CHAPTER 8: LAKE LEVEL MANAGEMENT

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SECTION 1: INTRODUCTION

The lake level operating regime described in this Chapter will attempt to raise average lake elevations in the spring and summer, compared to the existing regime, and lower lake elevations in the late summer and fall. Tourism and recreation are the socioeconomic factors most influenced by lake elevations and operating regimes. Higher lake levels earlier in the spring may result in more water-based recreation facilities being operational and accessible earlier in the year, potentially providing benefit to the local economy. Lowering the lake slightly earlier in the year will address fishery management agencies concerns regarding the buildup of sediment barriers at tributary mouths that may inhibit fish access to certain habitat areas.

This lake level management plan is intended to strike a balance between the needs of fish (see Chapters 6 and 7) and recreational needs (see Chapter 11).

Beginning within one year of the effective date of the New License, and for the term of the New License, including any subsequent annual licenses, Chelan PUD shall make every reasonable effort to comply with the lake level management practices described in this Chapter.

SECTION 2: BACKGROUND

The timing and volume of snowmelt inflow to Lake Chelan is highly variable from year to year, dependent on both the annual snowfall and the weather in spring and early summer. The operation of the Project has been managed to meet license conditions regarding the timing of refill since the Project began operation. Today, snow surveys and remote sensors gauge the accumulation of snow and water content in the drainage on a monthly basis, with the most accurate forecast becoming available in April.

Chelan PUD has accumulated 70 years of records, and has developed statistical curves for accumulated inflow during early, average, and late runoff conditions. These curves provide a predictive tool for inflow volumes and lake refill timing, based on the April runoff forecast. Chelan PUD uses these predictive curves to manage power generation to avoid drafting more water from the lake than can be replaced by snowmelt inflow.

Under the present FERC license, Chelan PUD also manages power generation and lake level very conservatively to insure that Lake Chelan, even during a cold spring and summer, will refill by June 30, the date specified in the license. The cumulative inflow, lake level, and weather forecasts are checked several times a week and power generation is reduced or curtailed during years with late runoff to be sure that the lake will be full by June 30.

Refilling the lake on time takes precedence over power generation. The refilling process is managed to guarantee meeting the refill date even when the unexpected occurs, such as the

failure of a forecasted heavy runoff to materialize. Warm weather usually arrives in June, and the lake refills before June 30 most of the time. In many cases, early refill occurs because powerhouse use was cut back to assure refill in case of late snowmelt. When this happens, water is spilled earlier in the season, and in greater quantities, than would have happened with some flexibility in management of the refill date.

The terms of the New License for the Project include a requirement for minimum instream flows into the bypassed reach of the Chelan River. This additional flow, which will take precedence over both refill timing and power generation, increases the uncertainty in refill timing in years with late runoff.

Fixed, inflexible dates, such as those contained in the existing license, for reaching full lake level increases the amount of spill in late June and July in some years. High spill levels are not beneficial to the fish populations in the Chelan River, and impact power generation. A minor degree of flexibility in the timing of lake refill, such as contained in the new operating regime, can prevent or reduce spilling.

The following describes the agreed-upon operation of the Project to meet the lake level requirements contained in Proposed License Article 8.

SECTION 3: IMPLEMENTATION

3.1 Lake Level Operation – Normal Conditions

Chelan PUD will manage the elevation of Lake Chelan from October 1 through May 1 based on monitoring of snowpack water content, lake level, and projected precipitation and runoff timing. Minimum elevations for Lake Chelan will be managed by Chelan PUD with the following objectives in mind:

1. Maintaining minimum flows in the Chelan River (this objective has priority over lake levels)
2. Reducing high flows in the Chelan River (this objective has priority over lake levels)
3. Satisfying regulatory requirements for flood control (adjusting lake level)
4. Providing usable lake levels for recreation (which varies between elevation 1,090 and 1,098 ft depending on the slope of the shoreline and boat dock configurations)
5. Reducing shoreline erosion
6. Preventing fish passage blockages (due to tributary barriers)
7. Minimizing the effect of refill on attainment of flow objectives for salmon in the mainstem Columbia River

Chelan PUD will make every reasonable effort to operate the Project to meet the above objectives. Additionally, Chelan PUD will operate the Project, to the extent practicable, to obtain minimum elevations by the dates specified in Proposed License Article 8 (within reasonable predictive probability):

Table 8-1: Proposed Lake Elevations (PME14)

Day	Minimum Elevation (ft)
May 1	1,087.6
June 1	1,094.0
July 1	1,098.0
August 1	1,099.0
September 7	1,098.7
October 1	1,097.2

Except for circumstances beyond its control (such as droughts and high runoff), Chelan PUD will maintain year-round minimum flows and minimize high flows in the Chelan River. Chelan PUD will control the lake levels to avoid spilling flows greater than 6,000 cfs, to the extent feasible.

