

## Technical Memorandum

To:	Paul Risse, Chugach Electric	Date:	January 31, 2020
Cc:	Mike Brodie, Chugach Electric	Project:	Eklutna Hydroelectric Project
From:	Samantha Owen, McMillen Jacobs	Subject:	Summary of Spill Events at Eklutna Dam

### 1.0 Background

Eklutna Dam is located in Southcentral Alaska approximately 30 miles northeast of downtown Anchorage near the outlet of Eklutna Lake. The dam is an earth and rockfill structure 815 feet long and 41 feet high with an ungated overflow spillway.<sup>1</sup> There have only been 9 spill events since the U.S. Bureau of Reclamation (USBR) completed construction of the current dam in 1965. This technical memorandum provides a summary of each spill event including the dates, duration, reservoir elevation, flow through the spillway, and spill volume.

### 2.0 Spill Events at Eklutna Dam

The spillway has a crest elevation of 871 feet (USBR, 1967). Therefore, for the purposes of this memo, a spill event is assumed to have occurred whenever the lake elevation exceeds 871 feet.

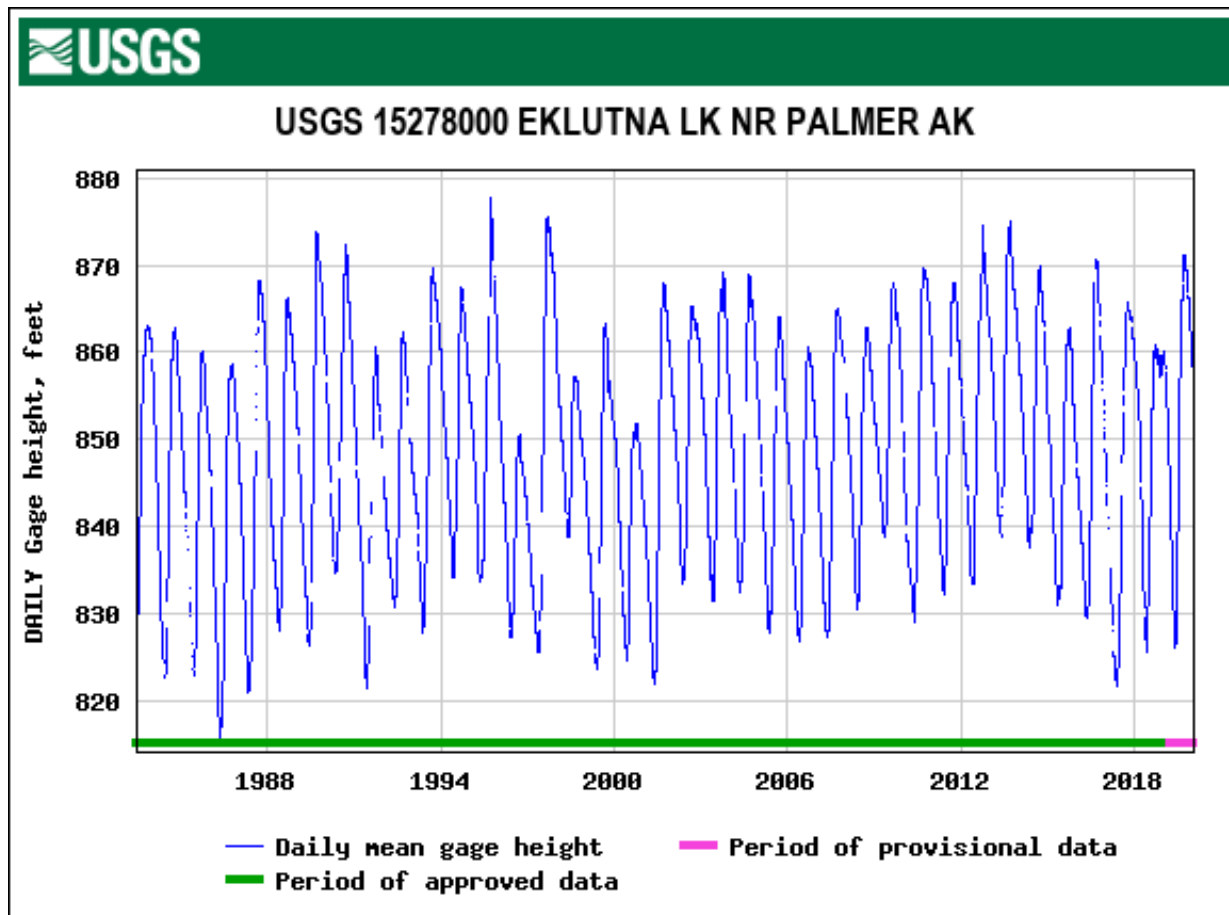
In 1987 the USBR reported that there had been 3 spill events since the dam was constructed. Table 1 summarizes these spill events including the spill period, maximum lake level elevation, and the date the maximum lake level elevation occurred (USBR, 1987).

