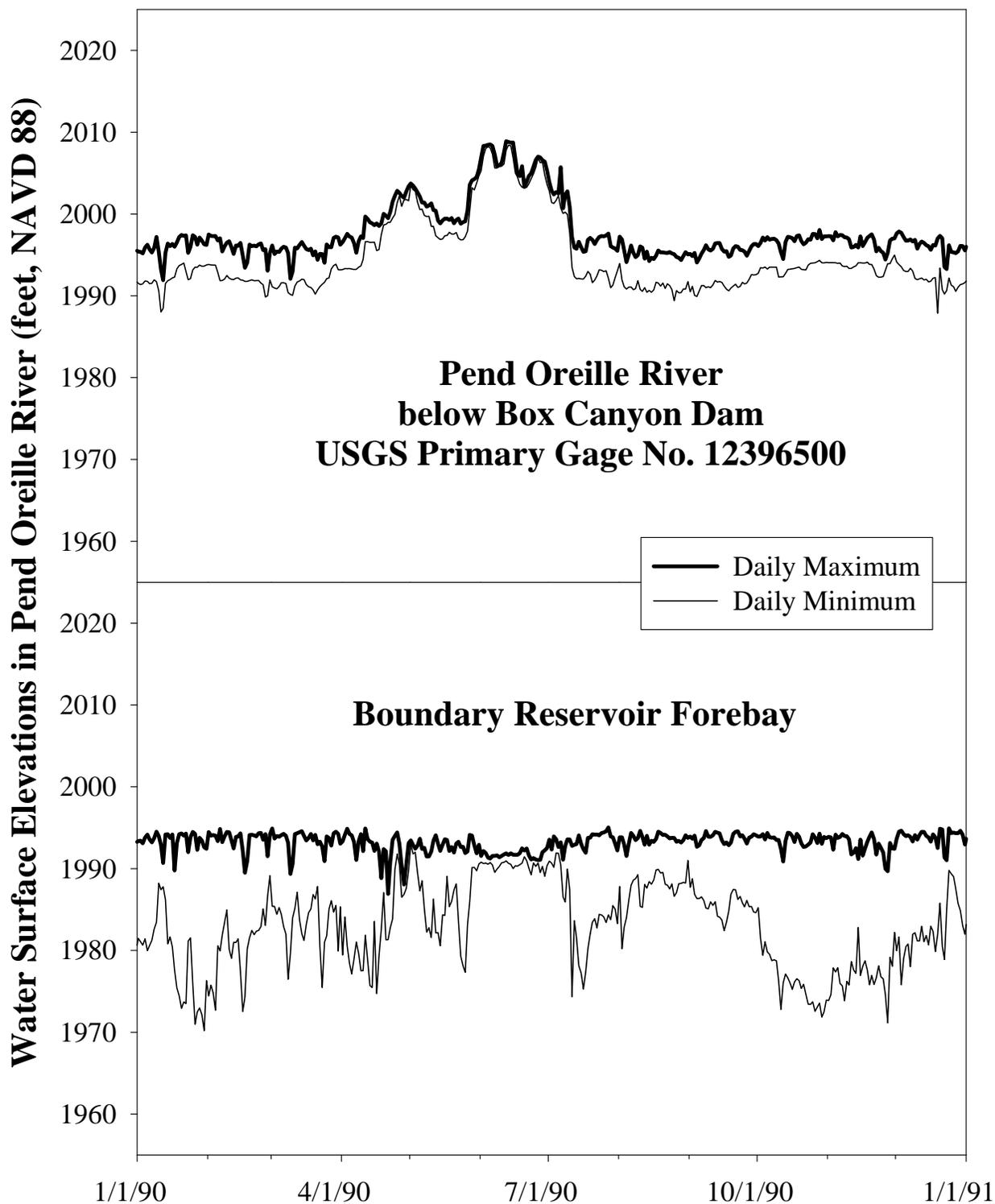
**Figure A-1.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1987.



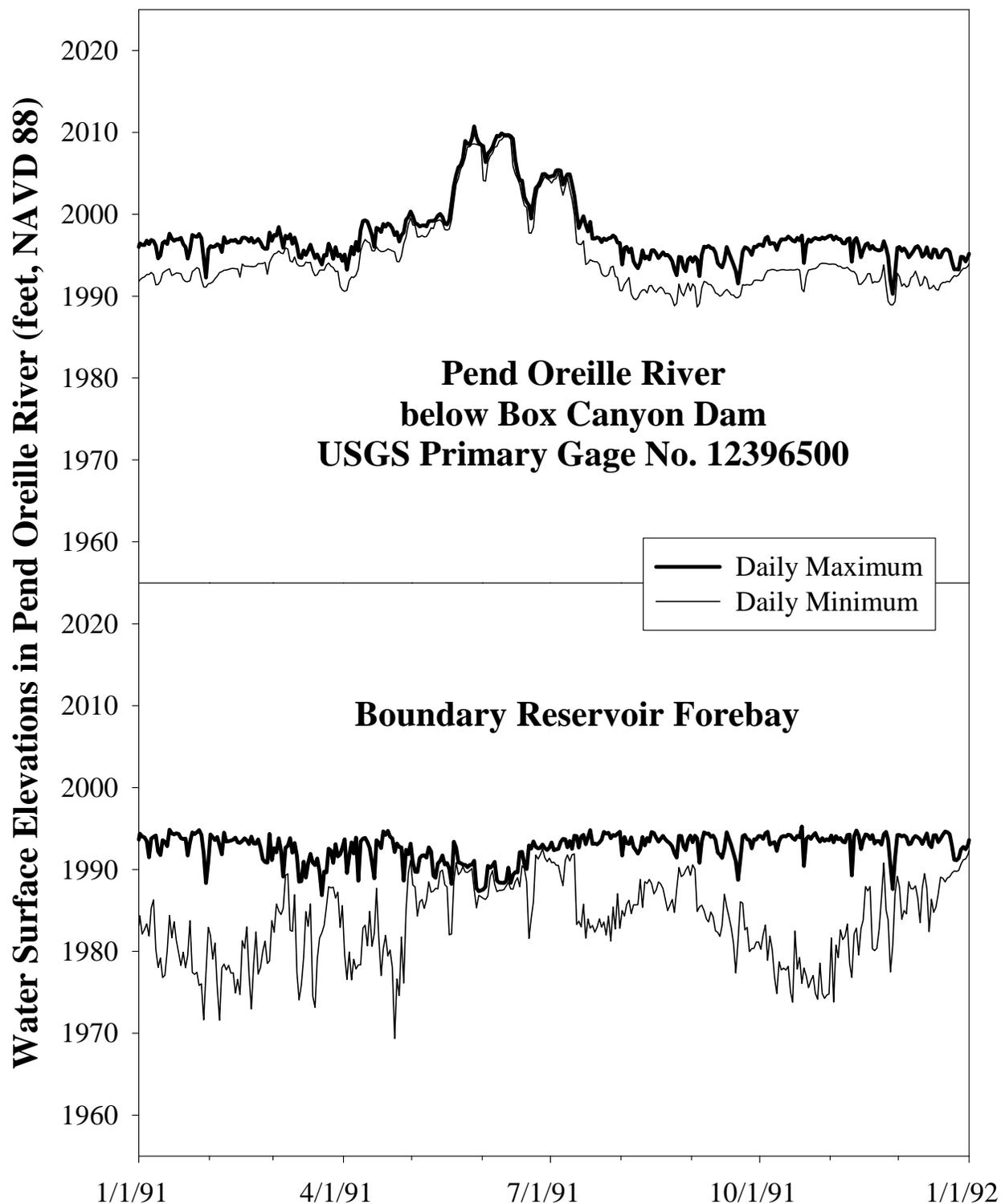
**Figure A-2.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1988.



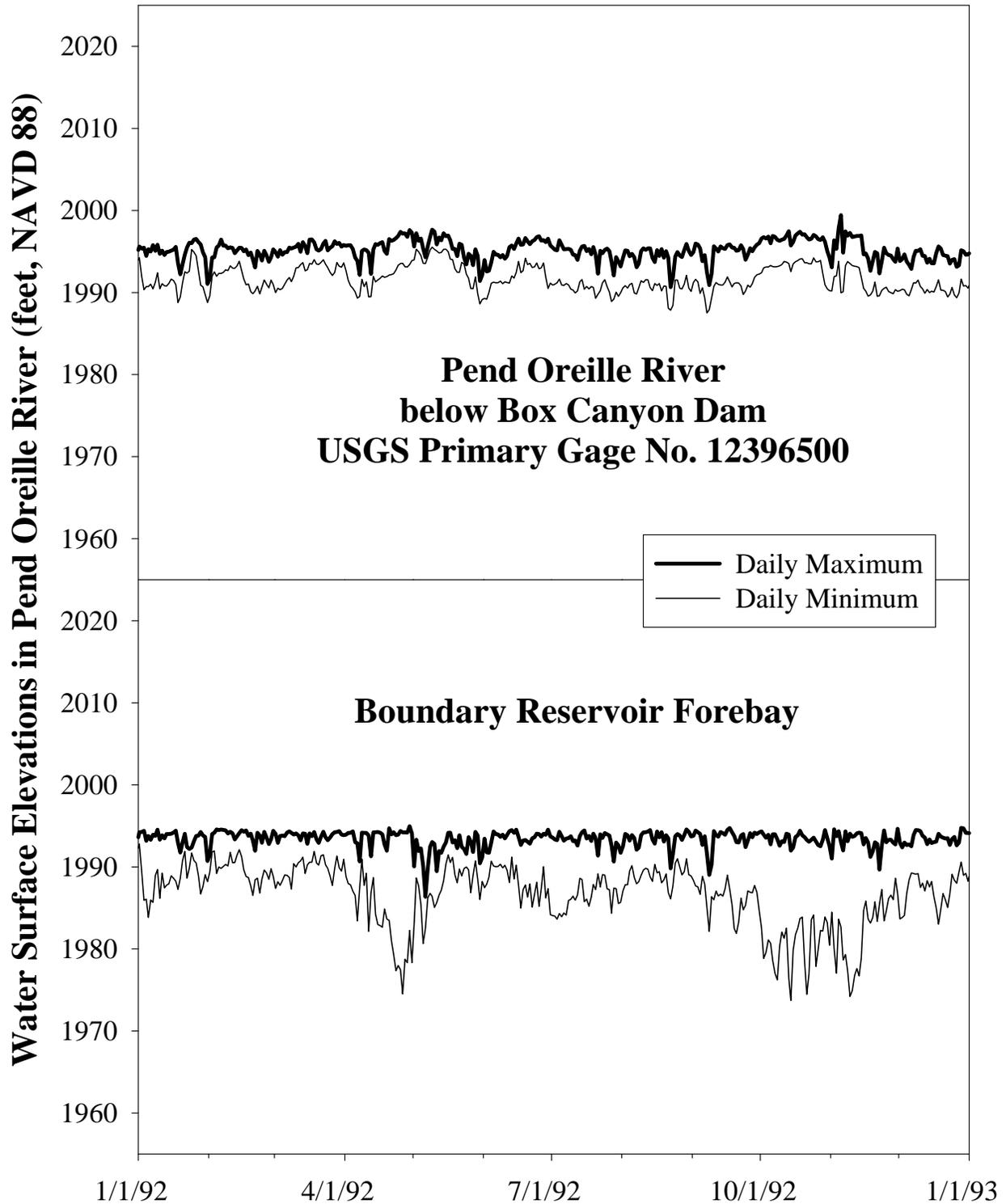
**Figure A-3.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1989.



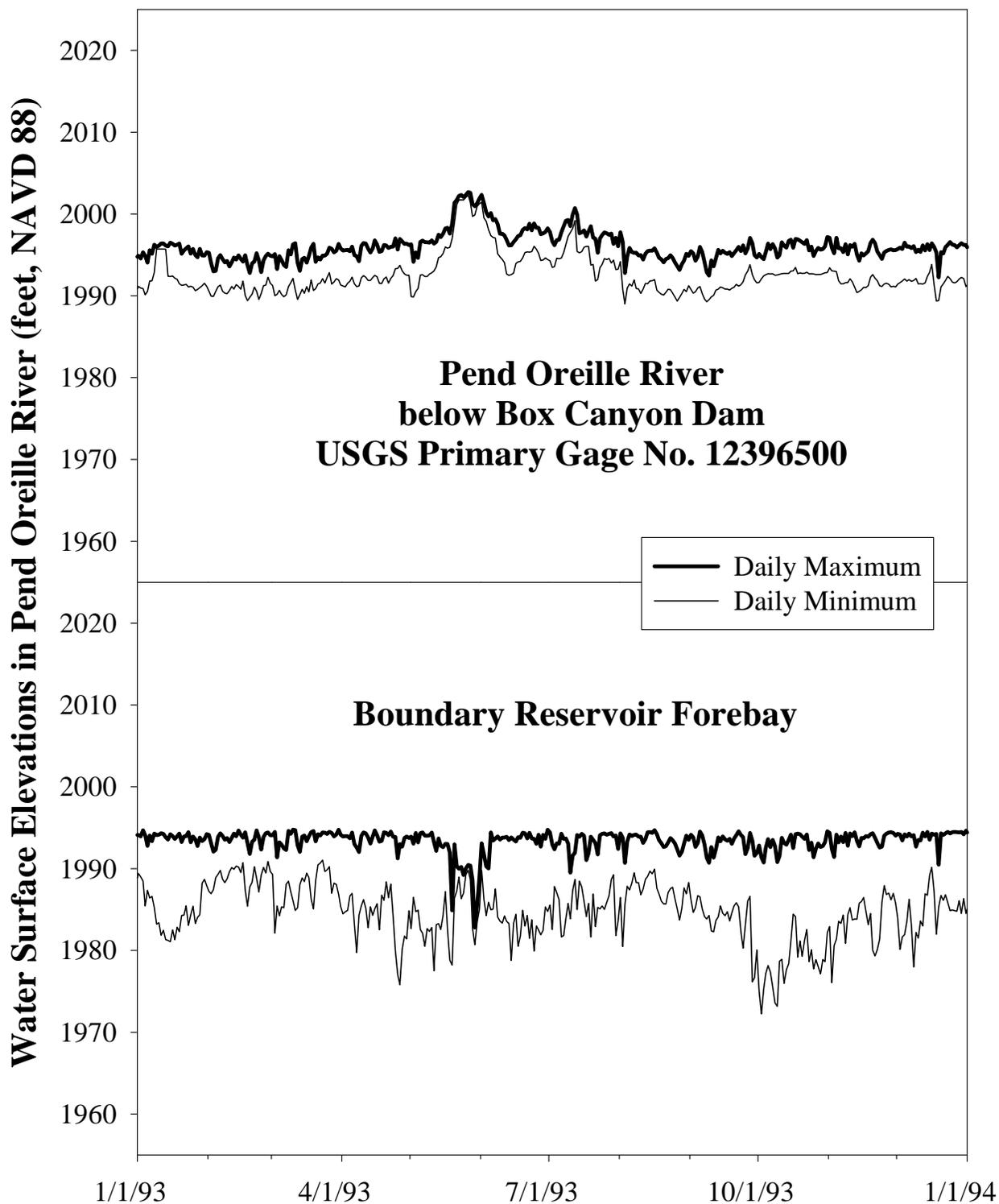
**Figure A-4.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1990.



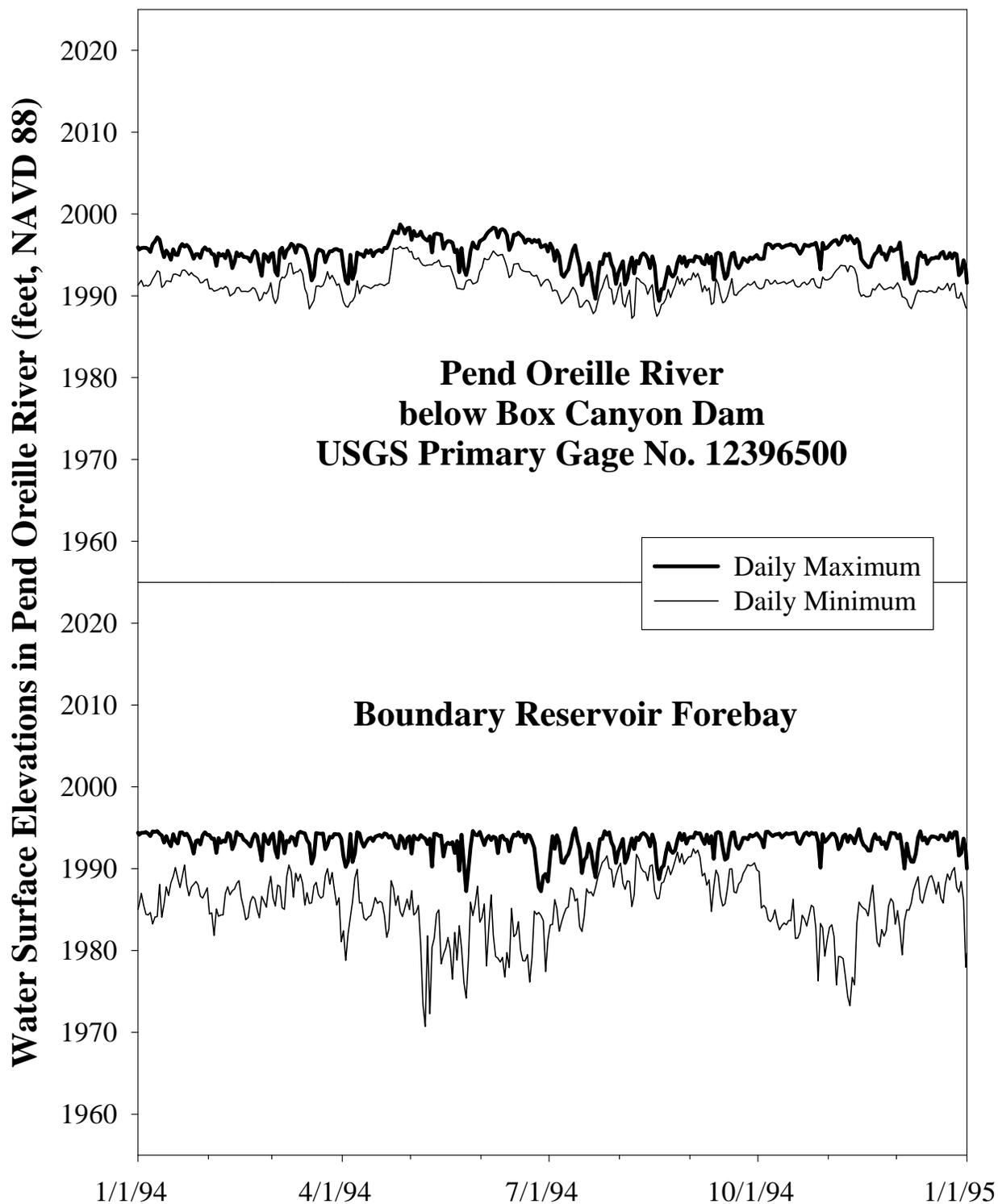
**Figure A-5.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1991.



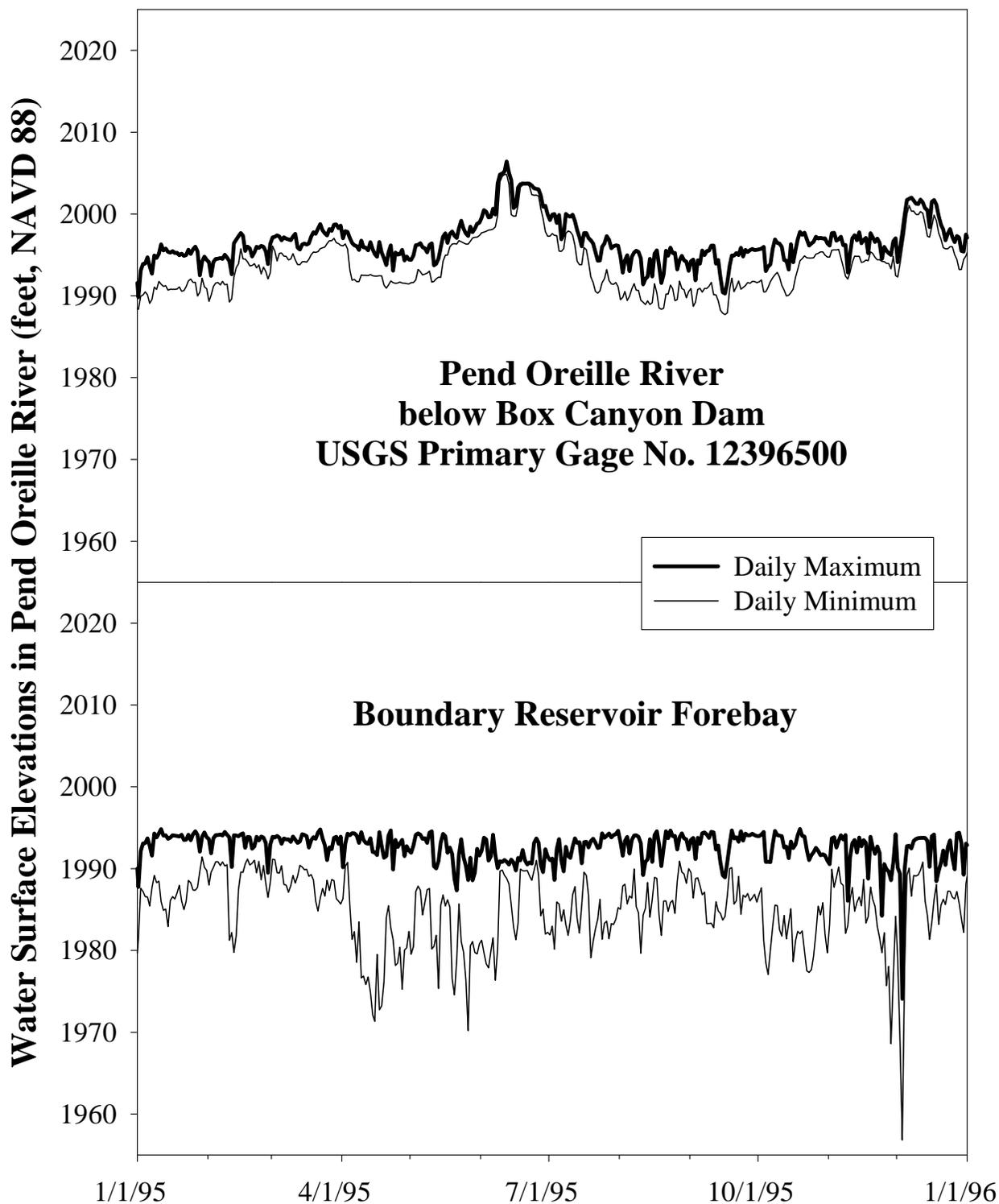
**Figure A-6.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1992.



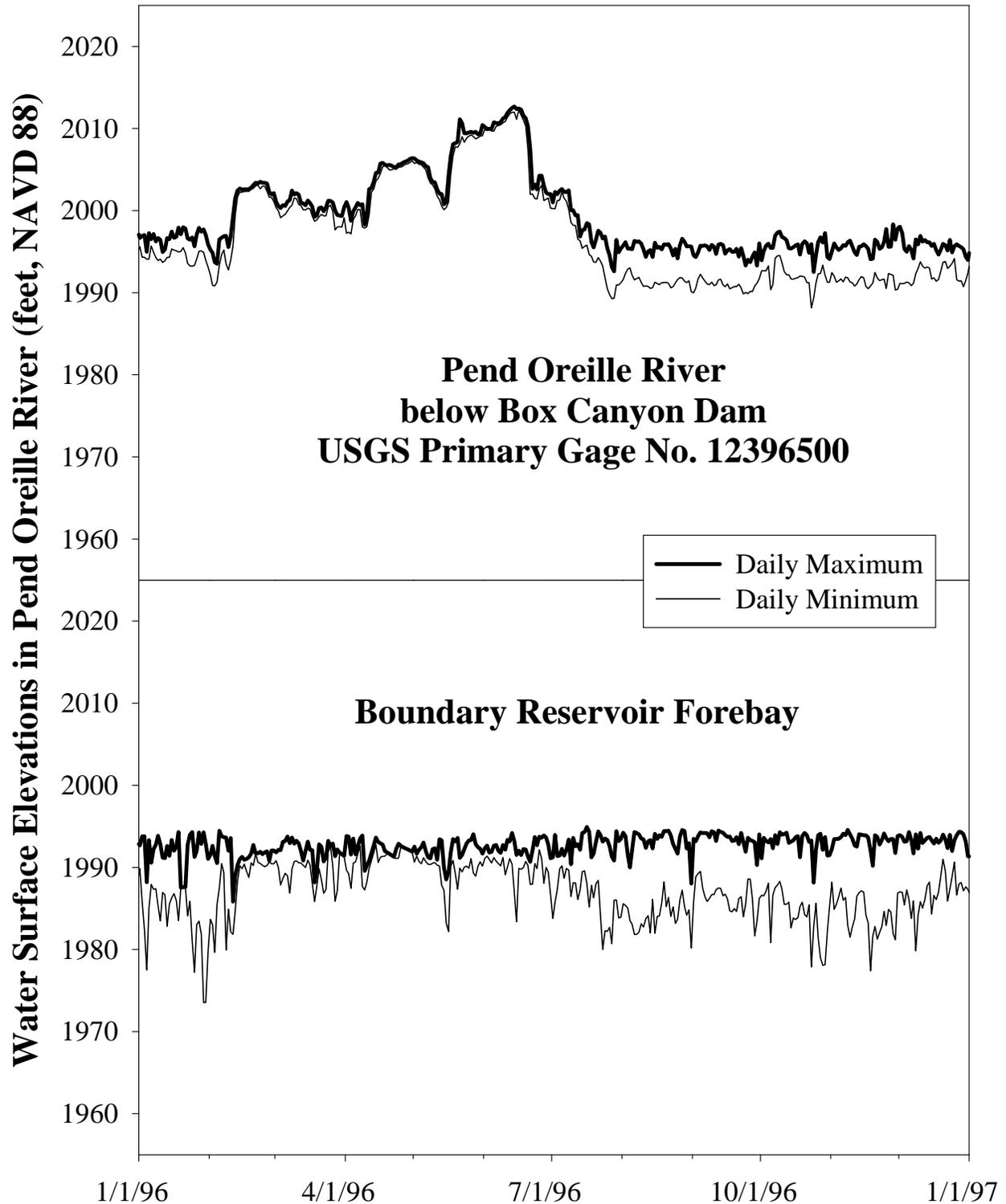
**Figure A-7.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1993.



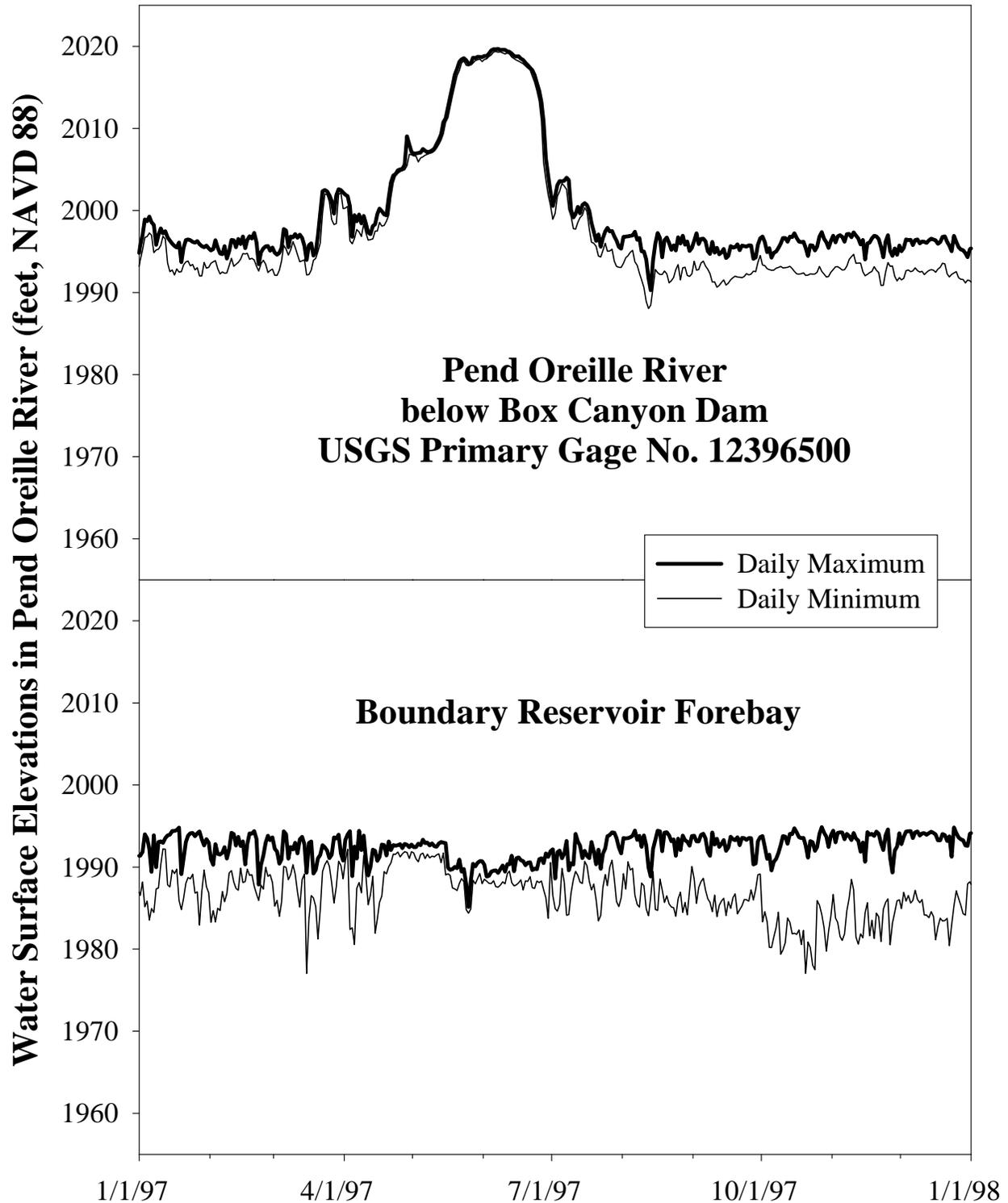
**Figure A-8.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1994.



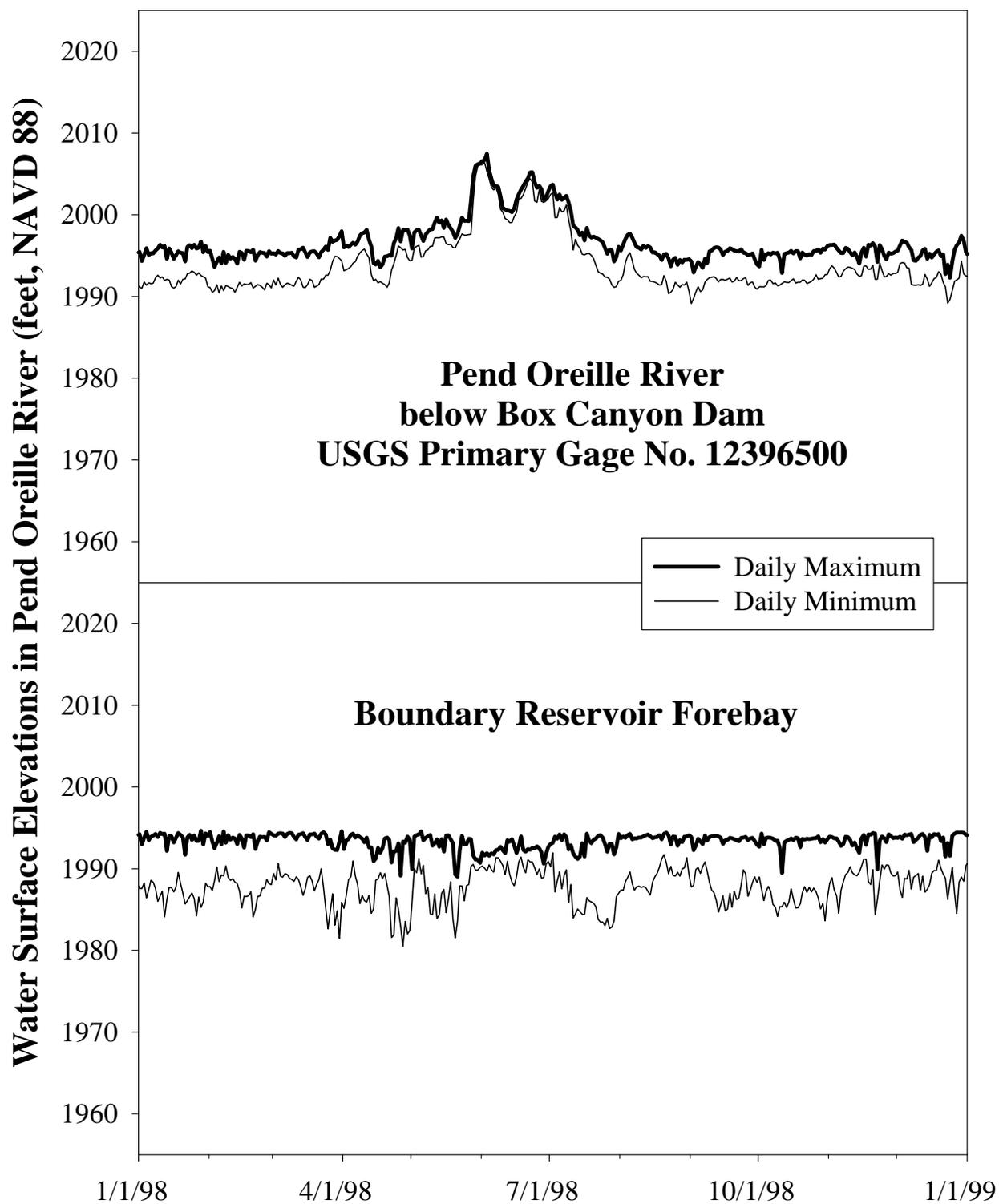
**Figure A-9.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1995.



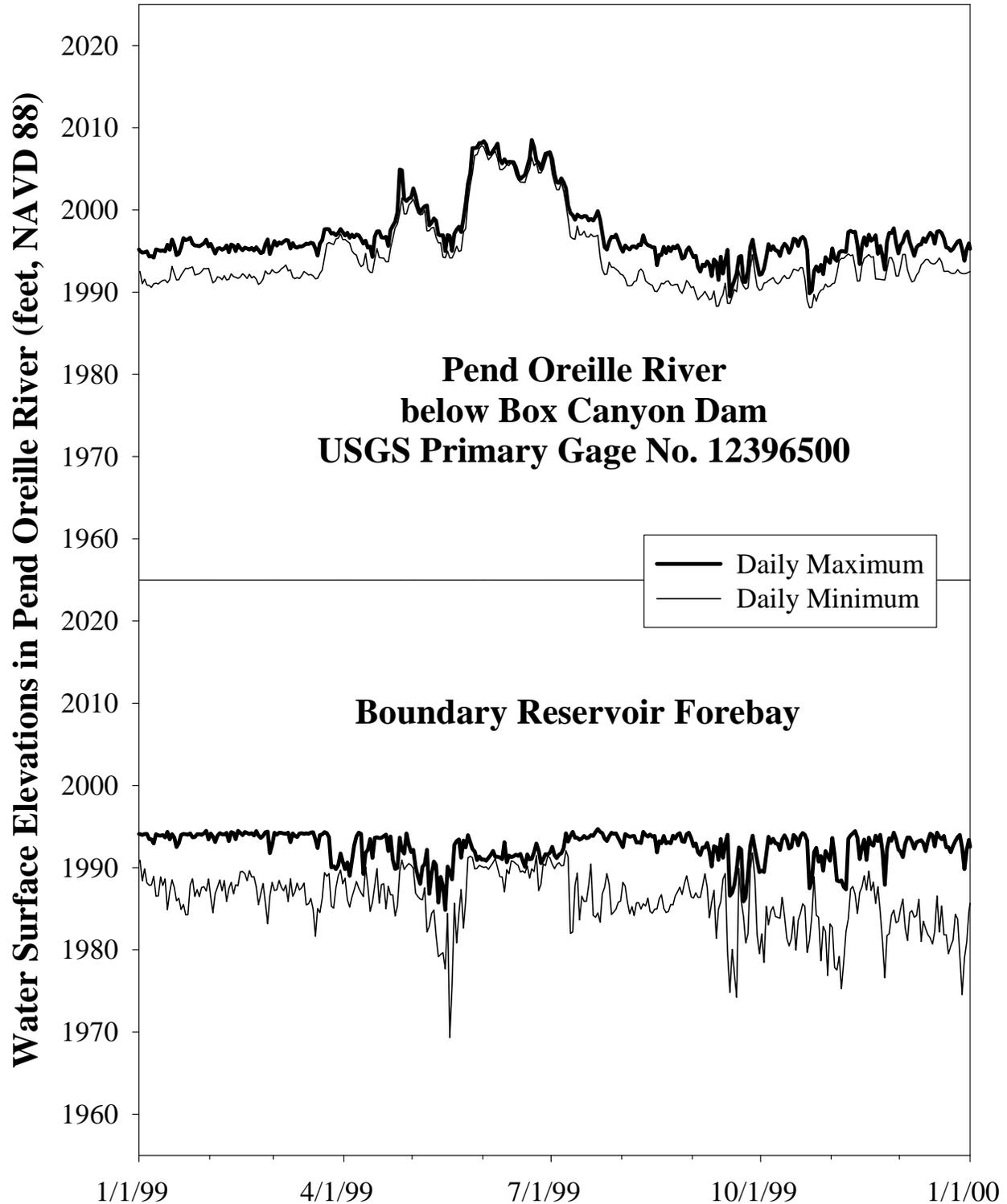
**Figure A-10.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1996.



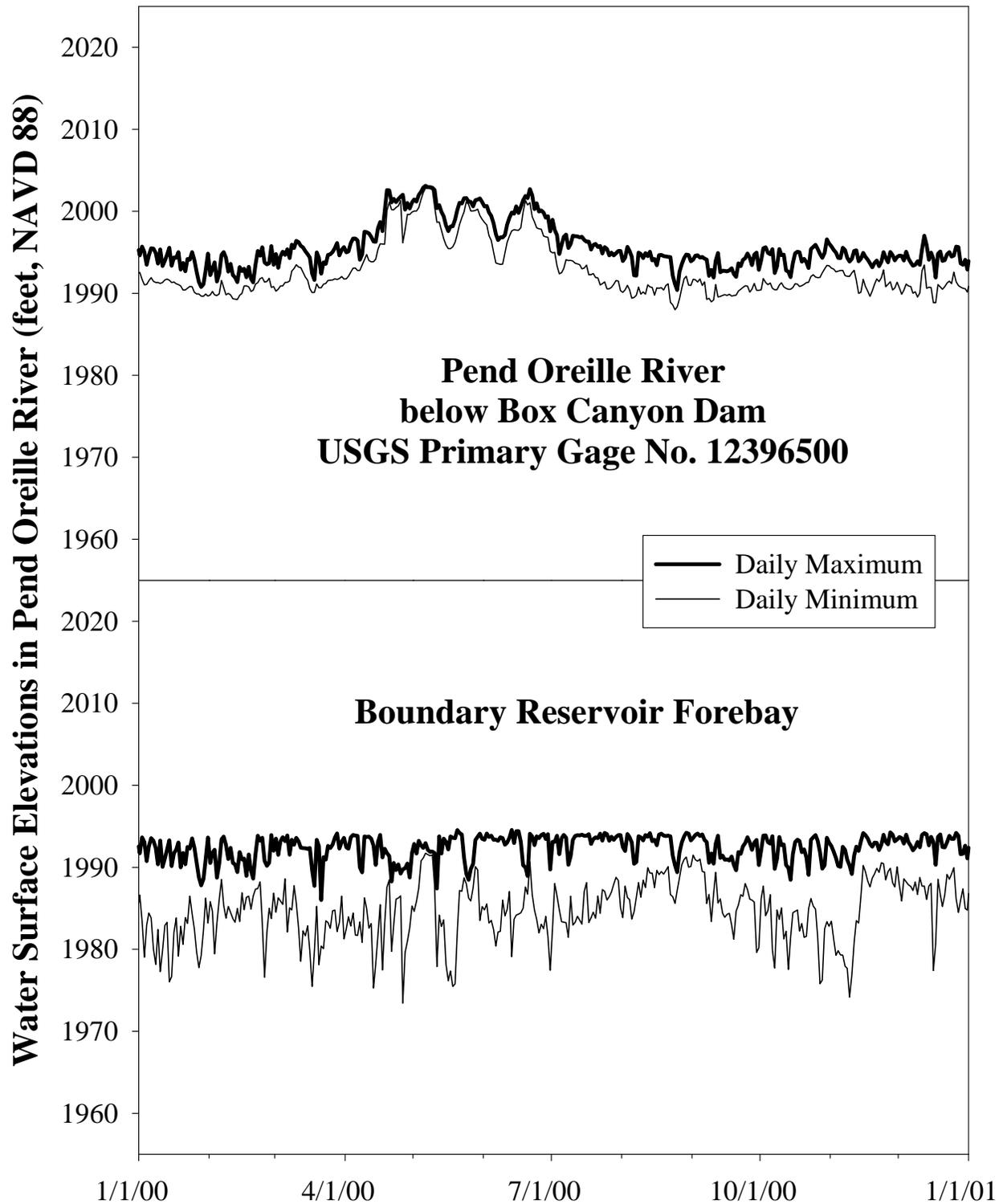
**Figure A-11.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1997.



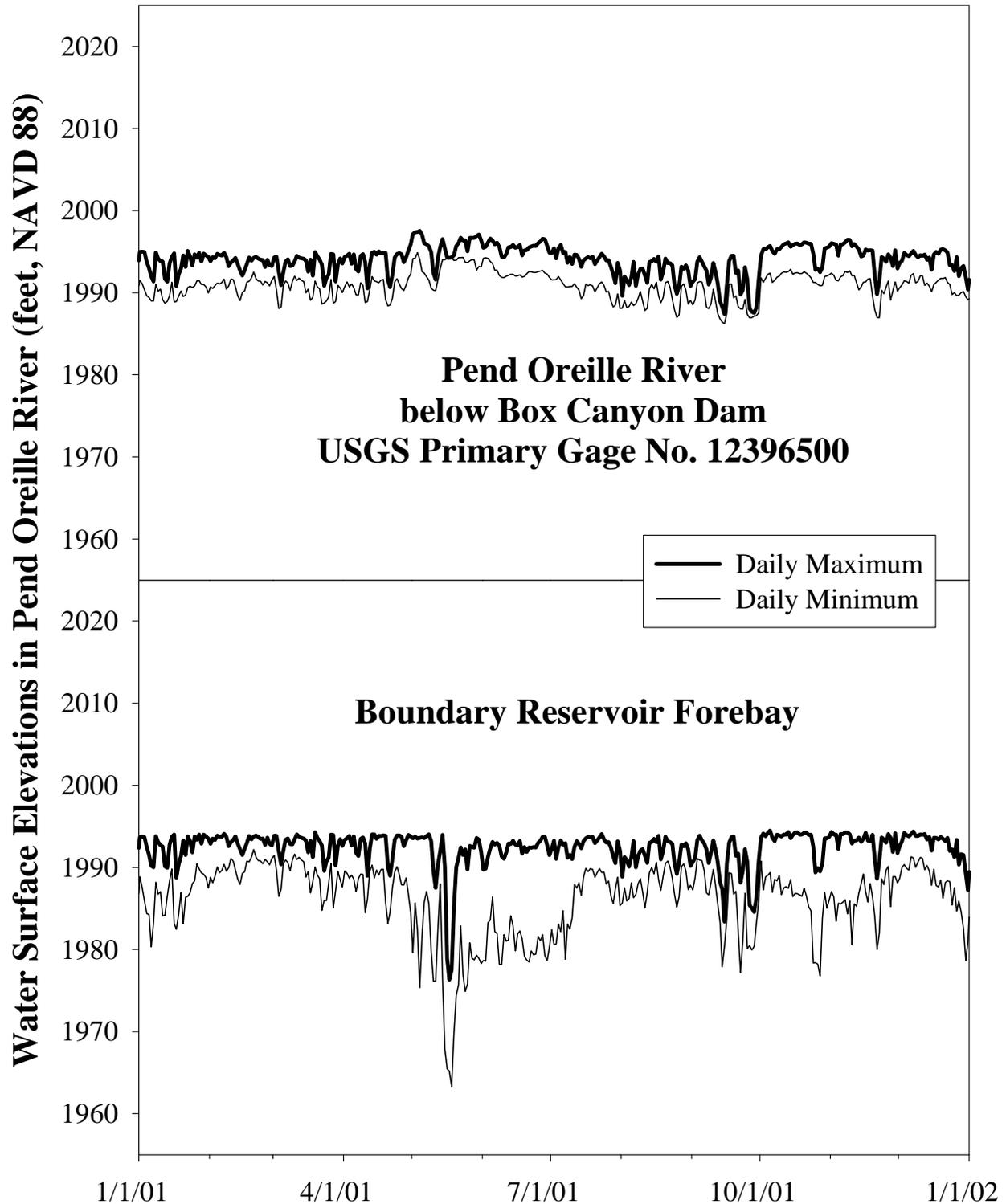
**Figure A-12.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1998.



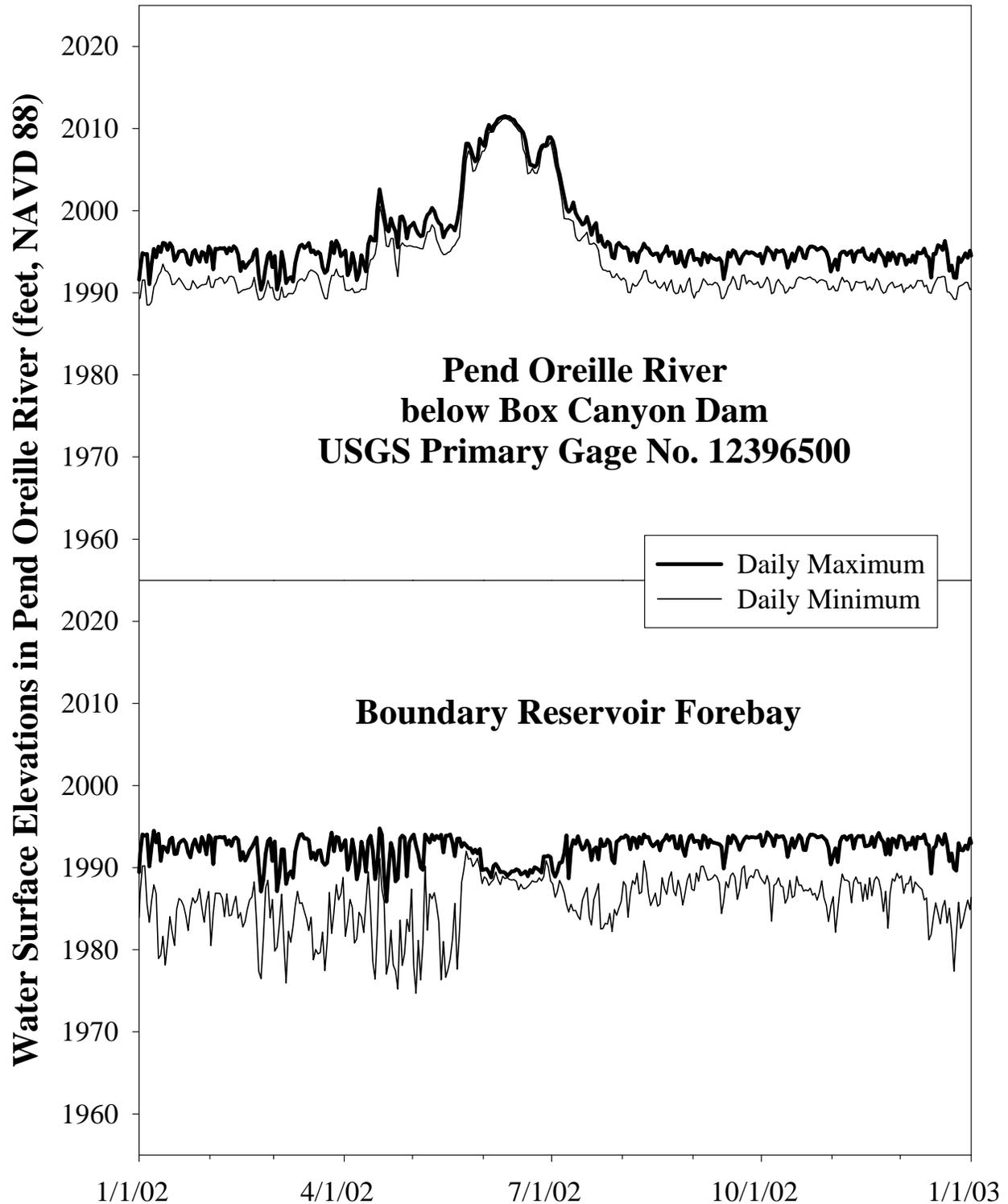
**Figure A-13.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 1999.



