# BRADLEY LAKE HYDROELECTRIC PROJECT

**FERC NO. 8221**

## BRADLEY LAKE EXPANSION NON-CAPACITY LICENSE AMENDMENT

# EXHIBIT B
# PROJECT OPERATION AND RESOURCE UTILIZATION

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# ACRONYMS AND ABBREVIATIONS

***A***

| | |
|---|---|
| ac-ft | acre-feet |
| AEA | Alaska Energy Authority |

***B***

| | |
|---|---|
| BLVD | Bradley Lake Vertical Datum |
| Bradley Lake Project | Bradley Lake Hydroelectric Project (FERC No. 8221) |

***C***

| | |
|---|---|
| cfs | cubic feet per second |

***E***

| | |
|---|---|
| EFMR | East Fork Martin River |
| El. | Elevation |

***F***

| | |
|---|---|
| FERC | Federal Energy Regulatory Commission |

***K***

| | |
|---|---|
| kV | kilovolt |

***L***

| | |
|---|---|
| LiDAR | light detection and ranging |

***M***

| | |
|---|---|
| MIF | minimum instream flow |
| MW | megawatt |
| MWh | megawatt-hour |

***S***

| | |
|---|---|
| SCADA | supervisory control and data acquisition system |

***U***

| | |
|---|---|
| USGS | United States Geological Survey |

***W***

| | |
|---|---|
| WFUBC | West Fork Upper Battle Creek |
| WSE | water surface elevation |

# 1.0 INTRODUCTION

The Alaska Energy Authority (AEA), licensee and owner of the 120-megawatt (MW) Bradley Lake Hydroelectric Project (Bradley Lake Project; Federal Energy Regulatory Commission [FERC] No. P-8221), is pursuing a non-capacity FERC license amendment. The Bradley Lake Project is an existing power generation facility constructed on the south shore near the head of Kachemak Bay, about 25 miles northeast of Homer, Alaska.

Bradley Lake Project features include a 125-foot-high, 610-foot-long concrete-faced, rockfill main dam at Bradley Lake (59.7553° North/150.8558° West), a separate concrete gravity spillway, and a 3.5-mile-long power tunnel that incorporates a 3,000-foot-long steel-lined tunnel/penstock at the powerhouse (Figure1.0-1). The Bradley Lake Project generates power from Bradley Lake, which includes water diverted to the lake from the Middle Fork Bradley River, Nuka Glacier, and Upper Battle Creek. Power is transmitted from the Bradley Lake powerhouse to the state's main grid at Bradley Junction via two parallel, 20-mile-long, 115-kilovolt (kV) transmission lines. Homer Electric Association operates the Bradley Lake Project under contract with AEA. Bradley Lake serves Alaska's Railbelt[1] from Homer to Fairbanks and easterly to the Delta Junction area.

AEA proposes to build a new diversion dam (Dixon Diversion) to divert seasonal meltwater and runoff coming from the Dixon Glacier, located at the headwaters of the Martin River, through an underground tunnel to Bradley Lake May through November, as flows allow (Figure 1.0-1). AEA also proposes to raise the normal maximum operating pool elevation of Bradley Lake by about 16 feet (Bradley Lake Pool Raise) through a combination of raising the concrete spillway crest elevation, adding spillway crest gates, and raising the dam embankment crest. Together, these two components make up the proposed Bradley Lake Expansion Project (Project or proposed development).

Raising the normal maximum operating pool elevation by 16 feet would increase the usable storage capacity from approximately 280,000 acre-feet to 342,000 acre-feet, increase the net head from 917 feet to 933 feet, and increase the installed capacity of the Bradley Lake Project from 119.7 MW to 122.8 MW. The amount of power the Bradley Lake

[1] The Railbelt in Alaska refers to the region served by the Alaska Railroad and the Railbelt electrical grid, which is responsible for providing electricity to approximately 75 percent of the state's population. This region extends from Homer to Fairbanks and easterly to the Delta Junction area.

Project can produce on average would increase from about 436,000 megawatt-hours (MWh) to 601,000 MWh each year, an increase of approximately 38 percent.[2]

This Exhibit B describes the proposed Bradley Lake Expansion Project operation and resource utilization as an amendment to the existing Bradley Lake Project and proposed operational changes to the Bradley Lake Project.

[2] Since the Battle Creek Diversion became operational in late 2020, other sources of inflow to Bradley Lake have been lower than the normal long-term average. Average annual power generation at the Bradley Lake Project from 2021 through 2025 was approximately 420,000 MWh, while the expected long-term average annual power generation with the Battle Creek Diversion is approximately 436,000 MWh.