**Table 1. Spill Events at Eklutna Dam from 1965 to 1987 (USBR, 1987)**

<u>Year</u>	<u>Spill period</u>	<u>Maximum elevation</u>	<u>Date of maximum</u>
1967	9/20 - 10/11	872.99	9/30
1977	8/15 - 9/26	874.6	8/25
1981	8/15 - 9/23	873.5	8/30

<sup>1</sup> There is a 30" x 30" drainage outlet gate in the base of the spillway crest that was designed to drain the water trapped in the pond between the old and current dam during late fall or early winter. It was thought that this water would cause detrimental frost action against the toe of the current dam and at the spillway inlet. This gate is not a typical reservoir outlet and was supplied only for drainage (USBR, 1967).

Since 1983 the U.S. Geological Survey (USGS) has continuously maintained a water level gage in Eklutna Lake near the project intake approximately 1 mile northeast of the dam. This data is publicly available online.<sup>2</sup> Figure 1 shows the mean daily gage height from June 1983 to January 2020. The USGS gage data indicates that there have been 6 spill events at Eklutna Dam since 1983 (USGS, 2020).<sup>3</sup>

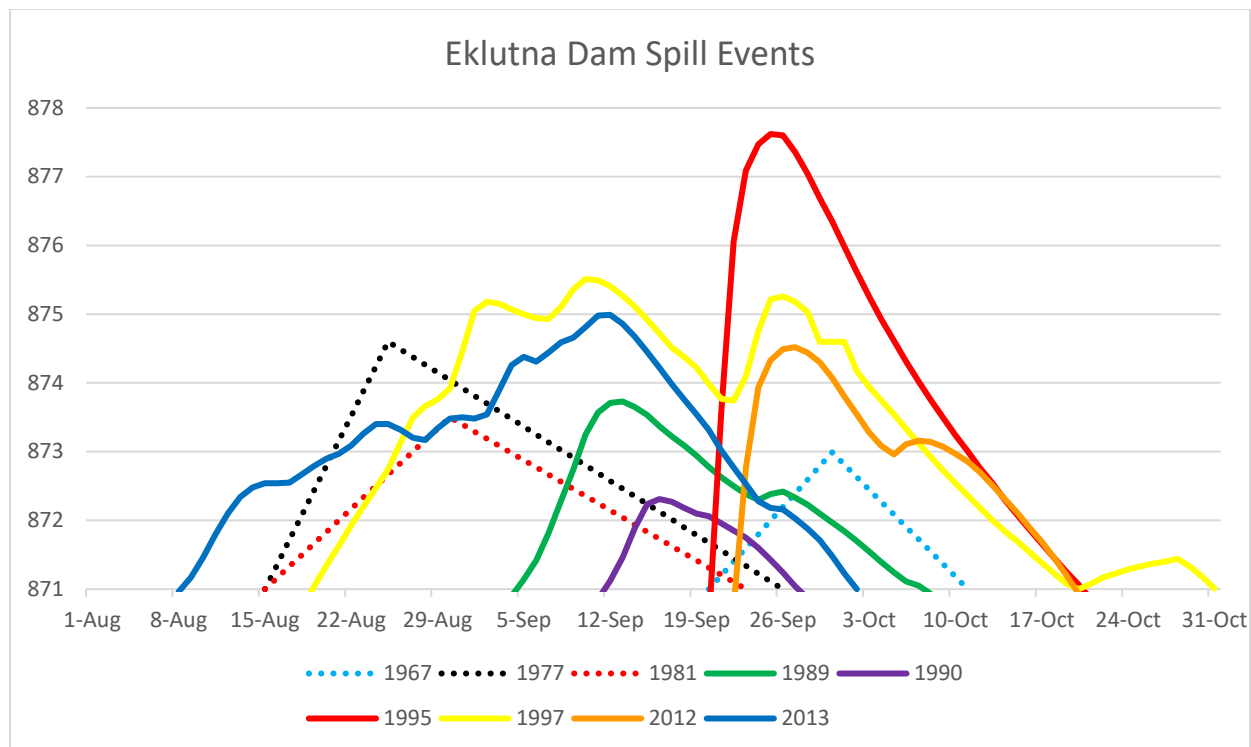


**Figure 1. Mean Daily Gage Height at Eklutna Lake from June 1983 to January 2020 (USGS, 2020)**

Figure 2 combines the information from the 1987 USBR report and the USGS gage data to show all 9 spill events that have occurred since the dam was constructed. Note that the 1967, 1977, and 1981 spill events are represented with a dotted line because the only data available for these spill events were the spill period, the maximum elevation, and the date the maximum elevation occurred.