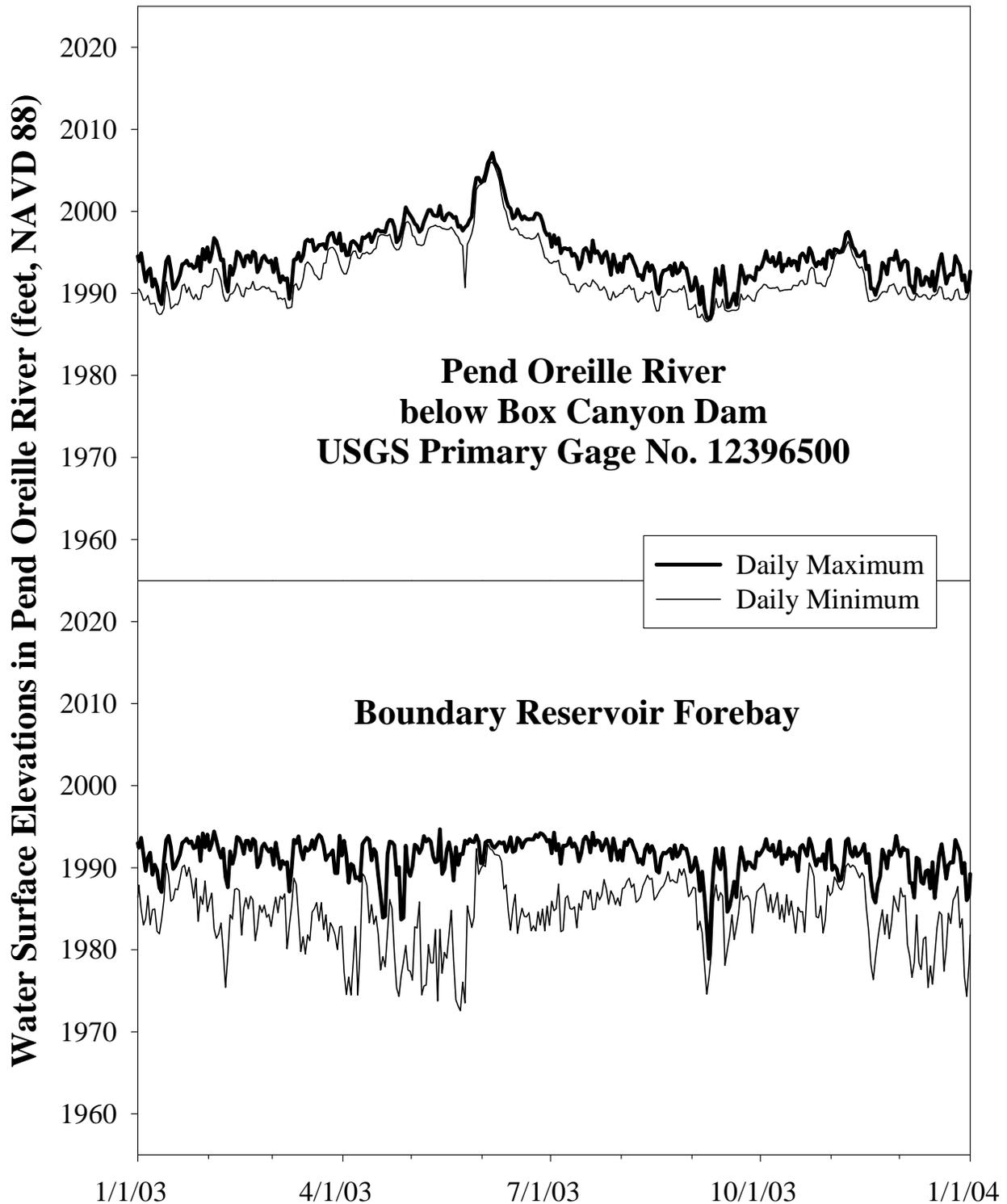
**Figure A-14.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 2000.



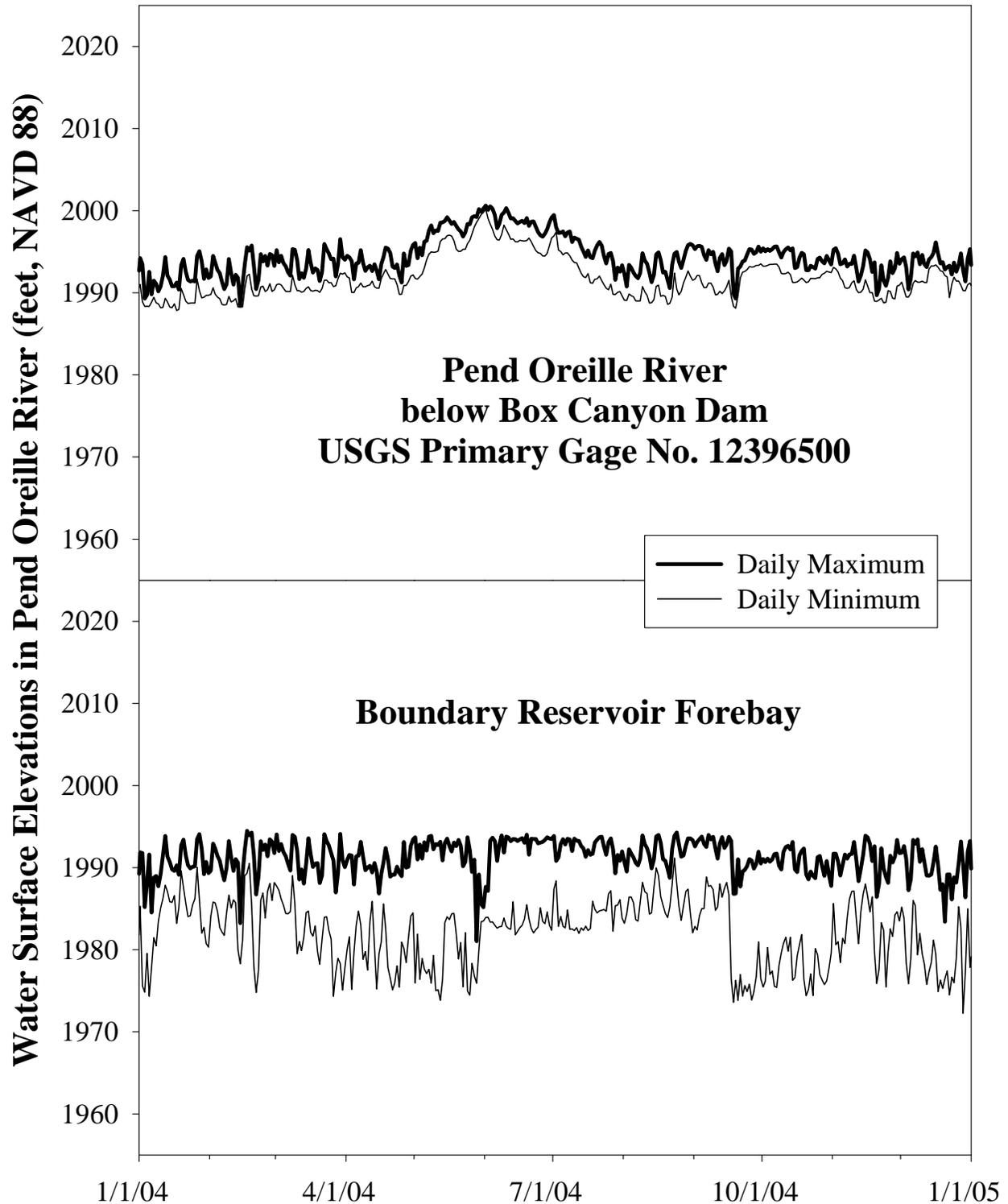
**Figure A-15.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 2001.



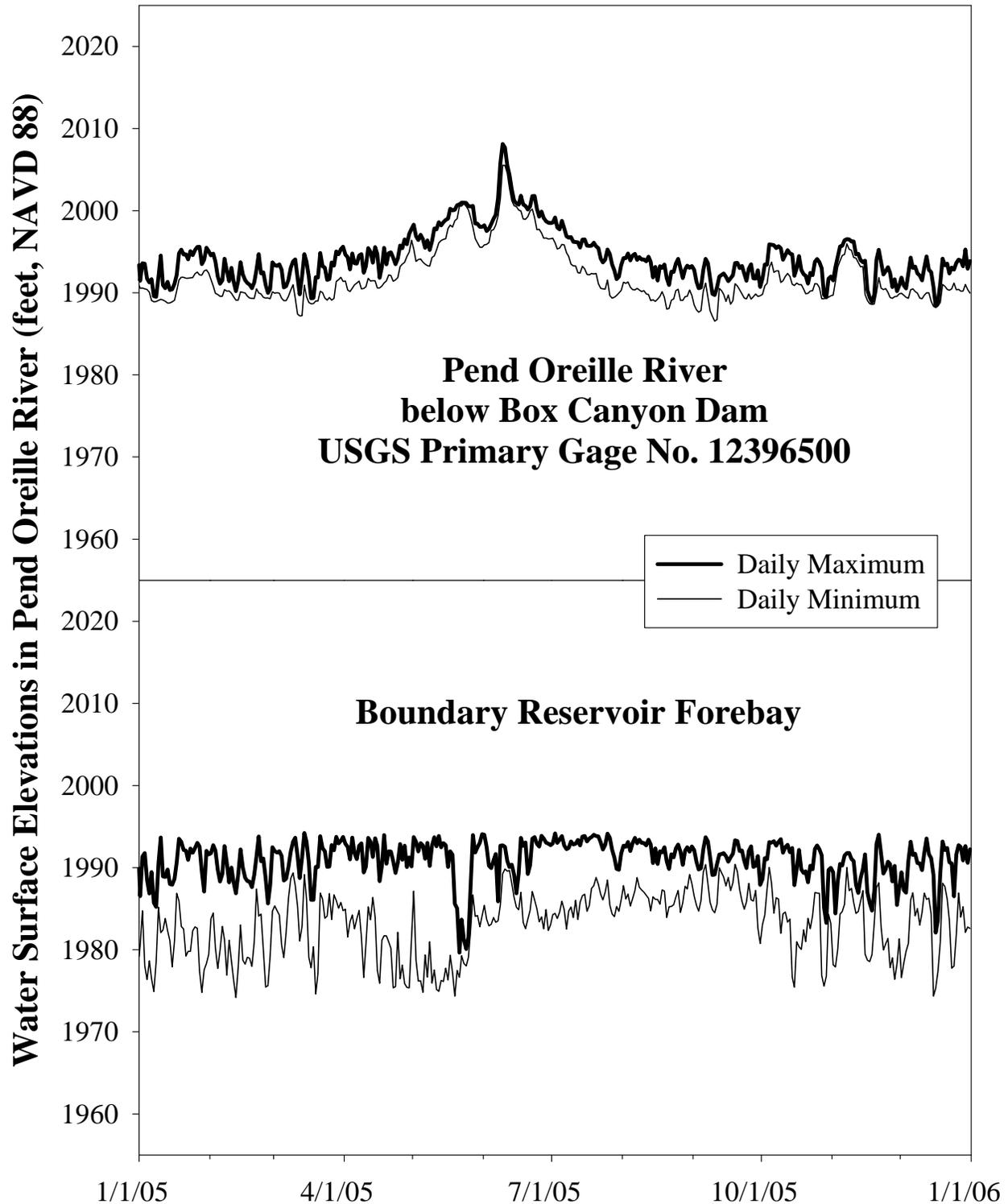
**Figure A-16.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 2002.



**Figure A-17.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 2003.



**Figure A-18.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 2004.



**Figure A-19.** Daily maximum and minimum water surface elevations in Pend Oreille River below Box Canyon Dam at USGS Primary Gage No. 12396500 and in Boundary Reservoir Forebay in 2005.

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## **Appendix B**

### **Monthly and Annual Frequency of Exceedance of Hourly Stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005**

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**Table B-1.** January frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	January Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,993.04	1,992.25	1,990.38	1,988.51	1,987.76	1,994.90	1,994.26	1,992.85	1,991.36	1,990.71
1988	1,993.02	1,992.01	1,990.00	1,987.69	1,986.33	1,993.28	1,992.57	1,991.09	1,989.77	1,989.14
1989	1,992.91	1,991.93	1,989.66	1,986.95	1,985.56	1,994.09	1,993.30	1,991.53	1,989.40	1,988.50
1990	1,992.61	1,991.27	1,987.97	1,982.39	1,979.24	1,995.94	1,995.21	1,993.90	1,992.43	1,991.80
1991	1,992.82	1,991.45	1,987.99	1,983.82	1,981.34	1,996.30	1,995.69	1,994.01	1,992.83	1,992.14
1992	1,993.49	1,992.95	1,991.66	1,989.61	1,988.63	1,995.52	1,994.98	1,993.42	1,991.71	1,990.98
1993	1,993.26	1,992.28	1,990.00	1,986.90	1,985.14	1,995.72	1,995.70	1,993.58	1,992.19	1,991.63
1994	1,993.46	1,992.63	1,990.84	1,988.77	1,987.57	1,995.60	1,994.97	1,993.80	1,992.77	1,992.20
1995	1,993.33	1,992.52	1,990.71	1,988.45	1,987.10	1,994.70	1,994.02	1,992.60	1,991.43	1,990.83
1996	1,992.29	1,991.26	1,988.56	1,986.24	1,983.80	1,996.93	1,996.50	1,995.60	1,994.61	1,994.20
1997	1,993.32	1,992.67	1,990.88	1,988.61	1,987.33	1,997.65	1,997.02	1,995.34	1,993.82	1,993.26
1998	1,993.57	1,992.92	1,990.95	1,988.48	1,987.55	1,995.40	1,994.88	1,993.67	1,992.58	1,992.08
1999	1,993.50	1,992.91	1,991.20	1,988.83	1,987.79	1,995.48	1,994.91	1,993.70	1,992.55	1,991.99
2000	1,991.44	1,990.38	1,987.59	1,983.99	1,982.06	1,994.12	1,993.53	1,992.20	1,991.16	1,990.47
2001	1,992.83	1,992.35	1,990.41	1,987.63	1,985.96	1,994.04	1,993.53	1,992.15	1,990.56	1,989.80
2002	1,992.66	1,991.78	1,989.59	1,986.42	1,984.65	1,994.74	1,994.13	1,992.88	1,991.59	1,991.01
2003	1,992.33	1,991.77	1,989.83	1,987.19	1,985.81	1,993.28	1,992.81	1,991.35	1,989.60	1,988.83
2004	1,991.33	1,990.17	1,988.06	1,984.85	1,982.49	1,992.77	1,991.67	1,990.29	1,989.15	1,988.80
2005	1,990.85	1,989.39	1,986.06	1,982.71	1,980.72	1,994.19	1,993.49	1,991.84	1,989.74	1,989.20
<b>1987 to 2005</b>	<b>1,993.00</b>	<b>1,992.10</b>	<b>1,989.80</b>	<b>1,986.78</b>	<b>1,984.68</b>	<b>1,995.63</b>	<b>1,994.76</b>	<b>1,993.03</b>	<b>1,991.18</b>	<b>1,990.07</b>

**Table B-2.** February frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	February Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,993.05	1,992.21	1,989.67	1,987.03	1,985.25	1,995.16	1,994.53	1,993.05	1,991.32	1,989.07
1988	1,993.36	1,992.70	1,991.40	1,990.25	1,989.67	1,994.58	1,994.10	1,993.04	1,991.71	1,990.95
1989	1,993.40	1,992.96	1,991.97	1,990.16	1,988.90	1,994.38	1,993.97	1,993.19	1,991.72	1,990.74
1990	1,992.95	1,991.45	1,988.31	1,983.73	1,981.72	1,995.84	1,995.10	1,993.56	1,992.26	1,991.95
1991	1,992.27	1,990.79	1,987.22	1,982.32	1,979.74	1,996.34	1,995.77	1,994.53	1,993.68	1,993.31
1992	1,993.81	1,993.28	1,991.95	1,990.24	1,989.46	1,995.01	1,994.55	1,993.34	1,991.88	1,991.20
1993	1,993.48	1,992.75	1,991.43	1,989.85	1,989.00	1,994.15	1,993.56	1,992.39	1,991.29	1,990.75
1994	1,992.96	1,992.02	1,989.87	1,988.01	1,986.46	1,994.46	1,993.80	1,992.40	1,991.22	1,990.86
1995	1,993.33	1,992.73	1,991.67	1,989.78	1,987.99	1,996.06	1,995.36	1,994.13	1,992.38	1,991.77
1996	1,991.73	1,991.29	1,990.63	1,988.30	1,985.56	2,003.19	2,002.94	2,002.03	1,994.73	1,993.27
1997	1,992.62	1,991.81	1,990.06	1,988.08	1,986.90	1,995.91	1,995.39	1,994.48	1,993.55	1,993.06
1998	1,993.34	1,992.65	1,991.18	1,989.22	1,988.29	1,994.76	1,994.16	1,992.98	1,991.84	1,991.43
1999	1,993.80	1,993.06	1,991.26	1,988.99	1,988.02	1,995.23	1,994.80	1,993.56	1,992.42	1,992.06
2000	1,991.40	1,990.46	1,988.23	1,986.15	1,984.84	1,993.56	1,992.86	1,991.53	1,990.72	1,990.22
2001	1,993.37	1,992.92	1,991.94	1,990.71	1,990.11	1,993.91	1,993.52	1,992.63	1,991.55	1,991.01
2002	1,992.43	1,991.28	1,988.83	1,986.36	1,984.67	1,994.58	1,993.79	1,992.26	1,991.01	1,990.48
2003	1,991.85	1,990.99	1,988.67	1,986.34	1,984.63	1,994.18	1,993.46	1,992.19	1,990.95	1,990.38
2004	1,992.06	1,990.94	1,988.70	1,985.95	1,983.30	1,993.70	1,992.87	1,991.20	1,989.79	1,989.21
2005	1,990.22	1,988.86	1,986.06	1,982.21	1,979.86	1,992.71	1,991.83	1,990.57	1,989.85	1,989.53
<b>1987 to 2005</b>	<b>1,993.09</b>	<b>1,992.29</b>	<b>1,990.37</b>	<b>1,987.35</b>	<b>1,985.17</b>	<b>1,995.38</b>	<b>1,994.56</b>	<b>1,992.99</b>	<b>1,991.38</b>	<b>1,990.60</b>

**Table B-3.** March frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	March Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,993.01	1,992.15	1,990.05	1,987.79	1,986.57	1,995.14	1,994.59	1,993.32	1,991.46	1,990.61
1988	1,992.79	1,992.09	1,990.01	1,987.95	1,986.57	1,995.21	1,994.63	1,993.24	1,992.05	1,991.60
1989	1,993.05	1,991.85	1,989.43	1,986.53	1,984.65	1,995.13	1,994.35	1,992.82	1,991.72	1,991.21
1990	1,993.10	1,991.92	1,989.03	1,986.04	1,984.17	1,995.55	1,994.87	1,993.27	1,991.83	1,991.34
1991	1,991.61	1,990.66	1,988.28	1,985.17	1,982.91	1,996.59	1,995.97	1,994.72	1,993.75	1,993.38
1992	1,993.57	1,993.01	1,991.74	1,990.61	1,989.80	1,995.28	1,994.90	1,994.05	1,993.07	1,992.16
1993	1,993.71	1,992.92	1,991.00	1,988.95	1,987.45	1,994.87	1,994.22	1,992.85	1,991.73	1,991.22
1994	1,993.38	1,992.50	1,990.87	1,989.04	1,987.59	1,995.35	1,994.81	1,993.43	1,991.95	1,991.19
1995	1,993.28	1,992.51	1,990.82	1,989.28	1,988.31	1,997.63	1,997.21	1,996.38	1,995.34	1,994.75
1996	1,992.58	1,992.11	1,991.28	1,989.68	1,988.43	2,001.55	2,000.95	2,000.31	1,999.39	1,998.99
1997	1,992.53	1,991.76	1,990.16	1,988.33	1,986.38	2,002.17	2,001.33	1,996.11	1,994.35	1,993.87
1998	1,993.65	1,992.94	1,991.14	1,989.19	1,987.92	1,995.95	1,995.28	1,993.88	1,992.59	1,992.08
1999	1,993.50	1,992.63	1,990.49	1,988.40	1,987.43	1,997.10	1,996.58	1,994.85	1,993.18	1,992.57
2000	1,992.28	1,991.02	1,988.31	1,985.25	1,983.29	1,994.91	1,994.26	1,992.91	1,991.70	1,991.17
2001	1,993.19	1,992.62	1,991.26	1,989.63	1,988.59	1,993.76	1,993.22	1,992.03	1,990.82	1,990.17
2002	1,991.97	1,991.00	1,988.18	1,984.55	1,982.39	1,994.75	1,994.16	1,992.64	1,990.77	1,990.11
2003	1,992.04	1,990.83	1,988.33	1,985.54	1,983.71	1,996.08	1,995.50	1,993.79	1,990.92	1,989.88
2004	1,991.68	1,990.24	1,987.69	1,984.14	1,981.74	1,994.09	1,993.24	1,992.00	1,990.95	1,990.51
2005	1,992.09	1,991.23	1,988.84	1,985.65	1,983.50	1,993.53	1,992.83	1,991.19	1,989.49	1,989.00
<b>1987 to 2005</b>	<b>1,992.96</b>	<b>1,992.11</b>	<b>1,990.09</b>	<b>1,987.27</b>	<b>1,985.35</b>	<b>1,997.01</b>	<b>1,995.56</b>	<b>1,993.64</b>	<b>1,991.82</b>	<b>1,991.00</b>

**Table B-4.** April frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	April Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,992.12	1,991.02	1,988.07	1,985.01	1,983.57	1,996.06	1,995.70	1,995.17	1,993.79	1,992.94
1988	1,992.20	1,990.87	1,987.46	1,982.74	1,979.73	1,997.83	1,996.94	1,994.64	1,993.28	1,992.62
1989	1,992.53	1,991.25	1,987.54	1,982.89	1,980.64	1,999.69	1,999.22	1,995.10	1,992.95	1,992.36
1990	1,992.73	1,991.36	1,988.03	1,983.48	1,981.33	2,002.29	2,001.71	1,998.09	1,995.20	1,994.04
1991	1,992.37	1,991.22	1,987.59	1,982.85	1,980.53	1,998.79	1,997.99	1,996.53	1,994.83	1,992.99
1992	1,993.51	1,992.49	1,989.69	1,986.10	1,983.43	1,995.75	1,995.05	1,993.66	1,992.11	1,991.37
1993	1,993.16	1,992.07	1,989.17	1,986.05	1,984.50	1,995.72	1,995.14	1,993.70	1,992.67	1,992.20
1994	1,992.93	1,991.95	1,989.58	1,987.12	1,985.76	1,997.23	1,996.35	1,993.52	1,991.57	1,990.60
1995	1,992.20	1,991.02	1,987.39	1,982.77	1,980.32	1,996.35	1,995.15	1,993.24	1,992.30	1,991.81
1996	1,992.85	1,992.48	1,991.83	1,991.09	1,989.93	2,005.86	2,005.56	2,004.64	1,999.71	1,998.27
1997	1,992.75	1,992.34	1,991.45	1,988.31	1,986.94	2,005.55	2,004.82	1,999.42	1,997.67	1,996.83
1998	1,992.99	1,992.11	1,990.12	1,987.41	1,985.67	1,997.13	1,996.53	1,995.26	1,993.48	1,992.74
1999	1,992.72	1,991.85	1,990.13	1,988.07	1,986.95	2,001.20	1,999.64	1,996.35	1,994.84	1,994.18
2000	1,991.59	1,990.43	1,987.71	1,984.49	1,982.67	2,001.46	2,000.78	1,996.78	1,994.19	1,993.48
2001	1,993.25	1,992.60	1,990.76	1,988.82	1,987.08	1,994.34	1,993.83	1,992.36	1,991.06	1,990.00
2002	1,992.41	1,990.87	1,987.92	1,983.85	1,981.56	1,999.22	1,997.71	1,995.80	1,992.09	1,991.03
2003	1,991.36	1,989.84	1,986.09	1,981.13	1,978.81	1,998.70	1,997.72	1,996.36	1,995.21	1,994.62
2004	1,990.22	1,989.05	1,986.30	1,982.18	1,979.99	1,993.86	1,993.27	1,992.21	1,991.22	1,990.90
2005	1,991.48	1,990.23	1,987.49	1,983.12	1,980.18	1,995.39	1,994.44	1,992.85	1,991.69	1,991.14
<b>1987 to 2005</b>	<b>1,992.63</b>	<b>1,991.76</b>	<b>1,988.90</b>	<b>1,984.90</b>	<b>1,982.30</b>	<b>2,000.35</b>	<b>1,998.05</b>	<b>1,995.10</b>	<b>1,992.71</b>	<b>1,991.85</b>

**Table B-5.** May frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	May Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,990.51	1,989.39	1,986.67	1,983.16	1,981.72	1,999.21	1,998.93	1,997.02	1,994.79	1,994.22
1988	1,992.94	1,992.04	1,989.91	1,986.03	1,980.37	1,997.54	1,996.85	1,995.61	1,994.69	1,994.20
1989	1,992.09	1,991.90	1,990.47	1,986.28	1,983.84	2,004.43	2,004.06	1,999.64	1,998.23	1,997.38
1990	1,992.73	1,992.10	1,990.40	1,986.60	1,984.34	2,003.68	2,003.04	1,999.86	1,998.12	1,997.61
1991	1,991.13	1,990.50	1,989.69	1,987.51	1,986.91	2,008.63	2,008.38	1,999.58	1,998.47	1,998.08
1992	1,992.71	1,991.97	1,990.24	1,988.00	1,986.49	1,996.35	1,995.84	1,994.85	1,993.18	1,991.98
1993	1,992.20	1,990.70	1,988.60	1,984.73	1,982.80	2,002.13	2,001.72	1,996.91	1,993.85	1,992.88
1994	1,992.73	1,991.32	1,987.94	1,983.66	1,980.96	1,996.58	1,995.93	1,994.50	1,992.86	1,992.06
1995	1,991.99	1,990.71	1,987.56	1,983.00	1,980.82	1,997.78	1,997.30	1,996.12	1,993.40	1,992.66
1996	1,992.44	1,991.87	1,991.09	1,990.15	1,989.41	2,009.40	2,009.16	2,005.92	2,003.20	2,001.67
1997	1,992.48	1,992.16	1,990.23	1,988.77	1,987.45	2,018.46	2,018.24	2,011.77	2,007.08	2,006.82
1998	1,993.15	1,992.29	1,990.47	1,988.33	1,986.66	2,004.43	1,999.05	1,997.74	1,996.63	1,996.18
1999	1,991.80	1,990.88	1,988.31	1,984.87	1,982.46	2,007.15	2,002.97	1,998.48	1,996.42	1,995.18
2000	1,992.50	1,991.91	1,989.93	1,986.58	1,983.63	2,002.82	2,002.01	2,000.58	1,998.61	1,997.14
2001	1,992.05	1,990.58	1,985.94	1,978.68	1,974.93	1,996.23	1,995.54	1,994.39	1,993.87	1,992.28
2002	1,992.67	1,992.10	1,990.13	1,985.49	1,982.44	2,007.31	2,005.83	1,998.29	1,996.27	1,995.65
2003	1,992.31	1,990.89	1,987.41	1,982.05	1,978.99	2,002.31	1,999.34	1,998.32	1,997.20	1,996.58
2004	1,991.46	1,989.95	1,985.71	1,981.05	1,978.35	1,999.21	1,998.52	1,996.86	1,995.13	1,994.00
2005	1,991.88	1,990.08	1,984.86	1,979.53	1,978.07	2,000.67	2,000.15	1,997.69	1,995.38	1,994.51
<b>1987 to 2005</b>	<b>1,992.34</b>	<b>1,991.62</b>	<b>1,989.22</b>	<b>1,984.77</b>	<b>1,981.69</b>	<b>2,006.75</b>	<b>2,002.33</b>	<b>1,997.86</b>	<b>1,995.16</b>	<b>1,994.14</b>

**Table B-6.** June frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	June Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,992.99	1,992.24	1,990.35	1,988.66	1,988.13	1,995.68	1,995.16	1,994.02	1,992.93	1,992.32
1988	1,992.10	1,991.11	1,988.77	1,986.20	1,984.59	1,996.02	1,995.45	1,994.04	1,992.19	1,991.35
1989	1,993.16	1,992.68	1,991.46	1,988.41	1,986.99	2,003.51	2,003.37	1,999.06	1,996.79	1,995.98
1990	1,991.64	1,991.39	1,990.95	1,990.53	1,990.34	2,008.42	2,008.23	2,006.07	2,004.62	2,003.95
1991	1,992.24	1,991.83	1,989.45	1,987.91	1,987.35	2,009.51	2,009.15	2,004.87	2,002.89	2,001.28
1992	1,993.41	1,992.71	1,990.92	1,988.79	1,987.80	1,995.76	1,995.12	1,993.74	1,991.99	1,991.38
1993	1,993.11	1,992.03	1,988.70	1,985.52	1,984.28	1,999.52	1,998.31	1,996.46	1,995.01	1,994.41
1994	1,992.65	1,991.00	1,987.05	1,983.82	1,981.58	1,997.13	1,996.49	1,995.11	1,993.58	1,992.98
1995	1,991.47	1,990.76	1,989.81	1,985.70	1,982.95	2,004.84	2,003.70	2,002.41	1,999.28	1,998.48
1996	1,992.41	1,991.99	1,991.22	1,990.41	1,989.54	2,012.17	2,011.63	2,009.98	2,002.54	2,001.86
1997	1,990.29	1,989.99	1,989.19	1,988.49	1,988.16	2,019.44	2,019.30	2,018.49	2,014.59	2,006.31
1998	1,992.45	1,991.98	1,991.35	1,990.41	1,990.08	2,005.39	2,004.38	2,002.80	2,000.74	2,000.32
1999	1,991.62	1,991.37	1,990.71	1,989.97	1,989.46	2,007.60	2,006.96	2,005.75	2,004.73	2,003.76
2000	1,993.07	1,992.09	1,988.73	1,985.22	1,984.06	2,001.32	2,000.21	1,998.64	1,996.84	1,995.59
2001	1,991.89	1,990.82	1,987.11	1,982.83	1,981.20	1,995.54	1,995.10	1,993.90	1,992.66	1,992.35
2002	1,990.16	1,989.60	1,989.06	1,988.62	1,988.39	2,011.19	2,010.90	2,009.54	2,006.83	2,005.32
2003	1,993.04	1,992.45	1,990.59	1,986.80	1,985.11	2,005.53	2,003.99	1,999.04	1,997.34	1,996.73
2004	1,992.68	1,991.55	1,988.11	1,985.06	1,983.95	1,999.63	1,998.92	1,997.60	1,996.54	1,995.84
2005	1,992.11	1,990.77	1,988.58	1,985.76	1,984.98	2,004.81	2,001.58	1,999.96	1,997.81	1,997.22
<b>1987 to 2005</b>	<b>1,992.52</b>	<b>1,991.70</b>	<b>1,989.99</b>	<b>1,987.34</b>	<b>1,985.21</b>	<b>2,009.84</b>	<b>2,006.26</b>	<b>1,999.75</b>	<b>1,994.98</b>	<b>1,993.54</b>

**Table B-7.** July frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	July Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,992.72	1,991.89	1,990.01	1,988.37	1,987.68	1,994.19	1,993.58	1,992.05	1,990.77	1,990.06
1988	1,992.67	1,991.71	1,989.54	1,987.61	1,986.66	1,994.05	1,993.25	1,991.51	1,989.99	1,989.26
1989	1,993.48	1,992.50	1,989.62	1,986.09	1,984.88	1,996.46	1,995.83	1,994.09	1,992.55	1,991.69
1990	1,993.17	1,992.46	1,990.32	1,985.45	1,983.64	2,002.48	2,001.59	1,995.41	1,993.25	1,992.60
1991	1,993.30	1,992.49	1,991.13	1,986.72	1,984.71	2,004.74	2,004.16	1,997.11	1,994.68	1,993.86
1992	1,992.98	1,992.14	1,989.91	1,987.64	1,986.34	1,994.73	1,994.00	1,992.33	1,991.03	1,990.55
1993	1,993.26	1,992.32	1,989.87	1,986.69	1,985.43	1,998.49	1,997.68	1,996.26	1,994.83	1,994.29
1994	1,993.06	1,992.17	1,990.09	1,987.44	1,985.99	1,994.35	1,993.48	1,991.81	1,990.23	1,989.42
1995	1,992.69	1,991.75	1,989.07	1,985.38	1,983.75	1,999.06	1,998.17	1,996.03	1,993.48	1,992.27
1996	1,992.95	1,991.86	1,990.10	1,987.50	1,985.75	2,002.00	2,000.98	1,996.54	1,993.78	1,991.92
1997	1,992.39	1,991.54	1,989.99	1,988.01	1,986.87	2,003.01	2,000.90	1,998.82	1,995.88	1,994.98
1998	1,993.00	1,992.35	1,990.19	1,987.09	1,985.56	2,002.04	2,001.24	1,996.79	1,994.28	1,992.98
1999	1,993.51	1,992.88	1,991.09	1,988.45	1,986.32	2,003.32	2,002.40	1,998.16	1,995.17	1,993.97
2000	1,993.30	1,992.61	1,989.99	1,987.03	1,985.45	1,996.41	1,995.69	1,994.42	1,992.87	1,992.10
2001	1,992.83	1,992.19	1,990.33	1,987.67	1,985.41	1,994.14	1,993.59	1,992.28	1,991.12	1,990.66
2002	1,992.32	1,991.22	1,988.97	1,986.71	1,985.37	2,004.34	2,000.19	1,997.48	1,994.29	1,993.16
2003	1,992.58	1,991.81	1,989.34	1,986.74	1,985.90	1,995.15	1,994.59	1,992.97	1,991.41	1,990.87
2004	1,992.31	1,991.42	1,989.14	1,985.76	1,984.60	1,997.01	1,995.91	1,994.03	1,992.06	1,991.27
2005	1,992.99	1,992.25	1,989.54	1,986.72	1,985.53	1,997.03	1,996.18	1,994.20	1,992.03	1,991.06
<b>1987 to 2005</b>	<b>1,992.99</b>	<b>1,992.15</b>	<b>1,989.90</b>	<b>1,987.05</b>	<b>1,985.49</b>	<b>2,000.22</b>	<b>1,997.64</b>	<b>1,994.49</b>	<b>1,992.06</b>	<b>1,991.09</b>

**Table B-8.** August frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	August Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,992.17	1,991.24	1,989.44	1,987.72	1,986.99	1,993.47	1,992.75	1,991.44	1,990.14	1,989.54
1988	1,992.47	1,991.75	1,990.36	1,988.56	1,987.64	1,993.19	1,992.30	1,990.93	1,989.24	1,988.23
1989	1,992.67	1,992.03	1,990.02	1,987.53	1,986.48	1,995.08	1,994.35	1,992.94	1,991.27	1,990.78
1990	1,993.44	1,992.77	1,990.94	1,988.95	1,988.09	1,995.05	1,994.49	1,993.00	1,991.66	1,991.13
1991	1,993.15	1,992.50	1,990.70	1,988.51	1,987.10	1,994.63	1,994.00	1,992.54	1,991.21	1,990.68
1992	1,993.53	1,992.88	1,991.28	1,989.67	1,988.94	1,994.54	1,993.99	1,992.54	1,991.23	1,990.64
1993	1,993.40	1,992.61	1,990.54	1,988.28	1,987.26	1,994.92	1,994.31	1,992.76	1,991.33	1,990.80
1994	1,993.35	1,992.75	1,991.39	1,989.49	1,988.54	1,993.95	1,993.39	1,992.13	1,990.38	1,989.40
1995	1,993.38	1,992.46	1,990.40	1,987.88	1,986.26	1,994.61	1,993.92	1,992.03	1,990.74	1,989.98
1996	1,992.89	1,991.83	1,989.08	1,986.11	1,984.75	1,995.36	1,994.85	1,993.33	1,991.94	1,991.44
1997	1,993.23	1,992.43	1,990.33	1,987.48	1,986.40	1,996.43	1,995.86	1,994.26	1,992.74	1,991.56
1998	1,993.77	1,993.34	1,991.80	1,989.80	1,988.93	1,995.98	1,995.37	1,993.88	1,992.60	1,991.99
1999	1,993.42	1,992.76	1,990.27	1,987.31	1,986.19	1,995.30	1,994.78	1,993.16	1,991.62	1,991.10
2000	1,993.28	1,992.65	1,990.80	1,988.71	1,987.51	1,994.27	1,993.68	1,992.13	1,990.75	1,990.07
2001	1,992.40	1,991.75	1,990.13	1,988.27	1,987.31	1,992.94	1,992.40	1,991.03	1,989.47	1,988.88
2002	1,993.31	1,992.65	1,990.79	1,988.59	1,987.49	1,994.82	1,994.41	1,993.01	1,991.73	1,991.20
2003	1,992.04	1,991.43	1,990.06	1,988.59	1,987.77	1,993.10	1,992.59	1,991.49	1,990.30	1,989.58
2004	1,992.50	1,991.48	1,989.34	1,986.93	1,985.59	1,994.26	1,993.31	1,991.72	1,990.18	1,989.63
2005	1,992.34	1,991.71	1,989.70	1,987.44	1,986.52	1,993.76	1,993.04	1,991.60	1,990.25	1,989.67
<b>1987 to 2005</b>	<b>1,993.11</b>	<b>1,992.33</b>	<b>1,990.42</b>	<b>1,988.19</b>	<b>1,986.94</b>	<b>1,994.81</b>	<b>1,994.07</b>	<b>1,992.38</b>	<b>1,990.87</b>	<b>1,990.08</b>

**Table B-9.** September frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	September Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,992.91	1,992.04	1,989.94	1,987.99	1,987.34	1,995.28	1,994.75	1,993.46	1,992.15	1,991.54
1988	1,992.14	1,991.19	1,988.56	1,985.50	1,983.37	1,993.08	1,992.23	1,990.56	1,988.53	1,987.95
1989	1,992.76	1,990.98	1,986.13	1,974.29	1,969.06	1,995.64	1,994.61	1,992.84	1,991.52	1,990.78
1990	1,993.34	1,992.51	1,990.14	1,987.63	1,986.54	1,995.28	1,994.66	1,993.17	1,991.86	1,991.41
1991	1,992.92	1,991.82	1,989.06	1,985.65	1,983.87	1,994.88	1,994.09	1,992.51	1,991.25	1,990.53
1992	1,993.50	1,992.66	1,990.07	1,987.82	1,986.77	1,995.04	1,994.47	1,992.67	1,991.36	1,990.86
1993	1,992.75	1,991.72	1,989.04	1,985.93	1,984.59	1,995.04	1,994.40	1,992.80	1,991.40	1,990.89
1994	1,993.69	1,993.13	1,991.66	1,989.82	1,988.68	1,994.30	1,993.85	1,992.68	1,991.45	1,990.81
1995	1,993.33	1,992.67	1,990.31	1,987.61	1,986.35	1,994.92	1,994.28	1,992.57	1,991.02	1,989.95
1996	1,993.23	1,992.48	1,990.13	1,987.89	1,986.83	1,994.96	1,994.29	1,992.74	1,991.50	1,990.99
1997	1,992.89	1,992.21	1,990.12	1,987.65	1,986.56	1,995.64	1,995.14	1,993.95	1,992.64	1,992.04
1998	1,993.45	1,992.96	1,991.23	1,988.99	1,987.89	1,995.30	1,994.76	1,993.40	1,992.27	1,991.77
1999	1,992.25	1,991.53	1,989.13	1,985.06	1,982.37	1,994.09	1,993.20	1,991.42	1,990.37	1,989.78
2000	1,992.74	1,991.84	1,989.59	1,987.00	1,985.71	1,993.78	1,993.10	1,991.83	1,990.64	1,990.15
2001	1,992.20	1,991.28	1,988.86	1,984.27	1,982.10	1,992.84	1,992.03	1,990.17	1,987.74	1,987.27
2002	1,993.34	1,992.71	1,991.19	1,989.36	1,988.65	1,994.47	1,993.98	1,992.77	1,991.50	1,991.02
2003	1,990.36	1,989.56	1,987.63	1,983.74	1,981.86	1,991.77	1,991.06	1,989.73	1,988.03	1,987.10
2004	1,992.46	1,991.29	1,988.21	1,982.65	1,978.97	1,994.69	1,994.11	1,993.13	1,991.59	1,990.43
2005	1,991.99	1,991.38	1,989.73	1,987.44	1,986.17	1,992.73	1,992.07	1,990.95	1,989.68	1,988.81
<b>1987 to 2005</b>	<b>1,992.97</b>	<b>1,992.08</b>	<b>1,989.71</b>	<b>1,986.71</b>	<b>1,984.57</b>	<b>1,994.78</b>	<b>1,994.02</b>	<b>1,992.39</b>	<b>1,990.74</b>	<b>1,989.69</b>

**Table B-10.** October frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	October Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,993.08	1,992.22	1,990.00	1,987.84	1,986.64	1,996.34	1,995.81	1,994.66	1,993.38	1,992.40
1988	1,992.95	1,992.01	1,989.39	1,985.75	1,983.01	1,995.70	1,995.05	1,993.50	1,992.06	1,991.45
1989	1,993.17	1,991.93	1,988.25	1,984.12	1,982.23	1,996.23	1,995.65	1,994.07	1,993.03	1,992.57
1990	1,992.47	1,990.97	1,986.43	1,980.65	1,977.69	1,996.49	1,995.82	1,994.44	1,993.64	1,993.34
1991	1,992.74	1,991.33	1,986.99	1,981.57	1,978.99	1,996.44	1,995.84	1,994.31	1,993.42	1,993.22
1992	1,992.65	1,991.45	1,987.84	1,983.40	1,981.25	1,996.40	1,995.86	1,994.54	1,993.60	1,993.19
1993	1,992.00	1,990.62	1,986.57	1,981.83	1,979.41	1,995.72	1,995.05	1,993.70	1,992.87	1,992.73
1994	1,993.31	1,992.34	1,989.54	1,986.22	1,984.61	1,995.67	1,995.02	1,993.36	1,992.14	1,991.74
1995	1,992.25	1,991.01	1,987.92	1,984.22	1,982.13	1,996.47	1,995.98	1,994.77	1,992.48	1,991.74
1996	1,992.96	1,992.01	1,989.52	1,986.62	1,985.09	1,995.96	1,995.35	1,993.89	1,992.40	1,991.84
1997	1,992.61	1,991.26	1,988.07	1,984.34	1,982.67	1,995.97	1,995.26	1,993.94	1,993.00	1,992.57
1998	1,993.20	1,992.50	1,990.40	1,987.83	1,986.84	1,995.13	1,994.73	1,993.46	1,992.27	1,991.92
1999	1,992.11	1,991.16	1,988.10	1,984.79	1,983.25	1,995.09	1,994.24	1,992.67	1,991.12	1,990.34
2000	1,991.89	1,990.60	1,988.13	1,984.91	1,982.80	1,994.71	1,994.00	1,992.65	1,991.46	1,991.02
2001	1,993.37	1,992.54	1,990.27	1,987.75	1,986.02	1,995.29	1,994.80	1,993.43	1,992.42	1,991.85
2002	1,993.20	1,992.42	1,990.45	1,988.29	1,987.24	1,994.86	1,994.29	1,992.96	1,991.74	1,991.22
2003	1,991.94	1,991.24	1,989.29	1,986.83	1,985.52	1,994.20	1,993.67	1,992.66	1,991.53	1,991.10
2004	1,990.22	1,988.91	1,984.94	1,980.42	1,978.11	1,994.72	1,994.09	1,993.09	1,992.22	1,991.78
2005	1,991.73	1,990.66	1,987.92	1,984.42	1,981.98	1,994.68	1,993.83	1,992.07	1,990.86	1,989.96
<b>1987 to 2005</b>	<b>1,992.70</b>	<b>1,991.61</b>	<b>1,988.72</b>	<b>1,984.76</b>	<b>1,982.19</b>	<b>1,995.77</b>	<b>1,995.08</b>	<b>1,993.63</b>	<b>1,992.29</b>	<b>1,991.57</b>

**Table B-11.** November frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	November Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,993.23	1,992.59	1,990.93	1,989.40	1,988.62	1,995.37	1,994.98	1,993.99	1,992.39	1,991.58
1988	1,993.17	1,992.12	1,989.04	1,984.92	1,983.23	1,995.92	1,995.29	1,993.88	1,991.86	1,990.94
1989	1,993.10	1,991.95	1,988.56	1,984.02	1,981.39	1,996.91	1,996.34	1,994.74	1,993.41	1,993.05
1990	1,991.92	1,990.69	1,986.46	1,980.42	1,978.21	1,996.60	1,995.90	1,994.73	1,993.95	1,993.55
1991	1,993.19	1,992.03	1,989.16	1,984.82	1,982.66	1,996.12	1,995.45	1,994.06	1,992.52	1,991.61
1992	1,992.58	1,991.62	1,988.94	1,985.39	1,982.62	1,996.10	1,994.69	1,993.20	1,991.44	1,990.69
1993	1,993.16	1,992.16	1,989.65	1,986.39	1,984.47	1,995.44	1,994.86	1,993.41	1,992.13	1,991.65
1994	1,992.86	1,991.82	1,989.19	1,985.19	1,982.57	1,995.91	1,995.05	1,993.67	1,991.96	1,991.25
1995	1,992.71	1,991.81	1,989.55	1,985.72	1,983.45	1,996.94	1,996.56	1,995.60	1,994.54	1,994.21
1996	1,993.00	1,992.08	1,989.90	1,986.70	1,984.83	1,995.54	1,994.94	1,993.56	1,992.20	1,991.65
1997	1,993.03	1,992.02	1,989.27	1,986.11	1,984.45	1,996.35	1,995.79	1,994.37	1,993.31	1,992.71
1998	1,993.48	1,992.97	1,991.50	1,989.84	1,988.79	1,995.71	1,995.29	1,994.38	1,993.50	1,993.07
1999	1,992.80	1,991.82	1,989.05	1,984.93	1,982.86	1,996.51	1,995.86	1,994.56	1,992.99	1,992.28
2000	1,992.74	1,992.08	1,990.29	1,985.22	1,982.46	1,994.50	1,994.00	1,993.03	1,992.07	1,991.37
2001	1,993.06	1,992.40	1,990.36	1,987.75	1,986.35	1,995.06	1,994.40	1,993.00	1,991.50	1,990.16
2002	1,993.03	1,992.36	1,990.54	1,988.72	1,987.72	1,994.39	1,993.90	1,992.77	1,991.64	1,991.24
2003	1,991.79	1,991.13	1,989.39	1,986.10	1,984.04	1,995.68	1,995.11	1,993.61	1,990.80	1,989.85
2004	1,991.31	1,990.44	1,987.91	1,984.50	1,982.36	1,993.81	1,993.24	1,991.85	1,990.47	1,989.79
2005	1,990.97	1,989.82	1,986.77	1,983.42	1,981.60	1,995.71	1,994.83	1,992.58	1,990.07	1,989.53
<b>1987 to 2005</b>	<b>1,992.87</b>	<b>1,991.92</b>	<b>1,989.53</b>	<b>1,985.73</b>	<b>1,983.29</b>	<b>1,996.01</b>	<b>1,995.26</b>	<b>1,993.82</b>	<b>1,992.12</b>	<b>1,991.19</b>

**Table B-12.** December frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	December Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,993.49	1,992.66	1,990.72	1,988.66	1,987.26	1,994.91	1,994.21	1,992.71	1,991.18	1,989.79
1988	1,992.87	1,991.95	1,989.69	1,987.80	1,986.77	1,994.33	1,993.51	1,992.08	1,990.69	1,990.10
1989	1,992.75	1,991.45	1,987.70	1,983.13	1,980.45	1,995.87	1,995.19	1,993.99	1,992.50	1,991.81
1990	1,993.33	1,992.38	1,989.56	1,985.53	1,982.97	1,996.12	1,995.41	1,993.86	1,992.44	1,991.86
1991	1,993.13	1,992.44	1,991.01	1,989.20	1,987.86	1,995.00	1,994.52	1,993.45	1,992.54	1,991.98
1992	1,993.05	1,992.40	1,990.91	1,988.99	1,987.69	1,994.07	1,993.46	1,992.27	1,991.09	1,990.55
1993	1,993.53	1,992.55	1,990.24	1,987.08	1,985.31	1,995.66	1,995.13	1,993.60	1,992.29	1,991.87
1994	1,993.13	1,992.32	1,990.51	1,988.36	1,987.05	1,994.35	1,993.74	1,992.20	1,990.83	1,990.17
1995	1,992.84	1,992.11	1,989.26	1,986.61	1,984.42	2,001.35	2,000.81	1,998.05	1,995.84	1,994.86
1996	1,993.14	1,992.53	1,990.80	1,988.28	1,987.10	1,995.70	1,995.21	1,993.99	1,992.73	1,992.00
1997	1,993.32	1,992.51	1,989.97	1,987.01	1,985.65	1,995.82	1,995.17	1,993.91	1,992.79	1,992.33
1998	1,993.79	1,993.25	1,991.71	1,989.73	1,988.98	1,995.76	1,995.26	1,994.17	1,992.55	1,991.72
1999	1,992.50	1,991.51	1,988.83	1,985.00	1,983.05	1,996.14	1,995.66	1,994.41	1,993.10	1,992.59
2000	1,993.03	1,992.34	1,990.65	1,988.47	1,987.42	1,994.51	1,993.91	1,992.71	1,991.34	1,990.84
2001	1,993.35	1,992.76	1,991.18	1,988.94	1,987.02	1,994.32	1,993.78	1,992.62	1,991.28	1,990.50
2002	1,992.46	1,991.68	1,989.91	1,987.17	1,985.56	1,994.39	1,993.86	1,992.52	1,991.31	1,990.75
2003	1,990.63	1,989.57	1,987.11	1,983.68	1,981.12	1,992.77	1,992.01	1,990.83	1,989.94	1,989.60
2004	1,990.63	1,989.16	1,985.96	1,980.91	1,978.69	1,994.07	1,993.54	1,992.63	1,991.50	1,990.94
2005	1,991.59	1,990.69	1,988.05	1,984.01	1,981.51	1,993.23	1,992.74	1,991.36	1,990.05	1,989.34
<b>1987 to 2005</b>	<b>1,993.04</b>	<b>1,992.14</b>	<b>1,989.92</b>	<b>1,986.72</b>	<b>1,984.47</b>	<b>1,995.65</b>	<b>1,994.72</b>	<b>1,993.12</b>	<b>1,991.52</b>	<b>1,990.71</b>