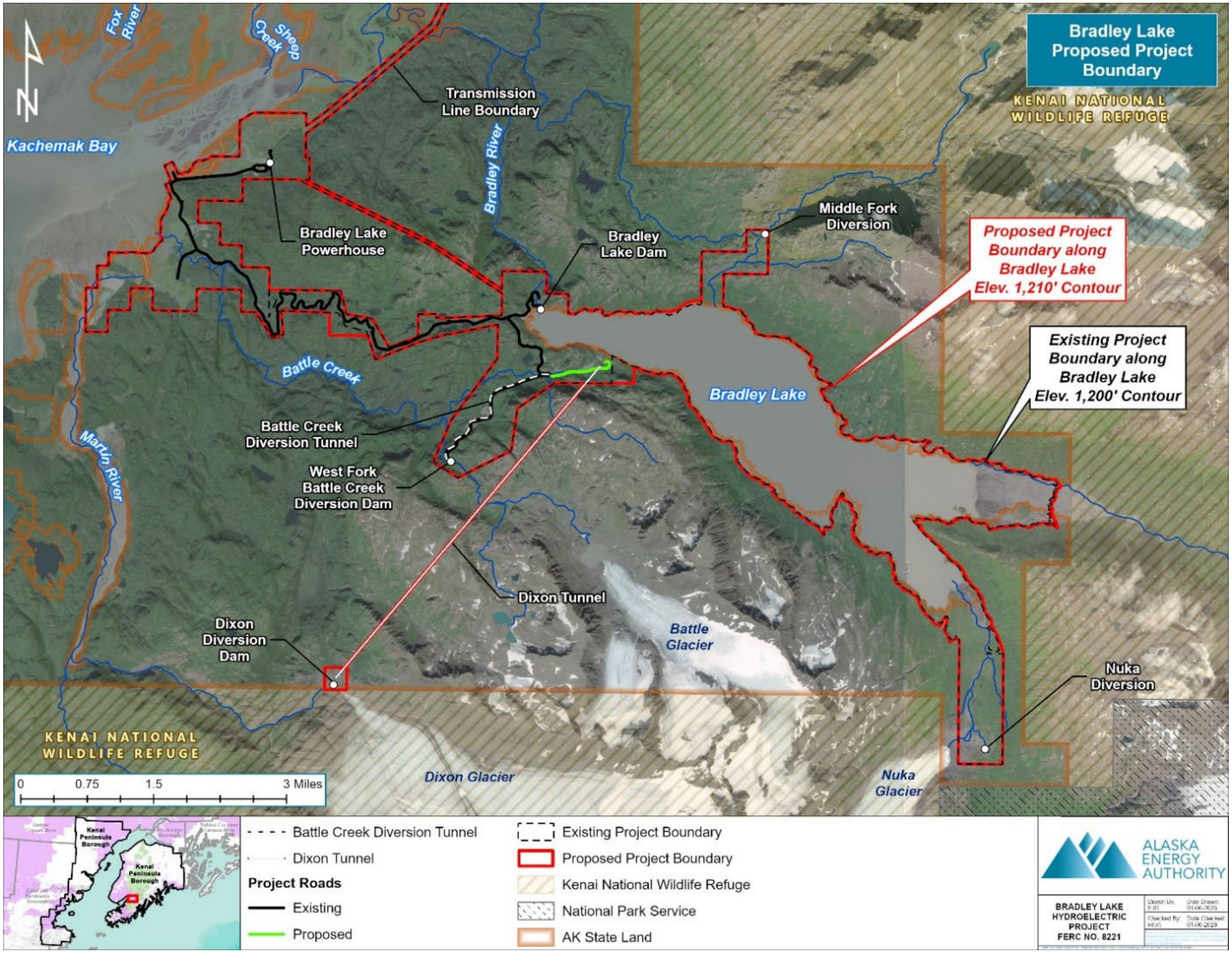


**Figure 1.0-1 Location and features of the Bradley Lake Expansion Project near Kachemak Bay, Alaska.**

# 2.0 BRADLEY LAKE PROJECT OPERATION AND RESOURCE UTILIZATION

## 2.1 Proposed Operational Changes

### 2.1.1 Bradley Lake Mode of Operation

The Bradley Lake Project would continue to be operated in automatic mode from a remote location. However, complete control facilities are also provided for local operation at the plant. A supervisory control and data acquisition system (SCADA) provides remote plant control and transmits operational data to the remote location. The SCADA system consists of a master control at a dispatch center and a remote unit at the power station. A second remote terminal unit is located at the reservoir gate house to start the propane generator and remotely operate the intake gate and receive gate position and reservoir level data. The proposed Dixon Diversion would be operated remotely.

### 2.1.2 Annual Plant Factor

The average annual plant factor is determined using the following equation:

$$\frac{\text{Average Annual Output}}{\text{Licensed Capacity x 8,760 hours/year}} = \text{Average Annual Plant Factor}$$

Average annual power generation at the Bradley Lake Project from 2021 through 2025 was approximately 420,000 MWh, and the average annual plant factor was approximately 40 percent based on the current licensed capacity of 119.7 MW. Since the Battle Creek Diversion became operational in late 2020, the inflow to Bradley Lake has been lower than the normal long-term average; the estimated long-term average annual power generation with Battle Creek is approximately 436,000 MWh, which would have an average annual plant factor of 42 percent. The proposed Bradley Lake Expansion Project is anticipated to produce 601,000 MWh annually on average, and the increase in the operational net head from 917 feet to 933 feet would increase the Bradley Lake Project's capacity to 122.8 MW, which would result in a plant factor of 56 percent.

### 2.1.3 Proposed Operation and Operation During Maintenance Activities

#### 2.1.3.1 Bradley Lake

The Bradley Lake Project operates in a peaking mode and provides some of the least expensive power to the Railbelt. Since 2003, spill events have occurred on five occasions, driven by specific circumstances. The last spill event occurred in 2019 due to the Swan Lake fire, which had destroyed part of the 115-kV transmission line north of Sterling, temporarily blocking transmission of Bradley Lake power to all Railbelt utility service territories north of the Homer Electric Association service area.

Under the proposed development, the Bradley Lake Project would continue to be operated in coordination with other Railbelt resources to maximize output and optimize water resources to meet load demand when water for generation is available and reduce reliance on natural gas generation. Reservoir elevations would continue to be highest during the fall months and lowest during the spring months prior to snowmelt and glacier melt. The Bradley Lake Project would continue to be operated to minimize spill, and no changes to minimum flows (timing, amount, or duration) into the Lower Bradley River or to operations during maintenance activities are proposed.

The Bradley Lake Dam currently impounds Bradley Lake to a full pool elevation (El.) 1,180 feet (Bradley Lake Vertical Datum [BLVD])[3] with a surface area of 3,802 acres. Normal operation pool elevations range from El. 1,080 feet to El. 1,180 feet providing a usable storage capacity of approximately 280,000 acre-feet and net head at full pool of 917 feet. Under the proposed development, the normal maximum pool elevation would increase from El. 1,180 to El. 1,196 feet. At the higher proposed normal maximum pool elevation of 1,196 feet the total surface area of Bradley Lake would be 4,033 acres and the usable storage capacity would increase to approximately 342,000 acre-feet.

#### 2.1.3.2 Dixon Diversion

The Dixon Diversion would divert water from the 19.1-square-mile Dixon Glacier subbasin, located in the East Fork Martin River (EFMR), to Bradley Lake via a 4.6-mile-long underground tunnel (Figure 2.1-1). The Project would be operated early May through November, as flows allow after meeting proposed minimum instream flow (MIF) releases of 100 cubic feet per second (cfs) to the EFMR.

[3] Bradley Lake Vertical Datum (BLVD) is specific to the Bradley Lake Hydroelectric Project. To convert from BLVD to North American Vertical Datum of 1988, add 9.76 feet.