<sup>2</sup> The raw 15-minute data is only available from 2007 to present. However, the USGS website provides the calculated mean daily gage height for the entire monitoring period from 1983 to present.

<sup>3</sup> In 2019 the USGS gage recorded a maximum lake level of 871.08 feet on both September 22<sup>nd</sup> and 23<sup>rd</sup>. At that elevation, water should have been spilling through the spillway. However, on September 23, 2019 one of the powerplant operators drove out to the dam and reported that the water level was still approximately 1.75 inches below the spillway crest. Therefore, even though the lake level gage measurement exceeded 871 feet, this is not considered a spill event (Bunnell, 2019).



**Figure 2. Lake Level Elevations during Spill Events at Eklutna Dam from 1965 to 2019**

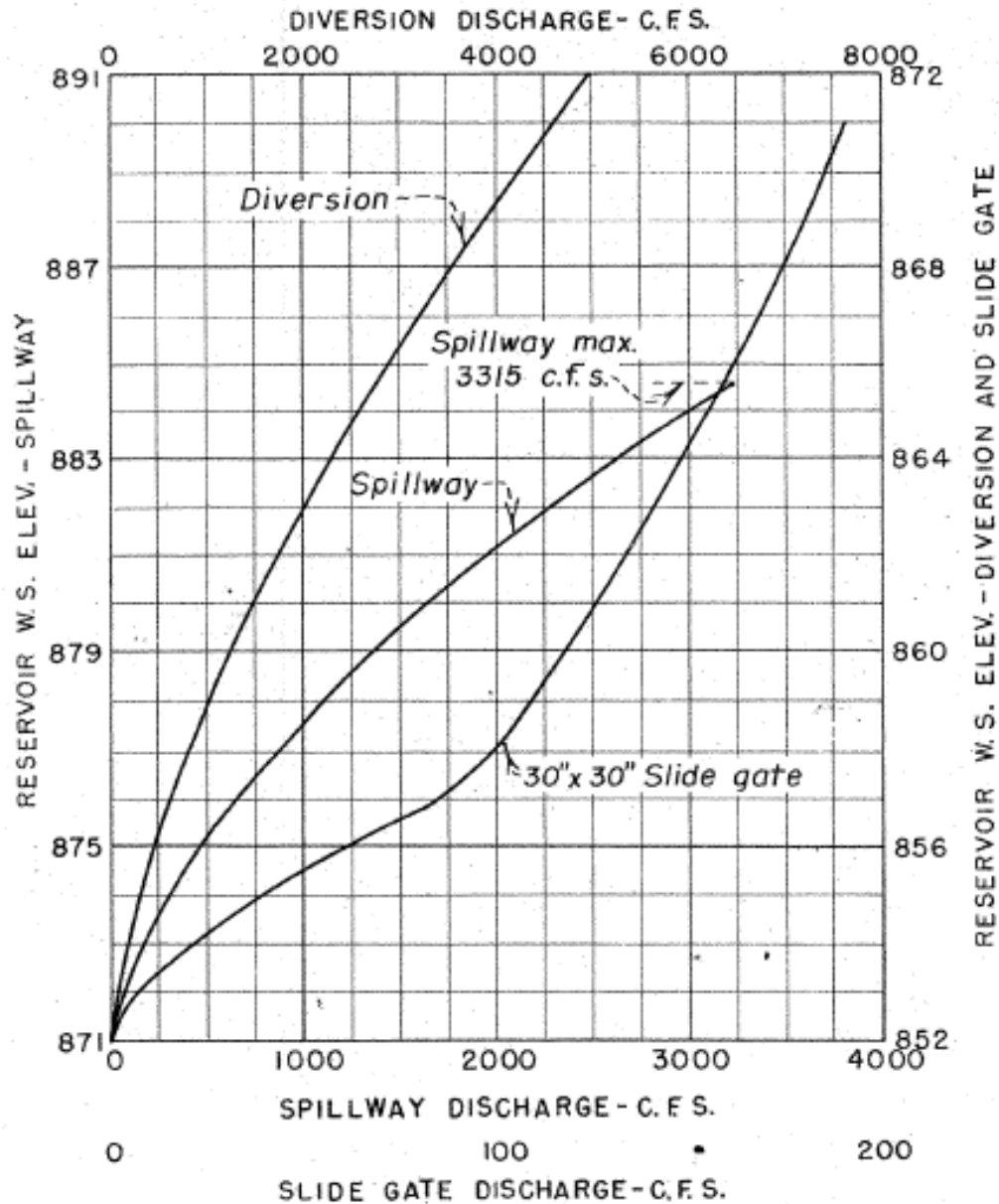
The theoretical discharge curve for the spillway as depicted on as-built drawing 783-D-644 (USBR, 1965) is shown in Figure 3. For the reservoir water surface at maximum elevation 884.8 feet, the spillway has a discharge capacity of 3,315 cubic feet per second (cfs). Discharges were calculated using the formula  $Q = CLH^{3/2}$  (USBR, 1967).