**Table B-13.** Annual frequency of exceedance of hourly stage in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	Annual Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,992.88	1,991.98	1,989.86	1,987.67	1,986.08	1,995.83	1,995.17	1,993.60	1,991.69	1,990.78
1988	1,992.80	1,991.90	1,989.75	1,986.89	1,984.83	1,995.76	1,994.86	1,992.87	1,990.87	1,989.81
1989	1,993.02	1,992.18	1,989.54	1,985.47	1,982.80	1,999.36	1,996.69	1,993.97	1,992.18	1,991.29
1990	1,992.90	1,991.92	1,989.64	1,985.13	1,982.16	2,003.20	1,998.78	1,994.60	1,992.85	1,992.06
1991	1,992.68	1,991.82	1,989.29	1,985.67	1,983.07	2,004.25	1,998.32	1,994.71	1,993.00	1,992.03
1992	1,993.32	1,992.58	1,990.73	1,988.14	1,986.27	1,995.54	1,994.88	1,993.45	1,991.72	1,991.00
1993	1,993.19	1,992.23	1,989.79	1,986.42	1,984.49	1,997.13	1,995.75	1,993.83	1,992.27	1,991.57
1994	1,993.20	1,992.35	1,990.21	1,987.16	1,985.20	1,995.74	1,994.86	1,993.21	1,991.61	1,990.83
1995	1,992.94	1,992.05	1,989.80	1,986.29	1,983.88	1,999.55	1,997.29	1,994.91	1,992.47	1,991.61
1996	1,992.77	1,992.04	1,990.69	1,987.91	1,986.28	2,006.07	2,002.73	1,995.88	1,993.19	1,992.12
1997	1,992.79	1,992.06	1,989.93	1,987.68	1,986.04	2,015.12	2,002.66	1,995.50	1,993.65	1,992.91
1998	1,993.42	1,992.73	1,991.06	1,988.93	1,987.57	2,000.64	1,996.94	1,994.48	1,992.83	1,992.16
1999	1,993.01	1,992.10	1,990.15	1,987.06	1,985.07	2,003.66	1,997.91	1,994.66	1,992.60	1,991.66
2000	1,992.70	1,991.73	1,989.20	1,986.05	1,984.08	2,000.03	1,996.49	1,993.29	1,991.55	1,990.90
2001	1,992.97	1,992.31	1,990.36	1,987.11	1,984.42	1,994.71	1,994.11	1,992.59	1,990.98	1,989.87
2002	1,992.72	1,991.88	1,989.56	1,987.21	1,985.20	2,005.30	1,997.38	1,993.57	1,991.80	1,991.10
2003	1,992.12	1,991.17	1,988.80	1,985.56	1,983.23	1,998.44	1,996.55	1,992.84	1,990.64	1,989.76
2004	1,991.76	1,990.57	1,987.68	1,983.78	1,981.11	1,997.04	1,995.01	1,992.68	1,990.98	1,990.11
2005	1,991.92	1,990.81	1,988.06	1,984.48	1,981.78	1,998.13	1,995.44	1,992.36	1,990.42	1,989.64
<b>1987 to 2005</b>	<b>1,992.87</b>	<b>1,992.00</b>	<b>1,989.77</b>	<b>1,986.53</b>	<b>1,984.27</b>	<b>1,999.50</b>	<b>1,996.39</b>	<b>1,993.81</b>	<b>1,991.83</b>	<b>1,990.91</b>

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## **Appendix C**

### **Monthly and Annual Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005**

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**Table C-1.** January frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	January Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	6.69	6.47	5.63	4.56	3.88	4.33	3.91	3.50	2.92	2.78
1988	7.55	6.48	4.67	3.93	3.73	4.37	3.90	3.27	2.72	2.58
1989	9.30	7.94	6.06	4.71	4.23	5.33	4.70	4.04	3.14	2.90
1990	21.29	20.34	13.41	11.88	7.98	4.65	4.42	3.82	3.31	3.12
1991	17.11	16.77	13.08	10.29	9.60	4.73	4.31	4.09	3.65	3.15
1992	7.55	7.11	5.52	3.08	2.36	4.78	4.53	3.83	2.61	2.06
1993	12.34	11.78	9.03	6.45	5.43	4.74	4.38	3.98	3.37	0.69
1994	10.04	9.31	6.74	5.30	4.80	4.58	4.38	3.65	2.90	2.71
1995	8.85	8.10	6.82	5.13	4.27	4.67	4.58	4.17	3.51	3.09
1996	13.30	11.43	8.52	4.89	2.64	3.09	2.98	2.41	1.69	1.25
1997	8.83	7.64	5.56	4.32	3.01	3.60	3.38	2.61	1.85	1.21
1998	8.10	7.74	6.64	6.01	5.55	4.22	4.08	3.71	3.30	2.99
1999	9.08	7.61	6.43	5.57	4.90	4.11	3.89	3.56	3.35	3.01
2000	14.04	13.24	9.95	8.32	6.84	3.99	3.95	3.15	2.15	2.00
2001	8.44	7.77	6.02	4.83	4.15	4.57	4.25	3.60	2.96	2.67
2002	11.52	10.95	7.74	6.48	5.61	4.60	4.18	3.61	2.99	2.65
2003	8.72	7.43	5.28	3.44	2.94	4.74	4.34	3.29	2.53	2.17
2004	10.30	9.03	6.07	4.53	4.02	4.44	3.92	2.86	2.30	1.51
2005	13.70	12.52	10.01	7.45	6.52	3.40	3.06	2.60	1.43	1.21
<b>1987 to 2005</b>	<b>12.53</b>	<b>10.30</b>	<b>6.92</b>	<b>4.90</b>	<b>4.02</b>	<b>4.57</b>	<b>4.21</b>	<b>3.51</b>	<b>2.62</b>	<b>2.09</b>

**Table C-2.** February frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	February Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	8.17	7.31	6.57	5.40	4.97	4.39	4.23	3.52	2.42	2.15
1988	5.10	4.43	3.67	2.86	2.36	4.05	3.50	2.79	2.20	1.89
1989	6.59	4.40	2.48	1.82	1.64	3.49	3.19	2.16	1.62	1.29
1990	19.39	16.47	12.55	11.24	9.22	4.62	4.42	4.01	3.52	3.10
1991	18.65	16.62	15.21	12.43	11.36	4.10	3.91	3.33	2.96	2.28
1992	5.77	5.45	4.42	3.00	2.51	4.30	4.13	3.32	2.53	2.06
1993	6.75	5.61	4.59	3.67	3.61	4.66	4.02	3.60	3.09	2.94
1994	9.57	9.03	7.84	5.88	5.51	4.70	4.61	4.24	3.70	3.52
1995	9.40	5.76	3.88	3.06	2.68	3.87	3.49	2.87	1.99	1.69
1996	9.97	7.33	2.45	1.30	0.78	3.43	2.90	0.93	0.35	0.25
1997	6.75	6.64	5.01	3.45	2.87	3.18	2.88	2.35	1.65	1.45
1998	7.43	7.13	6.10	4.89	3.93	4.51	4.20	4.02	3.23	3.17
1999	8.47	7.61	6.39	5.45	5.07	4.18	3.88	3.66	3.35	3.08
2000	10.34	8.66	6.24	5.05	4.59	4.04	3.73	2.76	2.11	1.68
2001	4.42	4.25	2.93	2.32	2.16	3.81	3.55	2.77	2.35	2.11
2002	10.43	9.62	7.41	6.08	5.73	4.37	4.21	3.45	2.81	2.43
2003	11.98	10.71	7.85	6.60	6.27	4.19	3.85	3.46	2.80	2.34
2004	10.85	8.94	6.71	5.21	4.40	4.35	3.87	3.16	2.41	1.93
2005	12.73	11.91	10.03	8.64	7.90	3.80	3.39	2.20	1.53	1.20
<b>1987 to 2005</b>	<b>12.26</b>	<b>9.54</b>	<b>6.13</b>	<b>3.65</b>	<b>2.64</b>	<b>4.33</b>	<b>4.02</b>	<b>3.23</b>	<b>2.20</b>	<b>1.65</b>

**Table C-3.** March frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	March Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	9.00	7.40	6.23	4.29	3.13	4.80	4.16	3.43	2.18	1.53
1988	10.49	9.79	5.96	4.39	3.90	4.32	4.08	3.59	2.96	2.72
1989	12.34	11.79	9.65	7.36	6.51	4.93	4.77	4.31	4.03	3.83
1990	12.83	12.24	9.63	8.31	7.22	4.75	4.55	4.21	3.52	2.91
1991	14.47	13.71	7.71	4.53	4.15	2.97	2.55	2.02	1.16	1.00
1992	6.02	5.42	4.09	2.93	2.73	4.08	3.93	2.92	2.12	1.81
1993	8.97	8.19	6.14	4.75	3.89	4.54	4.44	3.85	3.28	3.05
1994	8.66	7.76	6.42	4.32	4.01	4.89	4.44	3.51	3.03	2.45
1995	7.60	6.46	5.24	4.00	3.00	2.89	2.41	2.17	1.73	1.43
1996	4.81	4.17	2.52	1.47	0.20	1.42	1.31	1.01	0.59	0.56
1997	8.25	7.87	4.26	2.57	1.87	3.30	2.74	1.95	0.83	0.55
1998	9.21	8.81	5.67	4.96	4.55	4.16	3.99	3.68	3.38	2.74
1999	8.72	8.41	6.72	5.12	2.69	3.91	3.80	3.58	1.76	0.91
2000	12.58	11.77	9.03	7.31	6.57	4.01	3.80	3.16	2.72	2.41
2001	5.48	4.80	3.52	2.59	2.41	4.47	3.71	2.97	2.48	2.24
2002	12.55	12.06	8.55	6.81	5.80	4.17	4.08	3.42	2.22	1.79
2003	11.20	10.68	8.36	5.49	4.67	4.06	3.48	2.78	1.83	1.70
2004	12.59	11.23	9.23	6.71	6.09	4.20	3.73	2.78	1.93	1.63
2005	10.86	9.07	7.52	5.98	4.77	4.59	4.23	3.32	2.48	1.75
<b>1987 to 2005</b>	<b>11.34</b>	<b>9.58</b>	<b>6.66</b>	<b>4.20</b>	<b>3.09</b>	<b>4.44</b>	<b>4.08</b>	<b>3.16</b>	<b>2.03</b>	<b>1.32</b>

**Table C-4.** April frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	April Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	10.55	9.13	7.94	5.11	4.12	3.25	2.91	1.94	1.19	0.86
1988	19.40	17.46	12.15	8.96	8.04	4.05	3.84	3.17	2.44	2.25
1989	18.14	15.45	12.07	9.68	8.44	4.37	4.10	3.44	1.96	1.72
1990	16.99	14.93	10.99	4.56	3.13	3.83	3.36	2.39	1.28	0.92
1991	16.56	15.61	12.59	10.21	7.10	3.62	3.07	2.54	2.00	1.38
1992	16.01	15.52	10.60	6.05	5.09	4.63	4.51	4.09	3.45	3.00
1993	12.95	12.10	9.18	7.68	7.38	4.33	4.16	3.90	3.58	3.42
1994	10.38	9.63	8.40	6.94	5.70	4.69	4.51	3.89	2.67	2.16
1995	19.55	17.91	12.84	8.66	7.60	4.28	4.13	3.41	2.75	2.04
1996	4.13	2.59	0.96	0.17	0.14	2.79	1.22	0.52	0.35	0.26
1997	8.11	6.27	3.31	1.12	0.94	2.27	1.88	1.25	0.67	0.33
1998	10.30	8.37	6.85	4.61	3.80	3.42	3.01	2.45	2.09	1.94
1999	7.26	5.99	5.01	2.73	1.91	3.33	3.10	2.13	1.38	0.73
2000	12.88	12.13	9.49	6.96	4.18	3.69	3.56	2.56	1.28	0.83
2001	7.32	5.43	4.46	3.91	3.59	4.06	3.86	3.36	3.10	2.84
2002	13.56	12.05	9.42	6.52	5.39	3.94	3.68	2.50	1.81	1.55
2003	15.79	13.79	9.64	6.08	5.39	2.47	2.12	1.53	0.96	0.83
2004	13.94	13.02	10.13	8.66	8.11	3.66	3.08	2.42	1.81	1.41
2005	15.49	14.00	11.20	9.02	7.97	4.13	3.75	2.84	2.09	1.89
<b>1987 to 2005</b>	<b>15.61</b>	<b>12.79</b>	<b>8.77</b>	<b>4.68</b>	<b>3.14</b>	<b>4.21</b>	<b>3.82</b>	<b>2.74</b>	<b>1.52</b>	<b>0.94</b>

**Table C-5.** May frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	May Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.04	6.06	4.41	2.82	2.68	1.48	1.36	0.99	0.59	0.48
1988	16.09	12.88	5.85	4.69	3.31	3.24	2.98	2.31	1.59	1.41
1989	13.01	10.89	7.29	0.72	0.59	2.82	2.23	1.58	0.68	0.34
1990	11.93	10.87	7.45	3.35	2.34	2.59	2.17	1.58	0.97	0.74
1991	5.39	5.17	2.39	0.90	0.64	2.03	1.40	0.93	0.45	0.32
1992	6.86	5.66	4.28	3.55	2.70	3.36	2.84	1.97	1.34	1.23
1993	12.31	11.60	8.27	2.73	1.68	4.29	4.19	2.48	0.64	0.43
1994	16.76	14.55	11.96	8.99	8.09	4.49	3.77	3.33	2.49	1.70
1995	14.38	12.86	9.77	7.23	6.46	3.49	3.26	2.02	1.51	0.98
1996	5.50	4.25	2.20	1.43	0.91	1.78	1.31	0.66	0.41	0.34
1997	2.99	2.69	1.56	1.14	0.83	1.29	1.04	0.55	0.28	0.26
1998	9.29	7.88	5.64	3.99	1.29	2.63	2.27	1.97	1.50	1.13
1999	10.68	8.89	4.80	2.25	1.08	3.01	2.43	1.33	0.71	0.64
2000	16.01	11.23	6.91	2.22	1.22	2.73	2.42	1.72	0.57	0.28
2001	17.42	15.43	13.54	11.12	8.48	4.11	3.63	2.66	1.38	0.63
2002	16.27	15.14	8.44	1.83	1.34	3.16	2.96	2.16	1.61	1.06
2003	18.29	17.20	12.90	9.49	6.47	2.78	2.35	1.96	1.28	1.13
2004	17.86	17.61	12.92	9.52	7.94	3.22	2.69	2.29	1.53	1.13
2005	16.86	16.34	12.50	7.54	2.98	2.94	2.60	2.02	1.35	0.43
<b>1987 to 2005</b>	<b>15.59</b>	<b>12.85</b>	<b>6.85</b>	<b>2.50</b>	<b>1.42</b>	<b>3.25</b>	<b>2.78</b>	<b>1.80</b>	<b>0.78</b>	<b>0.45</b>

**Table C-6.** June frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	June Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	6.41	5.93	5.45	4.49	3.74	3.94	3.61	2.74	2.23	2.06
1988	10.63	9.87	8.19	5.59	5.16	5.00	4.46	3.21	2.23	2.13
1989	9.33	8.81	6.20	1.44	0.65	3.02	2.81	2.35	0.94	0.29
1990	1.90	1.76	1.35	0.84	0.74	1.71	1.62	0.77	0.37	0.25
1991	4.63	1.98	1.32	0.80	0.62	3.24	1.83	0.77	0.36	0.34
1992	7.77	7.01	5.55	3.92	3.32	4.39	4.09	3.40	2.91	2.81
1993	12.95	11.67	9.97	8.37	5.96	3.68	3.58	3.13	2.55	1.97
1994	15.44	14.71	12.28	7.21	5.58	4.57	4.15	3.76	3.09	3.00
1995	13.19	11.47	5.03	1.83	1.21	2.73	2.47	1.42	0.37	0.30
1996	4.56	3.75	2.34	1.51	1.27	1.73	1.34	0.63	0.33	0.25
1997	3.54	3.13	2.00	1.69	1.13	2.32	1.09	0.43	0.32	0.27
1998	3.77	3.21	2.08	1.51	1.26	1.77	1.44	1.04	0.46	0.41
1999	2.54	2.27	1.35	0.71	0.52	1.37	1.11	0.74	0.42	0.35
2000	12.31	11.50	9.78	7.69	5.67	3.30	2.92	2.41	2.00	1.55
2001	13.96	13.16	11.34	10.40	8.76	3.64	3.51	3.23	2.72	2.38
2002	2.11	1.79	1.28	0.89	0.55	1.75	1.06	0.57	0.31	0.28
2003	11.35	10.63	8.58	1.57	0.76	3.12	2.63	2.22	1.22	0.75
2004	11.07	11.00	10.23	8.86	7.79	2.85	2.64	2.47	2.13	1.48
2005	9.94	9.20	7.26	2.87	2.26	2.57	2.46	1.73	0.95	0.64
<b>1987 to 2005</b>	<b>11.48</b>	<b>10.17</b>	<b>5.20</b>	<b>1.50</b>	<b>1.00</b>	<b>3.62</b>	<b>3.21</b>	<b>2.05</b>	<b>0.60</b>	<b>0.38</b>

**Table C-7.** July frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	July Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	5.77	5.61	5.09	4.53	3.59	4.11	3.80	3.33	2.81	2.61
1988	8.07	7.14	5.38	4.40	3.52	4.88	4.73	3.99	3.33	2.71
1989	11.48	10.58	9.77	8.41	6.10	5.11	4.80	4.27	3.64	3.10
1990	15.77	12.12	10.16	3.78	2.77	4.99	4.61	3.86	2.16	1.09
1991	11.79	11.02	9.33	2.46	1.93	4.62	4.40	2.97	1.31	0.86
1992	9.50	8.81	6.83	5.78	5.13	4.92	4.86	4.35	4.06	3.63
1993	11.82	9.80	7.57	5.99	5.43	3.88	3.62	3.03	2.22	1.74
1994	8.99	7.32	6.01	3.33	2.57	5.01	4.82	3.59	3.09	2.48
1995	12.57	10.55	9.13	5.91	5.72	4.77	4.63	3.37	1.97	1.78
1996	10.62	9.57	5.63	3.94	2.78	4.79	3.84	2.33	1.19	0.77
1997	7.21	6.55	4.57	3.39	1.82	2.84	2.40	1.64	0.86	0.64
1998	10.23	8.70	7.22	5.51	4.56	3.99	3.61	2.68	1.57	1.45
1999	10.38	9.77	7.15	2.15	1.64	3.72	3.32	2.36	1.73	1.06
2000	10.64	10.38	8.86	6.30	5.56	4.31	4.07	3.64	3.11	2.74
2001	10.36	9.05	5.07	4.02	3.83	4.24	3.94	3.72	3.31	2.93
2002	9.71	8.95	7.81	4.10	2.52	3.61	3.15	2.32	1.34	1.14
2003	9.33	8.27	6.98	6.09	5.14	4.53	4.30	3.59	3.00	2.76
2004	10.60	10.01	8.92	7.10	6.12	4.11	3.74	3.01	2.49	2.20
2005	9.38	8.85	7.81	6.18	5.64	3.77	3.63	3.27	2.35	2.05
<b>1987 to 2005</b>	<b>10.64</b>	<b>9.77</b>	<b>7.06</b>	<b>4.74</b>	<b>3.52</b>	<b>4.68</b>	<b>4.27</b>	<b>3.33</b>	<b>2.15</b>	<b>1.51</b>

**Table C-8.** August frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	August Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	6.21	5.77	4.76	4.13	3.90	3.97	3.68	3.12	2.63	2.40
1988	6.05	5.14	3.81	2.88	2.58	5.06	4.31	3.52	3.04	2.47
1989	8.01	7.89	7.08	6.57	5.48	4.69	4.36	3.96	3.73	3.18
1990	8.62	6.92	5.65	4.63	4.50	5.07	4.52	4.11	3.76	3.62
1991	8.44	7.43	6.38	4.47	3.88	4.75	4.67	4.26	3.61	3.20
1992	6.02	5.25	4.61	3.73	3.59	4.55	4.36	3.99	3.41	3.28
1993	7.28	7.08	6.19	5.38	4.91	4.62	4.39	4.10	3.79	3.72
1994	5.41	4.60	2.88	2.00	1.91	5.13	3.68	2.75	1.90	1.78
1995	9.31	8.73	5.76	4.52	3.70	5.30	5.19	4.24	3.26	3.13
1996	11.92	10.40	8.67	7.73	6.49	4.80	4.75	4.42	3.94	3.16
1997	8.69	8.35	7.33	4.69	3.94	4.44	4.39	3.67	2.56	2.10
1998	6.41	6.16	4.81	3.72	3.08	3.91	3.72	3.37	2.93	2.73
1999	9.32	8.76	7.45	6.53	6.29	4.73	4.64	4.31	4.06	3.42
2000	7.62	6.39	4.70	3.33	3.05	4.89	4.57	3.82	3.12	2.65
2001	5.23	4.50	3.65	3.15	2.60	4.16	3.69	2.99	2.59	2.17
2002	7.27	6.82	5.97	4.53	4.32	4.73	4.05	3.75	3.50	3.30
2003	5.54	4.65	3.90	3.17	2.61	3.80	3.73	3.15	2.48	2.24
2004	7.57	6.93	5.82	5.30	4.44	4.27	4.04	3.30	2.94	2.59
2005	6.84	6.45	5.79	4.83	4.53	4.20	4.02	3.64	3.10	2.92
<b>1987 to 2005</b>	<b>8.44</b>	<b>7.33</b>	<b>5.48</b>	<b>3.88</b>	<b>3.23</b>	<b>4.73</b>	<b>4.41</b>	<b>3.76</b>	<b>3.01</b>	<b>2.59</b>

**Table C-9.** September frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	September Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	8.01	7.26	6.10	5.02	4.57	4.55	4.17	3.49	1.98	1.62
1988	10.15	8.22	5.89	4.82	3.77	4.90	4.19	3.64	2.29	1.58
1989	17.37	15.61	12.35	9.13	8.52	4.72	4.37	2.85	1.10	0.53
1990	9.82	9.47	8.30	6.93	6.31	4.95	4.67	4.35	3.97	3.74
1991	12.99	11.73	9.83	7.72	5.57	4.81	4.64	4.24	3.66	3.32
1992	9.54	8.46	7.10	6.38	5.52	4.99	4.81	4.39	3.99	3.66
1993	12.01	10.09	8.77	7.86	7.32	4.82	4.70	4.22	3.54	3.08
1994	7.12	5.46	4.33	3.31	2.56	4.44	3.81	3.19	2.75	2.55
1995	10.51	8.05	7.27	4.73	4.21	5.06	4.57	4.01	3.31	3.01
1996	9.08	8.38	7.53	6.32	4.78	4.74	4.59	4.35	3.83	3.62
1997	8.79	7.88	6.79	5.57	4.47	4.14	3.92	3.54	2.46	2.31
1998	8.44	7.42	6.22	4.22	3.53	3.90	3.83	3.50	3.14	3.01
1999	11.16	9.23	5.77	3.64	3.17	4.70	4.00	2.98	1.88	1.07
2000	8.43	7.64	6.25	3.89	3.33	4.19	3.90	3.21	2.91	2.68
2001	9.48	7.09	4.42	3.53	2.96	4.28	3.70	2.94	1.81	1.12
2002	6.24	5.22	4.52	3.96	3.69	4.18	3.95	3.48	3.07	2.72
2003	8.05	7.14	4.63	4.01	3.19	3.52	3.33	2.67	1.14	0.58
2004	15.44	15.02	10.21	6.19	5.55	4.33	3.98	3.46	1.59	1.44
2005	6.21	5.53	4.60	3.22	2.85	4.06	3.42	2.97	2.35	1.89
<b>1987 to 2005</b>	<b>11.01</b>	<b>9.13</b>	<b>6.63</b>	<b>4.39</b>	<b>3.67</b>	<b>4.71</b>	<b>4.39</b>	<b>3.58</b>	<b>2.71</b>	<b>1.83</b>

**Table C-10.** October frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	October Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.94	7.50	6.01	4.59	4.48	3.91	3.61	2.92	2.18	1.77
1988	13.82	11.71	9.18	7.50	5.16	5.09	4.48	3.72	3.01	2.64
1989	15.10	14.01	12.83	11.03	10.54	4.58	4.14	3.85	3.52	3.27
1990	20.72	19.79	17.72	14.79	14.29	3.90	3.86	3.34	3.11	2.89
1991	19.24	19.06	16.31	13.83	11.81	4.23	3.86	3.61	3.21	3.15
1992	17.14	15.38	12.24	11.10	10.61	4.32	3.88	3.24	2.93	2.75
1993	17.82	15.49	14.85	13.00	12.38	3.96	3.84	3.29	2.84	2.35
1994	12.25	11.64	10.72	8.95	8.25	4.80	4.76	4.44	4.06	3.65
1995	13.89	13.29	11.28	8.21	7.11	4.35	4.02	3.23	1.96	1.70
1996	14.07	10.51	8.09	6.41	6.00	4.77	4.35	3.64	2.84	2.80
1997	13.96	12.99	11.28	9.05	8.35	4.29	3.96	3.54	2.61	2.12
1998	8.52	8.15	6.92	6.16	5.89	3.91	3.79	3.56	3.14	2.93
1999	12.74	11.14	8.98	7.70	6.76	4.24	3.89	3.39	3.03	1.93
2000	12.40	11.50	8.71	7.66	7.15	4.17	3.93	3.40	2.17	1.93
2001	10.97	8.57	7.10	5.18	4.97	3.82	3.72	3.49	3.21	2.24
2002	7.66	7.29	6.03	5.02	4.82	4.29	4.05	3.80	3.44	2.92
2003	9.47	8.16	6.65	4.97	4.27	3.76	3.38	2.97	2.39	2.02
2004	15.92	14.59	13.14	10.89	10.20	3.01	2.80	1.86	1.53	1.40
2005	11.80	9.74	7.25	5.91	5.30	3.49	3.05	2.69	1.84	1.23
<b>1987 to 2005</b>	<b>16.08</b>	<b>13.97</b>	<b>10.04</b>	<b>6.74</b>	<b>5.74</b>	<b>4.38</b>	<b>3.96</b>	<b>3.44</b>	<b>2.67</b>	<b>2.03</b>

**Table C-11.** November frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	November Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	6.48	5.77	4.59	3.56	3.22	4.21	3.95	3.08	2.39	1.69
1988	12.95	12.35	10.77	8.31	7.28	4.45	4.20	3.70	2.93	2.52
1989	15.40	14.95	13.76	9.61	7.95	4.01	3.83	3.62	2.73	2.42
1990	18.63	17.96	15.81	14.38	13.50	3.62	3.56	3.09	2.47	2.01
1991	14.69	13.98	11.44	8.00	5.73	4.56	4.21	3.56	2.99	2.92
1992	17.05	15.96	9.90	7.52	6.61	5.10	4.82	4.11	3.60	3.15
1993	13.58	12.84	9.63	7.72	7.38	4.61	4.47	4.17	3.73	3.44
1994	17.42	15.36	11.12	8.11	7.71	4.61	4.58	4.01	3.62	3.30
1995	12.51	10.11	6.57	5.58	4.48	2.93	2.65	2.07	1.38	1.10
1996	11.73	10.82	9.25	7.12	6.78	6.12	4.87	4.10	3.77	3.41
1997	12.51	11.98	9.98	7.54	7.19	4.16	4.06	3.61	2.90	2.23
1998	6.81	5.82	4.52	3.35	3.27	3.05	2.94	2.58	2.11	1.82
1999	11.75	10.90	9.10	5.33	5.10	4.30	4.04	2.75	1.46	1.01
2000	13.20	11.85	5.70	3.82	3.48	3.91	3.63	2.92	2.22	1.80
2001	9.94	8.56	7.56	5.10	3.96	4.50	4.29	3.90	3.48	3.22
2002	8.22	7.25	5.55	4.91	4.66	4.33	3.93	3.65	3.26	3.09
2003	9.61	8.35	4.73	1.95	1.37	3.75	3.12	1.55	1.04	0.73
2004	11.12	10.55	8.38	6.28	5.89	4.03	3.73	2.68	2.09	1.66
2005	11.33	9.46	6.74	4.42	3.08	3.17	2.40	1.30	0.80	0.57
<b>1987 to 2005</b>	<b>14.57</b>	<b>12.53</b>	<b>8.42</b>	<b>5.26</b>	<b>3.95</b>	<b>4.43</b>	<b>4.12</b>	<b>3.39</b>	<b>2.23</b>	<b>1.51</b>

**Table C-12.** December frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	December Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.43	6.97	5.40	4.17	3.98	4.75	4.25	3.76	2.82	2.57
1988	8.60	8.26	6.72	5.36	4.27	5.11	4.62	4.12	3.35	2.97
1989	19.23	17.96	13.01	10.64	10.12	4.60	4.28	3.87	3.16	2.35
1990	14.24	13.53	12.19	9.11	6.78	4.71	4.57	4.07	3.76	3.59
1991	9.41	8.79	6.08	1.92	1.37	4.39	4.03	3.67	1.85	0.87
1992	8.80	8.07	5.78	4.62	4.29	4.52	4.38	3.93	3.51	3.37
1993	12.25	11.72	9.62	7.72	6.94	4.62	4.55	4.24	3.94	3.22
1994	8.84	8.09	5.76	4.46	4.08	4.83	4.60	3.98	3.41	2.82
1995	12.21	9.11	6.68	4.50	3.59	2.86	2.20	1.83	1.29	1.17
1996	9.00	7.94	6.74	5.52	3.88	4.47	4.30	3.40	2.95	2.09
1997	10.55	10.20	8.77	7.59	7.07	3.89	3.85	3.65	3.35	3.23
1998	7.18	6.75	4.99	4.33	3.88	4.24	4.02	3.13	2.69	2.48
1999	12.96	12.53	10.65	9.01	8.37	3.99	3.63	3.15	2.71	2.39
2000	8.06	7.66	5.77	4.93	4.89	4.67	4.28	3.54	3.18	2.88
2001	7.54	6.79	4.37	3.63	3.25	3.71	3.58	3.19	2.68	2.38
2002	9.54	9.36	7.36	5.99	4.78	4.46	4.03	3.54	3.11	2.64
2003	13.53	11.51	8.90	6.07	5.62	4.02	3.28	2.93	1.57	0.95
2004	14.68	13.23	11.39	8.76	7.34	3.88	3.63	1.94	1.15	1.08
2005	11.28	9.66	7.51	5.89	5.17	3.90	3.59	2.75	2.04	1.20
<b>1987 to 2005</b>	<b>12.73</b>	<b>10.90</b>	<b>7.36</b>	<b>4.98</b>	<b>4.18</b>	<b>4.53</b>	<b>4.24</b>	<b>3.55</b>	<b>2.62</b>	<b>1.87</b>

**Table C-13.** Annual frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	Annual Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.98	6.83	5.58	4.19	3.59	4.26	3.93	3.00	2.00	1.28
1988	12.14	10.16	6.47	4.11	3.47	4.76	4.29	3.46	2.56	2.19
1989	14.90	13.18	9.42	5.61	3.03	4.69	4.33	3.65	2.13	1.38
1990	18.02	15.31	10.51	5.17	2.56	4.65	4.36	3.61	2.04	1.15
1991	16.29	14.36	9.46	3.84	1.58	4.51	4.21	3.29	1.40	0.79
1992	12.43	9.46	5.99	4.09	3.27	4.80	4.45	3.74	2.86	2.27
1993	13.52	11.80	8.55	5.75	4.64	4.60	4.33	3.83	2.99	2.32
1994	13.09	11.06	7.48	4.45	3.46	4.77	4.53	3.71	2.90	2.39
1995	13.61	11.31	7.35	4.50	3.40	4.58	4.17	2.84	1.72	1.28
1996	10.71	9.12	5.94	2.04	1.15	4.59	4.25	2.74	0.68	0.42
1997	10.60	8.94	5.84	2.55	1.55	3.98	3.65	2.42	0.87	0.44
1998	8.50	7.58	5.93	3.95	2.96	4.06	3.81	3.14	2.07	1.47
1999	11.12	9.44	6.77	4.02	1.97	4.25	3.88	3.06	1.45	0.84
2000	12.44	10.69	7.86	4.93	3.79	4.22	3.90	3.07	2.15	1.53
2001	12.10	9.48	5.18	3.65	2.97	4.17	3.87	3.35	2.64	2.16
2002	11.23	9.39	6.55	4.32	2.36	4.23	3.93	3.29	2.12	1.27
2003	12.05	10.21	6.98	4.33	3.01	4.04	3.59	2.71	1.56	1.12
2004	14.55	12.54	9.34	6.26	5.15	4.04	3.62	2.65	1.81	1.39
2005	12.82	11.02	7.76	5.30	4.17	3.97	3.58	2.66	1.65	1.17
<b>1987 to 2005</b>	<b>13.09</b>	<b>10.77</b>	<b>7.00</b>	<b>4.27</b>	<b>2.93</b>	<b>4.46</b>	<b>4.08</b>	<b>3.21</b>	<b>1.95</b>	<b>1.19</b>

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## **Appendix D**

# **Monthly and Annual Frequency of Exceedance of Daily Maximum Ramping Rates in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005**

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**Table D-1.** January frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	January Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	9.1	8.8	7.7	6.6	5.9	7.2	6.6	4.9	4.1	3.7
1988	9.7	8.8	7.4	5.2	4.8	6.2	5.8	4.7	3.7	3.6
1989	20.9	18.2	14.9	9.4	8.0	9.4	9.0	7.2	5.4	5.0
1990	28.0	23.5	21.5	15.5	13.8	6.6	6.0	5.0	4.4	4.2
1991	29.0	25.8	20.2	14.6	13.1	6.6	6.0	5.3	4.7	4.3
1992	13.1	12.4	8.6	4.8	3.0	9.0	6.1	4.9	4.0	2.2
1993	16.9	16.6	14.5	11.6	10.3	6.4	6.0	5.3	4.2	3.8
1994	16.7	14.5	11.8	9.7	8.8	6.1	5.8	5.2	4.4	4.2
1995	12.8	12.0	9.8	6.4	5.5	8.0	7.0	5.5	4.2	3.7
1996	19.1	17.0	13.7	9.1	1.8	6.6	4.1	3.1	2.2	1.9
1997	13.8	12.2	9.4	6.2	5.2	7.7	6.4	4.2	2.4	1.4
1998	12.6	11.9	9.2	7.8	7.4	6.7	6.4	5.2	4.6	4.3
1999	12.1	11.5	8.6	7.4	6.7	7.0	5.5	4.6	3.7	3.5
2000	19.7	17.0	15.8	13.4	11.5	5.6	5.0	4.1	3.0	2.5
2001	14.9	13.2	10.3	7.3	6.7	6.7	6.5	5.4	4.0	3.2
2002	15.2	14.2	9.7	6.7	4.2	5.2	4.9	4.0	3.4	2.8
2003	18.4	15.2	11.9	9.1	6.8	8.4	7.9	6.8	4.3	3.8
2004	15.1	12.0	7.1	3.8	3.0	5.6	4.9	3.5	2.8	2.2
2005	15.6	14.3	11.2	8.6	6.1	5.2	4.4	3.2	2.0	1.8
<b>1987 to 2005</b>	<b>19.1</b>	<b>15.6</b>	<b>10.8</b>	<b>7.4</b>	<b>6.0</b>	<b>7.6</b>	<b>6.2</b>	<b>4.8</b>	<b>3.5</b>	<b>2.8</b>

**Table D-2.** February frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	February Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	10.2	8.9	8.0	6.8	5.5	6.7	6.4	5.2	3.5	3.0
1988	7.9	7.0	5.5	4.2	3.8	6.8	6.3	5.0	3.7	2.5
1989	11.5	9.1	5.9	3.6	3.6	10.0	7.7	5.1	2.9	2.6
1990	25.3	22.2	16.4	13.7	12.2	6.6	6.5	5.2	4.5	4.2
1991	30.0	26.0	21.0	17.9	16.5	7.0	5.6	4.8	4.0	3.7
1992	9.3	8.9	7.1	5.1	4.3	5.9	5.4	4.8	3.8	2.8
1993	14.4	12.5	10.6	7.9	7.7	8.0	7.7	6.9	5.2	4.7
1994	17.5	16.5	13.5	9.6	8.5	8.4	7.6	5.9	4.9	4.5
1995	14.2	10.4	7.9	5.8	5.0	9.8	8.1	5.3	3.0	2.0
1996	16.3	15.3	7.0	3.6	1.3	8.3	5.9	3.1	0.8	0.6
1997	14.5	13.0	10.3	6.9	6.0	4.9	4.5	3.7	2.6	2.1
1998	12.0	11.3	8.9	7.2	6.1	7.7	7.0	6.1	4.9	4.1
1999	13.4	10.8	8.9	6.4	5.9	5.4	5.1	4.2	3.4	3.2
2000	16.5	13.0	11.5	8.5	7.7	6.1	5.0	4.2	3.3	2.6
2001	11.5	9.2	7.6	5.6	4.8	7.4	6.9	6.1	4.8	4.3
2002	13.5	12.5	10.1	7.8	7.0	5.7	5.5	4.0	3.1	2.5
2003	17.8	16.3	15.2	12.4	9.8	6.5	6.0	5.1	3.6	3.3
2004	11.0	10.1	7.4	5.4	4.8	5.7	5.3	3.8	2.5	1.3
2005	16.7	16.2	14.7	11.3	9.9	5.4	4.7	3.5	2.4	2.2
<b>1987 to 2005</b>	<b>17.3</b>	<b>15.0</b>	<b>9.4</b>	<b>6.4</b>	<b>4.8</b>	<b>7.4</b>	<b>6.4</b>	<b>4.8</b>	<b>3.2</b>	<b>2.5</b>

**Table D-3.** March frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	March Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	9.4	8.5	7.0	4.0	3.1	6.2	5.5	4.1	2.4	1.4
1988	16.2	14.9	9.0	7.0	6.8	10.1	9.4	6.1	4.7	4.4
1989	19.1	17.8	15.0	11.9	11.3	9.8	9.0	6.5	5.3	4.6
1990	19.7	15.5	13.4	12.6	11.4	7.8	6.6	5.6	4.4	3.5
1991	18.4	14.3	11.4	10.1	8.4	4.2	3.8	2.8	1.7	1.7
1992	10.1	9.7	8.3	6.5	5.6	7.6	6.5	4.9	3.8	3.5
1993	13.6	12.0	9.2	7.0	6.2	8.4	7.6	5.3	4.4	4.3
1994	14.0	12.1	10.0	8.4	7.7	7.9	6.2	4.9	4.0	3.7
1995	14.5	12.5	10.7	9.5	8.4	12.2	5.3	3.4	2.5	2.0
1996	9.2	8.2	5.3	2.5	0.1	3.0	2.0	1.2	0.8	0.7
1997	12.6	10.9	8.3	5.5	3.5	5.5	4.1	2.5	1.1	0.8
1998	13.9	11.6	9.0	7.3	6.8	5.6	5.3	4.6	3.7	3.2
1999	12.1	11.4	9.6	7.0	4.8	5.2	4.8	3.8	2.2	1.2
2000	19.2	17.8	14.5	11.4	9.1	5.9	5.8	4.3	3.6	2.9
2001	9.4	8.3	5.9	4.4	4.1	5.9	5.5	4.4	3.4	3.2
2002	16.3	14.2	11.2	8.2	7.7	5.9	4.9	4.2	3.0	2.2
2003	15.4	14.0	11.6	8.8	6.4	4.6	4.3	3.4	1.8	1.3
2004	17.4	14.5	10.7	6.8	6.0	5.0	4.8	3.2	2.0	1.6
2005	15.6	13.4	10.8	7.3	5.5	6.2	5.5	4.3	3.1	1.8
<b>1987 to 2005</b>	<b>15.7</b>	<b>13.7</b>	<b>10.1</b>	<b>6.7</b>	<b>5.2</b>	<b>7.0</b>	<b>5.9</b>	<b>4.3</b>	<b>2.6</b>	<b>1.7</b>

**Table D-4.** April frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	April Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	10.6	9.1	7.9	6.7	5.2	4.9	4.3	3.1	1.4	1.2
1988	24.5	23.6	18.5	15.4	11.5	5.8	5.3	4.1	3.1	2.6
1989	19.9	18.6	14.6	12.4	11.3	12.8	7.8	4.9	3.7	2.4
1990	20.0	19.4	15.6	5.9	4.5	10.3	5.1	3.6	1.3	0.8
1991	22.3	19.1	17.0	12.1	8.5	5.4	4.3	3.1	2.2	1.3
1992	18.5	18.2	14.0	10.0	8.8	6.8	6.5	5.2	4.8	3.5
1993	17.7	15.6	12.8	10.3	9.8	5.9	5.6	4.9	4.3	4.0
1994	15.5	14.9	12.5	10.2	9.2	6.6	6.0	5.0	3.1	2.5
1995	26.3	24.0	19.4	14.2	10.6	7.4	6.1	5.0	3.7	2.9
1996	7.7	6.1	0.1	0.1	0.0	4.5	1.8	1.1	0.5	0.4
1997	12.2	10.3	6.4	4.5	1.9	4.8	3.6	1.8	0.8	0.8
1998	12.6	12.4	10.4	7.3	7.0	4.8	4.1	3.4	2.4	2.0
1999	11.5	9.7	7.6	6.0	5.1	4.3	3.6	2.5	1.5	0.8
2000	19.4	14.4	12.4	6.1	4.1	4.7	4.4	3.1	1.3	0.8
2001	12.6	10.3	7.8	5.9	5.5	6.6	5.8	4.9	4.0	3.6
2002	19.1	18.5	11.7	8.2	7.0	6.6	4.7	3.5	2.4	1.9
2003	16.8	15.6	11.2	8.5	6.8	4.0	2.6	1.8	1.1	0.8
2004	17.8	16.6	12.6	8.8	6.4	4.9	4.4	3.3	2.6	1.8
2005	18.4	15.9	12.6	10.0	9.3	4.9	4.7	3.5	2.6	2.4
<b>1987 to 2005</b>	<b>19.3</b>	<b>16.8</b>	<b>11.6</b>	<b>7.1</b>	<b>5.2</b>	<b>6.2</b>	<b>5.2</b>	<b>3.6</b>	<b>1.9</b>	<b>1.2</b>

**Table D-5.** May frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	May Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.4	6.7	5.5	4.8	4.2	2.2	2.0	1.1	0.7	0.4
1988	26.3	20.2	10.8	9.4	8.3	4.0	3.6	2.8	1.8	1.6
1989	16.1	13.8	10.3	2.5	1.7	8.6	5.2	2.5	0.8	0.4
1990	15.8	15.0	10.7	6.6	3.1	4.2	3.1	2.0	1.4	1.1
1991	7.8	7.2	4.8	3.6	2.3	2.3	1.8	1.3	0.7	0.7
1992	10.2	8.4	6.8	5.3	4.0	5.9	4.2	2.8	1.9	1.4
1993	16.2	13.7	10.7	5.2	3.1	5.3	5.0	2.9	0.8	0.4
1994	20.6	18.0	14.4	10.4	9.8	5.9	5.2	3.8	2.8	2.0
1995	22.6	20.0	14.8	11.0	9.2	5.8	4.2	3.0	1.7	1.6
1996	14.0	12.5	8.4	3.5	1.9	3.1	2.2	1.9	1.2	0.8
1997	11.0	9.0	5.3	3.2	2.4	2.5	2.2	1.6	1.3	1.2
1998	11.2	10.0	7.7	5.0	4.8	5.8	3.2	2.4	1.2	0.8
1999	14.0	13.4	8.4	4.8	3.5	5.4	3.4	1.7	0.8	0.6
2000	17.0	14.4	7.6	4.4	1.2	6.2	3.5	2.3	0.8	0.7
2001	19.3	18.4	15.1	12.5	11.6	5.0	4.8	3.7	2.4	1.2
2002	21.6	17.4	8.4	4.3	2.5	4.2	3.7	3.0	1.6	0.7
2003	20.3	17.6	14.0	11.4	5.4	3.2	3.0	2.4	1.7	1.2
2004	21.6	18.5	15.2	9.2	8.5	4.9	4.1	3.0	1.6	0.8
2005	20.4	18.2	14.3	7.3	4.7	3.8	3.7	2.9	1.7	0.8
<b>1987 to 2005</b>	<b>18.7</b>	<b>15.6</b>	<b>10.1</b>	<b>5.2</b>	<b>3.5</b>	<b>5.0</b>	<b>3.8</b>	<b>2.4</b>	<b>1.3</b>	<b>0.7</b>

**Table D-6.** June frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	June Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.9	7.4	6.3	4.8	4.4	4.9	4.7	3.7	2.8	2.6
1988	19.5	17.2	12.4	9.5	7.7	7.0	5.4	4.1	3.0	2.5
1989	14.3	11.8	7.6	2.7	1.0	4.4	3.8	3.0	1.0	0.4
1990	7.4	6.1	4.7	2.2	1.3	6.2	4.4	1.3	0.6	0.5
1991	9.0	6.5	4.1	1.9	1.0	5.6	4.0	1.7	0.7	0.6
1992	10.5	9.7	7.7	6.1	5.6	8.4	6.5	4.9	4.2	3.4
1993	16.3	15.4	13.1	10.2	8.8	6.0	5.0	4.1	3.4	2.8
1994	18.8	17.3	14.4	10.2	7.8	5.6	5.3	4.8	3.8	3.7
1995	19.5	17.9	14.6	5.8	4.3	6.3	4.9	1.8	0.4	0.2
1996	12.7	11.5	8.9	6.7	4.8	3.0	2.5	1.8	0.8	0.5
1997	13.3	9.4	7.1	4.7	3.8	5.2	3.0	2.2	1.6	1.4
1998	8.0	7.4	5.9	4.0	2.5	4.9	3.3	1.5	1.0	0.6
1999	5.6	3.8	2.8	1.6	1.3	3.3	2.6	1.3	0.4	0.2
2000	17.7	14.3	12.2	9.2	5.2	9.1	5.8	3.0	2.5	1.9
2001	15.9	14.5	13.0	11.8	11.4	4.7	4.4	4.1	3.7	2.9
2002	6.5	5.5	3.4	2.0	1.0	3.5	2.7	1.8	0.8	0.5
2003	13.6	12.9	10.6	4.2	1.8	7.7	4.5	3.0	1.7	0.7
2004	16.4	15.2	12.1	10.6	9.4	7.2	4.0	3.0	2.4	2.2
2005	12.8	11.2	8.8	4.9	3.4	4.6	3.6	2.0	1.0	0.7
<b>1987 to 2005</b>	<b>15.5</b>	<b>13.3</b>	<b>8.5</b>	<b>4.2</b>	<b>2.5</b>	<b>6.0</b>	<b>4.8</b>	<b>3.0</b>	<b>1.3</b>	<b>0.6</b>

**Table D-7.** July frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	July Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.6	6.6	5.9	5.0	5.0	5.3	4.9	4.4	3.6	3.0
1988	10.0	8.9	7.4	5.9	5.0	5.8	5.6	4.7	3.8	3.4
1989	14.6	14.2	11.9	10.8	10.1	8.8	5.9	5.2	4.6	3.2
1990	17.0	15.6	13.1	7.4	5.8	11.3	7.8	5.6	4.2	1.4
1991	15.0	14.0	11.5	6.6	5.5	8.2	5.6	4.2	3.0	1.0
1992	13.8	10.9	9.2	7.6	7.2	6.7	6.5	5.6	4.9	4.6
1993	16.2	13.6	10.9	8.4	6.5	6.0	5.2	3.5	2.5	2.2
1994	12.8	11.5	9.7	4.7	2.5	7.6	6.5	4.7	3.8	2.4
1995	17.2	16.0	12.1	8.6	7.6	8.4	6.2	4.8	2.5	1.8
1996	13.4	12.4	9.2	6.4	4.8	6.1	5.3	3.6	2.3	1.2
1997	16.1	11.6	7.7	6.0	4.7	3.6	3.4	2.2	1.4	1.3
1998	12.1	11.3	9.2	7.1	6.8	5.0	4.4	3.6	2.4	1.9
1999	14.5	13.0	9.4	4.6	3.6	5.5	4.2	3.4	1.9	1.8
2000	13.2	12.1	10.3	8.8	6.8	5.4	5.3	4.3	3.5	3.1
2001	14.5	11.9	7.3	5.6	5.3	6.2	5.6	4.7	3.8	3.7
2002	12.2	11.3	9.5	6.7	5.9	5.6	4.8	3.7	2.3	1.7
2003	13.8	12.7	11.2	9.5	7.3	6.4	6.1	5.2	3.6	3.1
2004	14.6	13.4	11.2	8.8	7.7	6.1	5.3	4.3	2.9	2.5
2005	14.2	12.0	10.7	8.8	8.3	6.5	5.6	4.4	3.6	2.9
<b>1987 to 2005</b>	<b>14.5</b>	<b>12.7</b>	<b>9.8</b>	<b>6.5</b>	<b>5.4</b>	<b>6.6</b>	<b>5.8</b>	<b>4.4</b>	<b>2.9</b>	<b>2.0</b>