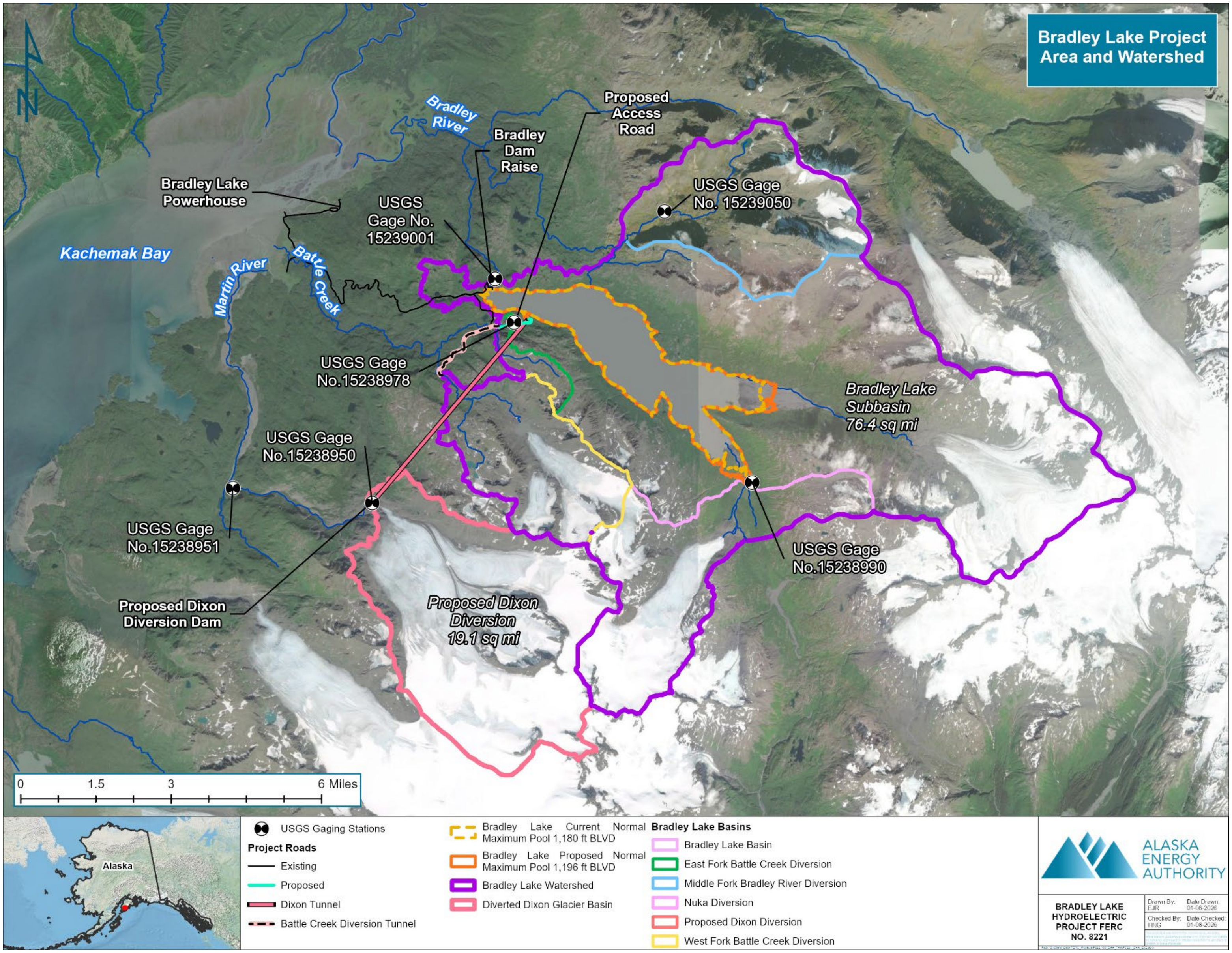


**Figure 2.1-1 Proposed Bradley Lake Expansion Project near Kachemak Bay, Alaska.**

#### 2.1.3.2.1 Diversion Dam, Head Works, and Conveyance Details

The Dixon Diversion dam would be constructed near the terminus of the Dixon Glacier to impound water to divert through a tunnel to the southwestern portion of Bradley Lake.

Water control features of the Dixon Diversion include the following:

- A motor-operated slide gate regulating MIF through the diversion dam to the EFMR below the diversion.
- A motor-operated slide gate at the diversion dam to provide a low-level outlet to maintain flow through the diversion dam during maintenance operations.
- Two "overshot" crest gates (tentatively Obermeyer gates) that would serve two primary purposes:
    - one (or both) gates would be lowered occasionally to flush accumulated sediments in the diversion pool through the diversion dam.
    - one (or both) gates would be lowered to pass large floods, particularly when the diversion pool exceeds El. 1,275.5 feet.
- A motor-operated slide gate at the inlet portal to the diversion tunnel for closing the tunnel outside of the operating season.

#### 2.1.3.2.2 Diversion Hydrologic Considerations

The EFMR drains approximately 19 square miles of the Dixon Glacier basin (Figure 2.1-1). The upper drainage basin is typically ice and snow covered with minimal runoff from sometime in November until sometime in May. In some years, late warm storms may increase flow for a couple of days in November before colder temperatures are re-established. Beginning around April, the heavy snowpack below the diversion starts to melt. Snow above the diversion tends to mostly melt in June and later. During June-July, the snow and ice melt from above the diversion is a more significant component of tidewater flow. During August and September, storms tend to be frequent and can result in flow in the Martin River increasing rapidly. Between storms, runoff from the upper basin may substantially decrease because the snowpack is largely depleted in July.

Historic flow data are unavailable, but the United States Geological Survey (USGS) installed the Dixon Creek gage (USGS Gage 15238950) in the fall of 2021, which has since been washed out and replaced with USGS Gage 15238951 EFMR at Mouth near Homer, Alaska. Historical EFMR flow has been estimated based on a 42-year record of gaged flow from the Nuka Glacier into the Upper Bradley River (USGS 15238990; 1979-2021), adjusted for differences in basin area (Figure 2.1-2).

The estimated annual peak flow from Dixon Glacier was greater than 1,000 cfs in 39 of 42 years and greater than 2,000 cfs in 19 of 42 years (Figure 2.1-2). The estimated annual average flows ranged from a minimum of 79 cfs in 1996 to a maximum of 358 cfs in 2013. Flow in the Martin River was estimated to be less than 1 cfs approximately 30 percent of the time, typically between November and May. Seasonally, the annual median estimated flows were highest in July (603 cfs) and August (635 cfs), followed by September (412 cfs) and June (320 cfs), and were less than 100 cfs more than half of the time during all other months of the year (Figure 2.1-2).

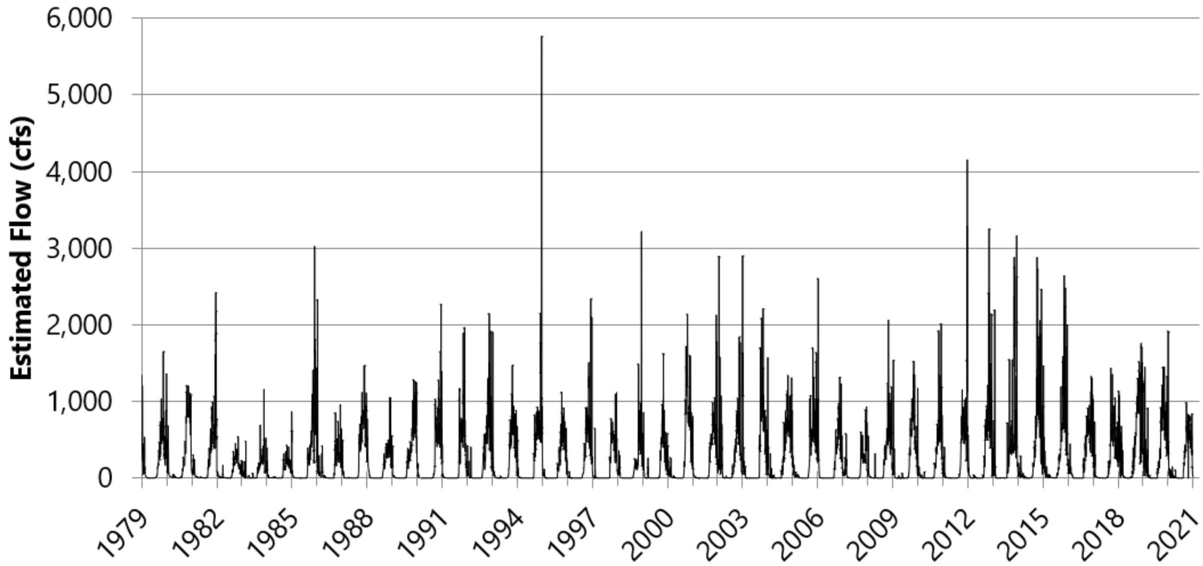


**Figure 2.1-2 Estimated flow in the East Fork Martin River, 1979–2021.**

#### 2.1.3.2.3 Diversion Operational Considerations

The proposed Dixon Diversion operating period is designated to capture flows during the peak runoff seasons, while maintaining stream flows for fisheries in the Martin River and providing periodic bedload transport.

**<u>Minimum Instream Flow Releases</u>**

An operation plan for the Dixon Diversion was developed based on releasing sufficient water through the diversion dam to maintain a minimum flow of 100 cfs in the EFMR below the diversion dam throughout the period of operation. If the incoming flow from the Dixon Glacier basin is less than 100 cfs, all of the water would be released to the EFMR. Water would not be diverted to Bradley Lake until the EFMR MIFs are met.