In the spring (May 1 through June 30), the averages shown in Table 8-2 will be higher in those years in which the timing of the runoff is early to average. These higher lake level elevations earlier in the year will help make recreational facilities more usable. Examples of the benefit of higher, earlier lake elevations are: 1) a lake elevation of 1,098 ft level is needed to make all fixed docks usable; 2) public marinas, such as Don Morse Park and Twenty-five Mile Creek State Park, need an elevation of 1,094 ft for boat slips to be usable, and 1,091 ft for the boat launch to be usable; and 3) most private marinas need a minimum elevation of 1,091 ft to be 25-35 percent usable. During early to average runoff conditions in early May[1], a lake elevation of 1,090 ft or above is likely.

In the fall (Sept. 1 to Nov. 1), the average lake elevations shown in Table 8-1 will be maintained to reduce erosion and to prevent barriers from forming at tributary mouths. In October, average elevations may be higher due to conservative Project operation and occasional fall rain events.

Operation in accordance with the conditions and minimum elevations described above is expected to result in the average elevations and lake level shown in Table 8-2 and illustrated by Figure 8-1.

[1] The difference between how the model simulates Project operation and how the operators will run the Project makes precise comparisons difficult, since the model works with perfect hindsight and the operators managing the Project will work with a significant amount of uncertainty. Average elevations (operators) on May 1 are expected to be higher than the model shows (e.g., 4 inches to 18 inches). The exact difference will depend on runoff timing and amounts and will depend on the operators' ability to predict runoff conditions.

Table 8-2: Average Lake Levels (Feet, USGS) for the Original License, Existing License, and Agreed Lake Level Cycle

Day	Original License (1927-1981)	Existing License (1981-2000)	Agreed for New License[1]
January 1	1,090.7	1,091.7	1,089.2
February 1	1,088.4	1,089.2	1,087.1
March 1	1,086.6	1,087.1	1,085.7
April 1	1,085.6	1,086.3	1,085.4
May 1	1,087.6	1,088.0	1,087.8
June 1	1,094.8	1,094.4	1,095.2
July 1	1,099.3	1,099.2	1,099.3
August 1	1,099.7	1,099.7	1,099.7
September 1	1,098.8	1,099.5	1,098.9[2]
October 1	1,096.9	1,098.3	1,097.4
November 1	1,094.7	1,095.8	1,094.3
December 1	1,092.9	1,094.2	1,091.8