**Table D-8.** August frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	August Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.8	6.7	5.8	5.0	4.8	5.5	5.2	4.2	3.6	3.4
1988	6.4	6.0	5.3	3.0	0.8	5.5	5.3	4.4	2.5	1.0
1989	9.7	9.6	8.0	7.2	6.8	5.4	5.2	4.2	3.5	3.4
1990	10.7	8.6	7.0	5.6	5.5	6.0	5.3	4.8	4.2	4.0
1991	10.6	10.0	8.0	6.0	4.1	6.4	5.5	4.6	3.8	3.5
1992	7.8	7.2	6.2	5.4	4.8	7.1	6.1	4.9	4.1	3.8
1993	11.8	11.3	8.3	7.0	6.7	6.4	5.9	4.9	4.6	4.6
1994	7.7	6.4	4.8	2.8	2.4	5.4	4.9	4.1	2.6	2.3
1995	18.8	13.8	10.4	6.7	4.8	8.6	6.2	5.3	4.2	3.2
1996	14.4	13.2	12.0	9.6	8.9	5.9	5.4	4.9	4.6	4.2
1997	11.8	11.2	8.5	5.5	5.0	6.0	5.5	4.1	3.1	2.4
1998	10.3	9.1	6.6	5.2	3.4	6.5	5.2	4.2	3.2	2.9
1999	15.5	14.2	11.6	9.4	8.5	7.3	6.7	6.1	4.8	4.0
2000	11.9	10.4	8.3	5.4	4.7	6.7	6.4	5.3	4.3	3.8
2001	6.0	5.6	4.9	4.0	2.8	4.9	4.6	3.6	3.0	2.4
2002	9.6	9.0	8.2	5.9	5.6	5.6	5.3	4.6	3.7	3.5
2003	9.0	8.6	6.8	5.3	4.2	6.1	5.5	4.7	3.8	3.4
2004	10.4	9.0	7.3	5.5	4.4	5.8	5.0	4.3	3.1	2.4
2005	12.7	11.8	8.9	6.6	5.9	6.7	6.0	4.9	4.2	3.8
<b>1987 to 2005</b>	<b>12.1</b>	<b>10.3</b>	<b>7.3</b>	<b>5.3</b>	<b>4.1</b>	<b>6.4</b>	<b>5.6</b>	<b>4.7</b>	<b>3.6</b>	<b>3.1</b>

**Table D-9.** September frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	September Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.8	7.4	6.6	5.4	4.8	5.5	5.2	4.3	2.5	2.0
1988	10.4	9.2	7.0	5.3	3.9	7.9	5.8	4.5	2.7	1.6
1989	19.3	17.7	13.0	10.5	7.8	16.7	6.0	4.8	1.6	0.8
1990	12.2	11.5	9.4	7.3	7.1	6.9	6.5	5.3	4.8	4.7
1991	14.4	12.4	10.1	9.2	8.0	7.2	5.5	4.8	4.2	3.2
1992	11.5	11.0	9.5	8.5	7.8	7.2	6.5	5.4	4.9	4.4
1993	15.6	13.5	10.5	9.5	8.4	6.0	5.4	4.8	3.7	3.5
1994	8.2	7.6	5.1	4.1	3.5	6.0	5.1	4.3	3.5	2.5
1995	11.9	11.4	9.4	7.2	6.7	6.0	5.8	4.8	4.2	4.0
1996	11.6	10.7	9.2	7.2	6.0	5.4	5.4	4.8	4.1	3.7
1997	11.0	10.4	8.2	7.1	6.4	4.9	4.2	3.6	3.0	2.3
1998	11.7	11.2	8.9	7.4	5.6	5.5	5.0	4.3	4.0	3.5
1999	13.9	10.2	6.6	3.4	2.8	5.1	4.7	3.2	1.9	1.3
2000	10.1	9.2	7.8	5.7	4.8	5.0	4.6	4.1	3.6	3.4
2001	9.2	7.3	5.1	3.7	3.0	5.1	4.3	3.5	1.8	1.3
2002	8.6	7.6	6.5	4.4	3.8	5.4	5.0	4.3	3.0	2.6
2003	10.7	8.9	6.4	4.2	3.2	4.4	4.2	3.0	1.3	0.6
2004	20.7	17.2	12.5	7.5	6.0	4.9	4.6	3.7	2.5	2.2
2005	8.4	7.5	6.2	4.3	3.2	5.8	5.2	3.8	2.8	2.4
<b>1987 to 2005</b>	<b>13.0</b>	<b>11.0</b>	<b>8.2</b>	<b>5.5</b>	<b>4.3</b>	<b>6.0</b>	<b>5.4</b>	<b>4.3</b>	<b>3.1</b>	<b>2.3</b>

**Table D-10.** October frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	October Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	8.6	8.4	6.7	5.5	5.3	6.0	5.4	4.0	2.9	2.4
1988	18.4	16.4	14.0	10.8	9.2	10.1	8.0	4.4	3.6	3.2
1989	17.9	16.8	14.6	13.2	12.1	5.3	5.2	4.4	4.0	3.7
1990	26.2	25.6	22.0	17.8	16.4	6.7	6.6	5.3	4.7	4.2
1991	23.8	22.9	19.2	16.0	14.4	8.8	5.4	4.6	4.1	3.8
1992	19.7	18.2	15.2	13.6	12.7	8.3	5.5	4.3	3.5	2.9
1993	22.9	19.9	17.8	14.8	12.5	5.0	4.8	4.2	3.5	3.5
1994	16.3	15.8	13.4	11.6	10.2	5.6	5.4	4.9	4.4	4.3
1995	17.8	15.5	13.9	12.1	10.2	4.9	4.4	3.4	2.3	1.9
1996	17.9	14.0	11.6	7.4	7.0	7.6	5.3	3.8	3.1	2.9
1997	18.1	16.2	13.8	10.9	10.0	5.6	5.2	4.0	3.2	2.9
1998	12.1	11.2	9.2	8.4	7.2	4.8	4.6	4.0	3.4	3.0
1999	15.2	13.2	11.3	9.8	9.0	6.5	4.9	4.1	3.4	3.4
2000	14.5	13.7	12.4	9.8	8.4	5.0	4.8	3.8	2.9	2.6
2001	14.0	12.0	8.9	7.3	6.8	4.4	4.1	3.7	3.2	3.1
2002	9.8	9.1	7.3	6.0	5.6	5.2	4.7	4.2	3.5	3.0
2003	13.8	13.0	9.5	7.3	6.1	5.5	4.4	3.7	2.8	2.4
2004	18.0	17.4	14.9	13.1	12.1	4.1	4.0	3.2	2.3	2.0
2005	16.0	14.4	8.4	6.4	4.9	4.2	3.5	2.6	1.6	1.4
<b>1987 to 2005</b>	<b>19.3</b>	<b>16.9</b>	<b>12.7</b>	<b>8.5</b>	<b>7.0</b>	<b>5.8</b>	<b>5.0</b>	<b>4.1</b>	<b>3.1</b>	<b>2.6</b>

**Table D-11.** November frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	November Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	7.8	7.2	5.9	4.6	4.2	5.5	4.9	3.7	2.5	2.3
1988	17.7	15.3	13.4	10.0	8.2	5.6	5.2	4.1	3.6	2.9
1989	20.2	18.4	15.6	11.1	10.3	5.2	5.0	4.3	3.0	2.5
1990	28.3	25.4	21.3	18.0	16.4	5.0	4.8	4.1	2.8	2.6
1991	18.0	16.4	12.9	8.3	6.9	5.4	4.7	4.1	3.4	3.1
1992	21.2	19.0	14.4	10.2	8.9	8.3	6.9	5.1	3.8	3.1
1993	18.5	16.3	13.9	10.2	9.5	6.6	6.2	5.5	4.6	4.0
1994	22.1	20.2	15.5	12.4	11.4	6.9	6.2	5.1	4.1	4.0
1995	17.6	16.2	12.0	9.2	8.2	5.4	3.9	2.7	1.9	1.6
1996	18.5	16.1	13.4	9.6	9.2	7.4	6.6	5.5	4.6	4.6
1997	15.2	14.7	12.4	9.1	7.3	5.1	4.8	4.1	3.2	2.6
1998	8.6	8.2	6.9	5.4	4.9	4.6	3.6	3.2	2.8	2.4
1999	14.9	13.7	11.4	7.3	6.2	4.8	4.3	3.2	1.4	1.1
2000	14.6	13.9	9.1	6.7	5.8	5.8	5.4	4.2	3.0	2.6
2001	11.2	10.2	9.2	6.8	5.8	5.8	5.4	4.4	3.6	3.0
2002	9.9	9.4	7.6	6.5	5.8	5.4	5.3	4.1	3.4	3.0
2003	13.7	10.7	7.1	3.7	3.4	5.7	4.3	2.7	1.4	1.1
2004	12.7	11.5	9.1	7.6	6.1	4.7	4.2	3.4	2.5	1.9
2005	14.6	13.3	7.5	4.9	3.4	3.7	3.6	2.1	1.1	0.8
<b>1987 to 2005</b>	<b>19.0</b>	<b>15.8</b>	<b>10.9</b>	<b>7.1</b>	<b>5.6</b>	<b>6.1</b>	<b>5.3</b>	<b>4.0</b>	<b>2.8</b>	<b>2.0</b>

**Table D-12.** December frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

Year	December Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	10.4	8.6	7.3	6.1	5.5	7.2	5.8	4.9	3.8	2.9
1988	16.3	13.1	10.7	8.9	7.9	8.9	6.8	6.0	4.8	4.3
1989	22.7	21.0	17.0	13.3	12.5	5.8	5.5	4.7	3.8	3.6
1990	27.0	24.0	18.6	15.1	12.2	13.9	9.7	5.3	4.6	4.2
1991	18.5	15.0	10.3	6.8	3.8	7.2	6.4	4.7	3.1	1.9
1992	15.7	14.6	12.0	9.1	6.4	8.0	6.8	6.1	5.3	4.1
1993	18.5	16.0	14.4	11.3	10.9	6.8	6.4	5.5	4.7	4.1
1994	18.6	16.7	11.5	7.8	6.8	7.8	7.2	6.0	4.4	4.1
1995	17.9	16.1	11.5	6.8	5.8	6.0	5.0	2.4	1.7	0.2
1996	16.0	14.6	11.4	8.3	7.2	8.3	6.6	5.2	3.7	3.6
1997	14.0	13.1	11.5	9.8	8.4	7.2	6.2	5.3	4.3	4.1
1998	11.5	9.6	8.3	6.4	6.0	5.9	5.5	4.2	3.6	3.0
1999	19.0	17.4	13.9	10.9	9.8	5.2	4.6	3.7	2.8	2.8
2000	13.4	12.6	9.0	6.6	6.0	6.2	5.8	5.2	3.6	3.6
2001	12.7	9.2	6.1	4.6	3.7	4.9	4.7	3.7	3.1	2.6
2002	15.5	14.5	12.6	10.3	9.8	6.7	5.9	4.9	3.8	3.6
2003	17.5	15.6	10.9	7.6	7.0	4.7	4.6	3.4	2.0	1.4
2004	18.8	17.0	12.7	10.0	8.0	4.8	3.8	2.8	1.7	1.6
2005	15.7	15.1	11.5	9.4	8.6	5.9	4.9	4.0	3.0	2.2
<b>1987 to 2005</b>	<b>18.6</b>	<b>15.5</b>	<b>11.6</b>	<b>7.7</b>	<b>6.4</b>	<b>7.0</b>	<b>6.1</b>	<b>4.7</b>	<b>3.4</b>	<b>2.6</b>

**Table D-13.** Annual frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Forebay and at USGS Primary Gage No. 12396500 below Box Canyon Dam, 1987 to 2005.

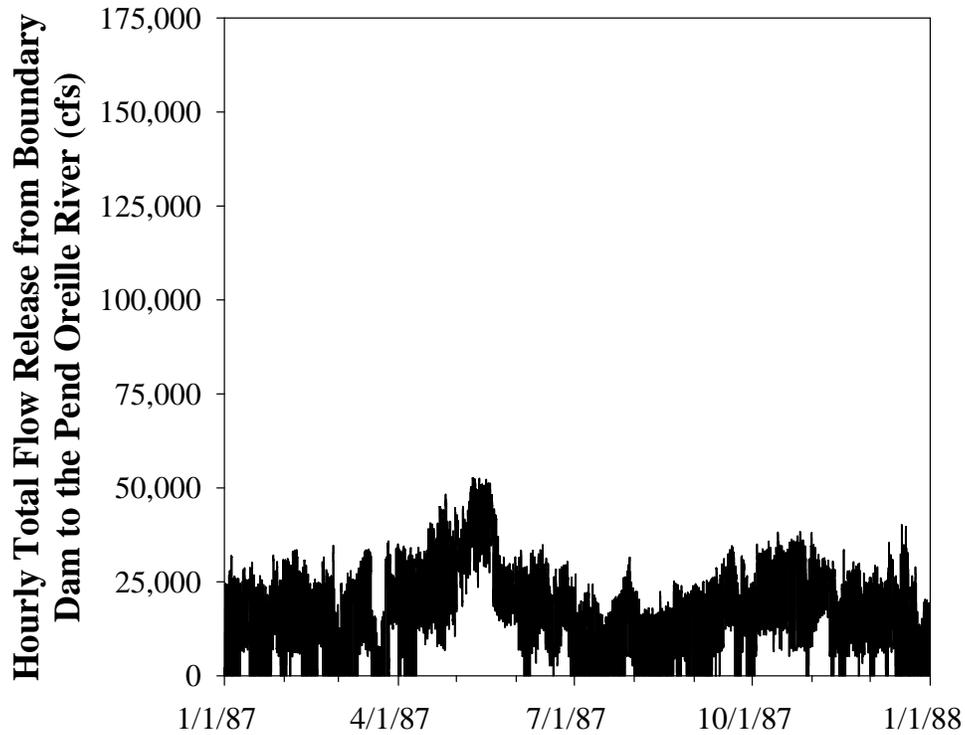
Year	Annual Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Forebay					USGS Primary Gage No. 12396500 below Box Canyon				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	9.0	8.2	6.7	5.2	4.6	6.2	5.4	4.1	2.6	1.7
1988	18.3	14.9	9.4	6.0	4.8	7.6	6.0	4.6	3.4	2.5
1989	19.3	16.9	12.5	7.8	5.4	8.7	6.2	4.7	3.1	2.1
1990	23.6	21.1	14.4	7.4	5.6	7.3	6.1	4.8	3.1	1.5
1991	22.1	18.8	12.0	6.5	4.1	6.6	5.4	4.2	2.2	1.3
1992	16.3	13.8	9.2	6.4	5.4	7.6	6.5	5.0	3.8	2.9
1993	17.6	15.7	12.0	9.0	7.4	7.0	6.0	4.9	3.7	2.9
1994	17.4	15.4	11.5	7.3	4.8	7.2	6.1	4.8	3.7	3.0
1995	19.7	16.0	11.8	8.0	6.0	7.4	5.9	4.1	2.2	1.7
1996	16.2	13.3	9.6	5.4	2.5	6.3	5.4	3.6	1.4	0.8
1997	14.2	12.5	9.1	5.8	4.6	6.0	4.8	3.5	1.8	1.3
1998	12.2	10.9	8.3	6.2	5.1	6.3	5.3	4.0	2.8	1.9
1999	14.9	12.8	9.4	6.0	3.5	6.2	5.0	3.6	1.8	1.0
2000	16.9	14.4	10.9	6.8	5.3	6.0	5.4	4.0	2.9	2.2
2001	14.6	12.5	8.0	5.2	4.2	6.2	5.4	4.2	3.4	2.8
2002	15.2	12.6	8.8	5.9	4.0	5.6	5.0	4.0	2.6	1.9
2003	16.4	14.3	10.3	6.5	4.7	6.4	5.4	3.6	1.9	1.2
2004	17.5	15.2	10.9	7.3	5.5	5.4	4.7	3.4	2.4	1.8
2005	16.2	14.5	10.3	6.7	4.9	5.8	5.0	3.5	2.2	1.4
<b>1987 to 2005</b>	<b>17.3</b>	<b>14.5</b>	<b>10.0</b>	<b>6.2</b>	<b>4.8</b>	<b>6.6</b>	<b>5.6</b>	<b>4.2</b>	<b>2.6</b>	<b>1.7</b>

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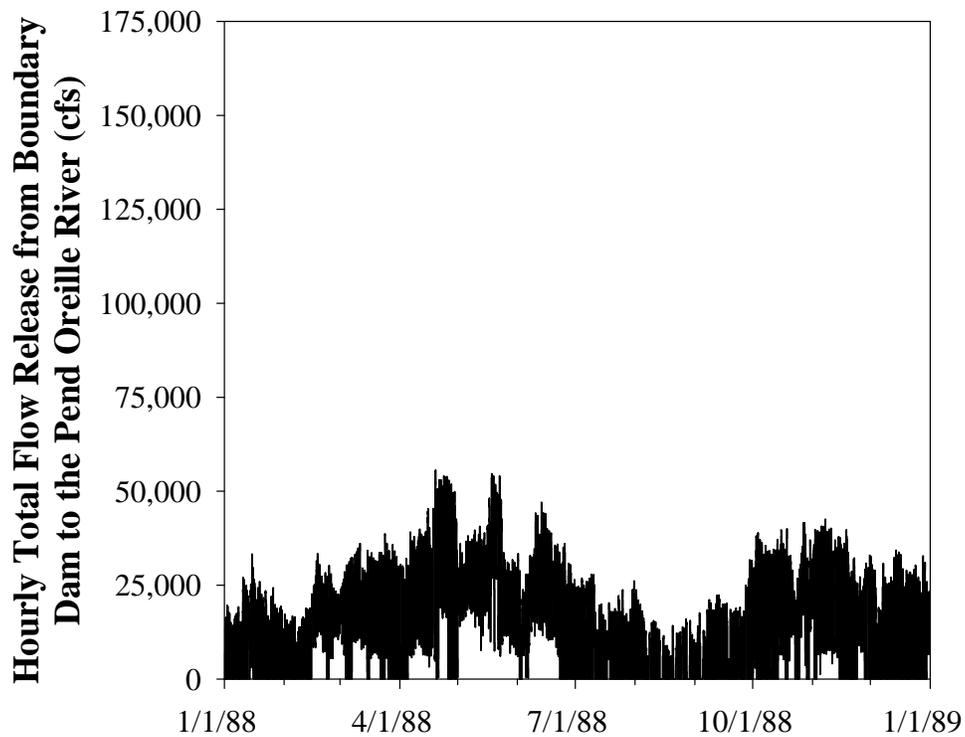
## **Appendix E**

### **Hourly Total Flow Release from Boundary Dam to the Pend Oreille River, 1987 through 2005**

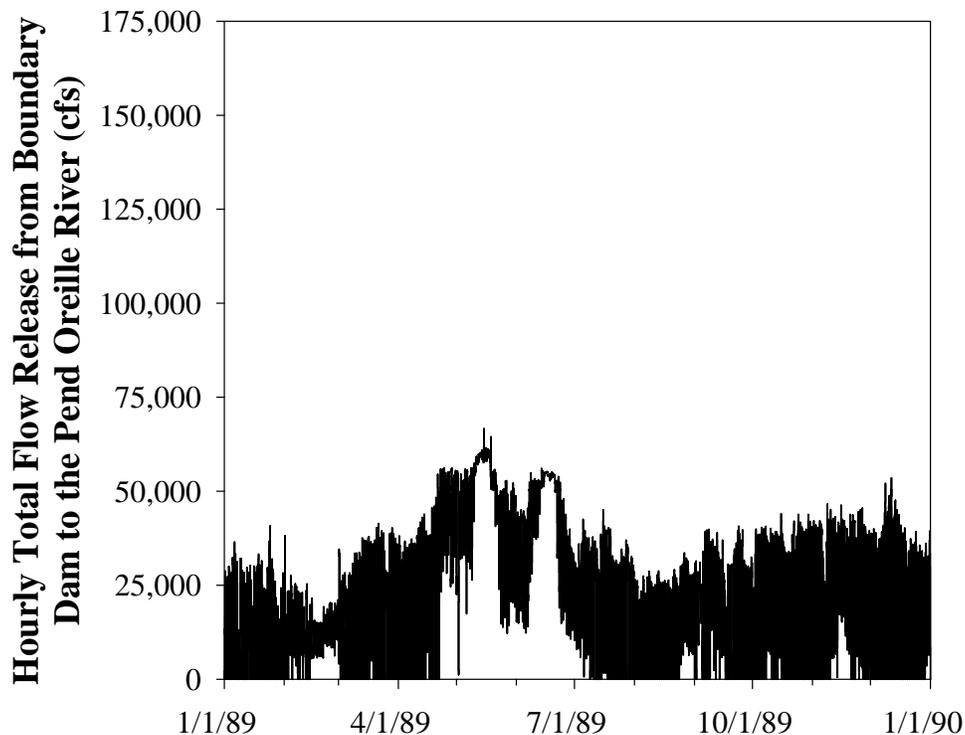
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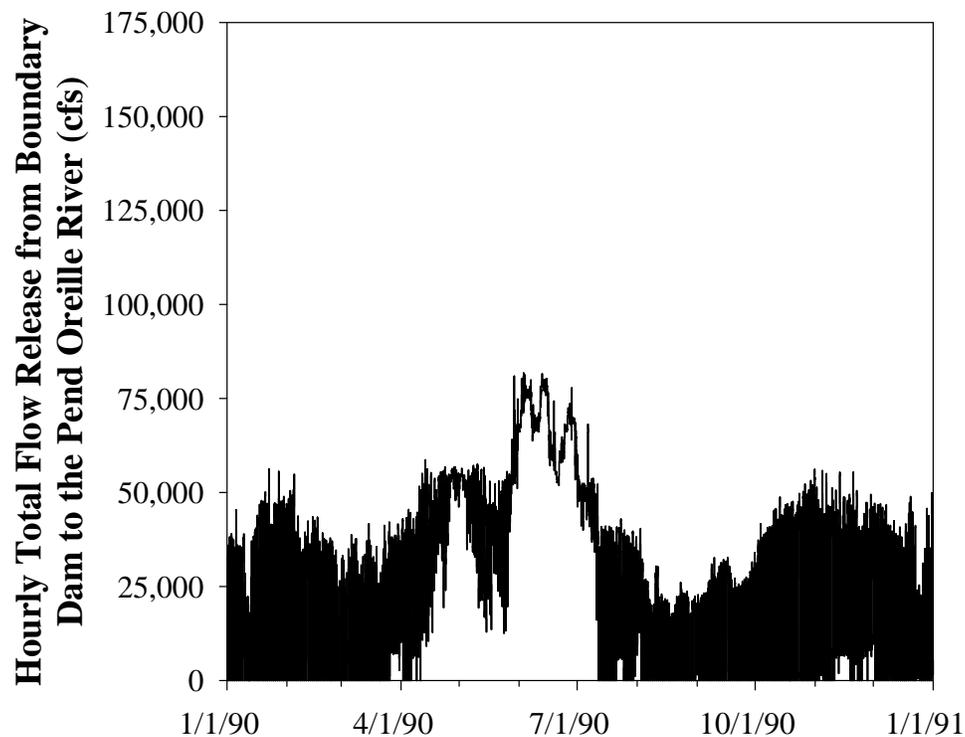
**Figure E-1.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1987.



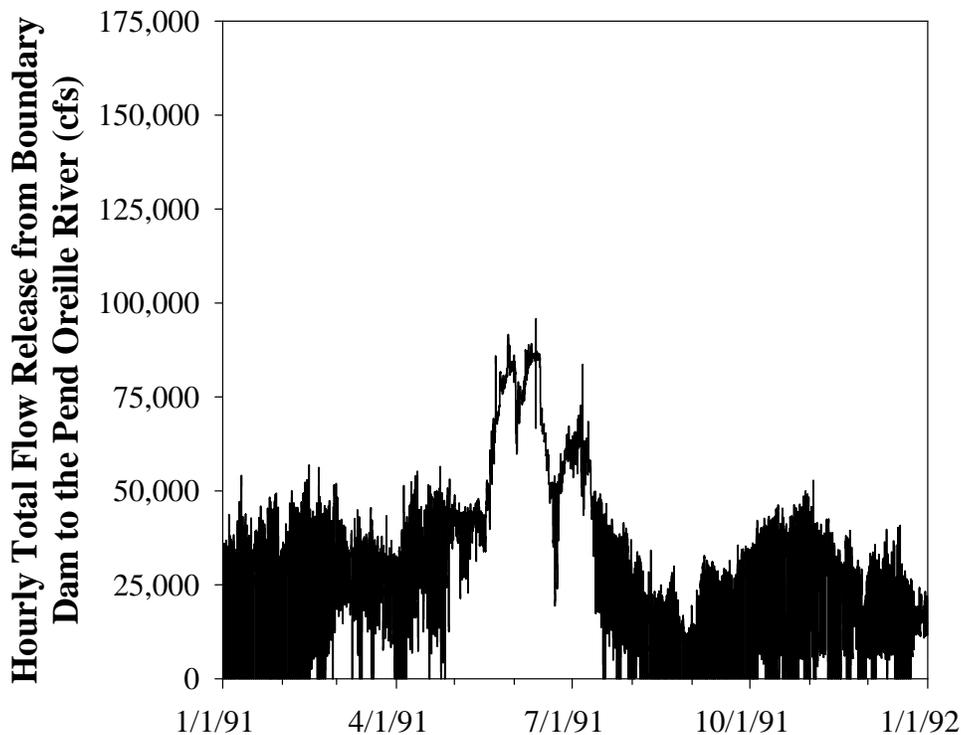
**Figure E-2.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1988.



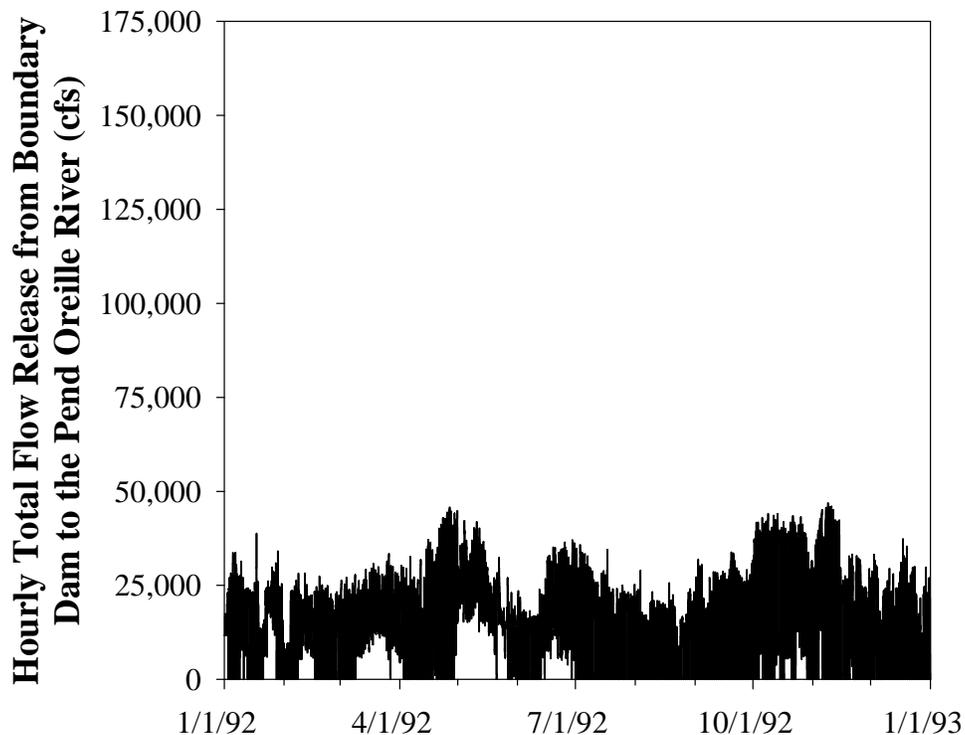
**Figure E-3.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1989.



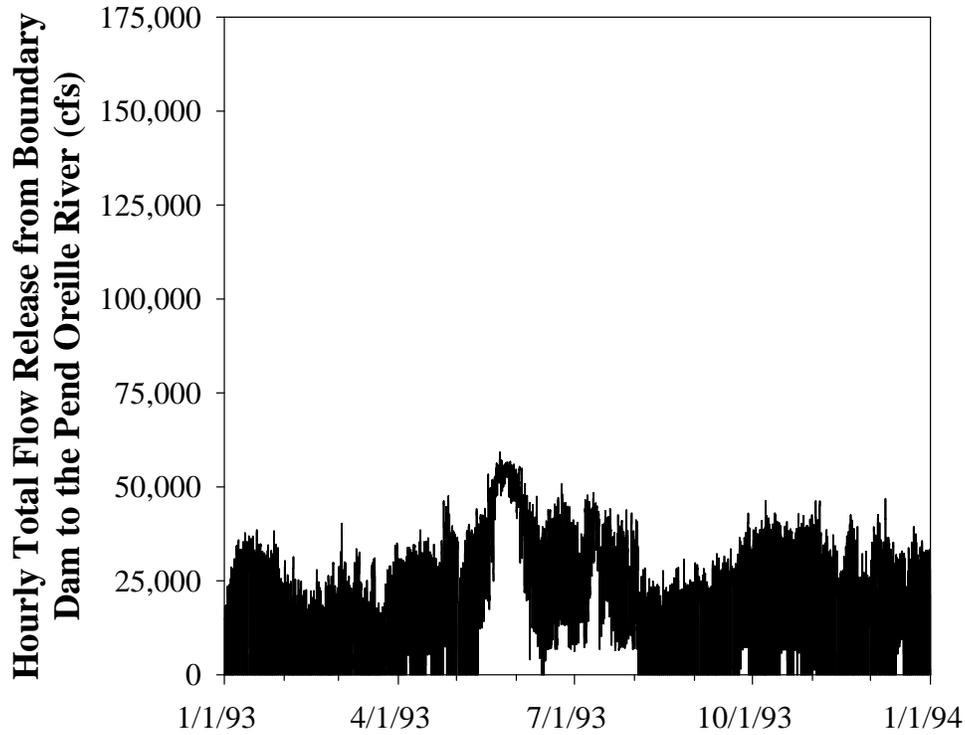
**Figure E-4.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1990.



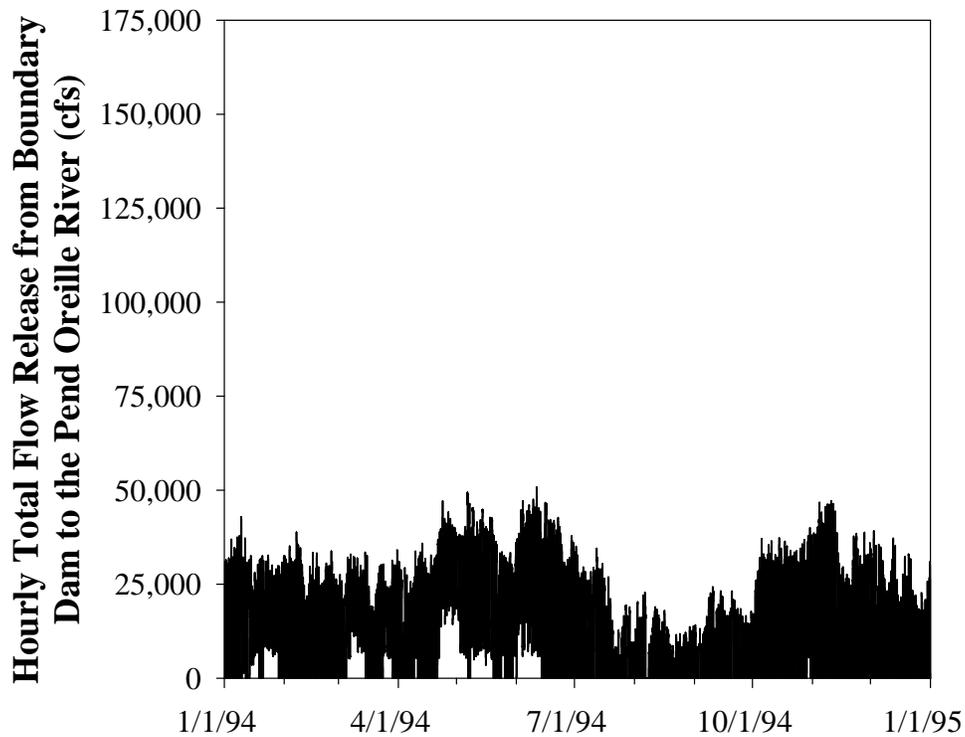
**Figure E-5.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1991.



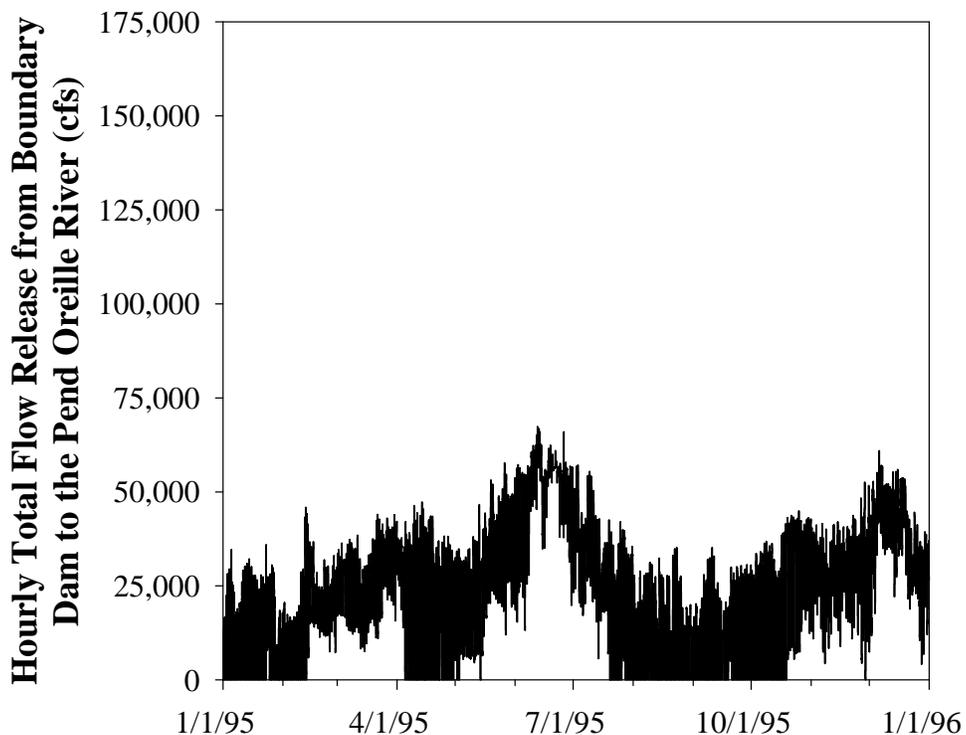
**Figure E-6.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1992.



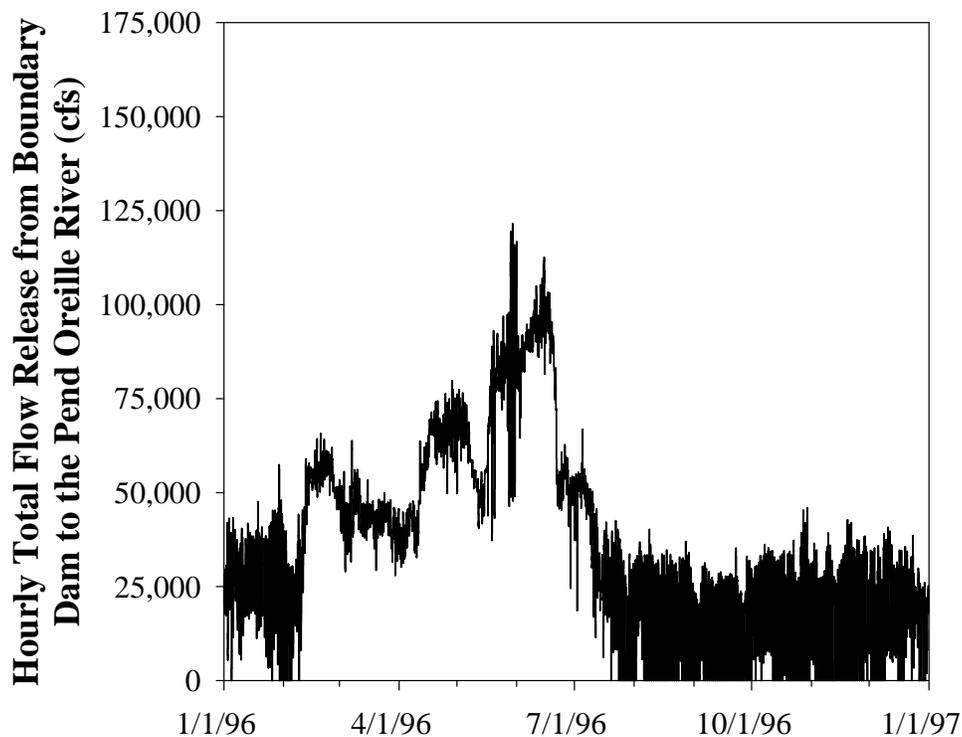
**Figure E-7.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1993.



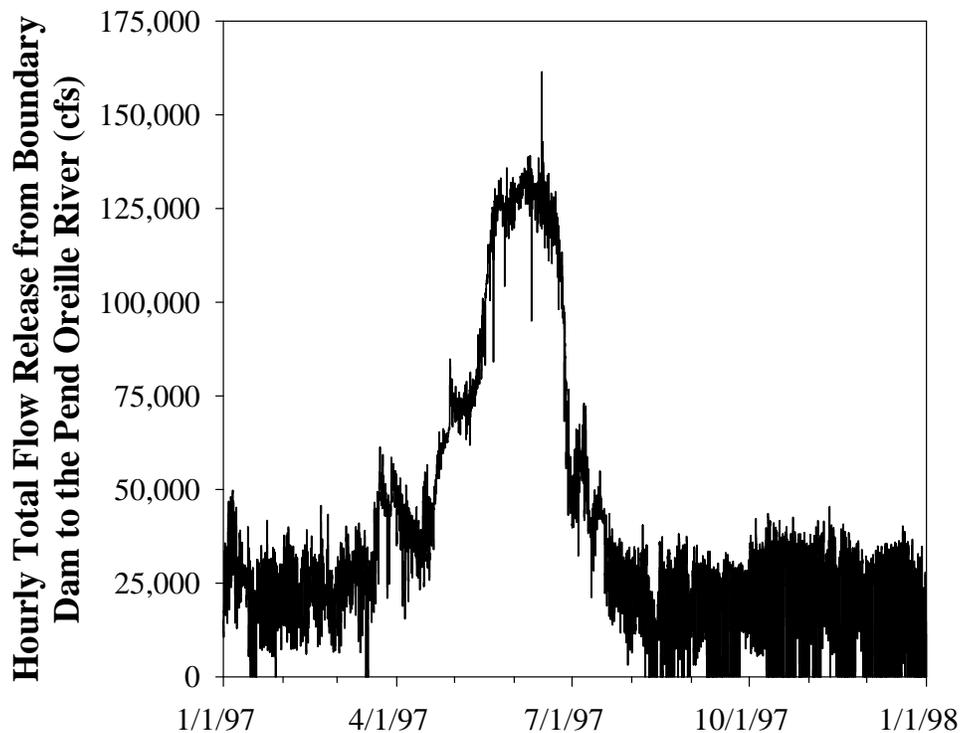
**Figure E-8.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1994.



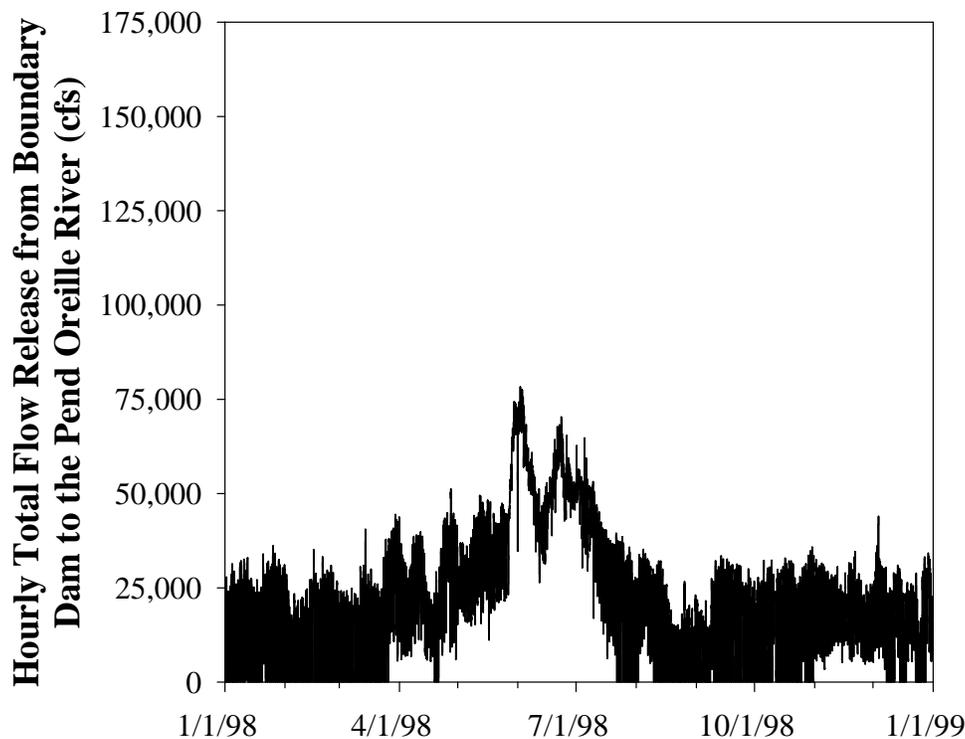
**Figure E-9.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1995.



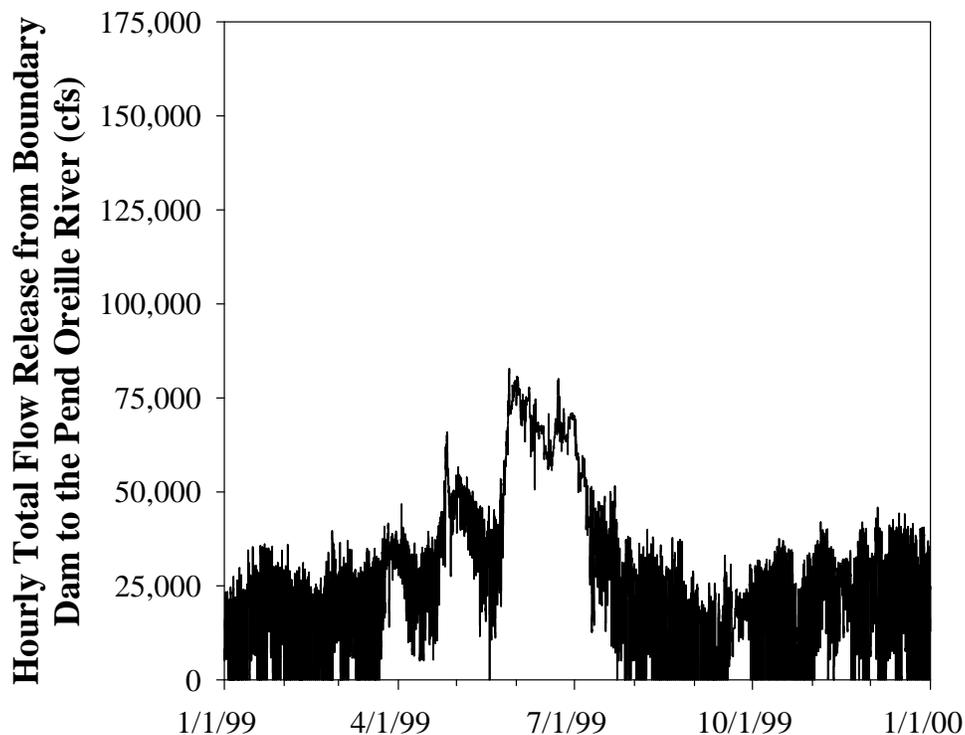
**Figure E-10.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1996.



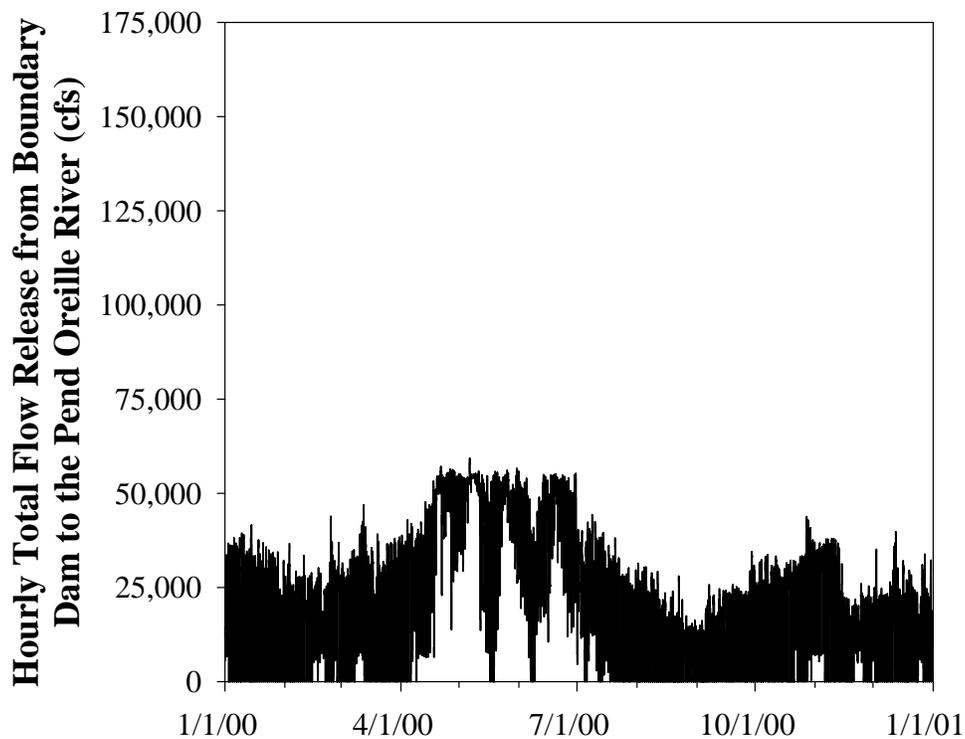
**Figure E-11.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1997.



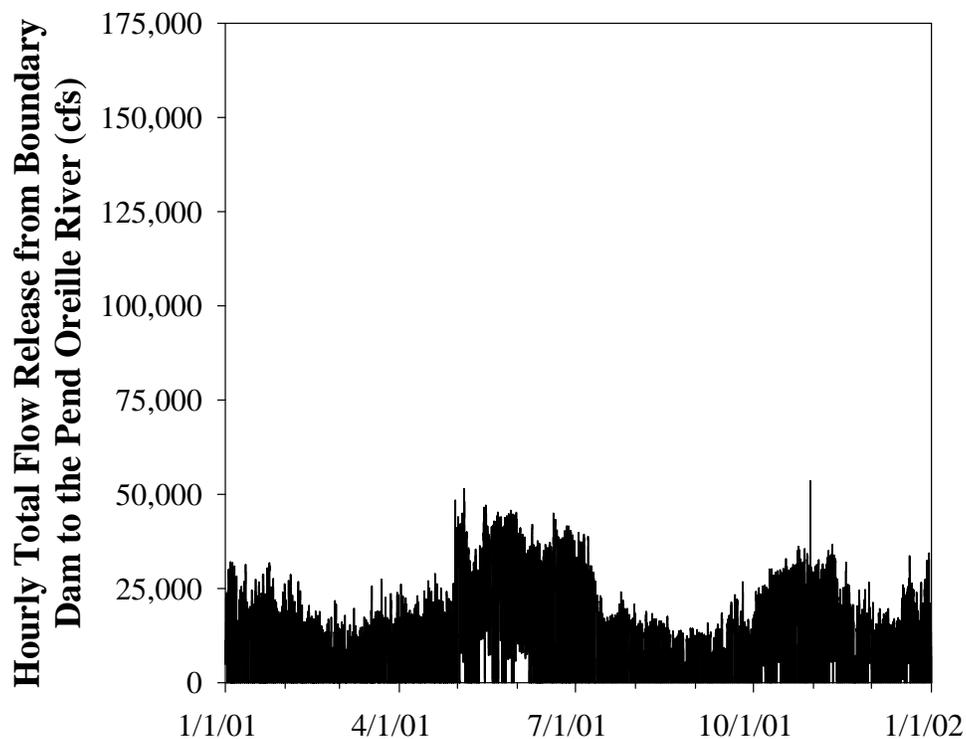
**Figure E-12.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1998.