**Sediment Control**

During Dixon Diversion operation, coarse sediment would accumulate in the diversion pool, and the accumulated sediment would be occasionally flushed downstream through the spillway gates. The intent would be to retain sediment away from the diversion tunnel inlet portal and convey it to the EFMR below the diversion and allow the river to transport the sediments downstream to their natural destination. Provisions to periodically flush sediment to the EFMR would maintain a source of course sediment and gravel for potential spawning habitat in the Martin River.

**EFMR Channel; Maintenance Flow Releases**

It is anticipated that periodic channel maintenance flows would be passed through the diversion dam to the EFMR and, hence, to the Martin River. A channel maintenance flow of 1,000 cfs for 12 hours would be released a minimum of 3 years out of each moving 10-year average of project operation.

#### 2.1.3.2.4 Diversion and Conveyance Capacity

During normal operation, the Dixon Diversion structure would divert up to 1,650 cfs, which is less than the 2-year recurrence flow of 2,300 cfs at the Dixon Diversion, without spilling, and convey that flow to Bradley Lake via a tunnel.

Flows that exceed the capacity of the diversion tunnel (after delivering the required MIF) would flow through the diversion dam to the EFMR. The excess flow would be routed over the two spillway overshot gates. During flood flows, the two approximately 30-foot-wide by approximately 20-foot-tall overshot gates can be lowered for a flood capacity of about 23,000 cfs (approximately a 35,000-year flood) before overtopping the diversion dam structure at El. 1,282 feet.

The lower slide gate would be approximately 6 feet by 6 feet in size and positioned to provide a low-level outlet to maintain flow through the diversion dam during maintenance operations. The upper slide gate would be approximately 4 feet by 4 feet in size with a capacity of greater than 100 cfs, to reliably deliver the EFMR MIF requirement. The capacity of the two slide gates would not be needed for flood routing.

Table 2.1-1 shows the capacity of the Dixon Diversion MIF bypass gate, spillway gates, and tunnel compared to extreme floods.

**Table 2.1-1 Dixon Diversion estimated bypass spillway and diversion tunnel capacity.**

| Flood Description | Water Surface Elevation of Diversion Pool (feet) | Flow (cfs) | | | |
|---|---|---|---|---|---|
| | | Total | Minimum Instream Flow (MIF) | Tunnel | Bypass in Excess of MIF and Tunnel |
| 2 feet of freeboard | 1,274 | 1,400 | 100 | 1,300 | 0 |
| 1 foot of freeboard | 1,275 | 1,600 | 100 | 1,500 | 0 |
| 0 feet of freeboard (diversion dam crest) | 1,276 | 1,750 | 100 | 1,650 | 0 |
| 10-year flood peak flow | 1,281.9 | 4,500 | 100 | 1,650 | 2,750 |
| 100-year flood peak flow | * | 7,900 | 100 | 0 | 7,800 |

*The overshot gate(s) would be lowered as needed during inflows that would result in a diversion pool level of El. 1,282 feet or greater if the gates were not operated. The elevation of the diversion pool when the gates are completely lowered is El. 1,268 feet,

#### 2.1.3.2.5 Flow Measurements

The MIF slide gate would have pre-defined diversion pool elevation versus discharge versus gate opening rating tables for EFMR bypass flows that operators would use to change the gate opening as necessary. A water level indicator would be installed at the diversion to measure the diversion pool water level, which would be used to establish the MIF gate opening. The diversion dam would be the point of compliance for measuring the EFMR MIF flows.

#### 2.1.3.2.6 Startup of Diversion and Head Works

The proposed Dixon Diversion is in a remote location, and access to the diversion for annual startup and shutdown, as well as maintenance and inspections during diversion operations, would be via helicopter.

Initially, the annual startup process would include a series of inspections and tests to verify the systems are operational and/or to perform maintenance and repair activities. Specific activities would be to review the diversion pool and, if necessary, mechanically stage accumulated sediments in front of the spillway gates so they can be flushed downstream; inspect the spillway, low-level, MIF, and diversion tunnel inlet portal gates for damage; and verify the gates and instrumentation are functioning properly. Upon completion of the inspection and any maintenance and repairs, the MIF gate and tunnel inlet portal gate would be opened, and the spillway gates would be set to their raised position to initiate the diversion process. Cameras would also be installed at the facility to allow operators to view conditions at the site. After a couple of years of operations, and if there is no need for any repairs or maintenance, the diversion process may be initiated remotely.

#### 2.1.3.2.7 Operation of the Diversion and Head Works

The Dixon Diversion would be operated remotely from early May through November, as flows allow. The MIF gate elevation would be designed such that water would flow through the diversion to the EFMR before the diversion pool elevation would be high enough to initiate diversion to Bradley Lake. Inflow to the diversion that exceeds the MIF requirement would flow over the diversion tunnel forebay berm sill, through the diversion tunnel, and to Bradley Lake. The diversion tunnel forebay berm and forebay would create depositional environments, allowing for large (i.e., greater than gravel) sediment to settle. Fine sediment (e.g., small gravels, sands, and silt) would be conveyed through the tunnel to Bradley Lake. The MIF gate would be continuously monitored at the Bradley Lake Project control room and remotely adjusted as necessary to maintain the required MIF.

Flows exceeding the capacity of the diversion tunnel would flow through the diversion dam and continue downstream to the Martin River. During extreme floods, the spillway gates would be lowered, and the dam could be safely overtopped.

In late October/early November, Bradley Lake Project operators would inspect the diversion, perform maintenance and repairs, and ensure the gates are in their appropriate position for the non-operating season; the diversion tunnel inlet portal gate would be closed, the overshot spillway gate leaves would be lowered, and the MIF and low-level outlet gates would be opened. During the non-operating period of December to April, all runoff from the Dixon Glacier basin would flow through the diversion to the EFMR.

## 2.2 Dependable Capacity and Average Annual Generation

### 2.2.1 Annual Energy Generation

The West Fork Upper Battle Creek (WFUBC) Diversion has been operational since July 2020. The average annual power generation at the Bradley Lake Project since the WFUBC

Diversion has been operational (2021-2025) was approximately 419,912 MWh (Table 2.2-1). This period of time was drier than long-term average conditions. The anticipated long-term average annual generation with the WFUBC Diversion is 436,000 MWh;[4] Table 2.2-2 provides the operations of the Bradley Lake Project during an average year with and without implementation of the Dixon Diversion and Bradley Lake Pool Raise. The proposed Bradley Lake Expansion Project is expected to increase generation by an average of 165,000 MWh annually, increasing the expected long-term average annual energy production from 436,000 MWh to 601,000 MWh (38 percent).

**Table 2.2-1 Current Bradley Lake Project generation (MWh) 2021-2025 by month.**

| Month | Average Monthly Generation (MWh) |
|---|---|
| January | 33,124 |
| February | 27,652 |
| March | 30,831 |
| April | 29,303 |
| May | 30,391 |
| June | 27,816 |
| July | 31,856 |
| August | 36,533 |
| September | 46,651 |
| October | 43,758 |
| November | 39,017 |
| December | 42,535 |
| **Average Monthly Generation** | **34,956** |
| **Total Annual Generation** | 419,912 |

MWh = megawatt-hours

[4] The long-term average was derived from the past 10 year of releases from Bradley Lake plus the average of the WFUBC Diversion added to the dataset as if the WFUBC Diversion had been online the entire 10-year period. The actual energy produced from the Bradley Lake Project 2021–2025 is about 420,000 MWh.