- Q – Discharge (cfs)
- C – Discharge Coefficient
- L – Length of Spillway Crest (feet)
- H – Hydraulic Head (feet)

The length of the spillway crest is 18 feet, and the discharge coefficient ranges from 3.087 at zero head to 3.60 at maximum head (USBR, 1967). Given a maximum water surface elevation of 884.8, the maximum head was calculated to be 13.8 feet. USBR did not provide an equation for how to calculate the discharge coefficient when the hydraulic head is between zero and 13.8 feet. Therefore, it was assumed to be a linear equation.

$$C = mH + b$$

$$C = [(3.6 - 3.087)/(13.8 - 0)]H + 3.087$$



**Figure 3. Theoretical Discharge Curve for the Spillway (USBR, 1965)**

Using the spillway discharge curve equation, the peak spillway flow was calculated for each spill event. In addition, the following values were calculated for each spill event that has occurred since 1983:

- Mean Daily Spillway Flows
- Mean Daily Spill Volumes
- Average Lake Level Elevation
- Average Spillway Flow
- Total Volume Spilled

Table 2 summarizes the historical data and calculated values for each spill event. The mean daily lake level elevations, mean daily spillway flows, and mean daily spill volumes for each spill event since 1983 are included as an attachment to this memo.

**Table 2. Summary of Spill Events at Eklutna Dam from 1965 to 2019**

Year	Spill Period	Duration (Days)	Peak Lake Level Elevation (ft)	Average Lake Level Elevation (ft)	Peak Spillway Flow (cfs)	Average Spillway Flow (cfs)	Total Volume Spilled (AF)
1967	9/20 – 10/11	22	872.99	-	160	-	-
1977	8/15 – 9/26	43	874.60	-	396	-	-
1981	8/15 – 9/23	40	873.50	-	226	-	-
1989	9/5 – 10/7	33	873.73	872.40	259	107	7,018
1990	9/12 – 9/27	16	872.31	871.78	85	43	1,370
1995	9/21 – 10/20	30	877.62	874.40	1,022	426	25,356
1997	8/19 – 10/31	74	875.51	873.33	561	242	35,591
2012	9/23 – 10/19	27	874.52	873.10	383	188	10,055
2013	8/9 – 10/1	54	874.99	873.18	464	201	21,567

The highest lake level elevation ever recorded in Eklutna Lake was 877.62 feet on September 25, 1995. At this elevation the flow through the spillway was calculated to be 1,022 cfs. However, the longest spill event at Eklutna Dam occurred in 1997 and lasted for a total of 74 days. The calculated total volume of water spilled during this time was 35,591 acre-feet (AF).

Note that the peak spillway flows for the 1967, 1977, 1981, 1989, 1990, 1995, and 1997 spill events are very close but do not exactly match the values calculated by HDR in the 2011 Periodic Dam Safety Report for Eklutna Dam. However, HDR did not provide an equation or explanation for how they calculated the spillway flows in the 2011 report. Therefore, their calculations could not be replicated for this memo.

The accuracy of the peak spillway flows for each spill event was checked by plotting the peak flow rates and respective elevations on a graph with the same axis parameters as the graph the theoretical spillway discharge curve is shown on. The picture of the theoretical spillway discharge curve was then uploaded as a background image and adjusted so that both axes on the image align with the axes in the graph (Figure 4). Upon comparison, the plotted data points appear to closely align with the theoretical spillway discharge curve. Therefore, it can be concluded that the calculated values are accurate.