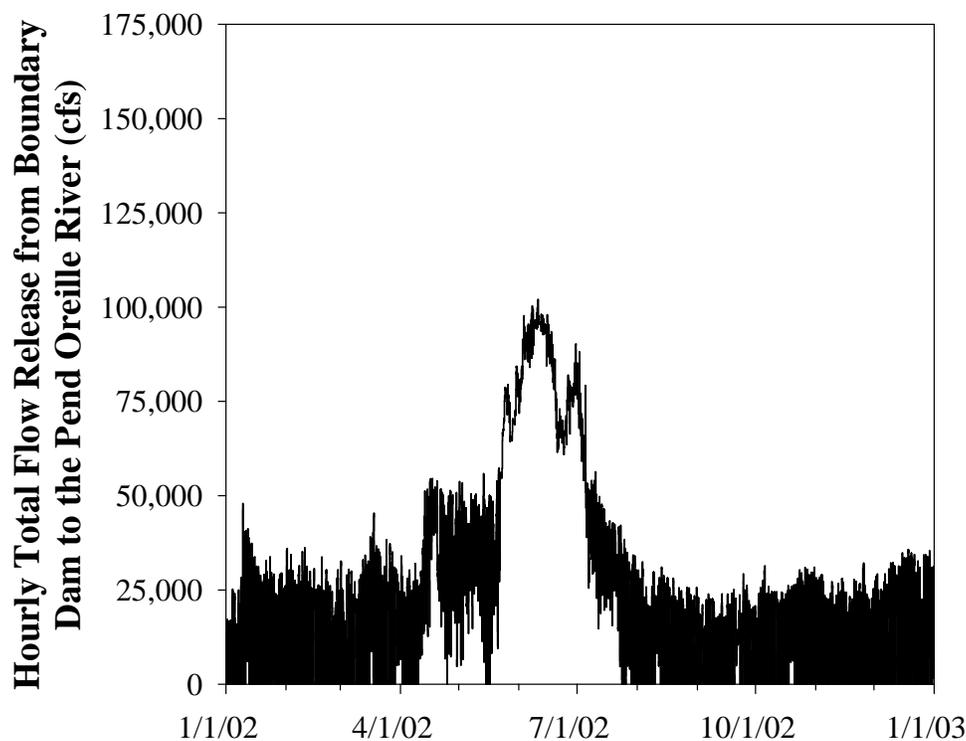
**Figure E-13.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 1999.



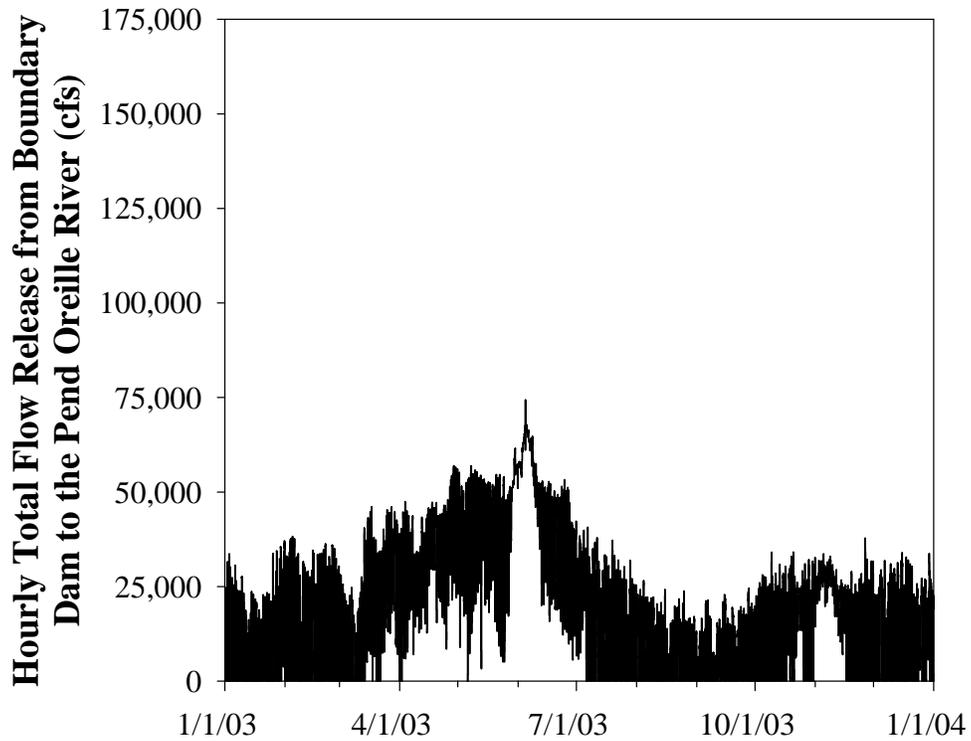
**Figure E-14.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 2000.



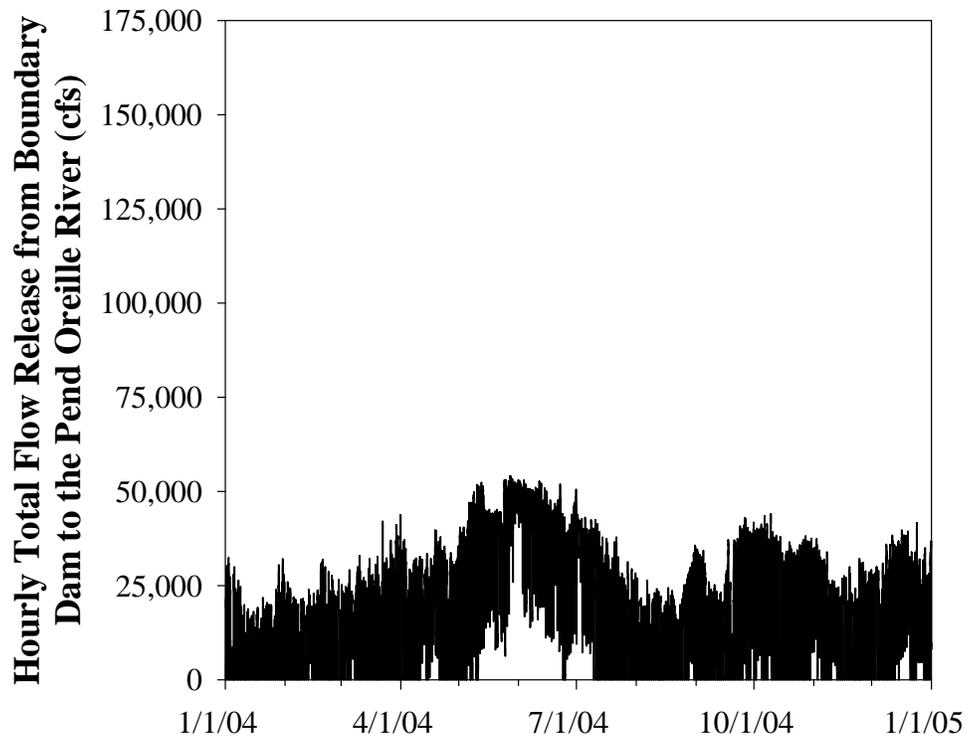
**Figure E-15.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 2001.



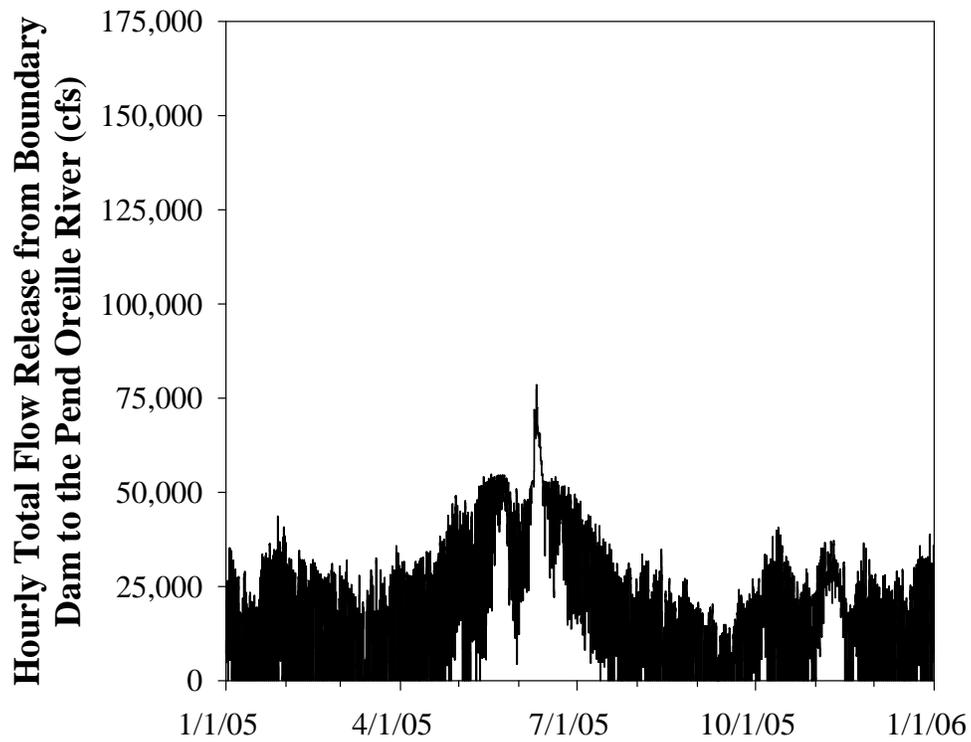
**Figure E-16.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 2002.



**Figure E-17.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 2003.



**Figure E-18.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 2004.



**Figure E-19.** Hourly total flow release from Boundary Dam to the Pend Oreille River in 2005.

## **Appendix F**

### **Monthly and Annual Flow Duration in Pend Oreille River based on Total Hourly Inflow to Boundary Reservoir and Total Hourly Flow Release from Boundary Dam, 1987 to 2005**

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**Table F-1.** January flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	January Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	18,800	17,900	14,300	11,500	10,200	25,700	24,300	16,600	100	0
1988	13,600	11,500	9,400	8,200	7,700	21,100	17,600	11,900	0	0
1989	15,300	13,900	11,100	10,000	9,600	27,200	22,700	11,200	0	0
1990	28,300	27,800	22,400	20,400	15,800	45,100	41,100	28,600	0	0
1991	26,600	24,200	22,200	20,100	20,000	40,400	36,500	28,500	0	0
1992	22,600	17,800	14,800	13,300	8,700	25,500	23,500	17,200	2,900	0
1993	21,300	20,600	17,900	14,200	13,000	32,500	30,300	20,900	0	0
1994	20,900	19,900	17,800	17,300	17,200	30,400	28,200	21,300	6,700	0
1995	17,200	16,800	14,500	11,400	10,100	26,800	24,000	15,000	0	0
1996	30,200	29,400	28,500	25,700	24,700	39,700	37,500	31,000	18,900	12,800
1997	33,500	28,500	22,400	19,200	18,600	36,200	31,500	26,100	17,000	8,500
1998	20,700	20,000	17,500	14,100	14,000	28,900	26,800	20,700	600	0
1999	21,100	19,700	17,500	13,600	13,100	29,900	27,300	20,400	5,900	200
2000	20,200	20,100	18,700	15,700	15,500	33,600	30,700	22,000	0	0
2001	13,400	13,300	12,200	10,200	9,900	24,100	21,100	14,700	200	0
2002	24,200	19,800	16,900	11,900	10,400	31,900	27,500	20,500	600	0
2003	15,000	13,700	10,200	9,200	8,300	23,900	20,200	8,300	0	0
2004	15,700	14,400	11,100	9,200	8,400	23,900	19,800	12,900	0	0
2005	23,800	23,000	18,000	13,000	12,700	32,700	30,500	19,100	1,100	0
<b>1987 to 2005</b>	<b>25,100</b>	<b>21,300</b>	<b>16,500</b>	<b>11,600</b>	<b>9,800</b>	<b>32,700</b>	<b>28,300</b>	<b>18,300</b>	<b>200</b>	<b>0</b>

**Table F-2.** February flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	February Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	21,100	18,700	16,600	13,100	9,500	29,000	25,800	19,800	200	0
1988	20,200	16,900	14,000	6,500	4,900	23,100	20,100	13,200	5,500	0
1989	14,000	13,700	11,900	10,000	9,300	19,900	16,900	12,000	6,900	3,500
1990	28,000	22,600	22,000	21,400	17,700	40,000	35,900	29,000	0	0
1991	28,700	28,400	27,100	25,700	22,800	44,200	40,900	33,500	2,500	0
1992	16,300	16,300	12,900	12,300	8,700	22,100	20,400	14,900	2,100	0
1993	13,000	12,100	11,100	9,800	9,700	21,500	18,100	12,100	0	0
1994	16,900	16,600	15,200	13,300	12,600	28,500	25,200	17,700	0	0
1995	26,300	23,300	19,600	10,300	9,800	30,100	25,300	17,100	9,000	0
1996	55,500	54,000	51,200	23,600	19,100	57,600	55,900	50,900	26,400	15,500
1997	25,800	25,100	22,900	21,400	19,300	31,900	29,500	23,300	14,600	11,400
1998	16,200	16,000	14,300	12,100	11,100	24,900	23,200	16,200	0	0
1999	20,000	17,400	16,200	15,100	14,800	27,400	25,400	20,900	3,700	0
2000	19,700	16,100	14,800	13,400	13,000	27,600	24,400	17,900	2,000	0
2001	10,400	9,600	6,600	6,300	6,100	16,900	14,200	8,200	0	0
2002	18,600	17,400	16,300	14,900	14,400	28,300	26,000	20,900	600	0
2003	22,500	17,400	17,000	14,800	14,700	32,200	28,500	18,500	900	0
2004	15,800	15,500	13,700	11,600	11,400	23,600	21,600	16,500	100	0
2005	17,700	16,900	15,500	14,500	14,300	28,200	26,500	19,700	0	0
<b>1987 to 2005</b>	<b>25,700</b>	<b>21,400</b>	<b>15,500</b>	<b>11,800</b>	<b>9,800</b>	<b>32,900</b>	<b>26,700</b>	<b>17,200</b>	<b>1,300</b>	<b>0</b>

**Table F-3.** March flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	March Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	23,300	22,300	15,100	10,900	6,300	30,900	26,900	15,500	700	0
1988	21,200	19,500	18,800	17,500	16,800	30,700	28,300	22,200	7,500	1,100
1989	20,200	19,900	18,700	15,000	13,600	33,700	31,000	22,500	0	0
1990	25,600	22,000	19,700	16,800	16,500	35,000	31,800	24,600	0	0
1991	31,100	29,100	27,700	24,600	22,900	38,400	35,400	28,600	18,300	13,200
1992	18,900	18,800	18,500	15,200	12,500	25,300	23,100	18,000	9,800	5,600
1993	19,000	17,900	14,300	11,600	11,200	28,100	24,000	15,900	0	0
1994	21,200	19,700	17,100	12,900	11,100	28,000	25,500	18,600	5,500	0
1995	33,700	33,200	26,100	24,900	20,800	38,400	36,000	28,000	19,700	15,700
1996	47,200	44,800	43,400	41,900	39,500	49,100	47,500	45,100	40,900	37,900
1997	51,300	48,500	28,000	24,000	22,900	52,000	47,100	30,700	22,300	18,000
1998	29,800	24,800	15,700	14,200	14,000	34,100	25,900	18,900	1,200	0
1999	32,200	29,800	19,300	18,300	17,500	35,000	33,000	26,900	12,200	1,000
2000	22,900	21,400	18,800	16,200	14,800	33,200	30,400	24,100	1,700	0
2001	9,700	9,400	7,800	6,500	6,200	16,600	14,600	9,200	200	0
2002	23,100	21,600	17,400	15,000	14,400	31,900	29,100	21,300	1,600	0
2003	32,400	28,700	21,400	12,400	11,500	38,800	34,600	21,100	8,700	0
2004	23,500	19,600	17,100	16,000	15,400	29,500	27,400	21,800	2,700	0
2005	17,400	14,400	13,100	11,700	10,300	25,900	22,200	15,000	0	0
<b>1987 to 2005</b>	<b>32,200</b>	<b>25,900</b>	<b>18,700</b>	<b>14,200</b>	<b>11,500</b>	<b>37,500</b>	<b>31,600</b>	<b>21,800</b>	<b>6,700</b>	<b>0</b>

**Table F-4.** April flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	April Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	30,000	29,500	23,900	20,600	18,800	39,800	35,900	29,200	12,900	6,100
1988	38,100	33,600	26,600	23,300	18,000	49,200	43,200	30,100	9,000	5,300
1989	44,100	42,700	25,700	20,200	20,100	51,500	44,600	34,100	6,800	0
1990	54,200	50,600	37,200	26,900	26,200	54,600	52,900	43,100	25,400	11,300
1991	39,600	36,900	33,400	27,900	23,100	47,200	45,400	38,000	15,800	7,800
1992	27,100	26,300	19,200	13,900	13,700	39,800	34,700	20,300	0	0
1993	27,200	24,000	21,300	19,200	18,600	35,500	32,200	26,800	2,700	0
1994	33,200	32,300	17,700	13,200	12,500	38,100	32,400	22,700	1,900	0
1995	25,600	24,100	22,700	20,900	20,400	38,300	36,100	29,100	0	0
1996	66,000	65,100	61,500	39,900	37,400	69,100	67,000	60,100	41,400	37,600
1997	65,300	61,900	41,600	34,900	34,000	66,100	61,900	45,100	35,200	31,100
1998	34,800	32,000	25,800	19,500	15,100	39,100	35,200	25,500	13,100	8,400
1999	46,900	41,600	27,400	23,300	21,600	47,900	43,700	32,500	24,000	15,200
2000	49,200	48,400	33,100	24,400	22,800	54,700	53,400	38,500	23,500	8,400
2001	12,400	11,500	10,900	10,600	10,300	21,300	19,000	13,700	200	0
2002	42,700	38,500	32,400	16,200	15,600	47,900	43,700	28,600	16,800	7,300
2003	45,000	39,400	33,600	29,100	26,800	46,500	44,100	36,800	22,600	15,800
2004	24,000	23,100	20,200	18,500	17,400	32,400	30,200	25,000	4,400	0
2005	29,900	23,200	19,300	18,000	17,600	38,400	32,600	25,500	4,700	0
<b>1987 to 2005</b>	<b>46,100</b>	<b>37,600</b>	<b>26,200</b>	<b>18,900</b>	<b>15,800</b>	<b>50,800</b>	<b>43,200</b>	<b>30,300</b>	<b>12,200</b>	<b>700</b>

**Table F-5.** May flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	May Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	43,200	42,600	34,900	22,800	22,600	49,300	46,200	33,900	23,900	18,200
1988	33,900	31,900	29,100	23,500	21,400	44,600	36,300	28,300	19,100	13,900
1989	60,700	59,500	44,100	36,900	36,400	59,900	58,300	50,700	38,100	28,900
1990	59,200	54,600	45,500	38,200	38,000	57,000	54,600	48,500	36,000	27,000
1991	82,200	80,600	44,100	39,400	37,900	82,300	78,700	45,500	40,700	37,500
1992	29,600	29,100	24,200	14,000	11,800	34,800	30,900	22,100	14,600	8,900
1993	54,800	54,300	35,700	24,400	19,600	54,600	52,900	39,100	20,800	5,500
1994	29,700	29,300	28,200	20,900	19,100	39,700	37,500	29,600	7,300	2,000
1995	38,900	37,600	30,600	21,900	21,600	46,700	42,200	29,700	20,400	7,500
1996	83,400	82,700	67,200	55,700	48,900	86,500	82,900	67,700	55,300	49,300
1997	130,100	130,000	96,700	69,400	68,700	127,200	125,700	98,200	73,700	71,600
1998	62,800	39,700	37,700	32,500	31,000	57,700	44,500	37,700	25,700	21,300
1999	77,200	55,800	40,200	32,600	31,500	72,700	55,100	44,100	34,700	25,800
2000	52,600	51,400	46,100	40,100	33,700	54,700	53,900	50,300	41,700	29,400
2001	30,800	29,900	28,700	22,400	18,600	42,500	40,300	30,000	8,700	200
2002	77,700	69,100	36,200	33,000	32,100	75,800	69,300	45,000	28,500	19,500
2003	53,400	43,500	41,700	36,400	34,800	54,300	52,500	46,800	25,300	17,900
2004	48,300	40,400	34,500	31,500	24,800	49,900	47,300	41,000	17,400	8,600
2005	53,700	49,600	36,900	29,700	28,000	53,000	51,300	43,600	23,800	11,300
<b>1987 to 2005</b>	<b>70,100</b>	<b>54,100</b>	<b>37,800</b>	<b>28,700</b>	<b>22,900</b>	<b>71,000</b>	<b>54,500</b>	<b>41,700</b>	<b>24,600</b>	<b>15,400</b>

**Table F-6.** June flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	June Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	23,600	22,600	20,000	16,800	15,500	29,500	28,000	22,000	7,900	5,200
1988	30,100	29,100	22,700	17,000	15,500	35,600	32,400	23,900	11,100	2,900
1989	56,500	56,000	40,000	32,500	29,000	54,400	53,900	43,400	31,200	19,500
1990	82,100	79,900	70,700	63,700	60,100	77,900	76,400	68,700	61,700	57,900
1991	84,500	83,900	68,100	55,400	50,200	86,100	84,400	65,400	53,300	50,700
1992	22,500	22,000	17,200	9,100	8,800	31,200	28,100	14,600	5,900	0
1993	43,900	37,200	30,600	28,600	25,900	46,400	43,500	37,100	15,500	9,600
1994	31,900	31,400	26,600	23,200	20,100	42,700	40,700	32,000	6,800	0
1995	63,500	60,300	53,200	43,100	42,600	59,500	56,900	54,600	45,500	35,300
1996	92,500	90,400	85,000	53,700	51,000	97,600	94,700	88,000	53,600	50,400
1997	135,900	135,500	130,200	106,000	70,100	132,200	130,300	126,200	108,600	75,200
1998	67,800	59,500	52,600	45,200	41,200	67,000	61,100	53,400	46,300	43,600
1999	77,300	75,900	68,100	66,400	62,500	75,200	72,100	67,400	63,400	60,100
2000	48,800	43,000	38,600	34,400	27,000	53,300	51,300	43,800	27,500	19,000
2001	28,200	24,000	23,300	22,000	21,600	37,800	36,200	29,900	3,100	0
2002	94,300	90,400	84,400	74,200	69,100	95,700	94,800	87,100	73,900	67,200
2003	65,400	61,400	40,500	36,600	31,200	63,500	57,800	47,100	33,800	20,400
2004	43,800	41,400	36,300	33,200	29,800	49,500	46,800	41,000	24,400	14,700
2005	64,500	52,100	46,700	37,000	36,100	62,200	52,600	47,400	38,500	27,200
<b>1987 to 2005</b>	<b>84,900</b>	<b>71,600</b>	<b>43,100</b>	<b>24,700</b>	<b>20,800</b>	<b>87,700</b>	<b>69,400</b>	<b>47,400</b>	<b>25,200</b>	<b>13,300</b>

**Table F-7.** July flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	July Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	16,700	14,200	11,700	9,700	9,000	22,300	20,100	14,300	0	0
1988	15,600	15,300	10,400	9,400	8,800	23,800	20,900	12,700	0	0
1989	24,900	23,700	22,400	18,300	17,400	35,000	32,500	27,600	3,600	0
1990	51,000	49,600	24,900	22,600	20,700	51,300	49,300	36,200	8,200	0
1991	61,500	59,800	33,000	25,800	23,400	62,300	58,300	40,200	19,700	9,300
1992	16,900	16,500	13,500	11,400	10,800	27,900	24,400	18,400	0	0
1993	39,000	34,100	28,000	26,300	25,200	43,100	39,400	31,900	15,600	10,200
1994	15,900	15,300	11,900	7,200	6,800	26,800	21,800	8,200	0	0
1995	40,700	38,700	27,200	19,400	17,500	44,000	39,600	31,200	19,000	0
1996	51,100	48,500	27,900	18,700	16,900	52,300	49,100	32,500	21,100	5,500
1997	57,000	50,700	38,000	28,200	23,700	55,600	48,700	39,200	28,500	20,300
1998	47,600	46,400	30,100	21,500	18,900	51,700	48,100	35,800	20,800	9,100
1999	57,200	50,800	35,600	22,600	20,200	57,300	50,600	38,100	23,100	13,400
2000	26,900	26,100	20,700	14,100	13,400	36,100	33,400	25,400	5,700	0
2001	20,100	18,000	10,400	9,000	8,500	28,400	21,900	13,900	0	0
2002	62,700	45,700	34,900	22,400	20,900	62,000	50,600	36,100	25,500	15,100
2003	25,600	22,100	16,900	14,200	12,700	32,000	28,600	18,900	2,700	0
2004	31,200	29,900	21,700	15,600	14,300	38,400	35,800	25,100	8,400	0
2005	33,900	30,900	21,900	14,500	13,700	38,900	34,800	21,700	9,000	1,800
<b>1987 to 2005</b>	<b>45,300</b>	<b>34,800</b>	<b>22,500</b>	<b>13,700</b>	<b>10,600</b>	<b>47,000</b>	<b>38,700</b>	<b>25,500</b>	<b>7,700</b>	<b>0</b>

**Table F-8.** August flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	August Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	14,000	13,800	9,800	9,400	9,200	20,700	18,800	13,600	0	0
1988	11,200	7,200	5,600	4,800	4,300	15,000	12,100	6,000	0	0
1989	21,400	19,800	15,300	14,400	13,800	27,300	25,200	21,900	0	0
1990	19,000	16,400	12,800	11,500	11,300	26,100	21,800	16,300	0	0
1991	17,800	15,900	13,600	10,200	9,400	26,000	22,200	14,400	0	0
1992	12,400	11,700	10,300	8,800	8,200	20,100	18,100	12,800	0	0
1993	16,700	15,400	14,000	13,600	13,300	24,200	22,700	17,900	0	0
1994	10,600	9,200	7,500	6,100	5,900	14,700	11,800	6,600	0	0
1995	15,500	14,900	12,100	10,700	9,900	26,600	22,200	12,200	0	0
1996	21,700	20,100	18,000	16,300	16,200	32,000	30,500	24,500	0	0
1997	25,100	24,900	22,200	17,400	12,400	33,000	30,900	22,400	8,500	0
1998	24,900	20,500	15,100	10,600	9,500	30,700	26,200	15,000	5,400	0
1999	19,800	18,000	16,200	13,600	11,900	31,600	28,200	18,800	0	0
2000	14,100	12,600	8,800	7,600	7,500	22,800	18,200	11,400	0	0
2001	8,400	8,300	7,800	6,800	6,500	14,900	13,600	8,500	0	0
2002	16,300	15,900	13,600	12,100	12,000	25,800	23,200	17,700	1,400	0
2003	13,100	11,900	10,100	9,200	7,700	19,100	16,000	10,400	0	0
2004	20,200	14,100	12,400	11,900	11,500	24,400	21,100	15,400	0	0
2005	16,200	14,100	12,300	10,800	10,200	24,500	21,200	12,200	0	0
<b>1987 to 2005</b>	<b>19,400</b>	<b>16,300</b>	<b>12,500</b>	<b>9,200</b>	<b>7,400</b>	<b>26,700</b>	<b>22,300</b>	<b>13,100</b>	<b>0</b>	<b>0</b>

**Table F-9.** September flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	September Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	24,600	21,000	16,500	14,000	13,800	29,100	26,600	21,500	900	0
1988	15,900	11,000	10,000	8,900	6,200	20,900	17,900	11,300	0	0
1989	24,100	23,900	22,000	19,500	18,800	35,300	31,900	26,800	6,400	0
1990	19,800	19,400	16,500	15,400	12,600	28,900	26,900	21,800	0	0
1991	21,600	19,300	16,500	16,100	11,800	31,400	28,700	22,300	0	0
1992	18,500	16,500	14,900	14,200	11,200	28,500	26,500	18,600	0	0
1993	24,400	21,700	17,400	15,700	15,200	31,200	28,400	23,200	0	0
1994	12,100	11,800	11,200	9,600	7,200	18,500	16,600	12,100	0	0
1995	17,700	17,000	14,900	9,900	9,000	27,500	25,300	15,700	0	0
1996	17,100	16,400	15,800	13,200	12,800	26,900	25,400	20,300	0	0
1997	22,600	22,400	20,600	18,100	17,800	29,400	28,200	24,500	7,700	200
1998	18,900	18,900	16,100	9,900	9,100	28,900	26,200	17,400	900	0
1999	18,700	17,400	13,300	10,200	9,900	23,500	22,200	16,600	1,700	0
2000	15,100	14,000	13,000	11,200	7,300	23,400	22,200	15,400	0	0
2001	10,500	10,200	8,600	6,600	6,400	17,000	14,500	8,500	0	0
2002	13,500	13,200	12,100	10,900	9,900	21,700	19,300	14,700	1,000	0
2003	12,700	11,800	10,700	8,100	7,200	18,200	16,000	10,800	0	0
2004	26,600	26,400	17,800	14,200	13,000	36,700	32,000	20,800	1,200	0
2005	13,500	12,000	8,900	7,900	7,000	19,000	16,200	9,000	0	0
<b>1987 to 2005</b>	<b>21,200</b>	<b>18,600</b>	<b>14,500</b>	<b>10,200</b>	<b>8,600</b>	<b>28,600</b>	<b>25,300</b>	<b>15,300</b>	<b>0</b>	<b>0</b>

**Table F-10.** October flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	October Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	25,700	25,000	23,700	22,600	18,200	33,800	32,100	27,800	12,200	7,800
1988	23,300	22,700	22,200	18,700	13,100	34,100	31,800	24,900	3,500	0
1989	25,500	25,300	25,000	21,500	20,900	38,500	37,000	32,500	800	0
1990	29,200	28,900	26,400	24,500	23,800	45,500	42,800	35,500	0	0
1991	28,400	26,900	26,100	25,500	22,600	42,700	40,900	35,400	900	0
1992	27,800	27,600	27,000	25,400	21,600	40,100	38,700	34,300	6,700	0
1993	25,300	25,000	24,800	24,300	24,100	38,700	37,600	34,300	0	0
1994	21,400	20,000	19,700	19,200	17,600	32,900	31,200	27,200	0	0
1995	31,300	30,600	22,500	17,700	17,400	41,200	37,700	28,300	8,000	0
1996	24,900	23,000	19,800	19,200	17,600	33,400	30,800	25,600	5,900	0
1997	25,400	25,300	24,300	23,100	22,900	36,300	34,900	31,000	2,600	0
1998	20,200	19,100	18,000	16,300	15,700	29,200	27,500	22,800	4,100	0
1999	22,500	21,400	18,300	16,300	11,700	32,000	30,200	24,000	200	0
2000	25,200	19,900	17,800	17,300	17,000	32,200	30,000	24,500	1,300	0
2001	19,900	19,600	19,000	15,400	15,300	29,600	28,300	22,400	5,600	0
2002	18,000	17,900	17,000	14,900	14,600	26,000	24,600	19,900	1,200	0
2003	19,300	19,200	18,200	16,400	16,200	27,500	25,300	20,800	6,400	0
2004	26,800	26,600	23,200	21,600	20,900	37,200	35,500	30,300	5,100	0
2005	22,600	21,700	18,500	15,800	15,100	30,100	27,700	20,900	6,600	0
<b>1987 to 2005</b>	<b>26,700</b>	<b>25,300</b>	<b>21,500</b>	<b>17,800</b>	<b>16,300</b>	<b>37,700</b>	<b>34,200</b>	<b>24,900</b>	<b>3,000</b>	<b>0</b>

**Table F-11.** November flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	November Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	24,300	24,100	18,100	16,200	14,200	28,800	26,700	21,200	8,200	5,600
1988	26,500	26,100	20,200	18,000	17,100	36,800	34,500	24,700	6,900	0
1989	31,700	29,100	26,200	24,800	23,300	41,400	39,800	34,600	7,200	0
1990	29,100	29,000	28,600	27,300	25,000	45,000	42,700	35,400	6,500	0
1991	27,600	26,200	21,900	19,500	15,100	38,700	36,000	25,600	6,100	0
1992	27,900	26,700	18,400	13,700	13,300	41,100	36,400	21,300	0	0
1993	25,400	23,400	19,700	15,900	15,600	35,200	32,100	23,900	0	0
1994	27,500	27,000	19,500	14,700	14,000	39,900	36,300	23,500	0	0
1995	28,100	27,200	26,400	23,300	21,900	39,000	36,600	30,200	20,400	15,400
1996	21,400	20,500	18,600	16,500	16,300	33,100	30,000	24,300	600	0
1997	27,000	26,700	24,900	21,700	19,900	36,300	34,600	28,800	8,000	0
1998	21,800	21,100	19,500	17,100	15,500	28,500	26,600	21,100	11,600	7,700
1999	28,700	27,300	24,400	19,500	17,700	36,000	32,900	27,900	13,300	7,100
2000	24,600	24,500	12,900	10,700	10,000	34,300	31,500	15,400	5,500	0
2001	21,500	19,000	14,500	10,300	9,700	30,000	26,900	17,000	600	0
2002	17,100	16,700	14,700	14,100	13,100	24,800	22,500	18,600	1,000	0
2003	28,300	27,900	19,100	15,100	14,700	29,300	27,500	22,900	15,300	400
2004	24,000	20,100	16,500	14,300	13,900	29,800	26,300	20,300	3,000	0
2005	29,100	28,700	18,300	14,800	13,600	31,100	28,800	22,900	11,700	1,100
<b>1987 to 2005</b>	<b>27,900</b>	<b>26,300</b>	<b>20,400</b>	<b>15,600</b>	<b>13,800</b>	<b>37,000</b>	<b>32,500</b>	<b>22,700</b>	<b>6,500</b>	<b>0</b>

**Table F-12.** December flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	December Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	20,900	18,500	15,000	10,500	9,100	27,500	24,800	15,900	100	0
1988	16,400	15,800	14,400	12,600	12,100	26,500	24,400	16,500	0	0
1989	28,800	28,600	22,800	20,600	19,600	41,700	37,900	29,700	0	0
1990	27,300	25,700	21,900	15,300	13,000	41,100	36,600	22,400	0	0
1991	19,400	19,000	17,800	15,500	15,200	29,100	25,700	17,400	7,000	1,300
1992	17,000	14,500	12,200	10,600	9,400	25,700	22,700	12,900	0	0
1993	21,500	20,600	19,300	17,900	15,500	33,100	30,700	24,200	0	0
1994	15,800	14,700	12,500	11,000	10,200	27,000	22,100	14,600	0	0
1995	46,800	45,900	39,100	29,600	25,700	51,300	48,000	38,700	29,800	23,400
1996	23,200	21,000	18,500	15,800	14,400	30,600	27,600	21,200	7,600	0
1997	22,900	21,300	20,100	18,300	17,300	33,900	31,600	25,900	700	0
1998	22,500	20,500	16,400	13,100	12,300	29,600	26,100	18,100	8,200	500
1999	27,000	26,100	22,800	21,300	20,400	38,500	35,800	29,800	7,600	0
2000	16,600	14,500	12,700	12,000	11,400	25,700	22,400	16,000	1,100	0
2001	15,600	14,400	12,400	9,300	8,900	22,900	19,100	14,000	1,300	0
2002	20,600	18,900	15,900	14,100	12,800	30,000	26,700	18,100	300	0
2003	17,400	16,000	15,000	13,600	13,400	26,300	24,300	17,700	700	0
2004	26,200	25,200	20,200	17,600	16,800	34,600	32,000	25,400	5,900	0
2005	18,700	16,500	14,700	13,400	13,100	27,100	23,700	16,700	1,200	0
<b>1987 to 2005</b>	<b>25,500</b>	<b>21,900</b>	<b>16,800</b>	<b>13,200</b>	<b>11,600</b>	<b>34,500</b>	<b>29,800</b>	<b>19,100</b>	<b>1,500</b>	<b>0</b>

**Table F-13.** Annual flow duration in Pend Oreille River based on total hourly inflow to Boundary Reservoir and total hourly flow release from Boundary Dam, 1987 to 2005.

Year	Annual Flow Duration in Pend Oreille River (cfs)									
	Total Hourly Inflow to Boundary Reservoir					Total Hourly Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	26,500	23,600	17,500	12,200	9,700	32,800	28,600	19,800	6,200	0
1988	28,900	23,500	16,800	9,500	6,700	33,600	28,700	16,400	900	0
1989	43,400	29,700	22,200	15,100	12,400	47,800	38,500	26,400	5,600	0
1990	54,900	39,400	25,100	17,400	14,700	55,200	46,600	31,100	2,800	0
1991	60,500	38,200	26,000	18,200	15,300	59,800	44,300	30,200	8,100	0
1992	27,100	22,200	15,200	11,700	9,600	33,500	26,900	17,300	700	0
1993	32,700	26,700	20,100	14,300	12,600	39,700	35,100	22,900	1,400	0
1994	28,100	22,000	17,000	11,300	8,200	35,100	29,600	16,400	0	0
1995	43,100	33,800	23,700	15,300	11,500	46,600	38,400	26,600	10,500	0
1996	67,900	54,000	26,800	17,700	16,100	69,400	55,200	32,400	18,500	1,500
1997	111,500	56,600	25,200	20,900	19,200	111,200	54,600	30,500	18,100	7,400
1998	45,100	32,500	18,700	14,800	12,500	46,300	35,000	22,700	9,800	0
1999	61,700	35,800	21,300	16,600	14,200	59,000	40,300	27,100	11,800	700
2000	44,200	32,100	17,800	12,700	10,900	48,900	36,000	22,200	5,200	0
2001	23,600	19,500	10,900	8,200	6,700	30,700	24,000	13,100	200	0
2002	68,800	34,700	17,100	14,100	12,500	67,000	40,300	22,300	7,100	0
2003	40,700	33,400	16,700	11,700	9,700	45,700	34,400	20,100	6,300	0
2004	35,400	26,800	19,400	14,000	12,100	40,100	33,500	21,400	5,200	0
2005	37,900	28,800	16,700	13,000	11,400	43,700	31,900	20,200	5,400	0
<b>1987 to 2005</b>	<b>43,100</b>	<b>29,700</b>	<b>19,500</b>	<b>13,400</b>	<b>10,700</b>	<b>46,900</b>	<b>36,600</b>	<b>22,600</b>	<b>5,900</b>	<b>0</b>

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## **Appendix G**

### **Monthly and Annual Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on Total Inflow to Boundary Reservoir and Total Flow Release from Boundary Dam, 1987 to 2005**

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**Table G-1.** January frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	January Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,900	2,200	1,600	500	300	28,700	26,600	25,400	23,700	21,900
1988	3,100	2,100	900	400	300	26,500	24,900	19,800	16,700	15,200
1989	2,000	1,300	800	400	300	32,400	31,500	29,200	24,300	19,500
1990	4,600	4,000	1,100	300	200	48,900	47,700	41,500	36,000	35,400
1991	2,400	2,200	800	200	0	47,200	45,600	42,000	36,800	34,600
1992	4,100	2,900	1,400	300	0	33,600	28,200	24,100	15,700	13,300
1993	2,000	1,500	600	300	200	36,900	35,800	33,300	28,300	24,300
1994	1,800	1,300	300	0	0	37,200	32,600	31,300	22,800	21,400
1995	2,000	1,300	800	300	0	30,900	30,100	27,400	18,900	17,800
1996	3,200	2,700	1,000	400	300	44,300	40,300	27,000	20,400	18,600
1997	4,100	3,300	2,000	800	600	31,300	29,100	25,000	17,000	15,300
1998	2,500	1,900	600	200	0	32,600	32,000	29,600	26,000	25,100
1999	2,000	1,200	600	400	300	35,000	34,400	27,900	23,500	21,400
2000	1,600	1,300	400	300	0	38,200	36,900	34,600	32,200	30,100
2001	1,200	800	400	0	0	31,300	30,100	25,300	21,300	18,800
2002	2,900	1,800	1,100	500	100	37,400	33,800	29,100	24,000	17,200
2003	1,300	1,200	600	100	0	33,600	30,600	23,600	21,000	18,700
2004	2,100	1,900	700	0	0	30,300	27,300	19,900	16,300	13,800
2005	2,000	1,800	600	100	0	36,800	34,700	29,600	21,900	19,600
<b>1987 to 2005</b>	<b>2,800</b>	<b>2,000</b>	<b>800</b>	<b>300</b>	<b>0</b>	<b>38,500</b>	<b>35,000</b>	<b>28,200</b>	<b>21,900</b>	<b>18,400</b>

**Table G-2.** February frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	February Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,400	2,100	1,000	600	300	30,900	30,300	27,300	24,500	21,100
1988	3,000	2,400	1,200	600	200	22,700	21,400	17,200	14,200	12,100
1989	1,700	1,300	900	100	0	23,400	23,300	15,800	10,000	9,000
1990	2,300	1,300	200	0	0	48,700	43,500	37,900	34,700	33,800
1991	1,800	1,700	300	0	0	52,500	49,800	45,600	40,900	39,400
1992	1,400	500	300	0	0	25,300	24,700	22,700	16,100	13,300
1993	1,600	1,200	500	100	0	28,500	26,300	24,000	21,600	20,000
1994	1,600	1,000	500	300	200	34,700	33,400	30,100	25,500	24,700
1995	3,100	2,500	700	300	200	29,800	22,200	18,000	15,300	12,700
1996	4,600	2,800	800	100	0	37,300	30,700	13,000	6,600	6,000
1997	2,100	1,800	1,400	400	200	31,000	26,800	23,400	16,600	15,000
1998	1,600	1,000	400	200	100	30,000	28,900	25,500	22,300	19,800
1999	1,100	1,000	400	100	0	34,500	30,800	27,900	24,500	23,500
2000	2,200	1,500	900	200	0	36,700	31,600	27,800	24,500	23,700
2001	600	400	300	100	0	25,000	21,800	18,600	15,700	14,700
2002	1,900	1,400	700	300	200	34,600	31,400	27,400	25,300	24,800
2003	3,100	1,800	500	200	0	36,700	34,900	32,800	29,500	27,800
2004	800	800	400	200	200	29,000	26,300	22,400	20,000	19,300
2005	1,500	1,100	600	300	300	32,200	32,100	29,700	27,300	26,300
<b>1987 to 2005</b>	<b>2,100</b>	<b>1,500</b>	<b>600</b>	<b>200</b>	<b>0</b>	<b>37,500</b>	<b>32,200</b>	<b>25,400</b>	<b>18,200</b>	<b>15,000</b>

**Table G-3.** March frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	March Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,800	2,000	700	100	0	28,600	28,000	24,200	15,600	13,400
1988	1,500	1,200	600	0	0	34,100	33,700	30,300	23,100	21,500
1989	2,200	1,900	1,000	300	0	39,500	38,700	36,000	28,400	27,700
1990	2,200	1,800	700	100	0	38,700	37,200	33,200	31,300	28,700
1991	1,800	1,300	400	100	0	37,200	34,800	26,000	21,900	19,600
1992	1,100	400	200	0	0	27,100	25,300	21,200	17,400	16,100
1993	4,100	3,400	1,100	400	200	33,500	30,000	26,200	20,400	19,000
1994	2,400	2,300	800	300	200	32,200	30,000	24,400	19,900	19,000
1995	2,600	1,600	400	100	0	24,900	24,100	20,700	17,500	16,800
1996	2,100	1,500	600	200	200	17,400	16,000	10,900	8,800	7,600
1997	6,300	4,000	1,500	400	300	31,000	29,300	20,900	14,300	13,800
1998	2,600	1,500	700	200	0	37,900	33,700	26,700	24,000	23,300
1999	2,000	1,300	500	300	0	34,700	32,500	29,800	22,200	11,200
2000	2,200	1,300	700	300	0	38,400	37,200	34,600	31,100	28,900
2001	600	600	300	200	200	23,500	19,700	16,800	14,700	13,700
2002	3,000	1,800	800	200	0	37,200	35,100	31,100	27,100	23,700
2003	3,300	3,000	1,300	400	100	38,000	34,400	30,800	22,700	20,000
2004	1,100	800	400	100	0	38,200	33,000	29,100	25,100	23,500
2005	1,700	1,400	600	0	0	32,000	29,400	26,800	20,900	18,600
<b>1987 to 2005</b>	<b>2,600</b>	<b>1,700</b>	<b>600</b>	<b>200</b>	<b>0</b>	<b>36,800</b>	<b>33,400</b>	<b>26,700</b>	<b>19,000</b>	<b>15,200</b>

**Table G-4.** April frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	April Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,000	1,300	600	100	100	36,200	33,800	30,000	24,800	21,900
1988	2,700	2,300	500	200	100	52,000	49,900	33,300	30,200	28,400
1989	3,500	2,600	1,000	500	200	46,200	43,200	37,000	31,800	27,400
1990	2,200	2,000	600	200	100	46,100	44,700	37,800	19,500	7,900
1991	4,300	2,500	700	200	100	49,700	45,300	39,300	32,700	27,100
1992	2,100	1,900	700	200	100	44,200	41,500	33,800	26,900	25,700
1993	1,800	1,300	700	100	0	42,900	38,300	34,200	31,000	30,400
1994	2,900	2,100	700	300	100	33,800	32,900	29,400	24,900	23,400
1995	2,900	1,300	600	100	0	44,500	43,500	37,700	32,900	29,000
1996	3,300	2,800	1,200	600	400	19,900	15,800	11,700	8,900	5,900
1997	6,200	4,500	2,100	600	300	26,700	22,800	15,400	10,000	5,600
1998	3,300	3,000	1,500	500	0	35,400	31,600	27,500	22,800	20,200
1999	7,300	3,900	2,400	1,000	400	30,000	28,700	24,700	17,200	12,100
2000	5,400	3,400	1,000	300	200	42,600	40,500	35,400	25,500	15,800
2001	900	600	300	100	0	27,100	26,100	22,300	19,500	18,500
2002	5,600	4,700	2,000	400	200	42,600	39,700	30,100	23,500	21,400
2003	3,800	2,200	1,400	500	400	39,500	35,700	29,600	21,200	20,100
2004	2,400	1,800	500	200	100	35,400	34,400	31,900	28,100	25,300
2005	2,500	1,800	900	400	200	41,300	38,400	32,600	29,300	28,000
<b>1987 to 2005</b>	<b>3,700</b>	<b>2,600</b>	<b>900</b>	<b>200</b>	<b>100</b>	<b>43,000</b>	<b>38,400</b>	<b>30,900</b>	<b>21,600</b>	<b>15,500</b>

**Table G-5.** May frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	May Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	3,300	2,400	500	200	200	25,800	24,300	20,300	15,800	14,500
1988	4,700	2,900	900	300	200	44,300	36,900	22,600	19,600	18,100
1989	4,400	2,600	900	500	300	36,700	33,300	23,900	4,800	2,300
1990	3,600	3,100	900	400	100	37,900	34,700	25,900	16,900	12,100
1991	5,200	3,800	1,800	700	200	21,200	19,000	10,400	7,100	4,000
1992	2,600	2,100	800	400	200	25,800	23,000	19,600	16,100	12,200
1993	4,300	3,800	1,700	400	200	39,100	37,500	28,300	9,600	7,900
1994	2,400	2,000	700	300	200	39,000	37,000	33,400	31,200	30,300
1995	2,000	1,200	500	100	0	34,800	33,500	29,200	23,700	22,500
1996	5,500	4,200	1,500	700	300	67,700	31,300	12,000	9,800	7,600
1997	5,500	4,700	1,500	400	100	17,200	14,400	11,700	8,600	6,800
1998	2,900	2,500	1,700	600	400	30,200	28,200	23,200	17,400	14,000
1999	6,700	3,000	1,300	800	300	31,400	29,800	19,300	13,400	7,600
2000	3,900	3,200	1,400	400	200	47,400	41,200	21,200	10,100	4,800
2001	2,900	1,800	600	300	200	45,200	44,300	39,500	32,400	29,900
2002	7,200	5,900	2,000	500	400	48,400	46,700	27,200	11,500	7,800
2003	4,400	3,100	1,300	400	300	49,700	45,300	34,900	29,000	17,000
2004	2,600	2,100	1,200	200	200	47,000	43,200	37,900	30,100	25,700
2005	3,800	3,000	1,700	700	400	47,900	46,300	35,400	20,400	12,800
<b>1987 to 2005</b>	<b>4,400</b>	<b>2,900</b>	<b>1,100</b>	<b>400</b>	<b>200</b>	<b>44,300</b>	<b>37,900</b>	<b>24,900</b>	<b>13,100</b>	<b>8,600</b>