**Table 2.2-2 Bradley Lake Project operations during average year currently and with the proposed Dixon Diversion and Bradley Lake pool raise.**

| Month | Existing Bradley Project with Average Year Inflow[a] | | | Raised Pool with Average Year Inflow plus Dixon Diversion Inflow | | |
|---|---|---|---|---|---|---|
| | Average WSE (ft) | Average Turbine Discharge (cfs) | Total Energy Production (MWh) | Average WSE (ft) | Average Turbine Discharge (cfs) | Total Energy Production (MWh) |
| January | 1,142.6 | 650 | 39,180 | 1,157.7 | 950 | 58,101 |
| February | 1,131.8 | 550 | 30,690 | 1,142.3 | 850 | 47,918 |
| March | 1,121.2 | 500 | 29,516 | 1,125.7 | 850 | 50,401 |
| April | 1,110.7 | 450 | 25,441 | 1,106.1 | 850 | 47,838 |
| May | 1,104.6 | 500 | 29,034 | 1,089.3 | 800 | 45,741 |
| June | 1,113.3 | 500 | 28,343 | 1,098.3 | 500 | 27,920 |
| July | 1,136.9 | 600 | 35,969 | 1,138.3 | 500 | 30,014 |
| August | 1,154.2 | 700 | 42,667 | 1,170.2 | 950 | 58,791 |
| September | 1,165.3 | 750 | 44,711 | 1,187.9 | 950 | 57,842 |
| October | 1,167.1 | 800 | 49,361 | 1,191.2 | 950 | 59,951 |
| November | 1,159.7 | 800 | 47,438 | 1,183.2 | 950 | 57,588 |
| December | 1,151.7 | 550 | 33,446 | 1,171.4 | 950 | 58,859 |
| **Total** | | | **435,797** | | | **600,965** |
| **Percent Increase** | | | | | | **38** |

cfs = cubic feet per second; MWh = megawatt-hours; WSE = water surface elevation

### 2.2.2 Dependable Capacity

The dependable capacity for the Bradley Lake Project is based on its load-carrying ability under adverse hydrological conditions. Table 2.2-3 includes operations during an adverse, or dry, year for the current Bradley Lake Project as well as the proposed Project. Under adverse conditions, the current Bradley Lake Project has a dependable operating capacity of 300,424 MWh. The proposed Dixon Diversion and 16-foot Bradley Lake Pool Raise would increase the dependable capacity by 53 percent to 458,728 MWh.

**Table 2.2-3 Bradley Lake Project expected operations during adverse (dry) year of inflow.**

| Month | Existing Dam with Dry Year Inflow | | | Raised Pool with Dry Year Inflow Plus Dixon Diversion Inflow | | |
|---|---|---|---|---|---|---|
| | Average WSE (ft) | Average Turbine Discharge (cfs) | Total Energy Production (MWh) | Average WSE (ft) | Average Turbine Discharge (cfs) | Total Energy Production (MWh) |
| January | 1,144.7 | 400 | 24,161 | 1,158.8 | 800 | 48,979 |
| February | 1,137.3 | 450 | 25,245 | 1,145.1 | 800 | 45,222 |
| March | 1,127.4 | 500 | 29,698 | 1,128.1 | 900 | 53,490 |
| April | 1,115.9 | 500 | 28,417 | 1,106.5 | 900 | 50,671 |
| May | 1,109.8 | 500 | 29,185 | 1,088.3 | 850 | 48,552 |
| June | 1,122.5 | 300 | 17,161 | 1,102.2 | 300 | 16,818 |
| July | 1,149.4 | 300 | 18,203 | 1,145.2 | 300 | 18,129 |
| August | 1,168.2 | 300 | 18,531 | 1,179.8 | 300 | 18,733 |
| September | 1,177.5 | 450 | 27,135 | 1,196.6 | 300 | 18,413 |
| October | 1,174.7 | 450 | 27,967 | 1,193.3 | 750 | 47,420 |
| November | 1,172.4 | 450 | 27,006 | 1,187.4 | 750 | 45,643 |
| December | 1,165.2 | 450 | 27,717 | 1,175.8 | 750 | 46,659 |
| **Total** | | | **300,424** | | | **458,728** |
| **Percent Increase** | | | | | | **53** |

cfs = cubic feet per second; MWh = megawatt-hours; WSE = water surface elevation

### 2.2.3 Bradley Lake Project Hydrology

The streamflow characteristics of the drainage basin within the Bradley Lake Project and surrounding environs are highly influenced by the presence of glaciers and the maritime climate of the Gulf of Alaska. Basin location, elevation, and physiographic features also strongly influence the runoff characteristics of the basins. Bradley Lake is located within the Kenai Mountains in an ice-free subalpine valley approximately 1,080 feet above Kachemak Bay. The basin above the lake consists of rugged and precipitous rocky slopes interspersed with various forms of low vegetation and other growth. Higher elevations are characterized by barren slopes with most of the land features carved from the glaciers within the basin. Characteristic of the maritime influence, the basin usually experiences cool summer and moderate winter temperatures. Average annual temperature is 36 degrees Fahrenheit with frequent periods of fog, rain, and clouds. Precipitation within the basin is greatest during the August through December period. The runoff response from rainfall in the basin is influenced greatly by the geologic conditions of the basin. Due to the limited amount of soil cover overlying bedrock, most of the rainfall reaches the stream with very little flow going into groundwater storage. Runoff contributions from snowmelt usually begin in early May and extend through September with the most significant rainfall runoff contributions occurring from August through October.

Bradley Lake is fed by both natural and diverted water sources, draining an area of approximately 76.3 square miles, including diverted drainage areas (Figure 2.1-1). Based on 2022 aerial imagery, approximately 29 percent of the drainage area above the lake outlet is covered by glaciers and permanent snowfields. The glaciers contribute flow as temperatures warm in the spring beginning in mid- to late May until late fall (October to November) when temperatures cool again. The Nuka and Kachemak glaciers are the two largest glaciers providing runoff directly into Bradley Lake. The Battle Glacier has also been diverted to Bradley Lake since operations of the WFUBC Diversion began in 2020.

There are currently few gages that record inflow into Bradley Lake or the amount of water available for generation. The two major natural inflow tributaries to the lake are Kachemak Creek, which begins at Kachemak Glacier, and the Upper Bradley River, which is fed by Nuka Glacier. There are also numerous unnamed first-order streams draining off the mountainside into the lake. There are USGS stream gages near the Nuka Glacier (USGS Gage No. 15238990), at the Upper Battle Creek diversion (USGS Gage No. 15238978), and the Middle Fork Bradley River (USGS Gage No. 15239050), and there is a gage in the Bradley River below the dam (USGS Gage No. 15239001).