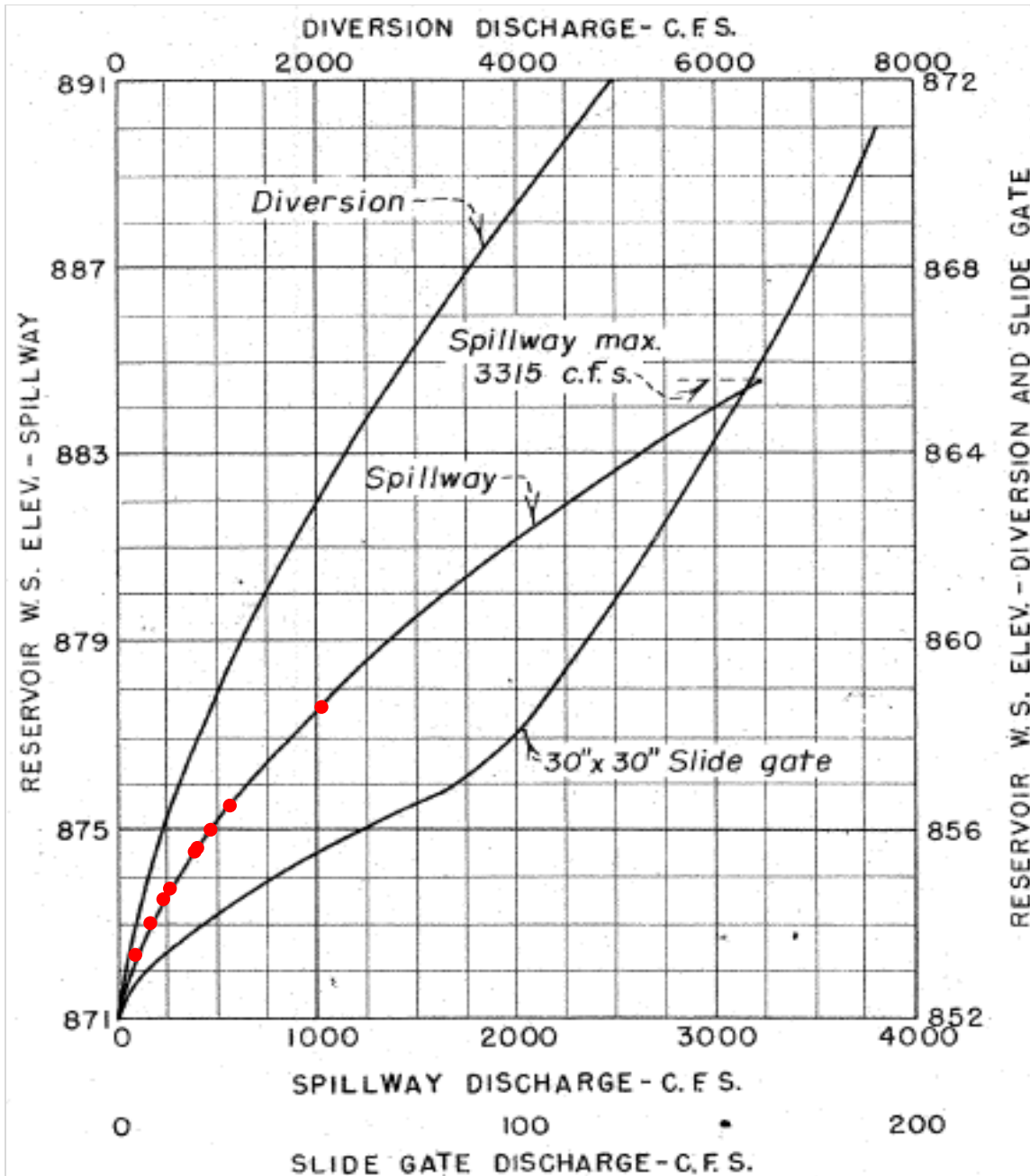


Figure 4. Comparison of the Peak Elevations/Flows for Each Spill Event at Eklutna Dam to the Theoretical Spillway Discharge Curve

### 3.0 References

- Bunnell, Mark. 2019. Email regarding Eklutna Lake Level. September 23, 2019.
- HDR. 2011. Eklutna Dam Periodic Safety Inspection Report. Anchorage, Alaska. March 2011.
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