**Table G-6.** June frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	June Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	3,100	2,600	1,800	200	100	27,600	26,400	23,900	21,000	20,500
1988	4,100	3,300	900	200	100	33,800	31,500	28,400	24,900	23,000
1989	4,200	3,200	1,300	400	300	32,400	31,100	25,500	4,500	1,800
1990	7,800	5,800	2,600	1,500	700	16,200	12,100	7,300	3,900	2,900
1991	6,200	4,200	2,700	600	500	28,500	15,100	7,400	4,700	3,900
1992	2,700	1,700	500	200	100	30,400	28,600	24,000	17,900	16,900
1993	3,000	2,700	1,400	600	400	39,200	37,800	33,900	28,700	25,300
1994	2,700	1,900	1,000	300	100	44,500	42,100	38,800	33,600	31,500
1995	6,400	4,300	1,200	300	200	36,900	32,000	20,200	11,700	5,700
1996	5,300	3,900	1,500	600	400	24,300	18,800	12,600	8,300	6,900
1997	7,500	6,300	1,500	200	100	38,700	24,600	15,400	9,600	6,700
1998	5,700	4,200	2,100	1,000	600	18,800	17,300	13,200	10,600	8,400
1999	5,800	4,500	1,600	300	300	12,100	10,200	6,700	2,400	1,400
2000	4,000	3,300	2,000	800	100	41,100	39,100	35,100	29,500	21,600
2001	1,500	800	500	100	0	41,600	40,300	37,000	32,600	31,400
2002	3,900	2,900	1,900	1,200	800	13,700	12,200	10,200	5,100	4,200
2003	5,500	3,100	1,200	300	200	36,700	34,800	30,000	9,900	4,400
2004	2,900	2,200	1,400	500	200	39,100	36,800	34,600	32,500	28,000
2005	6,600	4,800	1,800	400	200	31,800	30,100	22,900	10,900	8,300
<b>1987 to 2005</b>	<b>5,300</b>	<b>3,400</b>	<b>1,500</b>	<b>400</b>	<b>200</b>	<b>37,700</b>	<b>34,300</b>	<b>22,900</b>	<b>9,200</b>	<b>5,500</b>

**Table G-7.** July frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	July Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,300	1,700	1,000	600	300	26,100	24,200	20,500	16,900	16,400
1988	1,900	1,600	900	200	100	26,800	25,900	19,900	17,400	15,600
1989	3,100	2,100	1,300	500	300	39,900	38,000	32,800	30,500	29,200
1990	4,300	3,800	2,200	700	500	40,900	40,200	36,700	16,800	11,600
1991	5,600	4,300	1,900	800	300	40,100	38,000	31,500	12,100	10,400
1992	1,800	1,600	700	300	100	33,700	30,500	25,700	22,900	22,100
1993	3,500	2,800	1,600	900	800	36,000	33,200	30,000	22,600	18,500
1994	1,700	1,600	700	400	200	30,400	29,100	26,100	13,700	9,500
1995	4,800	3,700	2,100	700	600	39,600	36,200	29,500	24,200	20,500
1996	3,900	2,700	1,300	900	900	36,800	34,200	28,900	15,300	10,000
1997	5,400	3,200	1,600	700	500	28,600	24,700	19,500	15,300	12,800
1998	3,700	2,100	800	400	200	36,900	34,200	27,500	22,900	16,700
1999	6,100	5,000	1,700	500	300	38,100	37,300	26,800	16,000	9,500
2000	3,800	1,600	500	100	0	38,300	37,400	31,800	27,900	25,600
2001	2,000	1,800	500	300	200	37,300	31,300	21,800	17,600	17,200
2002	6,200	3,800	1,800	600	200	35,300	34,400	27,200	21,500	16,900
2003	2,100	1,700	900	600	400	36,700	33,100	29,400	26,300	25,400
2004	2,300	1,600	900	300	200	39,300	37,400	32,500	28,300	26,400
2005	2,500	1,700	1,100	400	0	35,500	33,200	30,100	27,200	25,600
<b>1987 to 2005</b>	<b>3,700</b>	<b>2,500</b>	<b>1,100</b>	<b>400</b>	<b>200</b>	<b>37,900</b>	<b>35,000</b>	<b>27,900</b>	<b>19,200</b>	<b>16,000</b>

**Table G-8.** August frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	August Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,800	1,400	300	100	100	23,900	22,600	18,500	16,900	16,300
1988	2,000	1,700	800	400	200	18,100	15,500	12,800	8,800	6,000
1989	1,800	1,400	600	400	200	28,700	27,300	26,000	23,400	21,300
1990	2,700	2,100	1,100	400	200	30,200	26,700	22,300	20,500	20,100
1991	2,700	2,100	1,000	400	100	31,000	28,700	23,000	19,400	15,500
1992	2,100	1,600	1,000	500	400	23,800	23,200	20,300	17,000	15,600
1993	2,100	1,400	600	300	200	28,600	28,000	24,400	22,700	22,100
1994	2,200	1,600	700	500	400	19,000	16,700	12,900	9,500	8,600
1995	2,300	1,500	800	400	400	32,300	28,900	27,400	19,100	16,300
1996	2,800	1,900	900	200	100	34,700	33,500	32,300	30,600	28,100
1997	4,400	2,900	1,600	500	200	35,400	35,100	28,900	22,700	22,300
1998	2,000	1,600	800	200	100	31,100	28,500	23,600	17,000	15,000
1999	2,300	1,800	900	500	400	37,300	36,300	32,500	27,400	26,200
2000	1,100	700	400	200	100	29,200	28,000	21,800	16,900	14,800
2001	700	500	300	200	100	16,800	16,400	14,500	12,500	11,700
2002	2,400	1,200	500	100	0	29,700	28,100	25,600	22,600	21,000
2003	1,000	800	300	200	200	23,800	22,200	19,900	15,800	14,700
2004	1,500	1,000	300	100	100	28,000	26,200	22,400	19,600	17,400
2005	1,600	1,300	700	200	0	31,700	28,600	23,600	20,500	19,300
<b>1987 to 2005</b>	<b>2,200</b>	<b>1,600</b>	<b>700</b>	<b>200</b>	<b>100</b>	<b>32,100</b>	<b>28,600</b>	<b>22,600</b>	<b>16,300</b>	<b>13,900</b>

**Table G-9.** September frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	September Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	4,700	1,800	900	300	100	28,700	26,300	24,400	22,300	21,400
1988	1,700	900	400	100	100	25,100	21,300	18,700	16,000	11,100
1989	2,100	1,800	900	400	100	39,700	38,800	32,100	30,000	27,600
1990	1,700	1,200	400	200	0	32,200	31,400	27,300	24,800	23,200
1991	1,900	900	200	100	0	34,500	33,100	29,500	27,300	23,300
1992	2,300	2,000	1,100	300	100	31,700	30,200	28,200	26,300	23,300
1993	1,700	1,200	400	100	0	33,700	32,000	29,600	27,600	24,900
1994	900	700	400	100	0	22,700	20,900	17,200	14,100	13,000
1995	2,400	1,900	600	400	300	32,000	30,300	27,000	20,600	18,700
1996	2,100	800	400	100	100	31,400	29,700	27,700	23,700	22,900
1997	1,400	1,000	500	200	100	32,600	31,300	29,200	22,500	20,700
1998	1,700	1,400	500	300	0	32,200	31,100	28,600	21,700	18,400
1999	2,000	1,700	1,200	200	100	28,600	25,400	19,800	11,600	8,800
2000	1,800	900	300	100	0	26,100	24,900	23,500	18,300	16,000
2001	800	500	400	200	200	21,400	18,000	14,800	13,000	11,600
2002	1,000	700	400	100	0	25,000	23,900	21,700	18,400	17,700
2003	900	700	400	200	0	21,200	20,000	16,900	13,800	8,800
2004	2,600	1,900	500	0	0	40,800	39,500	32,900	23,300	22,000
2005	1,700	1,200	700	300	100	22,700	20,800	18,000	14,300	12,300
<b>1987 to 2005</b>	<b>2,000</b>	<b>1,400</b>	<b>500</b>	<b>100</b>	<b>0</b>	<b>32,600</b>	<b>30,400</b>	<b>24,300</b>	<b>18,000</b>	<b>14,500</b>

**Table G-10.** October frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	October Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	3,100	2,700	900	200	0	30,400	29,300	27,300	22,600	21,700
1988	10,000	2,300	300	0	0	38,000	37,000	33,200	26,700	23,400
1989	2,000	800	300	0	0	42,100	40,600	39,200	37,900	33,700
1990	1,400	1,000	300	0	0	51,900	49,800	46,100	40,900	38,900
1991	2,200	1,200	300	0	0	46,400	45,400	42,900	38,900	36,100
1992	1,600	1,000	300	100	0	42,500	41,800	39,600	33,800	33,000
1993	500	300	100	0	0	42,500	41,700	39,700	38,300	37,600
1994	1,300	1,100	300	0	0	37,300	36,500	33,500	31,400	30,100
1995	3,000	1,600	300	0	0	38,400	36,800	34,000	28,800	26,700
1996	4,500	2,700	1,200	300	100	39,300	34,500	32,000	26,900	26,500
1997	900	700	200	0	0	41,600	39,900	37,200	31,500	28,400
1998	1,300	800	400	100	0	33,600	32,200	30,300	26,500	25,900
1999	2,800	1,500	900	400	300	35,400	34,600	31,800	27,500	25,600
2000	1,000	700	400	0	0	35,000	33,300	31,500	29,800	26,900
2001	900	700	400	0	0	35,100	32,700	30,100	25,100	24,100
2002	1,400	500	200	0	0	30,500	29,700	25,700	24,000	22,400
2003	900	900	300	0	0	32,600	31,000	27,400	24,000	22,600
2004	1,800	800	300	200	100	40,200	39,300	36,800	34,200	33,600
2005	1,600	1,300	500	200	200	38,200	32,300	27,800	23,100	22,300
<b>1987 to 2005</b>	<b>2,100</b>	<b>1,200</b>	<b>400</b>	<b>0</b>	<b>0</b>	<b>42,500</b>	<b>39,700</b>	<b>33,200</b>	<b>27,400</b>	<b>24,500</b>

**Table G-11.** November frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	November Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,900	1,700	700	200	0	28,400	24,500	22,200	17,400	15,100
1988	1,500	1,300	800	400	200	37,900	36,300	32,300	26,800	22,300
1989	2,300	1,900	800	300	200	43,900	42,500	39,900	32,800	28,400
1990	1,600	1,100	400	0	0	53,500	50,700	45,400	40,800	39,700
1991	2,600	2,000	600	100	0	41,600	39,000	34,600	28,800	24,100
1992	5,100	4,200	2,000	400	400	45,600	42,400	32,800	26,600	24,500
1993	2,900	1,900	600	0	0	41,300	39,500	34,800	27,600	26,400
1994	3,900	2,100	1,000	300	0	46,400	44,700	37,900	30,100	27,400
1995	2,500	1,600	1,200	500	300	38,900	30,700	26,500	19,000	15,600
1996	2,400	1,700	1,100	600	300	39,400	37,300	34,300	27,700	27,100
1997	3,100	2,700	1,200	400	0	40,000	38,500	35,000	27,300	25,900
1998	2,200	1,600	800	300	0	25,700	24,700	20,300	17,500	16,200
1999	4,000	3,500	2,000	600	400	36,700	35,000	29,900	22,600	20,400
2000	2,600	1,400	600	200	200	37,800	36,600	24,500	20,500	17,800
2001	3,500	1,800	800	300	300	33,800	32,000	26,400	20,300	19,400
2002	2,000	1,600	500	0	0	28,300	27,900	24,600	22,800	22,500
2003	2,500	2,000	1,000	400	100	31,700	27,300	20,400	9,300	7,700
2004	3,000	1,700	600	200	200	32,000	31,000	27,000	24,000	21,500
2005	3,000	2,500	1,000	400	200	31,800	28,100	20,700	10,800	8,500
<b>1987 to 2005</b>	<b>3,000</b>	<b>2,000</b>	<b>800</b>	<b>300</b>	<b>0</b>	<b>41,600</b>	<b>38,000</b>	<b>29,100</b>	<b>21,900</b>	<b>18,300</b>

**Table G-12.** December frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	December Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	4,200	2,800	1,700	700	500	34,800	29,400	24,300	18,900	18,200
1988	3,300	2,200	1,000	300	0	32,800	31,000	27,800	25,300	19,000
1989	2,100	1,900	1,100	100	0	47,600	43,800	38,900	35,700	34,100
1990	3,000	1,900	1,000	300	200	46,900	46,000	41,400	35,300	31,200
1991	1,700	1,500	500	0	0	35,600	33,300	26,600	12,500	10,600
1992	2,700	2,100	1,000	200	0	32,800	30,000	26,200	22,800	18,100
1993	2,500	1,800	1,200	700	300	39,300	37,200	33,900	31,900	27,100
1994	2,400	1,800	1,200	600	300	35,300	34,300	26,400	22,000	20,900
1995	4,700	3,600	2,100	1,100	500	33,200	28,500	20,500	16,000	15,000
1996	3,000	2,200	1,200	600	500	35,900	34,700	28,100	24,800	21,400
1997	2,300	1,100	600	200	0	36,000	35,600	34,600	31,000	30,400
1998	4,200	3,100	2,100	1,200	500	29,300	28,600	23,900	19,000	17,100
1999	3,600	1,400	800	400	0	40,700	40,500	36,200	33,300	31,800
2000	2,800	1,900	700	300	200	33,800	31,100	24,600	22,900	19,900
2001	2,000	1,500	700	300	200	27,400	25,400	20,900	16,500	15,500
2002	1,400	1,200	300	100	0	34,800	34,300	31,300	29,000	25,100
2003	1,600	1,000	400	0	0	31,800	31,000	26,100	22,900	22,200
2004	3,100	1,700	900	400	300	35,900	35,800	30,900	27,700	27,000
2005	2,800	1,600	700	200	0	32,900	32,100	27,700	24,300	21,900
<b>1987 to 2005</b>	<b>3,000</b>	<b>2,000</b>	<b>900</b>	<b>300</b>	<b>100</b>	<b>39,200</b>	<b>35,400</b>	<b>29,100</b>	<b>22,900</b>	<b>18,500</b>

**Table G-13.** Annual frequency of exceedance of daily flow fluctuation (daily maximum minus daily minimum) in Pend Oreille River based on total inflow to Boundary Reservoir and total flow release from Boundary Dam, 1987 to 2005.

Year	Annual Frequency of Exceedance of Daily Flow Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (cfs)									
	Total Inflow to Boundary Reservoir					Total Flow Release from Boundary Dam				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	2,900	2,200	900	200	100	30,500	28,000	24,000	18,900	16,800
1988	2,900	2,000	700	200	100	36,000	32,600	24,600	17,500	14,300
1989	2,600	1,900	800	300	0	41,300	39,100	31,800	23,900	15,600
1990	3,200	2,300	800	200	100	47,600	44,100	35,500	22,000	12,200
1991	3,600	2,200	800	200	0	45,600	42,000	31,400	16,800	9,300
1992	2,700	2,000	600	200	0	38,900	33,000	25,400	19,600	16,600
1993	2,900	2,000	700	200	0	39,700	37,600	31,000	24,200	22,000
1994	2,400	1,600	700	200	100	38,500	35,300	29,700	19,400	14,700
1995	3,400	2,500	800	300	100	37,600	34,200	27,100	18,800	16,000
1996	3,700	2,500	1,000	300	200	37,300	33,600	25,800	11,100	8,900
1997	4,500	2,800	1,100	300	100	37,200	34,500	25,000	15,000	10,600
1998	3,000	2,200	800	300	100	32,900	30,800	25,500	18,900	15,800
1999	3,700	2,500	1,000	400	200	36,700	34,200	27,500	17,400	9,700
2000	2,800	1,800	600	200	0	39,100	36,700	30,000	22,400	17,800
2001	1,700	900	400	200	0	37,800	32,000	23,000	16,400	14,300
2002	3,600	2,200	800	200	0	35,900	32,200	26,200	21,000	12,900
2003	2,700	1,700	700	200	0	36,500	33,400	26,800	18,000	13,500
2004	2,300	1,700	600	200	100	39,300	36,600	30,200	22,900	19,900
2005	2,700	1,800	800	300	100	36,000	32,600	27,400	20,500	15,500
<b>1987 to 2005</b>	<b>3,100</b>	<b>2,000</b>	<b>800</b>	<b>200</b>	<b>100</b>	<b>39,200</b>	<b>35,100</b>	<b>27,400</b>	<b>18,800</b>	<b>14,200</b>

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## **Appendix H**

# **Monthly and Annual Frequency of Exceedance of Hourly Stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005**

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**Table H-1.** January frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	January Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,732.38	1,731.98	1,729.64	1,718.42	1,716.03	1,714.21	1,712.37	1,707.90	1,704.79	1,703.41
1988	1,731.05	1,729.98	1,727.85	1,716.03	1,716.03	1,716.06	1,714.74	1,711.23	1,709.02	1,707.52
1989	1,734.80	1,733.76	1,731.61	1,729.02	1,728.04	1,731.85	1,730.97	1,728.98	1,727.69	1,726.78
1990	1,737.40	1,736.45	1,733.54	1,723.85	1,720.54	1,729.29	1,727.06	1,722.06	1,717.52	1,715.54
1991	1,736.61	1,735.73	1,733.32	1,725.06	1,721.78	1,728.61	1,726.90	1,722.24	1,717.78	1,715.75
1992	1,732.97	1,732.22	1,730.36	1,727.09	1,724.50	1,727.98	1,727.13	1,723.02	1,721.29	1,720.17
1993	1,735.35	1,734.66	1,732.62	1,728.24	1,726.19	1,731.20	1,730.12	1,727.54	1,724.73	1,723.72
1994	1,734.91	1,734.32	1,732.37	1,729.21	1,727.51	1,730.21	1,729.33	1,727.85	1,725.33	1,723.86
1995	1,734.66	1,734.01	1,731.83	1,729.77	1,728.79	1,731.55	1,730.78	1,729.33	1,727.88	1,726.87
1996	1,737.28	1,736.36	1,734.60	1,731.46	1,729.60	1,731.35	1,729.77	1,726.44	1,721.30	1,718.28
1997	1,736.73	1,735.60	1,733.69	1,730.94	1,728.78	1,731.32	1,730.31	1,727.56	1,724.28	1,723.32
1998	1,734.13	1,733.21	1,731.19	1,726.24	1,721.06	1,729.35	1,727.24	1,721.39	1,715.25	1,710.73
1999	1,735.37	1,734.70	1,733.41	1,731.21	1,729.97	1,732.28	1,731.62	1,730.12	1,728.41	1,727.27
2000	1,735.39	1,734.49	1,731.82	1,727.19	1,723.93	1,729.84	1,728.54	1,725.21	1,721.77	1,718.93
2001	1,733.51	1,732.72	1,730.80	1,727.43	1,726.17	1,730.41	1,729.50	1,727.56	1,725.19	1,724.11
2002	1,734.49	1,733.33	1,731.32	1,725.70	1,723.55	1,728.77	1,727.04	1,723.82	1,719.67	1,716.39
2003	1,733.64	1,732.23	1,729.38	1,725.97	1,722.04	1,730.73	1,729.49	1,726.80	1,716.05	1,709.76
2004	1,732.98	1,731.82	1,729.52	1,726.05	1,723.30	1,729.71	1,728.01	1,725.10	1,717.69	1,710.05
2005	1,735.10	1,734.38	1,730.84	1,726.74	1,723.54	1,729.89	1,728.52	1,724.90	1,720.44	1,717.51
<b>1987 to 2005</b>	<b>1,735.32</b>	<b>1,734.24</b>	<b>1,731.44</b>	<b>1,727.31</b>	<b>1,724.08</b>	<b>1,730.61</b>	<b>1,729.36</b>	<b>1,725.85</b>	<b>1,718.63</b>	<b>1,712.07</b>

**Table H-2.** February frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	February Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,733.26	1,732.41	1,730.66	1,719.02	1,716.03	1,710.69	1,709.05	1,706.59	1,703.42	1,702.20
1988	1,731.64	1,730.77	1,728.38	1,724.95	1,716.03	1,716.11	1,715.19	1,713.72	1,711.64	1,710.14
1989	1,733.35	1,732.55	1,731.08	1,729.65	1,728.55	1,731.00	1,730.21	1,728.92	1,727.72	1,726.57
1990	1,736.10	1,735.09	1,733.66	1,723.16	1,720.16	1,726.97	1,724.89	1,719.98	1,715.65	1,712.46
1991	1,737.32	1,736.61	1,734.68	1,726.72	1,722.72	1,729.39	1,727.22	1,721.38	1,714.81	1,711.64
1992	1,732.41	1,731.88	1,730.47	1,728.02	1,725.48	1,730.30	1,728.61	1,726.08	1,722.77	1,721.78
1993	1,734.10	1,733.34	1,731.67	1,730.15	1,729.47	1,731.66	1,731.30	1,730.28	1,728.64	1,727.43
1994	1,734.92	1,734.27	1,732.14	1,729.49	1,727.71	1,730.94	1,730.38	1,728.90	1,726.97	1,726.01
1995	1,734.58	1,733.69	1,731.96	1,730.28	1,729.00	1,730.48	1,730.12	1,727.95	1,723.83	1,722.08
1996	1,741.97	1,741.61	1,739.53	1,733.28	1,730.23	1,733.30	1,732.84	1,729.63	1,725.85	1,723.96
1997	1,736.06	1,735.12	1,733.03	1,730.90	1,729.25	1,731.71	1,730.12	1,727.73	1,725.56	1,724.37
1998	1,734.25	1,733.06	1,730.93	1,728.19	1,726.24	1,731.03	1,730.08	1,727.13	1,723.85	1,720.70
1999	1,734.59	1,733.71	1,732.14	1,729.39	1,728.00	1,731.03	1,729.95	1,727.82	1,725.62	1,723.71
2000	1,734.04	1,733.10	1,730.96	1,727.71	1,725.04	1,729.72	1,728.64	1,725.88	1,722.57	1,721.34
2001	1,732.54	1,731.93	1,729.75	1,726.58	1,725.15	1,731.20	1,730.44	1,727.73	1,723.03	1,720.99
2002	1,734.53	1,733.34	1,731.95	1,727.46	1,725.46	1,730.05	1,728.83	1,725.94	1,722.80	1,720.99
2003	1,735.31	1,734.26	1,731.83	1,728.73	1,725.95	1,731.16	1,729.98	1,727.33	1,722.59	1,711.78
2004	1,733.42	1,732.47	1,730.94	1,728.37	1,726.99	1,730.15	1,729.33	1,727.06	1,724.24	1,721.78
2005	1,734.20	1,733.42	1,731.73	1,727.94	1,726.55	1,730.49	1,729.18	1,726.67	1,722.19	1,717.81
<b>1987 to 2005</b>	<b>1,735.30</b>	<b>1,733.91</b>	<b>1,731.49</b>	<b>1,728.12</b>	<b>1,725.61</b>	<b>1,730.87</b>	<b>1,729.82</b>	<b>1,726.83</b>	<b>1,720.24</b>	<b>1,713.57</b>

**Table H-3.** March frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	March Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,733.76	1,732.71	1,729.25	1,720.52	1,716.03	1,714.76	1,713.48	1,710.50	1,708.23	1,705.74
1988	1,733.70	1,733.10	1,731.39	1,726.16	1,721.29	1,713.28	1,711.51	1,709.94	1,707.48	1,705.94
1989	1,735.68	1,734.94	1,732.44	1,727.02	1,725.15	1,730.64	1,729.00	1,726.15	1,722.73	1,720.73
1990	1,735.48	1,734.62	1,732.65	1,726.04	1,723.58	1,728.97	1,727.19	1,723.64	1,718.23	1,711.17
1991	1,737.73	1,736.83	1,734.26	1,731.30	1,729.22	1,733.43	1,732.25	1,726.41	1,718.69	1,715.38
1992	1,734.13	1,733.46	1,731.88	1,729.99	1,729.08	1,730.70	1,729.95	1,728.74	1,726.67	1,725.22
1993	1,735.07	1,734.39	1,732.84	1,730.79	1,729.48	1,732.04	1,731.40	1,730.44	1,728.84	1,727.75
1994	1,735.15	1,734.33	1,732.55	1,729.90	1,729.05	1,731.71	1,730.75	1,729.18	1,727.39	1,726.28
1995	1,736.76	1,736.12	1,734.81	1,732.61	1,731.59	1,731.85	1,731.20	1,729.20	1,725.00	1,722.94
1996	1,740.12	1,739.87	1,739.31	1,738.19	1,737.44	1,733.23	1,733.04	1,732.28	1,731.15	1,730.35
1997	1,740.83	1,739.78	1,735.63	1,733.06	1,731.69	1,733.48	1,733.04	1,731.19	1,726.78	1,723.31
1998	1,735.91	1,734.43	1,731.17	1,728.51	1,725.29	1,731.00	1,729.98	1,726.31	1,723.85	1,722.39
1999	1,736.24	1,735.26	1,733.57	1,730.88	1,728.06	1,731.99	1,730.69	1,727.26	1,723.86	1,720.87
2000	1,735.80	1,734.76	1,732.84	1,728.38	1,725.49	1,731.07	1,729.82	1,726.53	1,723.64	1,721.52
2001	1,732.36	1,731.54	1,729.82	1,727.41	1,726.10	1,730.74	1,730.16	1,728.36	1,724.57	1,720.95
2002	1,734.89	1,734.18	1,731.95	1,727.18	1,724.53	1,729.65	1,728.36	1,725.64	1,721.70	1,718.94
2003	1,736.81	1,735.97	1,731.95	1,728.13	1,722.77	1,731.42	1,730.03	1,724.46	1,715.27	1,712.62
2004	1,734.63	1,734.00	1,732.04	1,728.51	1,726.33	1,729.52	1,728.64	1,726.77	1,723.97	1,722.18
2005	1,734.49	1,733.69	1,731.68	1,729.72	1,728.41	1,731.47	1,730.70	1,729.26	1,727.49	1,726.29
<b>1987 to 2005</b>	<b>1,736.87</b>	<b>1,735.19</b>	<b>1,732.58</b>	<b>1,729.09</b>	<b>1,726.43</b>	<b>1,732.02</b>	<b>1,730.74</b>	<b>1,727.52</b>	<b>1,721.06</b>	<b>1,712.46</b>

**Table H-4.** April frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	April Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,735.91	1,735.01	1,733.31	1,728.26	1,725.27	1,715.61	1,714.10	1,710.05	1,706.10	1,703.74
1988	1,737.97	1,736.67	1,733.55	1,726.77	1,724.92	1,717.65	1,716.44	1,711.94	1,707.53	1,704.69
1989	1,740.46	1,738.54	1,735.39	1,729.78	1,724.60	1,732.77	1,732.28	1,726.77	1,720.47	1,716.46
1990	1,741.53	1,740.93	1,738.13	1,734.22	1,729.88	1,733.66	1,733.43	1,731.28	1,722.75	1,717.59
1991	1,738.69	1,737.69	1,736.09	1,731.18	1,728.22	1,731.59	1,729.79	1,723.51	1,718.67	1,716.57
1992	1,736.96	1,736.07	1,732.94	1,729.03	1,726.57	1,731.69	1,730.55	1,728.51	1,723.85	1,722.49
1993	1,736.04	1,735.42	1,733.70	1,729.13	1,726.91	1,731.56	1,730.42	1,727.69	1,724.44	1,722.90
1994	1,736.47	1,735.72	1,733.85	1,730.99	1,729.42	1,732.18	1,731.24	1,729.51	1,726.79	1,725.56
1995	1,736.52	1,735.85	1,734.30	1,728.37	1,725.45	1,730.37	1,728.57	1,725.36	1,721.48	1,719.12
1996	1,744.00	1,743.59	1,742.48	1,738.75	1,737.39	1,733.63	1,733.43	1,732.87	1,731.99	1,731.16
1997	1,743.60	1,742.85	1,738.87	1,735.24	1,734.20	1,733.43	1,733.30	1,732.14	1,722.18	1,718.90
1998	1,737.01	1,736.09	1,733.32	1,729.85	1,728.05	1,731.23	1,729.75	1,725.85	1,715.60	1,711.47
1999	1,739.63	1,738.46	1,734.52	1,732.65	1,730.30	1,731.79	1,730.29	1,724.73	1,711.33	1,708.88
2000	1,741.42	1,740.90	1,736.48	1,732.87	1,729.64	1,733.17	1,732.67	1,727.88	1,719.75	1,711.37
2001	1,732.75	1,731.55	1,729.88	1,726.78	1,723.26	1,729.62	1,728.21	1,724.43	1,720.17	1,718.55
2002	1,739.68	1,738.27	1,734.40	1,730.58	1,728.17	1,732.64	1,730.87	1,725.60	1,719.58	1,717.34
2003	1,739.22	1,737.80	1,736.13	1,733.33	1,730.81	1,731.69	1,729.70	1,725.49	1,720.43	1,716.72
2004	1,735.15	1,734.65	1,733.01	1,728.10	1,726.07	1,730.41	1,729.07	1,726.68	1,724.05	1,722.61
2005	1,736.34	1,735.63	1,733.99	1,730.49	1,728.79	1,731.62	1,730.96	1,729.20	1,726.11	1,723.46
<b>1987 to 2005</b>	<b>1,740.23</b>	<b>1,737.81</b>	<b>1,734.56</b>	<b>1,730.18</b>	<b>1,727.39</b>	<b>1,732.84</b>	<b>1,731.49</b>	<b>1,726.68</b>	<b>1,718.34</b>	<b>1,712.33</b>

**Table H-5.** May frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	May Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,735.91	1,735.01	1,733.31	1,728.26	1,725.27	1,715.61	1,714.10	1,710.05	1,706.10	1,703.74
1988	1,737.97	1,736.67	1,733.55	1,726.77	1,724.92	1,717.65	1,716.44	1,711.94	1,707.53	1,704.69
1989	1,740.46	1,738.54	1,735.39	1,729.78	1,724.60	1,732.77	1,732.28	1,726.77	1,720.47	1,716.46
1990	1,741.53	1,740.93	1,738.13	1,734.22	1,729.88	1,733.66	1,733.43	1,731.28	1,722.75	1,717.59
1991	1,738.69	1,737.69	1,736.09	1,731.18	1,728.22	1,731.59	1,729.79	1,723.51	1,718.67	1,716.57
1992	1,736.96	1,736.07	1,732.94	1,729.03	1,726.57	1,731.69	1,730.55	1,728.51	1,723.85	1,722.49
1993	1,736.04	1,735.42	1,733.70	1,729.13	1,726.91	1,731.56	1,730.42	1,727.69	1,724.44	1,722.90
1994	1,736.47	1,735.72	1,733.85	1,730.99	1,729.42	1,732.18	1,731.24	1,729.51	1,726.79	1,725.56
1995	1,736.52	1,735.85	1,734.30	1,728.37	1,725.45	1,730.37	1,728.57	1,725.36	1,721.48	1,719.12
1996	1,744.00	1,743.59	1,742.48	1,738.75	1,737.39	1,733.63	1,733.43	1,732.87	1,731.99	1,731.16
1997	1,743.60	1,742.85	1,738.87	1,735.24	1,734.20	1,733.43	1,733.30	1,732.14	1,722.18	1,718.90
1998	1,737.01	1,736.09	1,733.32	1,729.85	1,728.05	1,731.23	1,729.75	1,725.85	1,715.60	1,711.47
1999	1,739.63	1,738.46	1,734.52	1,732.65	1,730.30	1,731.79	1,730.29	1,724.73	1,711.33	1,708.88
2000	1,741.42	1,740.90	1,736.48	1,732.87	1,729.64	1,733.17	1,732.67	1,727.88	1,719.75	1,711.37
2001	1,732.75	1,731.55	1,729.88	1,726.78	1,723.26	1,729.62	1,728.21	1,724.43	1,720.17	1,718.55
2002	1,739.68	1,738.27	1,734.40	1,730.58	1,728.17	1,732.64	1,730.87	1,725.60	1,719.58	1,717.34
2003	1,739.22	1,737.80	1,736.13	1,733.33	1,730.81	1,731.69	1,729.70	1,725.49	1,720.43	1,716.72
2004	1,735.15	1,734.65	1,733.01	1,728.10	1,726.07	1,730.41	1,729.07	1,726.68	1,724.05	1,722.61
2005	1,736.34	1,735.63	1,733.99	1,730.49	1,728.79	1,731.62	1,730.96	1,729.20	1,726.11	1,723.46
<b>1987 to 2005</b>	<b>1,740.23</b>	<b>1,737.81</b>	<b>1,734.56</b>	<b>1,730.18</b>	<b>1,727.39</b>	<b>1,732.84</b>	<b>1,731.49</b>	<b>1,726.68</b>	<b>1,718.34</b>	<b>1,712.33</b>

**Table H-6.** June frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	June Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,733.39	1,732.99	1,731.31	1,726.09	1,724.79	1,715.32	1,713.65	1,710.69	1,708.43	1,707.04
1988	1,737.05	1,736.33	1,734.78	1,732.46	1,731.67	1,733.00	1,732.67	1,731.85	1,730.24	1,729.09
1989	1,741.52	1,741.35	1,737.94	1,734.94	1,732.07	1,733.59	1,733.33	1,732.02	1,725.25	1,723.09
1990	1,745.43	1,745.20	1,743.92	1,742.45	1,741.83	1,733.46	1,733.33	1,732.90	1,732.22	1,731.69
1991	1,746.72	1,746.42	1,743.45	1,741.22	1,740.62	1,733.63	1,733.46	1,733.07	1,732.58	1,732.38
1992	1,735.95	1,735.22	1,733.06	1,730.75	1,729.51	1,732.58	1,732.15	1,730.61	1,728.54	1,727.46
1993	1,739.38	1,738.00	1,736.34	1,733.25	1,731.13	1,733.10	1,732.00	1,727.94	1,723.91	1,722.67
1994	1,737.01	1,736.56	1,734.65	1,727.88	1,725.29	1,728.94	1,727.19	1,722.21	1,716.95	1,714.13
1995	1,742.69	1,742.13	1,741.46	1,739.75	1,737.25	1,733.63	1,733.36	1,732.87	1,731.99	1,730.29
1996	1,748.48	1,748.00	1,746.58	1,740.78	1,740.12	1,733.04	1,732.58	1,731.85	1,730.97	1,730.15
1997	1,754.55	1,754.14	1,753.39	1,749.45	1,744.45	1,732.54	1,732.22	1,731.59	1,730.61	1,729.09
1998	1,743.39	1,742.36	1,741.01	1,739.50	1,738.82	1,733.46	1,733.10	1,732.20	1,730.99	1,730.21
1999	1,744.62	1,744.23	1,743.33	1,742.50	1,741.93	1,732.38	1,732.05	1,731.56	1,730.97	1,730.67
2000	1,741.08	1,740.63	1,738.40	1,734.89	1,732.90	1,733.13	1,732.87	1,730.92	1,725.94	1,723.28
2001	1,735.96	1,735.50	1,734.24	1,728.22	1,725.30	1,729.26	1,727.26	1,722.86	1,718.34	1,715.09
2002	1,748.24	1,748.06	1,746.83	1,744.63	1,743.46	1,732.67	1,732.54	1,732.25	1,731.85	1,731.46
2003	1,742.74	1,741.74	1,738.37	1,735.88	1,732.97	1,732.38	1,731.82	1,728.74	1,725.16	1,723.55
2004	1,738.98	1,738.39	1,737.06	1,733.37	1,731.13	1,730.52	1,729.71	1,728.05	1,725.39	1,724.41
2005	1,742.32	1,740.58	1,738.11	1,736.24	1,733.35	1,732.17	1,731.47	1,727.31	1,721.17	1,717.57
<b>1987 to 2005</b>	<b>1,746.82</b>	<b>1,743.86</b>	<b>1,739.12</b>	<b>1,733.80</b>	<b>1,731.36</b>	<b>1,733.17</b>	<b>1,732.67</b>	<b>1,731.23</b>	<b>1,725.19</b>	<b>1,719.98</b>

**Table H-7.** July frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	July Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,731.42	1,730.75	1,728.80	1,716.03	1,716.03	1,714.63	1,713.81	1,712.66	1,710.36	1,709.31
1988	1,735.24	1,734.48	1,732.67	1,731.08	1,730.18	1,732.96	1,732.54	1,731.56	1,729.95	1,729.16
1989	1,736.66	1,735.54	1,733.63	1,728.72	1,725.25	1,732.40	1,730.82	1,726.74	1,722.77	1,721.17
1990	1,740.87	1,740.20	1,735.89	1,730.30	1,726.43	1,733.30	1,732.75	1,728.87	1,720.92	1,714.45
1991	1,743.03	1,742.26	1,736.92	1,732.50	1,729.38	1,733.53	1,733.30	1,729.75	1,722.52	1,720.14
1992	1,734.87	1,734.07	1,732.45	1,729.25	1,727.97	1,731.33	1,730.59	1,729.13	1,727.75	1,727.10
1993	1,738.10	1,737.01	1,735.66	1,733.51	1,732.27	1,732.93	1,731.21	1,727.45	1,724.60	1,722.71
1994	1,733.88	1,733.08	1,730.94	1,728.42	1,726.64	1,731.03	1,730.41	1,728.53	1,725.78	1,724.13
1995	1,738.73	1,736.71	1,735.05	1,731.80	1,729.50	1,732.37	1,730.33	1,726.67	1,723.65	1,722.03
1996	1,740.70	1,739.91	1,735.66	1,732.13	1,728.92	1,732.80	1,732.28	1,730.01	1,725.78	1,723.65
1997	1,741.59	1,740.17	1,737.72	1,734.01	1,732.10	1,733.49	1,733.07	1,731.36	1,725.36	1,722.81
1998	1,740.54	1,739.77	1,735.70	1,732.93	1,730.17	1,732.48	1,731.59	1,728.57	1,725.16	1,723.72
1999	1,741.28	1,740.20	1,737.81	1,733.12	1,731.11	1,731.99	1,731.46	1,728.92	1,724.92	1,722.90
2000	1,735.80	1,735.05	1,732.84	1,728.31	1,725.12	1,728.41	1,726.55	1,723.42	1,719.09	1,717.15
2001	1,733.64	1,732.01	1,729.27	1,724.90	1,721.77	1,726.80	1,725.16	1,721.86	1,717.68	1,716.24
2002	1,742.50	1,740.22	1,735.93	1,732.99	1,730.32	1,732.39	1,732.05	1,726.20	1,716.39	1,713.75
2003	1,735.36	1,734.60	1,732.70	1,729.76	1,728.36	1,731.43	1,730.34	1,728.21	1,725.42	1,723.84
2004	1,736.02	1,735.35	1,733.32	1,729.21	1,727.27	1,730.07	1,728.61	1,726.41	1,723.08	1,721.49
2005	1,736.82	1,735.97	1,733.42	1,730.36	1,729.13	1,731.82	1,730.79	1,728.58	1,726.00	1,724.16
<b>1987 to 2005</b>	<b>1,739.56</b>	<b>1,736.87</b>	<b>1,733.75</b>	<b>1,729.85</b>	<b>1,727.47</b>	<b>1,732.54</b>	<b>1,731.46</b>	<b>1,727.62</b>	<b>1,722.44</b>	<b>1,717.81</b>

**Table H-8.** August frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	August Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,730.95	1,730.36	1,728.53	1,716.03	1,716.03	1,715.97	1,714.99	1,713.25	1,711.17	1,709.18
1988	1,733.22	1,732.90	1,730.70	1,725.84	1,717.86	1,732.71	1,732.29	1,729.72	1,716.17	1,703.06
1989	1,734.02	1,733.35	1,731.97	1,726.84	1,725.09	1,729.65	1,728.80	1,726.22	1,721.39	1,718.04
1990	1,733.59	1,732.16	1,730.31	1,725.57	1,722.68	1,728.42	1,726.60	1,724.36	1,715.92	1,713.25
1991	1,734.04	1,733.09	1,730.49	1,727.34	1,724.29	1,730.71	1,729.33	1,726.38	1,723.13	1,720.83
1992	1,734.37	1,733.77	1,732.13	1,730.46	1,729.32	1,732.71	1,732.03	1,730.54	1,729.16	1,727.89
1993	1,735.13	1,734.04	1,732.67	1,730.73	1,729.12	1,731.09	1,730.19	1,728.34	1,726.11	1,725.06
1994	1,733.70	1,733.04	1,731.15	1,729.79	1,729.14	1,732.61	1,732.28	1,730.41	1,729.13	1,728.40
1995	1,734.74	1,733.68	1,731.09	1,727.78	1,725.36	1,731.66	1,731.03	1,727.75	1,722.96	1,720.32
1996	1,736.43	1,735.38	1,733.20	1,728.94	1,726.32	1,733.20	1,731.99	1,728.13	1,723.72	1,722.01
1997	1,735.88	1,735.02	1,732.89	1,729.61	1,728.10	1,731.84	1,730.15	1,727.69	1,724.16	1,721.23
1998	1,734.30	1,733.38	1,730.31	1,727.51	1,725.67	1,729.30	1,728.03	1,725.03	1,722.27	1,719.64
1999	1,735.18	1,734.37	1,732.21	1,728.74	1,726.29	1,731.82	1,730.67	1,726.87	1,723.73	1,721.45
2000	1,732.49	1,731.73	1,729.33	1,724.50	1,721.56	1,729.48	1,728.29	1,723.99	1,718.68	1,716.28
2001	1,731.31	1,730.37	1,728.81	1,726.29	1,724.48	1,729.67	1,728.62	1,726.01	1,722.51	1,718.15
2002	1,733.75	1,733.16	1,731.13	1,728.56	1,726.45	1,730.21	1,729.28	1,726.32	1,723.91	1,723.04
2003	1,732.51	1,731.89	1,730.39	1,728.85	1,726.85	1,730.35	1,729.77	1,728.27	1,725.74	1,724.83
2004	1,733.60	1,732.75	1,731.06	1,727.90	1,726.36	1,730.95	1,730.16	1,727.38	1,724.57	1,720.21
2005	1,733.48	1,732.71	1,730.75	1,727.45	1,725.64	1,731.33	1,730.11	1,726.89	1,722.77	1,721.11
<b>1987 to 2005</b>	<b>1,734.25</b>	<b>1,733.22</b>	<b>1,730.92</b>	<b>1,727.69</b>	<b>1,725.33</b>	<b>1,731.46</b>	<b>1,730.25</b>	<b>1,727.06</b>	<b>1,722.34</b>	<b>1,717.52</b>

**Table H-9.** September frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	September Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,733.29	1,732.63	1,731.17	1,720.87	1,716.03	1,715.75	1,714.43	1,712.46	1,710.07	1,708.76
1988	1,734.00	1,733.10	1,731.69	1,728.33	1,727.15	1,732.18	1,731.53	1,728.72	1,726.60	1,725.64
1989	1,735.76	1,735.05	1,733.19	1,728.11	1,725.36	1,730.65	1,729.07	1,724.44	1,719.41	1,716.88
1990	1,734.70	1,734.01	1,732.55	1,728.08	1,726.10	1,731.76	1,730.39	1,727.59	1,724.83	1,723.78
1991	1,734.45	1,733.81	1,732.29	1,726.00	1,723.64	1,730.57	1,728.74	1,724.75	1,720.98	1,718.82
1992	1,735.16	1,734.50	1,732.78	1,729.89	1,728.67	1,731.85	1,731.07	1,729.75	1,727.85	1,726.11
1993	1,734.70	1,733.75	1,732.18	1,725.42	1,721.42	1,730.35	1,727.79	1,722.45	1,718.03	1,716.53
1994	1,733.85	1,732.99	1,731.23	1,729.16	1,728.13	1,732.48	1,731.76	1,729.49	1,727.56	1,726.74
1995	1,734.50	1,733.61	1,731.42	1,728.59	1,727.32	1,730.97	1,729.95	1,727.90	1,724.83	1,723.19
1996	1,734.28	1,733.66	1,731.68	1,727.62	1,725.84	1,730.51	1,729.17	1,726.81	1,725.18	1,724.18
1997	1,734.91	1,733.98	1,732.78	1,731.50	1,729.32	1,730.64	1,728.54	1,724.24	1,714.51	1,710.37
1998	1,734.94	1,733.88	1,730.80	1,727.75	1,725.51	1,730.80	1,728.93	1,725.49	1,719.25	1,714.78
1999	1,733.86	1,733.21	1,731.21	1,728.66	1,726.98	1,731.07	1,730.02	1,727.00	1,724.90	1,723.62
2000	1,733.07	1,732.17	1,730.57	1,727.22	1,723.09	1,729.49	1,727.98	1,724.67	1,721.25	1,720.10
2001	1,731.86	1,730.93	1,729.38	1,727.25	1,726.24	1,729.89	1,729.13	1,726.97	1,724.92	1,723.59
2002	1,732.24	1,731.39	1,729.86	1,727.38	1,724.65	1,728.31	1,727.40	1,724.92	1,718.55	1,716.10
2003	1,733.25	1,732.45	1,730.54	1,728.49	1,726.95	1,731.07	1,730.48	1,728.70	1,725.56	1,724.11
2004	1,735.57	1,734.78	1,732.11	1,727.37	1,724.78	1,729.85	1,728.66	1,725.52	1,722.00	1,720.21
2005	1,731.65	1,730.64	1,728.14	1,724.42	1,720.61	1,729.97	1,727.40	1,720.96	1,717.23	1,716.43
<b>1987 to 2005</b>	<b>1,734.38</b>	<b>1,733.44</b>	<b>1,731.24</b>	<b>1,727.73</b>	<b>1,725.48</b>	<b>1,730.94</b>	<b>1,729.72</b>	<b>1,726.47</b>	<b>1,721.09</b>	<b>1,716.80</b>

**Table H-10.** October frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	October Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,734.49	1,734.06	1,732.94	1,727.98	1,726.06	1,717.08	1,715.49	1,712.30	1,708.48	1,705.44
1988	1,735.86	1,734.31	1,732.65	1,726.79	1,724.02	1,728.92	1,726.77	1,722.88	1,718.62	1,716.52
1989	1,736.29	1,735.68	1,734.40	1,726.39	1,722.36	1,729.35	1,727.62	1,721.67	1,715.96	1,712.21
1990	1,738.15	1,737.12	1,735.42	1,727.55	1,724.31	1,731.12	1,729.50	1,725.29	1,720.72	1,718.75
1991	1,737.63	1,736.77	1,735.38	1,727.09	1,724.83	1,730.86	1,729.16	1,724.37	1,719.49	1,717.46
1992	1,736.94	1,736.17	1,734.88	1,728.33	1,725.84	1,730.70	1,728.80	1,725.10	1,721.13	1,719.45
1993	1,736.46	1,735.78	1,734.87	1,727.05	1,723.90	1,730.46	1,728.61	1,724.20	1,719.41	1,717.65
1994	1,735.57	1,734.92	1,733.44	1,728.02	1,725.00	1,731.39	1,730.21	1,726.43	1,721.23	1,718.53
1995	1,737.42	1,736.41	1,734.22	1,730.59	1,728.04	1,732.28	1,730.15	1,726.44	1,722.56	1,720.78
1996	1,735.73	1,734.94	1,733.26	1,728.94	1,726.51	1,730.91	1,729.67	1,726.74	1,724.64	1,723.46
1997	1,736.31	1,735.62	1,734.33	1,728.52	1,724.54	1,731.84	1,729.85	1,725.65	1,720.93	1,718.87
1998	1,734.89	1,734.02	1,732.56	1,729.64	1,726.94	1,731.15	1,730.00	1,726.89	1,723.09	1,720.82
1999	1,735.18	1,734.52	1,732.95	1,727.89	1,725.43	1,730.48	1,729.16	1,725.88	1,722.83	1,721.11
2000	1,734.73	1,733.93	1,732.55	1,726.89	1,724.07	1,728.07	1,726.58	1,723.61	1,720.57	1,718.93
2001	1,734.70	1,734.27	1,733.16	1,729.29	1,727.30	1,730.12	1,729.23	1,727.64	1,724.90	1,723.27
2002	1,734.05	1,733.46	1,731.93	1,728.91	1,726.59	1,730.53	1,729.59	1,726.94	1,722.36	1,716.91
2003	1,734.37	1,733.75	1,732.10	1,730.12	1,728.19	1,730.88	1,729.62	1,727.16	1,723.26	1,718.57
2004	1,736.39	1,735.97	1,734.40	1,729.73	1,727.24	1,731.20	1,730.37	1,727.98	1,724.80	1,722.94
2005	1,735.37	1,734.64	1,732.71	1,730.80	1,729.52	1,731.50	1,731.00	1,729.45	1,726.77	1,725.30
<b>1987 to 2005</b>	<b>1,736.22</b>	<b>1,735.35</b>	<b>1,733.24</b>	<b>1,728.52</b>	<b>1,725.85</b>	<b>1,730.77</b>	<b>1,729.39</b>	<b>1,725.72</b>	<b>1,720.47</b>	<b>1,717.05</b>

**Table H-11.** November frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	November Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,733.21	1,732.65	1,731.10	1,726.27	1,724.98	1,715.75	1,714.56	1,712.00	1,708.98	1,705.57
1988	1,735.95	1,735.05	1,732.83	1,727.36	1,725.14	1,729.46	1,727.70	1,724.28	1,720.98	1,718.72
1989	1,736.53	1,736.13	1,734.88	1,727.18	1,723.27	1,727.76	1,725.79	1,720.54	1,714.04	1,711.21
1990	1,738.14	1,737.10	1,735.32	1,728.22	1,725.34	1,730.38	1,728.93	1,725.03	1,720.13	1,717.44
1991	1,736.04	1,735.41	1,732.76	1,726.62	1,724.36	1,728.70	1,726.51	1,722.41	1,717.57	1,715.48
1992	1,737.04	1,735.74	1,732.47	1,728.18	1,725.59	1,730.42	1,729.23	1,727.30	1,723.12	1,721.25
1993	1,735.74	1,734.58	1,732.56	1,726.96	1,723.98	1,729.95	1,728.09	1,725.02	1,721.52	1,719.25
1994	1,736.69	1,735.70	1,733.01	1,727.36	1,725.44	1,730.31	1,729.10	1,726.70	1,722.96	1,720.43
1995	1,737.09	1,736.05	1,734.36	1,731.86	1,730.11	1,731.10	1,729.46	1,725.92	1,721.81	1,720.17
1996	1,735.80	1,734.71	1,732.92	1,727.92	1,726.14	1,730.77	1,729.26	1,726.70	1,724.43	1,723.46
1997	1,736.67	1,735.79	1,733.83	1,730.23	1,726.70	1,731.53	1,730.02	1,726.06	1,721.52	1,719.45
1998	1,734.76	1,734.13	1,732.78	1,730.94	1,729.42	1,731.40	1,730.51	1,728.61	1,726.46	1,725.23
1999	1,736.14	1,735.52	1,734.11	1,730.55	1,728.73	1,731.14	1,730.39	1,728.05	1,725.49	1,724.14
2000	1,735.35	1,734.49	1,729.94	1,726.46	1,723.08	1,728.93	1,726.79	1,720.83	1,715.37	1,711.90
2001	1,734.75	1,733.83	1,730.52	1,726.64	1,723.95	1,729.92	1,728.97	1,726.13	1,721.59	1,720.57
2002	1,732.75	1,731.97	1,730.63	1,726.58	1,722.18	1,728.02	1,726.97	1,722.92	1,718.56	1,716.60
2003	1,734.41	1,733.85	1,732.30	1,730.27	1,728.78	1,729.79	1,728.68	1,726.15	1,721.48	1,719.49
2004	1,734.97	1,734.23	1,732.66	1,730.23	1,728.89	1,731.30	1,730.50	1,729.20	1,727.03	1,725.92
2005	1,735.45	1,734.61	1,732.55	1,729.67	1,728.22	1,731.04	1,729.65	1,726.90	1,723.52	1,719.98
<b>1987 to 2005</b>	<b>1,736.08</b>	<b>1,735.07</b>	<b>1,732.52</b>	<b>1,728.44</b>	<b>1,725.86</b>	<b>1,730.41</b>	<b>1,729.07</b>	<b>1,725.69</b>	<b>1,720.17</b>	<b>1,716.17</b>

**Table H-12.** December frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	December Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,732.87	1,732.11	1,729.41	1,718.63	1,716.03	1,714.37	1,713.53	1,710.61	1,708.27	1,706.61
1988	1,734.63	1,733.99	1,732.18	1,728.42	1,727.07	1,731.20	1,730.48	1,728.43	1,726.41	1,725.01
1989	1,736.79	1,735.82	1,733.59	1,724.02	1,720.19	1,728.37	1,725.93	1,720.57	1,715.35	1,713.25
1990	1,736.72	1,735.59	1,732.50	1,725.94	1,722.98	1,728.80	1,727.52	1,724.35	1,719.68	1,717.66
1991	1,733.65	1,732.84	1,730.71	1,726.87	1,725.55	1,727.56	1,726.47	1,723.23	1,719.07	1,717.85
1992	1,734.67	1,733.66	1,731.83	1,729.70	1,728.45	1,731.69	1,731.03	1,729.66	1,727.92	1,726.93
1993	1,735.74	1,734.88	1,733.07	1,728.58	1,726.43	1,730.74	1,729.73	1,727.41	1,724.53	1,721.93
1994	1,734.47	1,733.83	1,731.60	1,727.90	1,726.64	1,732.77	1,731.10	1,727.98	1,725.46	1,722.03
1995	1,740.97	1,740.15	1,737.69	1,734.58	1,732.84	1,733.76	1,733.46	1,732.12	1,725.76	1,722.86
1996	1,735.81	1,734.69	1,732.26	1,729.02	1,727.00	1,730.56	1,729.26	1,727.03	1,725.23	1,724.28
1997	1,735.75	1,735.07	1,733.51	1,731.13	1,728.40	1,729.80	1,728.54	1,725.88	1,722.96	1,721.39
1998	1,735.04	1,734.25	1,731.90	1,728.83	1,727.13	1,732.04	1,730.51	1,728.17	1,722.18	1,719.38
1999	1,736.70	1,736.03	1,734.00	1,729.31	1,726.32	1,731.01	1,729.62	1,726.36	1,722.09	1,720.03
2000	1,734.05	1,733.04	1,730.92	1,728.30	1,725.39	1,730.71	1,729.60	1,726.83	1,723.03	1,721.99
2001	1,733.18	1,732.26	1,729.25	1,726.48	1,722.22	1,729.69	1,728.72	1,724.92	1,719.34	1,718.00
2002	1,735.16	1,734.01	1,731.34	1,727.85	1,725.54	1,731.30	1,730.02	1,726.79	1,723.15	1,720.96
2003	1,733.66	1,732.82	1,730.96	1,727.53	1,725.14	1,729.09	1,728.41	1,725.96	1,723.18	1,722.27
2004	1,735.71	1,734.97	1,732.90	1,728.39	1,726.18	1,730.12	1,729.06	1,726.51	1,723.59	1,721.16
2005	1,733.11	1,732.12	1,730.12	1,726.08	1,721.33	1,727.57	1,726.45	1,721.88	1,712.56	1,710.20
<b>1987 to 2005</b>	<b>1,735.79</b>	<b>1,734.55</b>	<b>1,731.88</b>	<b>1,728.03</b>	<b>1,725.44</b>	<b>1,731.03</b>	<b>1,729.56</b>	<b>1,726.31</b>	<b>1,721.06</b>	<b>1,716.70</b>

**Table H-13.** Annual frequency of exceedance of hourly stage in Pend Oreille River in Boundary Tailwater and in Seven Mile Forebay, 1987 to 2005.