The estimated average inflow to Bradley Lake (2021–2025) was estimated from the daily reservoir elevations, water surface elevation-storage rating curve, discharge through the turbines, and flow released through the fishway valves (Figure 2.2-1). The current and proposed Bradley Lake inflows with the Dixon Diversion are shown in Table 2.2-4. Annual and monthly flow duration curves for the proposed Project are provided in Appendix B-1. The average annual inflow to Bradley Lake since completion of the WFUBC Diversion is estimated as approximately 441,000 acre-feet. Approximately 75 percent of the runoff in the Bradley Lake basin occurs from June through September. Mean monthly flows generally peak July through September and are lowest in February through April, highlighting the seasonal variability in water availability. Most of the floods occurring before mid-July are caused by snowmelt, and those after mid-July are primarily caused by rainfall events.

The Dixon Diversion would operate early May through November as flows allow after meeting the proposed MIF releases of 100 cfs to the EFMR. The average annual volume of water diverted from Dixon Glacier to Bradley Lake is approximately 161,000 acre-feet (Table 2.2-4) based on the 1,650-cfs capacity of the proposed diversion tunnel, the proposed EFMR MIF releases of 100 cfs, and the estimated discharge of the EFMR developed from the 10-year average of the synthetic record (2016–2022) and measured discharge (2022–2025; DOWL 2023).

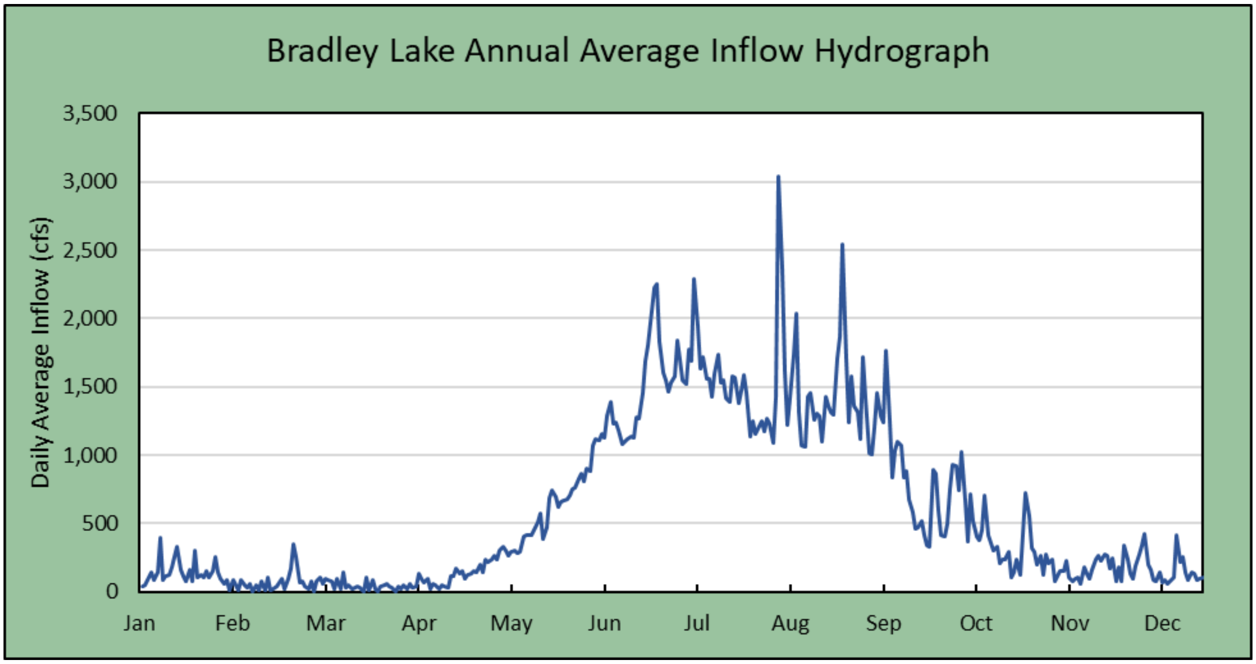


**Figure 2.2-1 Hydrograph of annual average inflow to Bradley Lake (2021–2025).**

**Table 2.2-4 Average daily and monthly inflows to Bradley Lake under current conditions (2021-2025) and with the proposed Dixon Diversion.**

| Month | Current Average Bradley Lake Inflow[a] | | Average Dixon Diversion Inflow[b] | | Total Proposed Average Inflow | |
|---|---|---|---|---|---|---|
| | Daily (cfs) | Monthly (ac-ft) | Daily (cfs) | Monthly (ac-ft) | Daily (cfs) | Monthly (ac-ft) |
| January | 91 | 5,607 | 0 | 0 | 91 | 5,607 |
| February | 53 | 2,955 | 0 | 0 | 53 | 2,955 |
| March | 57 | 3,501 | 0 | 0 | 57 | 3,501 |
| April | 100 | 5,958 | 0 | 0 | 100 | 5,958 |
| May | 476 | 29,256 | 21 | 1,301 | 517 | 30,557 |
| June | 1,433 | 85,259 | 233 | 13,876 | 1,753 | 99,135 |
| July | 1,653 | 101,625 | 873 | 53,698 | 2,567 | 155,323 |
| August | 1,671 | 102,743 | 892 | 54,832 | 2,499 | 157,575 |
| September | 1,059 | 62,990 | 454 | 26,986 | 1,322 | 89,976 |
| October | 455 | 27,974 | 166 | 10,194 | 455 | 38,168 |
| November | 165 | 3,603 | 0 | 0 | 165 | 3,603 |
| December | 155 | 9,539 | 0 | 0 | 155 | 9,539 |
| **Average Monthly** | **617** | | **222** | | **817** | |
| **Annual Total** | | **441,009** | | **160,887** | | **601,896** |

Source: Bradley Lake Dam operating records and the *Dixon Diversion Conceptual Study Hydrology Report* (DOWL 2023).

[a] Sources of inflow to Bradley Lake include: Middle Fork Bradley River (also known as Middle Fork) Diversion (gaged), Nuka Glacier Diversion (gaged), East Fork Upper Battle Creek Diversion, WFUBC Diversion (gaged), Kachemak Glacier, and other unnamed tributary drainages.

[b] Dixon Diversion flows and volumes are based on the 10-year average comprised of synthetic (2016-2022) and measured (2022-2025) discharge.

Minimum, mean, and maximum daily discharge data at the powerhouse and MIF releases to the Bradley River from the dam (2021 through 2025) are provided by month in (Table 2.2-4). No spill has occurred at any time since the 2019 Swan Lake fire, prior to operations of the WFUBC Diversion. Figure 2.2-2 depicts the daily reservoir elevation, the current normal minimum (El. 1,080 feet) and maximum (El. 1,180 feet) pool elevation, and the average Bradley Lake inflow for the period of 2021 through 2025.