[1] Average elevation derived from 1952-1995 period of record

[2] September 7

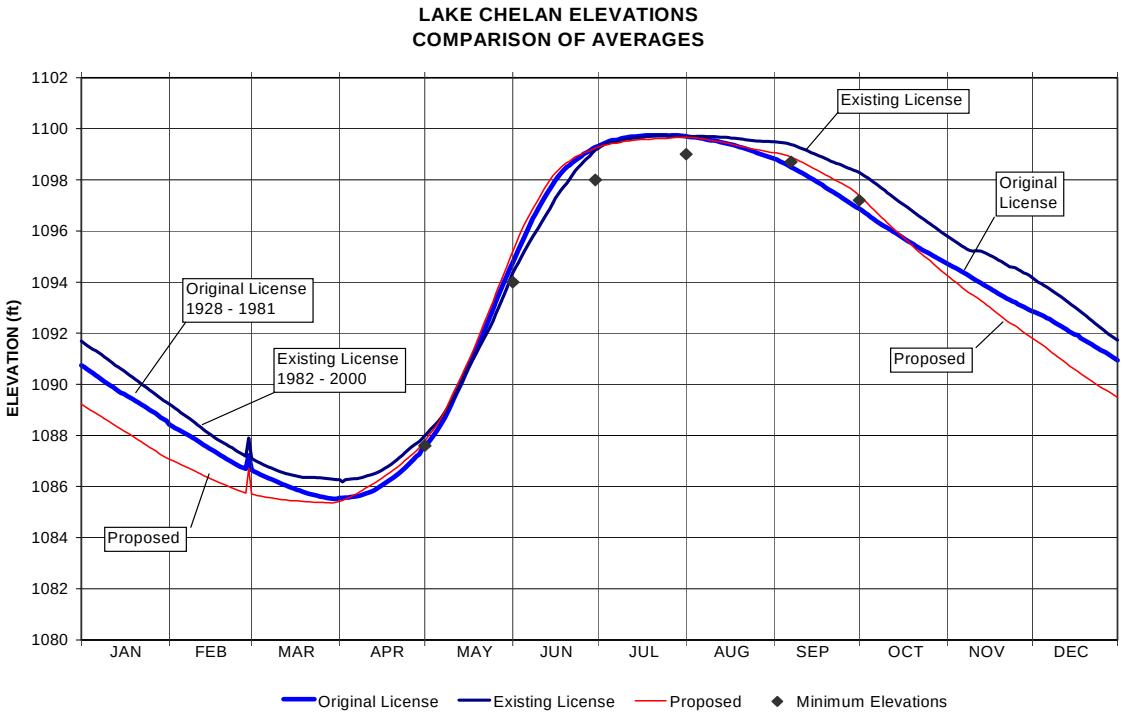

Figure 8-1: Comparison of Averages for Lake Chelan Elevations

3.2 Lake Level Operation – Late and High Runoff Conditions

Lake refill in the spring is affected by both the volume and timing of runoff. As part of the New License for the Lake Chelan Project, Chelan PUD is required to provide minimum instream flows to the Chelan River. Another requirement is to minimize high flows (greater than 6,000 cfs) in the Chelan River bypassed reach to protect modified habitat measures to be implemented at the lower end of the Chelan River to enhance anadromous fish production. These requirements will tend to increase the uncertainty for lake refill. As a result, the determination of early/late runoff years to adjust Project operations will need to be performed even more carefully than it is currently. The following sections discuss the definition of late runoff years and operations for lake refill timing.

3.2.1 Proposed Operating Regime – Late Runoff Conditions

The February 1, March 1, and April 1 runoff volume forecasts and the lake level elevation are used to establish the level of releases for April, May, and June. The volume of runoff needed to refill the lake is calculated from the lake elevation. The proportion of the runoff volume forecasts expected to occur prior to May 1, June 1, and July 1 is estimated, and the volume in excess of the refill requirement is used for power generation. Three predictive curves, one each for early, average, and late runoff timing, are generated based on the forecast. These curves are then used to manage generation.

On average, approximately 81 percent of the runoff entering the lake occurs before July 1 (average runoff). In years with cold spring weather, approximately 71 percent of the runoff occurs by July 1 (late runoff), whereas in warm years, as much as 87 percent occurs by July 1 (early runoff). For purposes of lake level management, early runoff is defined as a year in which at least 80 percent of the predicted runoff occurs before July 1, and late runoff is defined as a year in which less than 80 percent of the predicted runoff occurs before July 1.

The lake is currently managed assuming average to late runoff conditions, which can be defined also as operating to 95-100 percent probability of refill by July 1. In most years, the cold spring weather breaks by early June and the lake refills before July 1, which results in substantial levels of spill. The agreed upon approach assumes early to average runoff conditions, also defined as operating to 80 percent probability of refill by June 30, (see Section 3.3), and includes minimum flow releases into the bypassed reach of the Chelan River. This level of flexibility will help reduce spill levels that would provide: 1) reduced impacts on aquatic biota in the bypassed reach of the Chelan River from high peak spill level; 2) benefits to aquatic biota by providing conditions in the bypassed reach of the Chelan River that more closely mimic the natural hydrograph; 3) more flow in the tailrace in early spring (April and May) for steelhead egg incubation and fry emergence; and 4) reduce impacts on power generation.

Operations model analyses were conducted, based on historic data, to forecast lake refill under the agreed upon management approach. Model results show that minimum elevations can be met in most years by the specified dates, even with conflicts between runoff volume and timing, providing minimum flows, desired higher spring lake elevations, and controlling spring spill levels. For example, the May 1 minimum elevation, 1,087.6 ft, was achieved in 35 of 44 years (9 misses). However, in the years when the May 1 elevation was not achieved, the lake was filling

rapidly and was not far below the minimum elevation. Specifically, the average delay to reach elevation 1,087.6 ft was 4 days (May 5), and the maximum delay was nine days (May 10). Similar results are shown for the June 1 and July 1 dates. Results from 1977 were omitted from the tabular results because it was such an extreme low flow year and skewed results significantly.

Results of model runs for the 44-year period of record (1952-1995) are shown in Table 8-3.

Table 8-3: Operations Model Results

Date	No. Years Missed	Average Delay {w/o 1977}(days)	Maximum Delay {w/o 1977} (days)
May 1	9	4	9
June 1	11	2	6
July 1	2	1	1

3.2.2 Proposed Operating Regime - High Runoff Conditions (PMF)

FERC regulations require the Project to be able to pass the outflow from the probable maximum flood (PMF) without failure of the dam. From October through mid-November, the Project's PMF is based on a maximum probable precipitation event in the watershed, but does not include significant amounts of snow in place. From late November through February, the PMF would be produced by maximum probable precipitation falling on an unusually large (100-year) snowpack.

To maintain the ability to pass the PMF without dam failure, the Project must be operated in a way that provides enough storage to capture part of the PMF inflows. The amount of available storage required varies with the water content of the snow present in the watershed. The effect of this requirement is that the lake must be kept at lower levels when larger snowpack exists in the watershed. This coincides with the current approach (which would be continued under the New License) of drawing the lake down through the winter to accommodate the amount of runoff anticipated the next spring.