Year	Annual Frequency of Exceedance of Hourly Stage in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	1,734.23	1,733.17	1,730.67	1,725.30	1,716.03	1,715.94	1,714.30	1,711.38	1,707.58	1,705.44
1988	1,735.59	1,734.36	1,731.89	1,727.55	1,724.92	1,732.08	1,731.00	1,724.21	1,711.48	1,709.12
1989	1,739.72	1,736.60	1,733.55	1,729.00	1,725.68	1,732.84	1,731.11	1,727.06	1,720.80	1,717.09
1990	1,741.61	1,739.06	1,734.45	1,728.22	1,724.59	1,733.13	1,732.15	1,726.28	1,720.37	1,716.70
1991	1,742.45	1,738.56	1,734.24	1,728.99	1,725.62	1,733.20	1,732.31	1,725.85	1,720.01	1,717.35
1992	1,735.51	1,734.43	1,732.05	1,729.33	1,727.67	1,731.71	1,730.67	1,728.48	1,723.95	1,721.75
1993	1,737.15	1,735.86	1,733.41	1,730.00	1,727.15	1,732.22	1,730.97	1,727.92	1,723.78	1,721.42
1994	1,735.69	1,734.74	1,732.29	1,729.11	1,727.02	1,731.69	1,730.51	1,728.18	1,724.64	1,721.32
1995	1,739.76	1,736.90	1,734.05	1,730.65	1,728.62	1,732.94	1,731.62	1,728.38	1,724.08	1,721.91
1996	1,744.08	1,741.31	1,735.62	1,731.52	1,728.36	1,733.10	1,732.58	1,729.82	1,725.62	1,723.91
1997	1,750.74	1,741.41	1,734.87	1,732.04	1,729.64	1,733.00	1,732.22	1,728.64	1,723.98	1,721.06
1998	1,739.51	1,736.14	1,732.78	1,729.33	1,727.12	1,732.28	1,730.97	1,727.43	1,722.85	1,719.49
1999	1,741.69	1,737.76	1,733.93	1,730.62	1,728.37	1,731.99	1,731.26	1,728.31	1,724.13	1,721.25
2000	1,740.06	1,736.12	1,732.36	1,728.28	1,725.22	1,732.47	1,730.31	1,725.75	1,721.32	1,718.41
2001	1,734.81	1,733.39	1,730.16	1,727.15	1,725.13	1,730.08	1,729.07	1,726.05	1,721.42	1,718.99
2002	1,743.38	1,736.87	1,732.40	1,728.78	1,725.89	1,732.22	1,730.74	1,726.21	1,721.06	1,717.85
2003	1,738.23	1,735.98	1,732.23	1,729.23	1,726.97	1,731.07	1,729.82	1,727.03	1,722.67	1,718.53
2004	1,736.82	1,735.39	1,732.44	1,728.68	1,726.60	1,730.44	1,729.43	1,726.97	1,723.55	1,721.11
2005	1,737.48	1,735.37	1,732.18	1,728.87	1,726.47	1,731.30	1,730.21	1,727.16	1,722.00	1,718.17
<b>1987 to 2005</b>	<b>1,739.19</b>	<b>1,736.18</b>	<b>1,732.84</b>	<b>1,728.96</b>	<b>1,726.33</b>	<b>1,732.28</b>	<b>1,730.80</b>	<b>1,727.00</b>	<b>1,721.02</b>	<b>1,715.68</b>

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## **Appendix I**

### **Monthly and Annual Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005**

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**Table I-1.** January frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	January Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	17.14	16.60	16.25	15.16	7.84	10.13	7.94	4.89	3.05	2.46
1988	16.42	15.95	14.56	13.25	12.83	7.19	5.88	3.74	2.89	2.37
1989	8.62	8.13	6.50	5.82	4.81	4.66	3.87	2.76	1.90	1.61
1990	20.51	19.69	17.61	15.64	13.03	18.76	15.39	13.13	10.89	8.79
1991	18.43	17.99	16.86	15.02	14.13	15.91	15.02	12.11	9.88	8.10
1992	13.23	10.73	7.97	5.82	4.06	7.12	5.55	3.90	2.06	1.77
1993	12.63	11.67	10.55	7.37	6.73	9.12	7.71	6.17	3.44	2.92
1994	10.66	10.47	7.54	6.89	5.93	8.36	6.99	4.07	3.21	2.46
1995	8.34	7.50	5.76	4.57	3.70	5.94	4.43	2.69	1.90	1.70
1996	16.69	13.37	8.65	5.93	5.14	14.40	12.93	9.15	6.00	4.56
1997	9.99	9.68	7.50	4.88	3.79	7.21	6.73	4.86	3.38	2.72
1998	15.15	14.57	12.83	9.80	8.44	9.22	7.78	6.56	3.64	3.28
1999	9.45	9.13	5.28	4.50	3.42	7.74	5.90	3.54	2.14	1.65
2000	14.54	14.04	11.14	9.33	8.02	9.25	8.53	6.53	4.30	3.89
2001	9.08	8.77	7.80	6.24	5.76	5.88	5.34	4.13	3.44	2.96
2002	14.88	14.34	11.84	9.33	7.87	12.17	10.00	6.26	4.50	3.66
2003	13.83	12.98	8.36	6.90	5.33	7.35	6.26	4.72	3.48	2.29
2004	14.81	13.29	7.52	6.19	5.23	10.24	5.78	4.53	3.44	2.76
2005	14.02	12.56	9.47	7.68	7.21	8.29	7.32	5.26	3.15	2.58
<b>1987 to 2005</b>	<b>16.38</b>	<b>14.61</b>	<b>9.45</b>	<b>6.36</b>	<b>5.23</b>	<b>11.92</b>	<b>8.59</b>	<b>5.02</b>	<b>3.07</b>	<b>2.36</b>

**Table I-2.** February frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	February Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	17.73	17.58	16.64	13.99	9.13	10.76	9.22	7.22	5.01	3.88
1988	14.28	13.90	12.57	6.27	5.25	5.62	4.21	2.56	1.67	1.41
1989	7.87	6.32	3.97	3.07	2.74	4.22	3.92	2.94	2.06	1.70
1990	19.52	19.02	17.26	14.83	13.66	17.46	15.47	12.25	9.94	8.90
1991	20.78	19.71	17.72	14.75	12.30	19.76	18.66	14.05	12.16	9.92
1992	10.51	9.35	6.44	5.03	3.69	8.29	4.62	2.69	1.95	1.57
1993	7.54	6.59	5.04	4.08	3.56	4.17	3.29	2.73	1.49	1.31
1994	9.92	8.91	6.89	5.58	5.20	5.89	5.25	3.12	2.23	1.69
1995	10.90	9.00	4.79	3.28	2.89	7.72	5.79	3.46	0.67	0.46
1996	11.43	8.73	2.62	1.74	1.42	7.49	6.88	2.88	1.45	1.33
1997	8.61	7.75	7.05	4.23	3.83	7.55	6.35	4.82	3.00	2.89
1998	10.22	8.58	7.41	5.74	4.91	5.62	4.98	3.77	2.71	2.04
1999	10.17	9.43	7.71	6.26	5.12	6.89	6.18	5.04	4.07	3.81
2000	13.04	12.09	10.50	7.12	6.92	9.57	8.61	6.16	4.08	3.27
2001	10.40	9.11	5.49	3.99	3.32	6.13	4.44	3.04	2.26	1.72
2002	13.98	12.38	9.39	7.54	5.47	9.42	8.44	5.90	3.57	3.21
2003	14.58	11.99	9.15	6.44	5.83	7.18	5.84	4.46	3.58	2.87
2004	9.35	8.59	6.49	4.80	4.39	6.76	5.61	4.20	2.46	2.26
2005	14.77	13.23	8.27	6.93	6.59	8.70	7.38	4.76	3.14	2.52
<b>1987 to 2005</b>	<b>16.64</b>	<b>13.29</b>	<b>7.74</b>	<b>5.04</b>	<b>3.68</b>	<b>11.09</b>	<b>7.51</b>	<b>4.39</b>	<b>2.50</b>	<b>1.74</b>

**Table I-3.** March frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	March Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	17.13	16.73	13.34	8.56	5.91	12.44	10.30	6.03	3.28	2.53
1988	18.06	17.57	16.03	7.57	7.24	7.02	6.73	4.82	3.77	2.66
1989	14.83	13.26	11.76	9.75	8.59	10.60	9.51	7.68	5.11	4.16
1990	16.04	14.72	12.14	10.08	9.65	14.63	14.04	9.48	5.05	4.30
1991	13.02	11.00	7.40	5.58	4.50	15.19	12.10	7.28	4.56	4.07
1992	7.02	6.16	5.20	4.51	4.37	5.02	4.10	3.02	1.25	1.05
1993	8.91	7.82	5.47	4.30	3.49	5.84	4.46	3.11	1.67	1.35
1994	7.48	6.91	5.83	5.13	4.54	6.04	3.68	2.89	2.30	2.07
1995	6.66	6.24	5.05	4.11	3.61	7.22	5.54	4.30	2.95	1.90
1996	4.34	3.81	2.85	2.12	1.44	3.84	3.15	2.29	1.54	1.05
1997	8.77	7.90	5.42	3.18	2.64	7.12	6.83	4.10	1.94	1.71
1998	11.60	10.82	8.60	7.24	6.62	8.30	7.16	5.25	2.76	2.27
1999	10.09	9.42	8.07	5.41	2.78	8.20	7.87	5.41	4.00	2.79
2000	14.06	12.87	10.51	8.88	7.27	10.28	9.61	6.62	4.96	3.42
2001	9.95	8.94	5.31	3.09	2.78	8.00	5.97	3.31	2.17	1.94
2002	14.97	13.80	10.50	8.09	6.44	14.07	10.07	6.27	4.46	3.61
2003	14.28	13.42	10.21	8.26	7.39	9.91	8.79	6.17	4.36	4.12
2004	11.48	10.95	8.35	5.85	5.15	7.47	6.76	4.07	2.49	1.83
2005	7.52	7.05	6.08	5.38	4.11	4.74	4.09	3.35	2.66	2.43
<b>1987 to 2005</b>	<b>14.29</b>	<b>11.88</b>	<b>7.64</b>	<b>4.98</b>	<b>3.72</b>	<b>9.92</b>	<b>7.87</b>	<b>4.60</b>	<b>2.63</b>	<b>1.99</b>

**Table I-4.** April frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	April Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	18.28	18.01	9.57	7.61	6.54	14.63	13.15	10.29	7.31	6.05
1988	20.67	18.96	12.15	9.38	8.57	19.47	16.32	9.94	7.74	5.50
1989	19.04	18.53	14.67	7.17	6.03	18.61	16.23	11.22	3.51	2.55
1990	16.25	13.58	10.17	4.43	1.91	15.66	14.65	9.60	2.32	1.53
1991	16.51	14.15	11.84	8.26	7.60	15.12	14.26	11.61	9.22	7.85
1992	17.21	13.97	10.69	6.69	5.50	14.50	12.15	7.48	2.98	2.52
1993	12.34	11.27	10.27	7.85	7.70	11.36	9.03	7.76	5.56	4.74
1994	9.98	8.76	6.77	5.30	5.13	7.60	6.73	4.36	3.35	2.66
1995	17.88	15.22	12.70	8.71	6.62	16.23	12.92	10.32	6.88	4.70
1996	3.76	3.53	2.30	1.72	1.48	3.29	2.56	1.58	1.20	0.85
1997	6.00	5.34	3.75	2.15	1.17	7.61	6.42	2.20	1.11	0.94
1998	12.06	10.01	7.20	6.28	5.52	13.72	10.83	7.99	4.66	3.75
1999	9.70	8.11	6.14	3.69	3.00	9.52	8.50	5.79	3.39	2.73
2000	16.52	12.93	9.11	5.49	3.88	13.42	12.63	6.52	2.39	1.73
2001	12.89	11.50	8.68	7.04	6.51	8.89	7.14	5.10	2.99	2.63
2002	11.98	11.08	8.57	6.83	3.82	13.09	12.03	7.61	3.42	2.41
2003	12.01	9.64	6.54	5.54	4.58	13.87	10.43	6.99	4.90	3.66
2004	12.17	11.38	9.17	7.38	6.25	8.95	7.35	5.68	3.39	2.42
2005	12.25	11.12	8.35	5.34	5.11	9.80	7.90	4.10	2.33	1.69
<b>1987 to 2005</b>	<b>15.85</b>	<b>12.57</b>	<b>8.55</b>	<b>5.33</b>	<b>3.39</b>	<b>14.15</b>	<b>11.59</b>	<b>6.80</b>	<b>3.07</b>	<b>1.83</b>

**Table I-5.** May frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	May Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	6.79	5.79	5.08	4.51	4.09	9.22	7.19	5.38	3.28	2.49
1988	10.34	8.98	5.64	4.30	3.96	9.54	7.84	2.83	1.15	0.89
1989	9.72	8.01	4.70	1.38	0.89	9.15	8.01	1.84	1.02	0.82
1990	9.46	8.23	5.25	3.56	2.77	8.80	7.52	4.66	1.80	1.24
1991	4.65	4.52	2.33	1.45	1.12	4.62	3.09	1.97	1.41	1.18
1992	7.22	6.22	5.28	4.20	3.55	7.84	6.79	4.23	2.92	2.42
1993	12.73	12.10	7.24	1.93	1.78	12.10	9.61	4.85	1.28	0.95
1994	15.05	13.73	11.16	9.80	9.77	12.99	11.49	9.87	7.39	5.58
1995	10.89	9.85	7.64	6.42	5.60	9.94	9.32	7.51	6.03	5.54
1996	9.86	5.09	2.36	1.64	0.99	3.28	2.46	1.81	1.12	0.92
1997	3.93	2.96	2.28	1.52	1.29	2.79	2.52	1.77	1.24	0.99
1998	7.71	6.95	5.62	3.18	2.04	8.04	7.94	5.97	3.28	1.78
1999	8.59	6.83	4.40	2.37	1.41	12.57	9.58	3.31	1.64	1.58
2000	14.50	10.40	4.56	1.36	0.79	13.05	10.31	1.68	0.86	0.59
2001	15.56	15.32	11.88	8.90	7.63	14.60	13.12	10.30	6.73	5.38
2002	14.06	12.39	6.69	2.35	1.54	15.02	14.64	9.05	1.61	1.25
2003	13.70	12.01	8.12	5.73	3.57	10.73	9.39	5.88	4.59	3.61
2004	18.84	15.30	10.87	7.25	6.39	14.86	12.27	7.12	4.00	3.32
2005	15.10	14.08	9.29	4.93	2.92	11.64	10.64	8.37	5.30	3.85
<b>1987 to 2005</b>	<b>12.94</b>	<b>10.42</b>	<b>5.84</b>	<b>2.54</b>	<b>1.67</b>	<b>11.70</b>	<b>9.51</b>	<b>5.10</b>	<b>1.68</b>	<b>1.22</b>

**Table I-6.** June frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	June Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	16.73	15.92	8.48	7.18	6.78	10.01	7.00	5.45	3.19	2.39
1988	7.45	6.51	5.63	4.71	3.93	5.12	3.67	2.68	1.76	1.62
1989	8.24	7.45	6.10	0.92	0.50	9.74	9.07	5.20	1.15	0.88
1990	3.12	2.25	1.45	0.82	0.57	1.94	1.74	1.32	0.73	0.42
1991	4.93	3.26	1.50	0.97	0.71	4.04	1.61	0.94	0.71	0.56
1992	7.39	6.89	5.70	3.96	3.60	6.57	5.52	3.23	1.96	1.66
1993	10.00	9.10	6.98	6.06	5.34	11.08	10.41	7.61	4.32	4.00
1994	17.20	16.98	12.19	9.82	8.61	14.02	13.67	11.44	8.40	6.77
1995	8.54	7.75	3.62	2.03	1.04	6.23	4.82	1.82	1.13	0.91
1996	5.18	4.02	2.83	1.83	1.67	3.30	2.89	1.69	1.30	1.23
1997	6.72	4.79	2.95	1.73	1.31	3.59	2.91	1.88	1.19	0.88
1998	3.83	3.37	2.83	2.06	1.78	4.16	3.75	3.04	2.03	1.54
1999	2.69	1.88	1.12	0.67	0.44	2.24	1.92	1.43	1.13	0.78
2000	10.74	9.79	8.13	6.60	3.77	11.29	10.69	6.72	3.82	1.08
2001	14.94	14.46	12.71	9.40	9.03	14.79	11.91	10.07	8.48	8.16
2002	2.11	2.02	1.58	0.93	0.79	1.74	1.59	1.19	0.69	0.55
2003	9.26	8.17	6.49	1.63	1.04	7.59	7.14	4.69	1.42	0.71
2004	10.23	9.74	8.64	7.32	6.82	7.90	7.59	5.70	3.46	3.14
2005	8.29	7.85	5.63	2.96	2.30	10.05	9.22	6.30	3.84	2.59
<b>1987 to 2005</b>	<b>10.72</b>	<b>8.64</b>	<b>5.03</b>	<b>1.78</b>	<b>1.08</b>	<b>10.08</b>	<b>7.88</b>	<b>3.16</b>	<b>1.31</b>	<b>0.92</b>

**Table I-7.** July frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	July Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	15.97	15.33	14.60	13.48	11.50	6.53	4.99	3.48	1.87	1.55
1988	5.36	5.11	4.21	3.17	2.90	3.97	2.92	1.97	1.48	1.41
1989	14.11	13.33	11.11	8.85	7.21	12.07	11.36	8.73	7.02	5.55
1990	16.56	15.16	11.53	3.41	2.80	15.48	13.45	10.04	2.07	2.00
1991	14.74	13.19	8.71	2.66	2.18	11.16	10.36	6.47	1.27	1.02
1992	8.83	8.52	7.14	5.43	4.88	6.14	5.28	3.57	2.10	1.84
1993	7.41	6.71	6.08	5.17	4.87	10.21	9.22	6.72	4.69	4.27
1994	9.71	9.20	6.57	3.33	2.31	5.58	4.23	2.89	1.57	1.05
1995	11.43	9.83	7.69	6.02	4.74	10.43	9.58	7.18	5.35	4.49
1996	11.39	10.10	6.20	3.71	2.28	7.45	6.95	4.92	2.27	1.84
1997	7.41	6.67	5.15	3.85	3.46	7.45	5.18	3.84	2.26	1.81
1998	11.06	9.70	6.61	5.01	3.98	10.79	8.53	5.68	4.20	3.55
1999	10.69	8.92	6.61	1.23	0.98	11.25	10.17	6.79	1.91	1.15
2000	14.67	13.55	10.66	7.64	6.88	10.07	8.60	6.53	4.53	3.67
2001	13.95	12.70	10.85	8.58	7.69	7.78	7.26	5.61	4.49	3.81
2002	17.00	11.97	5.86	4.35	2.92	11.36	10.00	6.23	3.28	1.71
2003	9.29	8.63	6.90	5.15	4.26	8.69	6.89	5.88	4.36	4.13
2004	12.65	10.97	8.64	7.24	4.91	9.79	8.79	5.81	3.54	2.81
2005	9.46	8.56	7.18	5.19	3.82	7.91	6.40	5.42	3.51	2.73
<b>1987 to 2005</b>	<b>14.14</b>	<b>11.51</b>	<b>7.41</b>	<b>4.52</b>	<b>3.41</b>	<b>10.56</b>	<b>8.61</b>	<b>5.32</b>	<b>2.56</b>	<b>1.78</b>

**Table I-8.** August frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	August Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	15.84	15.48	14.24	13.69	13.51	5.25	4.30	2.95	2.26	1.64
1988	10.88	8.23	4.64	1.99	1.59	7.51	4.95	2.95	1.57	0.76
1989	15.24	13.39	9.09	6.78	5.92	13.78	11.65	5.61	2.85	1.90
1990	15.04	13.21	8.63	6.72	5.93	10.99	5.31	3.68	2.00	1.47
1991	12.37	10.92	8.20	5.51	5.24	9.94	6.92	4.49	2.56	1.68
1992	8.13	5.86	4.58	3.42	2.72	5.31	3.61	2.66	1.74	1.58
1993	7.68	7.26	6.23	5.64	5.10	6.83	4.86	3.71	2.26	1.54
1994	4.94	3.81	3.04	2.05	1.58	3.80	3.25	1.97	1.35	0.99
1995	12.18	9.37	7.12	4.43	3.63	8.76	6.83	4.33	1.58	1.34
1996	13.70	12.49	11.21	7.77	6.07	11.18	9.78	7.48	4.33	2.95
1997	12.46	11.21	8.37	5.82	5.26	10.14	9.28	6.79	3.54	2.36
1998	10.37	8.52	7.32	5.27	4.63	8.07	7.77	5.67	3.31	2.30
1999	12.47	10.62	8.08	5.72	5.30	8.33	8.27	5.38	4.00	2.59
2000	14.67	12.14	9.78	6.58	4.83	9.15	7.35	4.43	3.05	2.76
2001	11.77	8.65	5.43	3.90	2.99	6.29	5.03	3.61	2.20	2.00
2002	9.21	9.02	7.17	5.07	4.59	6.76	6.27	5.32	2.72	1.70
2003	6.89	6.21	3.76	2.42	2.09	6.20	4.86	3.74	2.40	2.17
2004	11.44	10.33	6.99	5.42	4.83	7.91	7.45	3.96	3.22	2.54
2005	9.88	8.86	6.65	4.64	4.47	7.43	6.78	4.97	3.59	2.76
<b>1987 to 2005</b>	<b>13.44</b>	<b>11.08</b>	<b>7.10</b>	<b>4.47</b>	<b>3.21</b>	<b>8.97</b>	<b>7.13</b>	<b>4.00</b>	<b>2.30</b>	<b>1.64</b>

**Table I-9.** September frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	September Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	16.67	16.44	15.91	7.95	6.47	9.74	8.53	5.62	2.58	2.15
1988	7.78	6.66	4.87	3.57	2.00	5.82	4.02	2.45	1.35	1.04
1989	16.93	15.91	11.94	9.09	7.81	16.40	13.36	9.68	5.78	4.16
1990	12.10	11.04	9.35	7.91	5.78	9.92	9.29	6.49	4.47	3.52
1991	15.95	13.88	11.71	9.76	6.18	12.69	10.76	9.29	6.62	4.68
1992	9.72	8.50	6.41	5.23	4.76	6.48	5.70	3.40	2.33	2.01
1993	15.77	15.40	13.22	9.36	7.79	11.40	11.15	9.32	6.98	5.04
1994	6.24	5.33	4.00	2.53	2.23	5.93	3.88	2.49	1.18	0.98
1995	11.74	10.36	8.26	4.96	4.46	10.52	9.19	6.32	2.21	1.71
1996	10.41	9.46	8.47	7.16	6.90	7.64	6.76	5.59	3.25	2.26
1997	15.21	11.67	6.03	3.95	3.58	9.91	9.61	7.45	4.92	3.83
1998	13.19	11.93	8.83	7.32	6.25	9.46	8.79	6.56	4.71	3.55
1999	8.75	7.58	5.92	3.71	3.16	7.75	7.28	3.72	2.92	1.91
2000	12.64	11.21	8.41	6.74	5.22	8.57	6.92	4.15	2.53	2.32
2001	7.91	6.89	4.92	3.46	2.70	5.90	4.15	2.65	2.04	1.75
2002	13.61	11.75	7.04	4.66	3.91	9.73	6.77	4.40	2.33	1.96
2003	8.30	6.30	4.76	3.30	2.74	6.00	4.98	3.79	2.65	2.33
2004	15.38	14.10	10.91	5.79	5.35	10.08	8.29	4.79	2.74	1.80
2005	11.68	11.50	9.67	6.34	4.25	7.69	7.33	5.30	3.47	2.70
<b>1987 to 2005</b>	<b>14.76</b>	<b>12.06</b>	<b>7.95</b>	<b>4.82</b>	<b>3.73</b>	<b>10.24</b>	<b>8.54</b>	<b>5.16</b>	<b>2.65</b>	<b>2.01</b>

**Table I-10.** October frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	October Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	16.11	9.71	9.01	6.92	6.68	11.85	10.96	9.12	7.55	7.02
1988	16.38	15.33	13.25	10.00	8.45	12.66	11.88	9.09	6.43	5.41
1989	18.43	18.19	15.80	13.54	12.03	17.98	16.80	12.37	9.45	8.37
1990	19.43	19.16	16.40	14.34	13.82	16.70	15.98	13.51	11.19	11.00
1991	18.32	18.20	15.60	13.03	12.20	16.83	16.31	14.11	12.57	11.55
1992	17.29	15.55	12.76	11.10	9.16	16.80	13.88	10.86	7.68	7.06
1993	17.99	17.21	15.33	14.47	11.53	17.09	15.62	14.37	13.13	12.63
1994	15.36	14.58	11.47	8.56	7.48	11.81	10.37	7.58	5.41	4.62
1995	12.50	11.63	10.38	8.70	6.58	12.40	11.35	9.71	6.43	5.35
1996	12.10	11.13	9.01	7.24	6.19	8.23	7.12	4.86	3.28	3.12
1997	17.52	16.83	15.01	9.65	8.96	14.31	12.93	11.71	9.02	7.74
1998	13.07	11.92	8.51	6.06	5.22	9.39	7.74	5.67	4.36	2.95
1999	12.79	12.30	10.77	8.93	8.59	11.09	10.17	7.84	5.42	4.60
2000	14.65	13.39	11.58	9.96	9.82	12.47	10.50	9.15	6.43	5.97
2001	10.91	9.89	7.73	6.03	5.45	7.91	5.93	3.91	2.52	1.97
2002	13.23	11.84	7.40	4.61	4.40	7.15	6.37	4.72	2.40	1.74
2003	11.96	10.72	6.31	4.66	4.10	8.63	8.47	5.48	3.25	2.65
2004	12.93	12.48	11.06	8.84	7.51	10.27	10.14	8.13	4.78	3.41
2005	8.65	7.88	6.39	4.78	4.12	6.85	6.10	4.10	2.94	2.27
<b>1987 to 2005</b>	<b>17.15</b>	<b>15.32</b>	<b>11.13</b>	<b>7.49</b>	<b>6.01</b>	<b>14.55</b>	<b>12.76</b>	<b>8.62</b>	<b>4.84</b>	<b>3.27</b>

**Table I-11.** November frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	November Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	17.07	15.08	8.21	5.68	4.38	7.54	6.43	3.38	1.94	1.34
1988	16.80	13.46	10.72	8.00	6.61	12.07	10.91	8.19	5.08	3.40
1989	19.39	18.69	15.00	10.83	8.08	19.69	18.58	14.88	11.21	10.46
1990	19.00	18.31	15.72	11.68	10.40	17.13	14.96	12.45	8.80	7.51
1991	16.94	16.71	12.38	9.01	8.03	16.01	14.29	12.15	6.00	4.33
1992	17.11	16.05	9.32	6.42	5.71	13.88	11.58	4.41	2.02	1.51
1993	16.27	15.14	12.22	9.51	7.39	14.46	12.37	8.51	4.21	3.30
1994	18.67	15.71	11.73	7.93	7.01	13.84	12.96	6.90	3.60	2.55
1995	11.78	9.41	7.18	5.55	4.57	10.83	9.68	7.45	5.45	5.09
1996	12.55	12.44	10.17	8.42	7.27	8.36	7.63	4.85	3.01	2.64
1997	15.41	14.38	11.81	8.98	6.31	12.23	11.26	8.67	5.74	5.07
1998	7.81	7.17	5.59	3.74	3.21	6.68	6.23	3.73	2.66	2.40
1999	10.84	9.92	8.12	6.09	4.55	9.78	8.29	5.92	4.11	2.76
2000	14.21	13.84	12.48	9.27	7.10	11.75	11.16	8.13	5.48	4.72
2001	11.75	11.36	8.94	7.58	5.60	8.18	7.16	4.64	3.29	2.18
2002	14.61	13.28	10.34	7.20	5.49	8.51	7.31	4.92	3.29	2.73
2003	13.16	10.49	4.90	3.00	2.38	8.26	7.07	4.69	2.91	2.10
2004	8.53	7.54	6.55	4.23	3.53	6.20	4.90	3.55	2.02	1.77
2005	10.04	8.78	5.87	3.54	2.86	9.32	7.97	5.47	4.14	3.10
<b>1987 to 2005</b>	<b>16.61</b>	<b>13.99</b>	<b>9.40</b>	<b>6.21</b>	<b>4.59</b>	<b>13.52</b>	<b>11.07</b>	<b>6.49</b>	<b>3.46</b>	<b>2.44</b>

**Table I-12.** December frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	December Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	18.70	17.34	15.76	8.56	6.92	10.24	8.27	3.32	2.07	0.82
1988	9.47	8.16	6.99	4.85	4.71	4.60	3.84	2.95	1.87	1.77
1989	18.86	18.11	17.17	15.34	14.55	17.19	15.65	13.19	11.25	7.41
1990	18.24	18.04	15.86	11.95	9.41	15.06	14.34	11.49	7.32	5.94
1991	14.34	12.87	8.92	3.96	3.15	7.05	6.89	5.28	2.50	2.04
1992	7.84	7.14	6.08	4.47	3.82	5.12	3.61	3.09	2.37	1.61
1993	14.18	12.71	9.42	7.50	6.70	10.50	8.69	5.87	4.23	3.48
1994	12.73	10.43	6.78	5.70	4.48	8.10	6.30	3.08	2.33	1.61
1995	9.47	7.68	4.78	3.77	3.39	10.34	8.99	4.40	1.64	1.25
1996	11.42	10.63	8.85	7.19	5.55	5.81	5.52	4.07	2.43	2.03
1997	12.68	11.79	9.21	7.77	6.92	8.43	8.04	5.51	4.00	2.79
1998	12.87	11.20	6.80	4.91	3.88	9.48	7.68	5.05	2.56	2.40
1999	14.94	14.17	11.95	10.04	8.68	11.52	10.26	8.92	7.31	5.98
2000	12.75	10.15	8.46	5.67	5.29	7.28	6.03	4.59	2.79	2.34
2001	12.09	11.66	8.64	6.81	5.53	8.43	6.59	4.54	3.64	3.19
2002	11.84	11.12	9.07	7.62	7.13	6.80	6.53	5.31	3.64	3.22
2003	11.14	9.57	8.07	6.51	5.72	5.74	5.31	4.27	3.21	2.76
2004	12.90	12.14	9.51	7.67	5.82	7.71	7.14	5.21	3.57	3.15
2005	14.98	14.58	12.69	8.57	7.28	10.14	8.61	6.04	4.23	3.44
<b>1987 to 2005</b>	<b>15.87</b>	<b>13.56</b>	<b>9.03</b>	<b>6.35</b>	<b>4.93</b>	<b>11.25</b>	<b>8.46</b>	<b>5.12</b>	<b>2.98</b>	<b>2.25</b>

**Table I-13.** Annual frequency of exceedance of daily stage fluctuation (daily maximum minus daily minimum) in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	Annual Frequency of Exceedance of Daily Stage Fluctuation (daily maximum minus daily minimum) in Pend Oreille River (feet, NAVD 88)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	17.25	16.44	13.57	6.97	5.65	11.00	9.19	5.35	2.72	2.04
1988	16.38	13.87	7.93	4.71	3.75	10.21	7.98	3.71	1.87	1.47
1989	17.73	15.77	10.22	6.05	3.62	15.74	13.04	7.97	2.76	1.73
1990	18.29	17.17	12.14	5.79	2.84	15.47	13.99	9.48	2.81	1.66
1991	17.74	16.38	10.48	4.33	2.09	15.39	13.45	8.34	2.43	1.27
1992	13.38	10.25	6.59	4.67	3.86	10.81	7.12	3.57	2.10	1.68
1993	15.31	12.71	8.30	5.69	4.67	13.05	10.42	6.17	3.12	1.76
1994	14.59	11.48	7.45	4.86	3.31	11.45	8.54	4.20	2.33	1.59
1995	12.28	10.38	6.96	4.49	3.48	10.95	9.36	5.87	2.07	1.57
1996	12.08	10.42	6.61	2.43	1.84	8.93	7.02	3.61	1.77	1.31
1997	13.64	10.52	6.62	3.29	2.26	10.31	8.64	4.86	2.17	1.39
1998	12.60	10.23	7.29	4.85	3.24	9.13	7.74	5.22	3.02	2.31
1999	11.61	10.10	7.19	3.40	1.82	10.07	8.33	5.22	2.59	1.64
2000	14.45	12.82	9.83	6.88	5.08	11.23	9.58	6.15	3.38	2.34
2001	13.15	11.67	8.17	5.37	3.94	10.01	7.93	4.50	2.81	2.19
2002	14.04	12.05	8.06	4.76	2.31	11.30	8.54	5.38	2.55	1.54
2003	12.92	10.22	7.10	4.29	3.14	8.80	7.19	4.92	3.25	2.52
2004	13.33	11.44	8.52	6.07	4.99	9.87	7.71	4.89	3.12	2.33
2005	12.96	10.41	7.37	5.07	3.81	9.44	7.75	5.17	3.18	2.53
<b>1987 to 2005</b>	<b>15.33</b>	<b>12.66</b>	<b>8.06</b>	<b>4.83</b>	<b>3.20</b>	<b>11.87</b>	<b>9.38</b>	<b>5.23</b>	<b>2.57</b>	<b>1.74</b>

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## **Appendix J**

### **Monthly and Annual Frequency of Exceedance of Daily Maximum Ramping Rates in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005**

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**Table J-1.** January frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	January Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	118.9	99.1	87.4	50.4	31.4	14.9	13.3	9.4	7.1	5.9
1988	126.4	115.3	88.1	75.7	70.3	16.6	14.2	8.3	4.3	3.6
1989	42.1	35.9	29.8	24.0	21.5	13.4	10.2	7.9	5.4	3.8
1990	97.1	87.8	73.4	54.2	40.0	25.9	24.0	22.4	19.2	11.8
1991	95.0	90.4	79.0	62.4	53.0	24.7	23.2	20.9	18.8	18.1
1992	80.2	60.6	40.7	22.8	19.9	14.5	10.6	7.6	4.7	3.6
1993	65.0	55.6	47.6	26.0	21.8	20.0	18.5	13.8	9.5	7.8
1994	57.8	51.6	40.2	26.0	20.4	21.6	18.5	13.8	7.6	7.1
1995	43.7	41.3	32.0	21.7	19.2	15.0	13.4	7.9	6.2	4.7
1996	54.0	45.7	28.3	16.9	14.6	29.2	26.8	18.1	13.4	10.7
1997	45.0	43.1	24.5	15.8	10.7	18.1	15.0	10.3	6.2	4.8
1998	95.5	86.9	58.2	39.6	33.8	19.7	18.1	11.0	7.4	5.0
1999	38.8	37.7	29.2	13.9	11.5	16.9	13.8	8.3	6.7	6.2
2000	88.6	78.0	53.5	38.8	34.4	23.6	22.8	17.3	12.2	8.6
2001	49.3	45.6	33.4	23.6	22.0	15.4	12.6	9.8	7.8	6.2
2002	62.0	60.0	47.9	35.6	29.4	22.8	17.8	13.4	9.5	7.6
2003	76.0	68.0	43.1	32.3	26.5	18.5	15.7	11.0	7.9	6.4
2004	79.4	67.3	49.6	25.9	22.1	22.8	19.7	13.3	9.5	7.9
2005	71.3	64.1	47.4	36.5	32.9	20.9	20.0	11.8	9.4	8.6
<b>1987 to 2005</b>	<b>88.2</b>	<b>74.9</b>	<b>44.3</b>	<b>27.0</b>	<b>20.0</b>	<b>22.8</b>	<b>19.2</b>	<b>11.8</b>	<b>7.4</b>	<b>5.5</b>

**Table J-2.** February frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	February Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	132.9	128.6	106.4	72.7	69.9	19.4	18.1	13.8	10.2	8.8
1988	116.9	92.8	65.9	30.3	16.0	11.1	8.9	6.7	3.6	2.8
1989	23.2	18.4	13.4	9.4	8.7	10.3	8.3	5.5	4.0	3.6
1990	117.6	104.8	79.2	65.3	55.7	27.8	24.6	21.7	18.2	15.3
1991	100.3	82.3	64.8	52.1	40.1	36.2	31.6	23.8	21.2	20.8
1992	51.7	40.1	27.6	17.3	12.0	11.7	9.2	5.9	4.3	3.5
1993	33.3	29.6	22.9	17.9	16.2	12.0	9.7	6.2	4.2	3.7
1994	52.0	48.7	41.1	32.7	29.3	18.2	17.1	12.6	8.8	7.2
1995	54.0	35.8	17.5	13.3	10.7	15.1	10.8	7.4	2.3	0.3
1996	46.2	27.1	14.0	7.8	6.5	20.2	14.2	5.4	3.8	2.3
1997	32.0	26.3	19.9	15.0	14.0	15.7	14.4	10.4	7.4	5.3
1998	75.0	60.7	44.0	32.0	24.3	12.0	10.7	8.5	5.9	5.1
1999	60.7	51.0	30.1	18.0	15.4	16.1	14.6	10.6	9.0	8.0
2000	79.3	59.1	41.2	30.2	25.3	20.4	19.3	15.8	10.7	9.5
2001	47.9	43.2	26.1	14.9	11.8	14.9	11.1	9.4	7.8	5.5
2002	62.8	55.2	33.3	27.4	23.0	20.8	18.6	12.6	8.8	8.4
2003	62.5	54.9	34.8	27.2	22.8	16.5	15.8	11.9	8.2	6.9
2004	55.3	49.0	37.0	25.9	20.8	15.0	12.9	10.2	6.9	5.0
2005	69.8	63.5	46.7	32.1	29.6	17.9	16.9	10.9	7.3	5.1
<b>1987 to 2005</b>	<b>82.2</b>	<b>63.7</b>	<b>33.7</b>	<b>18.8</b>	<b>13.6</b>	<b>20.7</b>	<b>16.9</b>	<b>10.2</b>	<b>5.6</b>	<b>4.0</b>

**Table J-3.** March frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	March Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	124.8	114.0	87.4	59.8	36.2	17.4	16.9	10.9	6.4	5.9
1988	93.1	76.4	60.6	42.8	36.0	19.3	17.8	9.8	5.9	4.8
1989	61.1	58.4	43.7	34.6	30.2	21.6	19.3	15.7	9.2	7.1
1990	74.9	72.1	61.0	47.2	41.3	24.8	21.2	18.1	14.5	11.0
1991	59.8	45.2	21.2	12.7	11.8	23.6	22.1	11.4	8.3	7.1
1992	38.0	33.4	19.9	15.7	12.4	8.3	7.2	5.2	4.0	2.4
1993	35.4	32.4	26.5	20.6	15.6	16.2	13.8	7.4	5.2	3.1
1994	49.2	43.2	35.5	24.5	16.1	14.2	12.2	7.9	5.2	4.0
1995	22.6	19.2	16.2	13.1	9.7	17.8	14.6	7.1	5.5	4.4
1996	18.6	17.3	11.0	8.4	7.7	9.8	8.3	6.6	4.2	2.4
1997	48.4	28.3	19.1	12.5	11.9	19.8	13.8	9.0	5.5	4.0
1998	73.8	64.1	45.1	32.2	24.0	19.7	17.3	9.8	6.7	5.5
1999	53.2	41.6	28.4	17.8	15.1	18.8	16.9	12.2	7.4	5.0
2000	60.7	52.6	45.0	38.0	34.3	21.1	20.5	16.6	11.9	11.0
2001	51.6	33.7	22.3	14.8	10.4	11.9	11.0	7.1	5.5	5.4
2002	55.7	53.3	38.4	29.3	25.7	22.8	19.7	15.7	10.3	9.5
2003	69.6	58.2	37.1	26.2	24.4	18.8	18.5	14.9	9.0	7.1
2004	61.4	59.8	41.9	31.1	27.7	16.1	14.2	9.5	6.2	5.5
2005	39.5	36.8	33.1	26.5	23.9	12.6	11.2	9.5	6.4	5.5
<b>1987 to 2005</b>	<b>69.7</b>	<b>56.2</b>	<b>34.3</b>	<b>18.0</b>	<b>12.7</b>	<b>20.0</b>	<b>16.9</b>	<b>9.8</b>	<b>6.0</b>	<b>4.8</b>

**Table J-4.** April frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	April Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	131.4	105.4	73.3	46.4	30.4	27.8	24.1	18.3	14.1	11.8
1988	88.0	80.0	67.3	58.7	51.3	35.4	30.8	18.6	12.8	10.8
1989	85.3	78.4	51.8	31.9	28.2	30.6	27.8	21.7	8.6	7.4
1990	72.1	61.0	43.2	13.7	10.2	30.5	24.9	20.9	5.2	3.9
1991	75.0	65.2	55.5	29.3	19.9	29.5	27.3	20.5	13.2	10.1
1992	73.0	66.2	49.1	35.2	30.0	23.4	21.2	14.8	7.0	6.1
1993	50.5	44.1	34.8	28.8	27.1	21.8	18.6	15.4	10.7	8.6
1994	51.8	46.7	40.0	33.6	31.4	18.5	16.3	14.4	8.8	7.1
1995	91.7	81.5	62.7	47.3	23.2	23.0	22.8	20.5	14.1	12.7
1996	30.3	16.1	10.5	6.6	6.0	10.2	9.1	5.4	3.5	3.1
1997	31.2	22.9	16.0	8.2	4.9	14.6	11.0	5.5	3.7	0.7
1998	54.9	49.0	39.3	24.3	15.4	24.7	19.7	14.8	10.9	9.8
1999	42.6	36.0	24.2	9.8	7.5	21.4	15.7	10.6	4.8	4.0
2000	69.7	63.4	34.3	20.3	14.8	26.8	22.6	13.6	8.9	7.6
2001	65.8	59.4	42.5	28.2	21.3	15.7	15.0	11.4	7.1	4.7
2002	73.5	59.7	42.0	25.8	16.6	25.3	18.6	13.3	9.0	6.6
2003	48.2	45.0	34.0	17.6	14.3	21.4	19.8	13.4	9.5	8.1
2004	71.4	63.3	48.6	38.8	34.4	20.5	18.5	12.6	9.1	7.5
2005	47.1	44.0	34.6	30.0	27.1	24.3	20.7	12.5	7.7	5.1
<b>1987 to 2005</b>	<b>74.3</b>	<b>62.9</b>	<b>40.6</b>	<b>21.9</b>	<b>13.7</b>	<b>24.8</b>	<b>21.4</b>	<b>14.2</b>	<b>7.9</b>	<b>5.2</b>

**Table J-5.** May frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	May Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	31.7	25.1	20.6	13.6	11.6	16.1	13.1	9.5	6.7	5.9
1988	42.4	31.2	19.9	13.7	12.8	18.0	12.2	5.9	3.6	3.1
1989	42.1	40.8	20.3	6.5	3.4	19.0	15.7	4.7	3.1	2.0
1990	50.9	46.8	26.4	18.5	10.0	19.7	15.4	10.6	4.7	2.8
1991	20.5	17.5	8.9	4.3	3.1	11.4	8.3	4.8	2.4	1.9
1992	31.7	23.4	17.4	13.9	8.4	15.0	10.6	6.7	4.8	2.8
1993	46.6	38.8	18.6	12.5	10.1	20.5	19.0	10.6	4.7	2.8
1994	83.0	75.4	58.1	50.4	45.1	28.7	24.7	19.0	10.9	9.5
1995	58.1	54.7	25.9	17.6	16.6	20.8	18.5	13.1	10.3	9.5
1996	70.1	53.5	11.6	6.7	5.9	12.6	9.8	4.4	3.6	2.4
1997	29.6	22.6	13.7	7.4	5.6	8.8	7.4	5.5	3.1	2.4
1998	36.8	34.1	19.2	10.9	7.0	19.7	16.2	12.6	8.6	5.5
1999	37.7	34.8	17.5	7.2	6.6	19.0	15.7	8.6	5.9	5.0
2000	60.6	51.4	15.1	6.8	6.1	27.6	20.9	6.1	3.1	2.8
2001	62.4	55.0	45.5	35.2	29.4	32.3	29.2	23.6	15.0	8.8
2002	63.1	53.2	30.0	5.4	2.3	25.2	22.8	11.8	4.7	2.4
2003	66.2	62.3	44.0	29.9	16.3	28.4	23.5	19.7	10.2	8.6
2004	79.1	68.8	47.0	28.0	16.0	28.7	26.8	17.6	11.4	6.0
2005	57.6	51.6	36.1	22.6	12.4	27.1	24.8	22.3	7.6	6.6
<b>1987 to 2005</b>	<b>60.4</b>	<b>49.7</b>	<b>23.8</b>	<b>10.9</b>	<b>6.6</b>	<b>24.4</b>	<b>20.4</b>	<b>10.2</b>	<b>4.7</b>	<b>3.1</b>