The average daily discharge through the powerhouse from 2021 through 2025 was approximately 598 cfs and ranged from 86 cfs in May to 1,325 cfs in January. The daily average MIFs released at the Bradley Lake Dam from the fishway valves to the Bradley River ranged from less than 0.1 cfs to a daily average maximum of 111 cfs, with an annual average daily release of 35 cfs (Table 2.2-5). The point of compliance for measuring the required Bradley River MIF releases is at the Bradley River USGS gage near Tidewater (USGS Gage No. 15239070), located at River Mile (RM) 1.65 on the Lower Bradley River. The required Bradley River MIFs at the Tidewater gage are: 100 cfs May 12 – September 14; 50 cfs September 24 – October 31; and 40 cfs November 2 – April 30 with ramping rates of 5 cfs per day between seasonal transitions.[5]

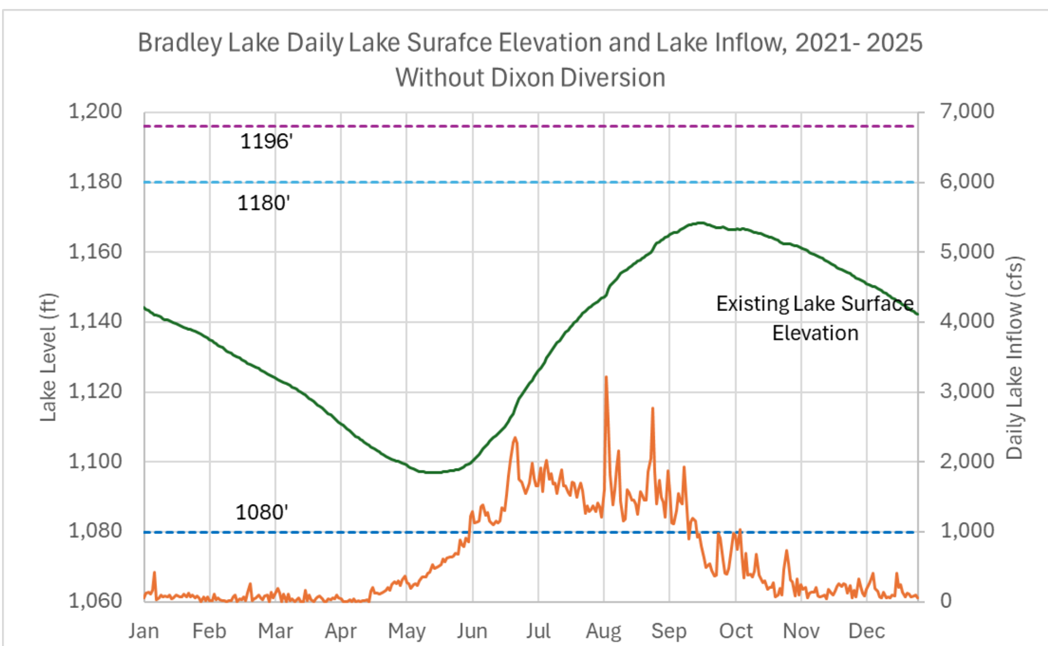


**Figure 2.2-2 Average Bradley Lake water surface elevation without the Dixon Diversion in feet BLVD and average inflow (2021–2025).**

[5] Order Amending Minimum Flows (172 FERC 62,132). Issued September 8, 2020.

**Table 2.2-5 Bradley Lake Project average monthly and minimum, maximum and average daily discharge through the powerhouse and instream flows released from Bradley Lake Dam to the Bradley River (2021–2025).**

| Month | Bradley Powerhouse Flows | | | | Bradley Dam Instream Flow Releases[a] | | | |
|---|---|---|---|---|---|---|---|---|
| | Daily Min (cfs) | Daily Mean (cfs) | Daily Max (cfs) | Monthly Mean (ac-ft) | Daily Min (cfs) | Daily Mean (cfs) | Daily Max (cfs) | Monthly Mean (ac-ft) |
| January | 179 | 553 | 1,326 | 34,023 | 0.3 | 37.1 | 49.6 | 2,282 |
| February | 176 | 511 | 993 | 28,360 | 0.6 | 40.7 | 50.0 | 2,263 |
| March | 117 | 551 | 930 | 33,853 | 3.7 | 39.7 | 60.9 | 2,442 |
| April | 172 | 566 | 1,067 | 33,702 | 0.3 | 31.3 | 56.2 | 1,865 |
| May | 86 | 526 | 1,175 | 32,318 | 0.0 | 11.8 | 53.3 | 725 |
| June | 161 | 492 | 858 | 29,282 | 0.0 | 3.8 | 43.4 | 226 |
| July | 176 | 529 | 803 | 32,550 | 0.0 | 44.2 | 99.5 | 2,721 |
| August | 253 | 603 | 1,280 | 37,076 | 3.5 | 78.6 | 109.2 | 4,832 |
| September | 352 | 783 | 1,311 | 46,561 | 0.3 | 60.0 | 111.4 | 3,569 |
| October | 166 | 708 | 1,279 | 43,511 | 0.3 | 15.8 | 77.5 | 970 |
| November | 103 | 652 | 1,065 | 14,225 | 0.3 | 26.4 | 54.0 | 575 |
| December | 345 | 701 | 1,009 | 43,111 | 0.2 | 34.9 | 52.0 | 2,147 |
| **Annual Average** | **190** | **598** | **1091** | | **0.8** | **35** | **68** | |
| **Total Annual** | | | | **408,574** | | | | **24,617** |

[a] Note that the point of compliance for Bradley River MIFs is the USGS Gage No. 15239070 Bradley River Near Tidewater, located at RM 1.65.

Figure 2.2-3 shows the estimated daily reservoir elevation and the estimated average Bradley Lake inflow with the proposed Dixon Diversion and Bradley Lake 16-foot pool raise. The average annual volume of water diverted from Dixon to Bradley Lake is approximately 161,000 acre-feet (Table 2.2-4), ranging from 500 cfs in June to 950 cfs August through January (Table 2.2-4). No changes to the Bradley River MIF releases are proposed.