**Table J-6.** June frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	June Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	78.8	62.8	43.3	30.8	25.4	18.1	14.2	10.2	5.8	4.3
1988	33.9	32.9	25.2	17.3	14.5	14.2	10.4	7.3	5.9	5.2
1989	46.3	35.0	20.7	4.9	2.5	18.2	17.8	8.9	2.0	1.2
1990	11.8	10.6	6.0	3.0	2.3	6.0	4.4	3.2	1.4	0.7
1991	18.9	16.8	7.5	4.3	3.5	12.1	5.7	3.1	2.2	1.7
1992	32.7	29.7	20.0	13.0	7.8	12.7	11.8	9.6	4.3	3.9
1993	68.9	57.3	41.5	27.4	22.3	22.2	21.6	15.4	11.3	9.1
1994	88.4	85.1	65.4	48.4	40.6	28.7	25.1	21.9	17.2	13.7
1995	33.6	28.1	18.5	6.4	5.0	12.8	10.7	6.9	3.9	3.0
1996	28.5	21.8	13.1	10.1	8.4	13.2	11.2	7.3	4.0	3.1
1997	49.1	40.5	18.9	14.3	11.3	14.9	13.3	6.7	4.0	3.2
1998	23.9	18.0	10.4	8.8	8.2	11.1	10.0	6.7	4.6	3.5
1999	8.2	6.6	4.1	2.8	1.7	8.8	6.3	3.6	2.8	2.3
2000	51.2	41.6	35.5	22.7	12.4	21.6	20.2	16.8	7.6	6.6
2001	63.0	55.2	44.6	38.3	34.5	25.9	23.4	20.0	16.9	15.0
2002	9.1	8.0	6.1	4.3	2.6	6.4	5.5	3.6	2.6	1.9
2003	45.3	35.9	23.1	7.7	6.0	15.0	13.5	8.9	3.8	2.4
2004	51.7	46.0	37.8	25.8	22.7	19.8	18.8	14.4	9.2	7.1
2005	36.1	35.2	25.5	13.5	7.9	19.8	18.7	13.3	7.4	4.9
<b>1987 to 2005</b>	<b>52.4</b>	<b>41.6</b>	<b>21.7</b>	<b>7.7</b>	<b>4.6</b>	<b>20.5</b>	<b>16.9</b>	<b>8.3</b>	<b>3.8</b>	<b>2.8</b>

**Table J-7.** July frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	July Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	105.6	99.4	88.3	61.2	48.4	13.4	7.9	5.9	3.6	3.1
1988	29.5	27.4	15.2	8.4	7.6	9.8	9.5	6.4	4.8	4.3
1989	71.9	62.9	46.2	33.0	25.7	21.7	20.9	17.8	12.6	11.0
1990	63.1	55.0	38.3	16.4	15.1	24.5	22.1	20.0	7.1	4.8
1991	89.2	70.1	36.4	15.2	8.4	25.2	19.0	13.4	5.2	3.6
1992	48.7	41.5	35.8	28.1	25.7	17.3	15.0	9.5	5.5	4.3
1993	63.7	54.0	40.4	28.1	18.6	22.1	20.5	14.5	10.2	6.4
1994	59.3	46.7	30.5	14.3	10.3	13.8	11.5	7.6	2.4	1.6
1995	54.8	50.3	25.8	17.5	14.4	20.0	16.9	13.8	10.6	8.6
1996	70.1	54.6	32.9	13.7	9.5	18.1	15.8	11.0	4.3	3.5
1997	42.8	36.8	24.4	17.4	14.6	19.7	16.2	11.0	6.4	5.5
1998	42.2	38.4	23.9	17.8	11.4	23.2	20.9	14.2	9.5	8.6
1999	52.1	40.4	23.5	5.3	4.3	24.8	21.2	11.8	6.4	4.3
2000	83.5	69.5	55.9	37.1	31.7	18.8	15.4	11.4	9.5	7.4
2001	74.6	61.0	47.8	39.4	29.9	15.7	13.8	10.2	8.8	8.6
2002	67.7	52.0	32.5	15.8	10.2	22.8	20.4	13.4	9.5	5.5
2003	36.7	27.7	20.9	14.6	13.4	14.5	14.2	11.9	10.2	8.6
2004	56.5	46.3	32.5	24.7	21.7	20.5	19.7	12.5	8.4	6.2
2005	40.0	30.8	22.9	15.7	13.9	19.3	15.5	10.6	8.8	7.9
<b>1987 to 2005</b>	<b>68.3</b>	<b>54.2</b>	<b>33.2</b>	<b>17.5</b>	<b>13.0</b>	<b>20.9</b>	<b>18.1</b>	<b>11.5</b>	<b>6.7</b>	<b>4.7</b>

**Table J-8.** August frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	August Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	130.1	124.3	113.4	93.0	71.9	9.4	8.3	6.4	4.0	2.4
1988	56.9	41.8	14.6	6.0	4.2	13.1	8.6	4.0	1.1	0.4
1989	69.1	65.8	46.4	34.9	31.7	24.5	24.0	15.7	11.4	8.3
1990	85.7	76.0	50.5	39.1	28.7	16.1	12.6	9.5	6.7	5.2
1991	69.6	53.2	38.9	26.3	25.1	20.0	15.4	12.6	7.1	3.1
1992	34.2	25.3	16.9	11.5	10.8	12.6	9.8	5.9	3.2	2.4
1993	76.0	64.3	39.1	25.4	23.0	14.5	13.8	10.2	6.6	4.0
1994	22.2	19.0	10.6	6.2	5.5	10.6	6.7	4.3	2.8	2.4
1995	61.0	46.4	34.2	19.4	16.9	16.6	14.2	9.5	5.5	4.0
1996	53.4	52.0	42.6	34.9	28.2	22.9	22.1	18.8	13.0	7.8
1997	57.1	48.6	39.8	30.5	22.8	26.8	19.7	12.6	9.0	6.4
1998	44.6	38.8	26.3	19.6	18.6	18.8	16.9	12.2	6.7	5.9
1999	52.2	49.1	33.5	22.0	18.2	19.7	17.8	14.2	7.9	6.4
2000	73.1	63.2	42.0	25.9	15.8	15.7	12.6	8.6	7.1	3.6
2001	65.9	44.6	17.2	13.4	10.1	12.6	9.5	8.3	5.5	4.0
2002	35.2	31.7	29.0	20.2	14.8	14.9	11.0	9.5	5.2	4.7
2003	31.3	23.4	15.1	8.3	7.6	12.6	11.0	7.9	5.4	3.6
2004	49.9	44.6	31.7	20.4	13.4	14.8	11.8	8.8	5.8	3.6
2005	43.6	35.0	24.6	17.3	12.2	16.1	13.0	9.4	6.4	4.2
<b>1987 to 2005</b>	<b>69.7</b>	<b>53.2</b>	<b>31.7</b>	<b>16.8</b>	<b>11.5</b>	<b>19.0</b>	<b>15.0</b>	<b>9.1</b>	<b>5.2</b>	<b>3.2</b>

**Table J-9.** September frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	September Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	131.5	125.9	111.1	66.4	54.2	16.1	13.9	11.8	8.4	7.4
1988	45.2	40.6	29.9	14.2	9.0	15.9	11.2	7.9	5.2	4.3
1989	78.8	67.6	50.3	29.0	25.2	23.6	22.2	17.4	14.1	12.2
1990	57.0	51.8	41.3	31.2	27.8	17.5	16.3	14.6	9.8	7.8
1991	99.9	74.2	54.0	45.3	29.8	18.7	16.8	15.4	12.8	9.1
1992	44.0	39.2	31.4	25.2	24.0	16.1	15.1	9.8	8.2	6.4
1993	89.5	83.9	73.1	40.0	32.0	22.8	20.1	16.2	12.5	11.8
1994	34.8	31.0	19.0	10.0	8.8	18.7	10.1	6.8	3.0	2.1
1995	54.2	42.4	34.1	22.2	18.4	16.6	15.5	11.6	8.3	6.0
1996	63.9	52.0	42.2	29.1	24.4	19.4	18.1	13.1	9.0	7.9
1997	72.4	57.6	35.0	26.3	24.3	23.0	20.4	15.8	10.9	9.0
1998	49.2	44.2	30.9	25.3	18.3	21.4	18.6	15.5	8.5	4.9
1999	49.6	43.9	28.1	7.2	6.0	15.9	12.6	7.1	3.8	3.0
2000	85.2	78.8	41.0	28.5	20.5	16.5	15.8	11.6	7.8	6.0
2001	54.8	42.3	23.5	14.2	13.6	9.9	8.0	6.9	3.8	2.3
2002	60.2	53.4	30.8	19.1	15.3	14.3	11.2	8.6	6.0	4.8
2003	33.5	21.3	14.6	9.7	6.8	11.1	9.8	7.8	5.0	3.1
2004	57.7	54.8	41.9	30.7	24.7	21.7	19.8	13.8	8.2	6.4
2005	53.2	49.0	41.2	20.7	15.1	15.3	13.9	10.4	6.6	4.0
<b>1987 to 2005</b>	<b>74.6</b>	<b>56.2</b>	<b>36.8</b>	<b>20.9</b>	<b>14.9</b>	<b>19.3</b>	<b>16.6</b>	<b>11.4</b>	<b>7.1</b>	<b>4.4</b>

**Table J-10.** October frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	October Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	70.2	62.4	56.6	46.9	45.8	19.3	19.0	13.4	12.2	11.8
1988	76.9	69.8	59.0	41.4	37.6	22.4	22.1	16.4	13.4	11.4
1989	107.8	92.4	62.5	50.8	42.2	33.5	26.0	22.1	16.2	15.4
1990	74.3	71.2	59.9	50.5	46.6	29.5	25.9	22.4	19.3	18.5
1991	82.3	71.2	65.0	57.6	52.7	26.8	25.2	23.2	20.9	19.0
1992	75.8	69.4	54.2	41.2	37.9	29.5	25.2	20.5	15.0	13.0
1993	74.2	67.8	49.7	39.5	38.8	24.8	24.4	23.5	21.6	19.0
1994	100.6	75.2	58.0	41.8	33.0	27.1	24.0	21.6	11.9	7.6
1995	47.3	42.7	34.9	28.2	25.8	24.0	22.4	17.8	15.0	12.6
1996	76.1	63.8	44.8	31.9	23.2	30.7	23.3	15.7	8.6	7.8
1997	80.8	72.5	53.8	25.0	22.0	26.9	26.8	22.8	18.5	15.4
1998	46.8	44.0	31.6	22.6	16.8	18.8	16.9	13.8	8.6	7.4
1999	52.8	48.0	38.2	31.0	29.0	21.4	19.7	17.3	8.8	7.1
2000	73.6	71.3	49.9	39.7	30.5	20.5	19.2	17.8	11.0	9.5
2001	56.4	50.5	37.0	28.8	25.8	16.6	14.2	10.7	6.4	4.8
2002	64.7	43.7	26.9	20.8	18.8	17.3	15.8	14.2	6.4	4.0
2003	53.9	32.5	22.3	17.9	16.2	17.8	14.5	11.4	9.5	7.1
2004	48.8	41.5	33.4	26.3	24.0	25.3	20.0	15.4	13.3	12.1
2005	39.1	36.0	26.9	20.2	18.5	13.8	12.5	9.6	7.7	5.8
<b>1987 to 2005</b>	<b>73.6</b>	<b>65.6</b>	<b>45.4</b>	<b>28.4</b>	<b>22.6</b>	<b>25.2</b>	<b>23.2</b>	<b>17.4</b>	<b>11.0</b>	<b>7.9</b>

**Table J-11.** November frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	November Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	99.4	78.3	42.2	26.5	13.1	17.1	12.1	9.1	5.4	4.2
1988	87.0	76.7	48.8	39.4	29.3	20.0	18.0	14.9	9.1	5.9
1989	92.4	86.6	65.0	51.5	48.4	30.5	27.6	23.5	19.2	16.6
1990	80.5	69.8	61.5	38.9	32.9	29.4	24.1	21.4	16.4	15.4
1991	83.0	78.8	57.9	39.3	30.6	25.3	23.6	18.9	11.8	9.5
1992	71.0	66.2	51.0	42.9	32.3	22.8	22.4	11.9	1.6	0.4
1993	89.7	78.6	57.8	45.7	37.9	23.7	23.6	18.7	7.6	7.1
1994	74.3	68.9	54.2	42.3	35.7	27.6	23.3	20.9	14.8	10.9
1995	37.6	28.8	23.0	15.8	15.3	18.2	16.7	13.4	10.5	9.8
1996	70.3	63.8	52.7	38.9	35.0	19.1	18.8	15.9	9.3	8.2
1997	70.8	61.6	44.9	29.8	21.3	27.6	25.0	19.3	12.5	11.3
1998	33.8	24.4	19.6	15.4	12.7	14.3	12.1	9.5	5.0	4.3
1999	43.7	42.5	32.0	21.0	17.4	17.8	16.6	14.0	8.2	7.8
2000	80.9	69.6	49.3	36.0	32.3	23.9	22.6	17.5	13.1	9.9
2001	66.3	55.7	42.6	27.0	24.1	18.4	17.5	11.2	7.0	6.4
2002	62.5	57.5	44.8	27.8	25.7	15.0	14.9	11.2	8.5	6.2
2003	62.7	44.0	25.4	16.0	13.4	16.7	13.9	9.2	6.7	5.5
2004	54.4	43.7	35.9	21.2	18.4	11.6	10.2	7.9	5.6	4.4
2005	45.2	36.3	26.0	13.3	12.7	17.2	15.9	11.9	9.6	8.4
<b>1987 to 2005</b>	<b>77.2</b>	<b>64.4</b>	<b>43.2</b>	<b>24.5</b>	<b>17.6</b>	<b>23.6</b>	<b>21.2</b>	<b>14.2</b>	<b>8.0</b>	<b>6.0</b>

**Table J-12.** December frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	December Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	118.7	103.7	79.0	49.1	29.8	18.1	16.6	9.1	3.6	1.2
1988	56.6	51.0	36.1	22.7	14.6	14.2	13.0	9.1	5.5	2.8
1989	92.4	86.3	71.3	51.6	37.0	28.3	24.5	22.1	15.7	12.6
1990	71.4	69.2	61.7	50.8	41.3	28.0	23.3	21.2	15.7	13.8
1991	63.0	60.1	43.3	22.8	15.7	16.1	15.0	9.5	6.2	4.3
1992	42.5	34.8	28.8	25.3	21.7	13.8	12.6	9.0	6.2	4.0
1993	67.6	60.5	49.3	36.1	29.5	20.9	19.3	15.4	10.2	9.1
1994	58.8	49.8	36.6	22.6	20.2	21.4	16.6	8.3	4.0	2.4
1995	34.9	23.8	16.6	13.8	11.9	18.8	15.4	9.0	5.5	4.3
1996	62.6	53.5	34.3	23.4	22.0	17.3	15.0	10.2	6.7	4.7
1997	79.2	68.8	55.1	45.7	41.8	22.1	20.9	13.0	8.6	6.2
1998	54.2	39.7	28.7	15.2	12.8	16.2	13.4	10.3	5.5	4.7
1999	61.8	54.2	46.9	35.0	29.6	23.3	21.2	18.6	16.6	13.1
2000	57.6	46.2	26.4	20.2	14.9	13.4	11.9	9.5	6.4	4.8
2001	66.7	64.2	27.5	19.8	16.1	15.8	13.8	10.2	7.9	7.1
2002	55.2	50.0	30.1	21.8	19.9	16.9	16.6	11.8	8.0	7.1
2003	80.9	67.8	50.0	34.8	30.7	21.6	14.9	12.6	8.8	8.6
2004	79.7	67.7	50.3	37.7	31.2	18.5	13.4	11.4	7.9	6.4
2005	68.3	63.1	46.3	32.4	25.4	23.8	19.6	14.6	11.3	10.7
<b>1987 to 2005</b>	<b>72.8</b>	<b>63.0</b>	<b>42.0</b>	<b>23.8</b>	<b>18.2</b>	<b>21.6</b>	<b>18.3</b>	<b>12.1</b>	<b>7.1</b>	<b>5.2</b>

**Table J-13.** Annual frequency of exceedance of daily maximum ramping rate in Pend Oreille River in Boundary Tailwater and Seven Mile Forebay, 1987 to 2005.

Year	Annual Frequency of Exceedance of Daily Maximum Ramping Rate in Pend Oreille River (inches per hour)									
	Boundary Tailwater					Seven Mile Forebay				
	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance	10% Exceedance	20% Exceedance	50% Exceedance	80% Exceedance	90% Exceedance
1987	124.6	112.7	72.1	40.0	24.1	19.3	16.4	10.3	5.9	4.3
1988	87.9	72.2	39.9	17.3	12.2	19.0	15.7	8.6	4.8	3.6
1989	83.8	67.0	43.3	23.2	13.3	24.8	22.5	16.1	7.1	4.3
1990	83.5	71.2	51.5	26.3	11.4	25.7	22.8	17.4	7.4	4.3
1991	82.5	70.3	47.4	16.4	8.3	25.2	22.9	15.4	6.4	3.6
1992	60.5	48.7	31.0	18.8	14.8	20.3	15.2	8.3	4.7	3.5
1993	73.8	60.6	39.1	25.0	18.8	22.9	20.9	14.2	7.4	5.4
1994	71.0	58.7	40.8	22.0	13.8	24.0	21.2	12.2	5.9	3.5
1995	58.7	44.5	25.9	16.0	13.2	20.9	17.4	11.9	6.4	4.3
1996	61.5	51.5	28.3	11.3	8.4	22.1	17.8	9.8	4.8	3.6
1997	64.5	51.3	27.2	15.4	10.7	23.1	19.2	11.0	6.0	4.0
1998	59.0	48.2	29.8	16.6	11.7	19.5	16.9	11.0	6.7	5.0
1999	52.2	43.0	29.0	12.1	5.9	19.7	17.6	11.0	6.4	4.0
2000	74.8	62.9	42.1	26.8	17.0	22.4	19.0	13.8	7.9	5.5
2001	64.3	53.6	36.4	20.8	15.4	20.5	15.8	10.2	7.1	5.2
2002	61.7	52.3	31.6	18.4	8.2	20.4	16.9	11.0	6.2	4.0
2003	63.3	52.2	29.2	15.1	11.6	19.3	15.7	11.0	7.2	5.5
2004	65.5	56.3	39.8	26.6	20.9	20.9	18.5	11.9	7.6	5.9
2005	58.0	46.5	33.1	20.8	15.5	20.9	16.9	11.0	7.9	5.8
<b>1987 to 2005</b>	<b>73.6</b>	<b>59.8</b>	<b>36.2</b>	<b>18.7</b>	<b>12.4</b>	<b>22.4</b>	<b>18.8</b>	<b>11.8</b>	<b>6.4</b>	<b>4.3</b>

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**Appendix K**

**Boundary Reservoir  
Storage/Elevation Curves**

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## Appendix K

### Boundary Reservoir Storage/Elevation Curves

To assist with relicensing studies associated with the Boundary Hydroelectric Project (FERC No. 2144), relationships between Boundary Reservoir storage volume and water surface elevation were developed from recently surveyed bathymetry. Storage volume was calculated in two phases. In the first phase, storage volume was calculated based on the assumption of a level water surface throughout the entire reservoir to allow comparison with storage volumes previously used by Seattle City Light (SCL). In the second phase, the total storage volume was divided into two portions: a lower reservoir extending from Boundary Dam to Metaline Falls; and an upper reservoir extending from Metaline Falls to Box Canyon Dam because the water surface elevations in the upper reservoir are typically higher than the water surface elevations in the lower reservoir. The boundary between the lower and upper reservoirs was defined by the bedrock-controlled constriction at Metaline Falls, as illustrated in Figure 1.

Analyses of reservoir storage were based on topographic and bathymetric surveys of the Pend Oreille River and adjacent floodplain between Boundary Dam and Box Canyon Dam from 2005 through 2007. The upland topographic survey data were collected in August and November 2005. Bathymetric survey data were collected in April 2006 and in May, June, July, August, and October 2007.

In Boundary Reservoir, the active storage zone is associated with Boundary Reservoir Forebay water surface elevations ranging from 1954.03 feet to 1994.03 feet NAVD 88 (equivalent to 1950 feet to 1990 feet NGVD 29). The inactive storage zone is below elevation 1954.03 feet NAVD 88 (1950 feet NGVD 29). Contours were developed from the recent topographic and bathymetric survey data at the following intervals:

- 5-foot intervals in the lower reservoir from elevation 1740 feet to 1945 feet NAVD 88 (equivalent to an elevation range of 1735.97 feet to 1940.97 feet NGVD 29). These elevations are all within the inactive storage zone of the reservoir (below elevation 1954.03 feet NAVD 88 or 1950 feet NGVD 29),
- 2-foot intervals in the entire reservoir from elevation 1948 feet to 2000 feet NAVD 88 (equivalent to an elevation range of 1943.97 feet to 1995.97 feet NGVD 29). These elevations encompass the range of elevations in Boundary Forebay that would occur under current operations (active zone range of 1954.03 feet to 1994.03 feet NAVD 88, or 1950 feet to 1990 feet NGVD 29),
- 2-foot intervals in the upper reservoir from elevation 2000 feet to 2010 feet NAVD 88 (equivalent to an elevation range of 1995.97 feet to 2005.97 feet NGVD 29),
- 5-foot intervals in the upper reservoir from elevation 2010 feet to 2030 feet NAVD 88 (equivalent to an elevation range of 2005.97 feet to 2025.97 feet NGVD 29).

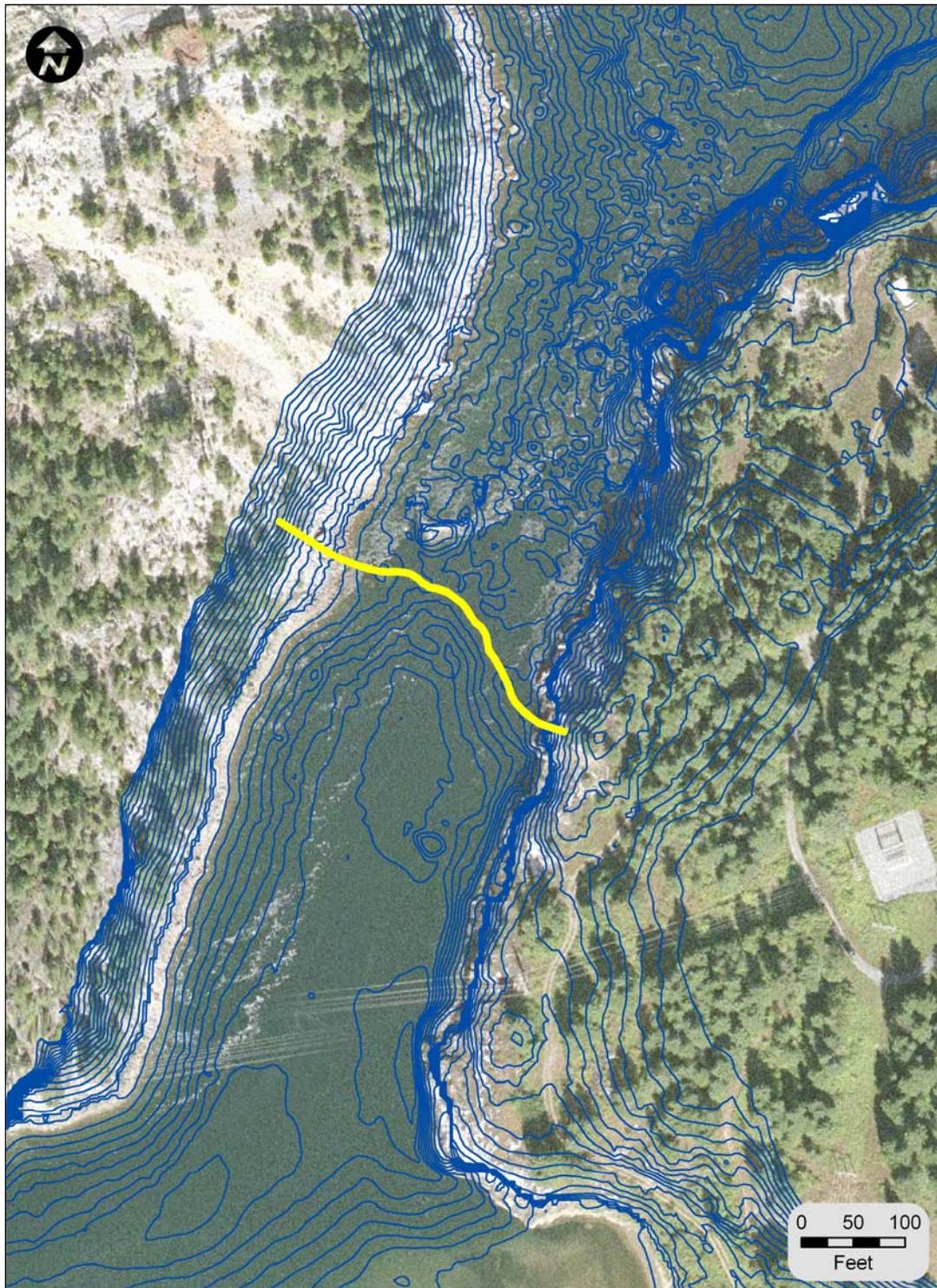


Figure K-1. Location of bedrock-controlled constriction at upstream end of Metaline Falls on Pend Oreille River, used to divide Boundary Reservoir into upper and lower portions for development of reservoir storage/elevation curves.

Islands and potholes (isolated pockets of water not connected to the reservoir) were excluded from the determination of surface areas encompassed by contours. Linear interpolation was used to determine surface areas in Boundary Reservoir in a manner similar to that previously used by SCL. The following formula was used to calculate surface areas:

$$A = A_1 + \frac{(E - E_1)}{(E_2 - E_1)} * (A_2 - A_1)$$

where A is the surface area at an elevation E that lies between elevations E<sub>1</sub> and E<sub>2</sub> where the surface areas are known to be A<sub>1</sub> and A<sub>2</sub>, respectively.

To be consistent with the linear interpolation method used to determine surface area, storage volume is calculated using the following formula:

$$V = V_1 + A_1 * (E - E_1) + 0.5 * \frac{(A_2 - A_1)}{(E_2 - E_1)} * (E - E_1)^2$$

where V is the storage volume at an elevation E that lies between elevations E<sub>1</sub> and E<sub>2</sub>. The surface area and storage volume at elevation E<sub>1</sub> are known to be V<sub>1</sub> and A<sub>1</sub>, respectively. The surface area at elevation E<sub>2</sub> is known to be A<sub>2</sub>.

## TOTAL RESERVOIR STORAGE

Total surface areas in Boundary Reservoir and the corresponding water surface elevations in Boundary Reservoir are listed in Table K-1. These surface areas include the surface areas previously used by SCL and the surface areas derived from the recent topographic and bathymetric surveys performed from 2005 through 2007. Surface areas previously used by SCL were based on 20-foot vertical intervals, while surface areas derived from recent surveys were based on vertical intervals ranging from 2 to 5 feet. Surface area versus elevation curves are shown in Figure K-2. Surface areas based on recent surveys are shifted to the left of the surface areas previously used by SCL over elevation ranges indicating that there is less storage in those elevation ranges. Some reduction of storage would be expected with the accumulation of sediment in the reservoir.

The two curves shown in Figure K-2 suggest that there has been an accumulation of finer sediments near the bottom of the reservoir (below elevation 1775 feet NAVD 88, or elevation 1770.97 feet NGVD 29), and that there has been an accumulation of coarser sediments at higher elevations in the reservoir (above elevation 1964.03 feet NAVD 88, or elevation 1960 feet NGVD 29). Some of the apparent reduction of storage may simply be due to the coarse resolution of the previously used surface areas (20-foot vertical intervals) particularly near the elevation of the thalweg of the bedrock-controlled constriction at Metaline Falls (1970.6 feet NAVD 88, or 1966.57 feet NGVD 29). The morphology of the river near the bedrock-controlled constriction at Metaline Falls was not accurately accounted for with the previously used surface areas.

Table K-1. Total surface area in Boundary Reservoir versus water surface elevation in Boundary Reservoir Forebay. Surface areas previously used by Seattle City Light (SCL), and surface areas derived from surveys performed from 2005 through 2007.

Water Surface Elevation (feet)		Surface Area (acres)		Water Surface Elevation (feet)		Surface Area (acres)		Water Surface Elevation (feet)		Surface Area (acres)	
NGVD 29	NAVD 88	Previously Used by SCL	Derived from Survey Data Collected from 2005 through 2007	NGVD 29	NAVD 88	Previously Used by SCL	Derived from Survey Data Collected from 2005 through 2007	NGVD 29	NAVD 88	Previously Used by SCL	Derived from Survey Data Collected from 2005 through 2007
1735.97	1740.00		1.06	1845.97	1850.00		197.16	1949.97	1954.00		637.49
1740.00	1744.03	28.14		1850.97	1855.00		206.41	1951.97	1956.00		648.44
1740.97	1745.00		1.26	1855.97	1860.00		218.30	1953.97	1958.00		658.26
1745.97	1750.00		1.47	1860.00	1864.03	229.11		1955.97	1960.00		667.20
1750.97	1755.00		1.72	1860.97	1865.00		227.19	1957.97	1962.00		676.13
1755.97	1760.00		2.01	1865.97	1870.00		238.85	1959.97	1964.00		684.86
1760.00	1764.03	79.95		1870.97	1875.00		253.73	1960.00	1964.03	739.78	
1760.97	1765.00		2.37	1875.97	1880.00		265.18	1961.97	1966.00		693.65
1765.97	1770.00		2.80	1880.00	1884.03	289.83		1963.97	1968.00		702.42
1770.97	1775.00		73.35	1880.97	1885.00		278.89	1965.97	1970.00		710.81
1775.97	1780.00		78.23	1885.97	1890.00		296.23	1967.97	1972.00		763.82
1780.00	1784.03	96.99		1890.97	1895.00		311.24	1969.97	1974.00		809.82
1780.97	1785.00		82.33	1895.97	1900.00		327.69	1971.97	1976.00		1043.32
1785.97	1790.00		85.68	1900.00	1904.03	368.06		1973.97	1978.00		1127.28
1790.97	1795.00		88.56	1900.97	1905.00		344.94	1975.97	1980.00		1212.84
1795.97	1800.00		104.11	1905.97	1910.00		367.24	1977.97	1982.00		1278.59
1800.00	1804.03	112.66		1910.97	1915.00		386.00	1979.97	1984.00		1360.67
1800.97	1805.00		108.13	1915.97	1920.00		404.82	1980.00	1984.03	1349.90	
1805.97	1810.00		114.23	1920.00	1924.03	465.16		1981.97	1986.00		1448.68
1810.97	1815.00		118.55	1920.97	1925.00		426.88	1983.97	1988.00		1525.67
1815.97	1820.00		122.60	1925.97	1930.00		453.20	1985.97	1990.00		1586.44
1820.00	1824.03	143.02		1930.97	1935.00		477.99	1987.97	1992.00		1643.87
1820.97	1825.00		126.19	1935.97	1940.00		540.93	1989.97	1994.00		1692.12
1825.97	1830.00		156.06	1940.00	1944.03	585.28		1991.97	1996.00		1723.79
1830.97	1835.00		172.34	1940.97	1945.00		573.63	1993.97	1998.00		1755.84
1835.97	1840.00		180.10	1943.97	1948.00		594.72	1995.97	2000.00		1792.14
1840.00	1844.03	180.04		1945.97	1950.00		608.73	2000.00	2004.03	1986.00	
1840.97	1845.00		188.81	1947.97	1952.00		623.93				

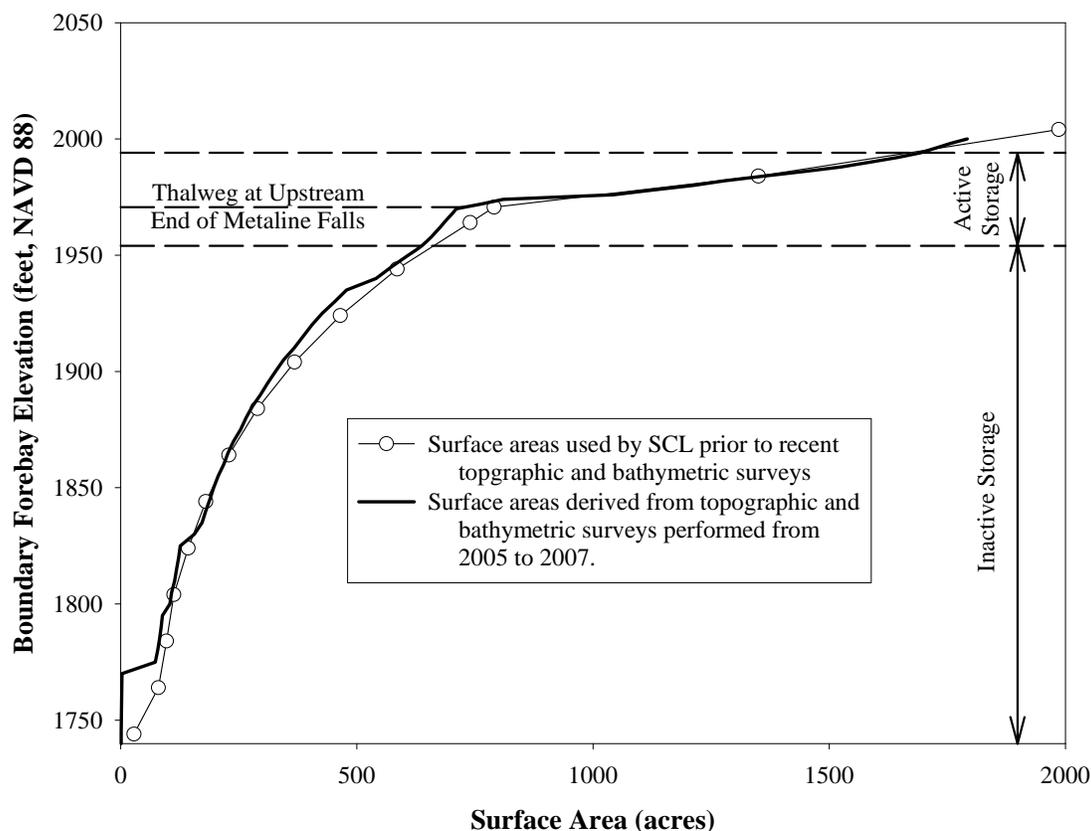


Figure K-2. Total surface area in Boundary Reservoir versus water surface elevation in Boundary Reservoir Forebay. Surface areas previously used by Seattle City Light (SCL), and surface areas derived from surveys performed from 2005 through 2007.

Total storage volumes in Boundary Reservoir above elevation 1744.03 feet NAVD 88 (1740 feet NGVD 29) are listed in Table K-2 and illustrated in Figure K-3. The total storage in the inactive storage portion of the reservoir (below elevation 1954.03 feet NAVD 88, or 1950 feet NGVD 29) was 51,670 acre-feet from the storage curve previously used by SCL. The total storage in the inactive storage portion of the reservoir is 47,070 acre-feet based on the recent surveys performed from 2005 through 2007. The reduction in storage in the inactive storage portion of the reservoir is 4,600 acre-feet, equivalent to a 9% reduction in storage.

The total storage in the active storage portion of the reservoir (between elevation 1954.03 feet and 1994.03 feet NAVD 88, or between elevation 1950 feet and 1990 feet NGVD 29) was 42,997 acre-feet from the storage curve previously used by SCL. The total storage in the active storage portion of the reservoir is 40,843 acre-feet based on the recent surveys performed from 2005 through 2007. The reduction in storage in the active storage portion of the reservoir is 2,154 acre-feet, equivalent to a 5% reduction in storage.

Table K-2. Total storage volume in Boundary Reservoir above elevation 1744.03 feet NAVD 88 (1740 feet NGVD 29) versus water surface elevation in Boundary Reservoir Forebay. Storage volumes previously used by Seattle City Light (SCL), and storage volumes derived from surveys performed from 2005 through 2007.

Water Surface Elevation (feet)		Storage Volume (acre-feet)		Water Surface Elevation (feet)		Storage Volume (acre-feet)	
		Previously Used by SCL	Derived from Survey Data Collected from 2005 through 2007			Previously Used by SCL	Derived from Survey Data Collected from 2005 through 2007
NGVD 29	NAVD 88			NGVD 29	NAVD 88		
1740.00	1744.03	0	0	1870.97	1875.00	17,522	15,126
1745.97	1750.00	214	8	1875.97	1880.00	18,872	16,424
1750.97	1755.00	465	16	1880.97	1885.00	20,298	17,784
1755.97	1760.00	780	25	1885.97	1890.00	21,815	19,222
1760.97	1765.00	1,159	36	1890.97	1895.00	23,430	20,740
1765.97	1770.00	1,573	49	1895.97	1900.00	25,142	22,338
1770.97	1775.00	2,009	240	1900.97	1905.00	26,953	24,019
1775.97	1780.00	2,466	619	1905.97	1910.00	28,878	25,800
1780.97	1785.00	2,945	1,020	1910.97	1915.00	30,924	27,683
1785.97	1790.00	3,443	1,440	1915.97	1920.00	33,091	29,660
1790.97	1795.00	3,961	1,876	1920.97	1925.00	35,380	31,739
1795.97	1800.00	4,499	2,357	1925.97	1930.00	37,810	33,939
1800.97	1805.00	5,057	2,888	1930.97	1935.00	40,390	36,267
1805.97	1810.00	5,646	3,444	1935.97	1940.00	43,121	38,815
1810.97	1815.00	6,274	4,026	1940.97	1945.00	46,002	41,601
1815.97	1820.00	6,940	4,629	1945.97	1950.00	49,062	44,557
1820.97	1825.00	7,643	5,251	1950.00	1954.03	51,670	47,070
1825.97	1830.00	8,390	5,956	1955.97	1960.00	55,763	50,969
1830.97	1835.00	9,184	6,777	1960.97	1965.00	59,413	54,361
1835.97	1840.00	10,024	7,658	1965.97	1970.00	63,641	57,861
1840.97	1845.00	10,910	8,581	1970.97	1975.00	68,632	61,774
1845.97	1850.00	11,853	9,545	1975.97	1980.00	74,386	67,269
1850.97	1855.00	12,857	10,554	1980.97	1985.00	80,902	73,783
1855.97	1860.00	13,922	11,616	1985.97	1990.00	88,204	81,296
1860.97	1865.00	15,049	12,730	1990.00	1994.03	94,667	87,913
1865.97	1870.00	16,248	13,895	1995.97	2000.00	105,192	98,306

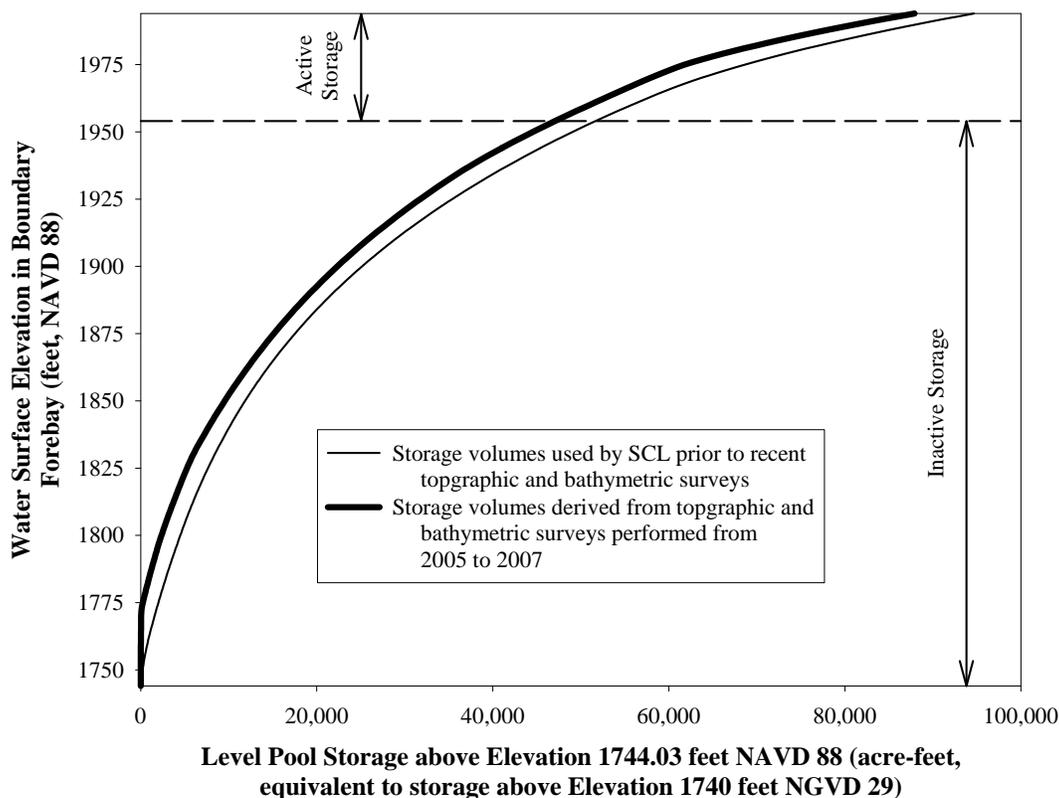


Figure K-3. Total storage volume in Boundary Reservoir above elevation 1744.03 feet NAVD 88 (1740 feet NGVD 29) versus water surface elevation in Boundary Reservoir Forebay. Storage volumes previously used by Seattle City Light (SCL), and storage volumes derived from surveys performed from 2005 through 2007.

## STORAGE IN UPPER AND LOWER PORTIONS OF THE RESERVOIR

The total surface area between elevations 1970 feet and 2000 feet NAVD 88 (between elevations 1965.97 feet and 1995.97 feet NGVD 29) was separated into the portions in the upper and lower reservoir using the boundary defined by the bedrock-controlled constriction at the upstream end of Metaline Falls (Figure K-1). Surface areas in the upper reservoir were determined for elevations ranging from elevation 2000 feet and 2030 feet NAVD 88 (between 1995.97 feet and 2025.97 feet NGVD 29). These surface areas are summarized in Table K-3.

The total storage volume in the active zone of Boundary Reservoir (above elevation 1954.03 feet NAVD 88, or elevation 1950 feet NGVD 29) was separated into the portions in the upper and lower reservoir using the boundary defined by the bedrock-controlled constriction at the upstream end of Metaline Falls (Figure K-1). Storage volumes in the upper reservoir were determined for elevations ranging from elevation 2000 feet and 2030 feet NAVD 88 (between 1995.97 feet and 2025.97 feet NGVD 29). These storage volumes are summarized in Table K-4, and illustrated in Figure K-4.

Table K-3. Surface areas in Boundary Reservoir above elevation 1970 feet NAVD 88 (elevation 1965.97 feet NGVD 29). Total surface area and portions in upper and lower portions of reservoir.

Water Surface Elevation (feet)		Surface Area (acres)		
NGVD 29	NAVD 88	Lower Reservoir	Upper Reservoir	Total Surface Area
1965.97	1970.00	710.81	0.00	710.81
1966.57	1970.60	713.24	13.47	726.71
1967.97	1972.00	718.91	44.91	763.82
1969.97	1974.00	727.07	82.75	809.82
1971.97	1976.00	735.59	307.73	1043.32
1973.97	1978.00	745.74	381.54	1127.28
1975.97	1980.00	754.83	458.01	1212.84
1977.97	1982.00	764.77	513.82	1278.59
1979.97	1984.00	776.64	584.03	1360.67
1981.97	1986.00	791.04	657.64	1448.68
1983.97	1988.00	807.93	717.74	1525.67
1985.97	1990.00	816.94	769.50	1586.44
1987.97	1992.00	825.18	818.69	1643.87
1989.97	1994.00	833.05	859.07	1692.12
1991.97	1996.00	841.19	882.60	1723.79
1993.97	1998.00	849.57	906.27	1755.84
1995.97	2000.00	857.88	934.26	1792.14
1997.97	2002.00		960.65	
1999.97	2004.00		980.51	
2001.97	2006.00		1004.93	
2003.97	2008.00		1029.03	
2005.97	2010.00		1054.65	
2010.97	2015.00		1120.81	
2015.97	2020.00		1181.94	
2020.97	2025.00		1245.74	
2025.97	2030.00		1303.76	

Table K-4. Storage volumes in Boundary Reservoir above elevation 1954.03 feet NAVD 88 (elevation 1950 feet NGVD 29). Total storage volume and portions in upper and lower portions of reservoir.

Water Surface Elevation (feet)		Storage Volume (acre-feet)		
		Lower Reservoir	Upper Reservoir	Total Storage Volume
NGVD 29	NAVD 88			
1950.00	1954.03	0	0	0
1955.97	1960.00	3,899	0	3,899
1960.97	1965.00	7,290	0	7,290
1966.57	1970.60	10,791	0	10,791
1970.97	1975.00	14,396	308	14,704
1975.97	1980.00	18,111	2,088	20,199
1980.97	1985.00	21,953	4,760	26,713
1985.97	1990.00	25,964	8,262	34,226
1990.00	1994.03	29,289	11,554	40,843
1995.97	2000.00	34,336	16,899	51,235
2000.97	2005.00		21,745	
2005.97	2010.00		26,941	
2010.97	2015.00		32,487	
2015.97	2020.00		38,383	
2020.97	2025.00		44,629	
2025.97	2030.00		51,224	

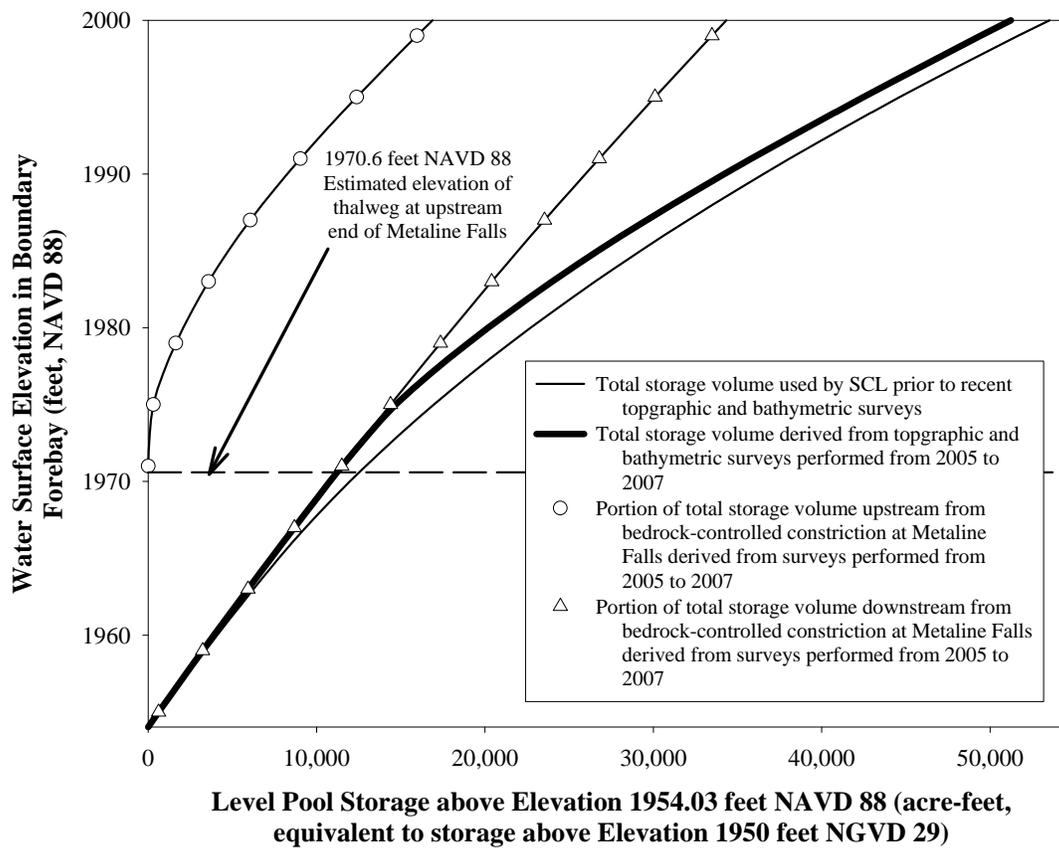


Figure K-4. Total storage volume in Boundary Reservoir above elevation 1954.03 feet NAVD 88 (1950 feet NGVD 29) versus water surface elevation in Boundary Reservoir Forebay. Storage volumes previously used by Seattle City Light (SCL), and storage volumes derived from surveys performed from 2005 through 2007.