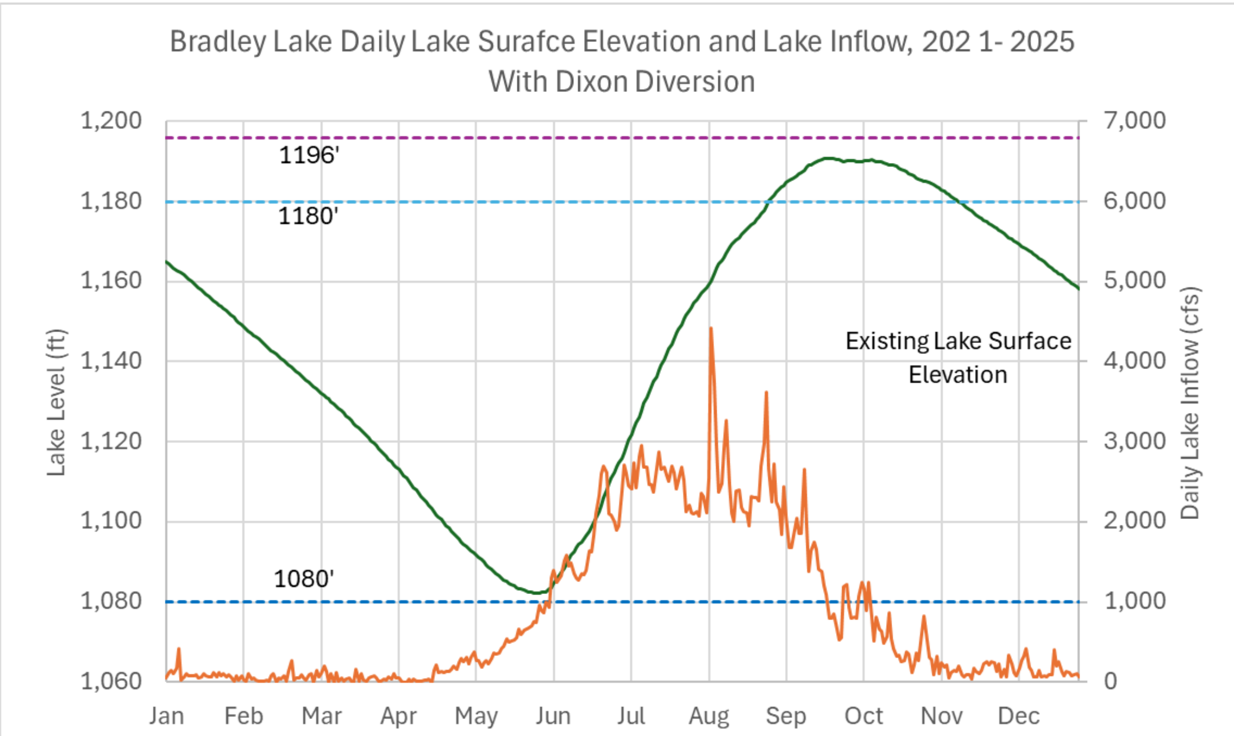


**Figure 2.2-3 Estimated average Bradley Lake water surface elevation in feet BLVD and average inflow with the proposed Dixon Diversion and 16-foot Bradley Lake Pool Raise.**

### 2.2.4 Area-Capacity Curve

Bradley Lake currently has an active storage capacity of approximately 280,000 acre-feet at normal maximum operating pool elevation of El. 1,180 feet. Under the proposed development, the normal maximum pool elevation would increase by 16 feet to El. 1,196 feet, increasing the active storage capacity to approximately 342,000 acre-feet and increasing the surface area from 3,802 acres to 4,033 acres.

Bradley Lake's normal minimum operating pool elevation is El. 1,080 feet, which is the minimum elevation that provides sufficient hydraulic head to deliver the maximum required instream flow through the fish bypass outlet to the Bradley River. Storage above this elevation is used for normal operations, while volumes below El. 1,080 feet are designated as dead or emergency storage.

Approximately 31,200 acre-feet of emergency storage is available between El. 1,060 feet and El. 1,080 feet, allowing temporary drawdown to the crown of the power tunnel at El. 1,060 feet. For reference, the power tunnel inlet invert is at El. 1,030 feet, and the fish bypass inlet invert is at El. 1,065 feet. The current active storage volumes (i.e., volumes above El. 1,080 feet) were calculated using 2016 and 2022 LiDAR[6] imagery (Figure 2.2-4). The emergency and dead storage volumes (Figure 2.2-4) are based on the bathymetric survey used to report the area and capacity of Bradley Lake in the 1984 License Application.

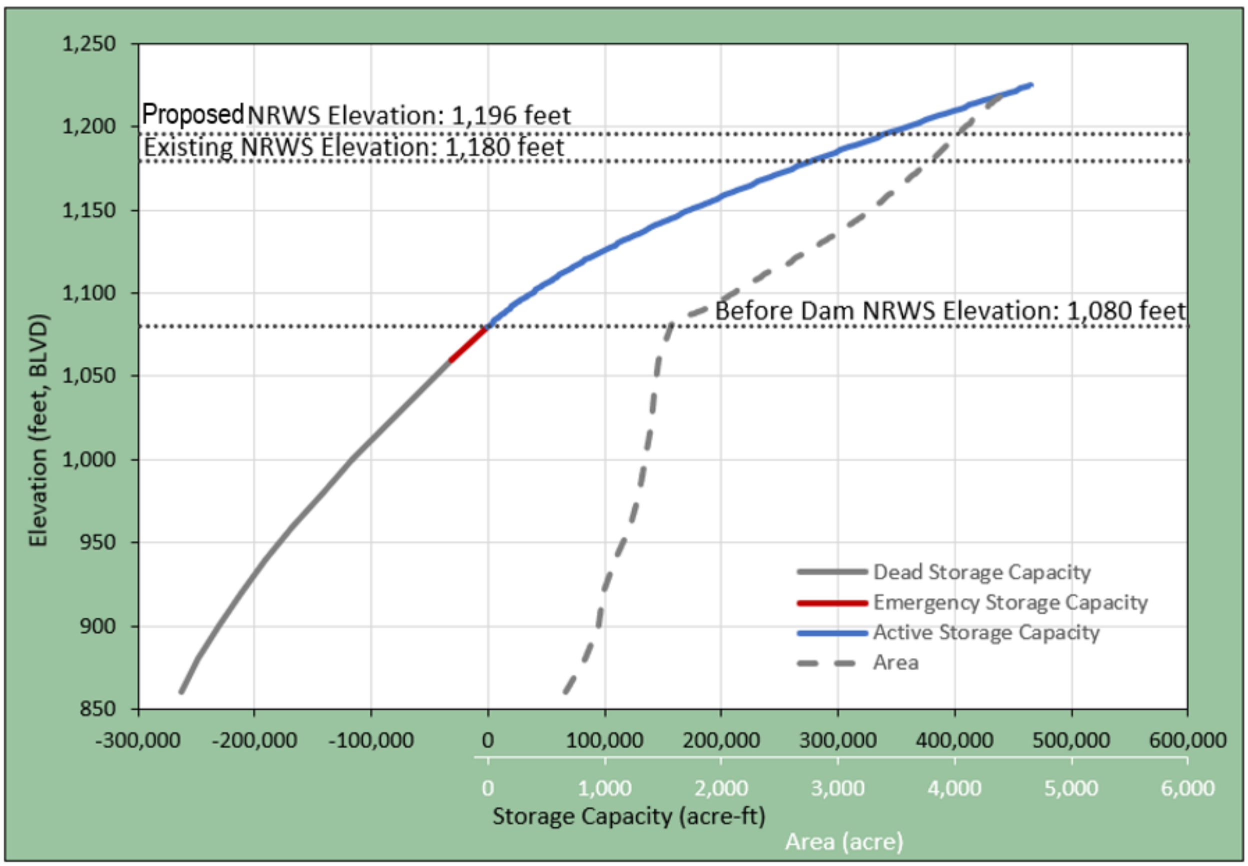


**Figure 2.2-4 Bradley Lake area-capacity curve.**

[6] Light detection and ranging; a technology that uses laser light to measure distances.

### 2.2.5 Estimated Hydraulic Capacity

The hydraulic capacity of the Bradley Lake Project is approximately 1,200 cfs. No Bradley Lake Project features are proposed to be modified to increase the hydraulic capacity at the same head, but the increased head would marginally increase the hydraulic capacity. However, due to constraints on the transmission system, the hydraulic capacity rarely exceeds 1,000 cfs. During routine annual maintenance, the Bradley Lake Project is shut down and the capacity is 0 cfs.

### 2.2.6 Tailwater Rating Curve

The tailwater rating curve for the Bradley Lake Project would not change.

### 2.2.7 Power Plant Capability Versus Head

The minimum head on the powerplant would not change, but the average and maximum head would increase because of the increased normal maximum lake level and inflow volume. The Bradley Lake Project turbine performance and characteristics will be provided with the Final Amendment Application.

# 3.0 USE OF PROJECT POWER

The energy produced by the Bradley Lake Project facility is purchased by the five Railbelt utilities to offset fossil fuel generation. Bradley Lake Project energy has historically been used for peaking generation. During dry and average years, with the proposed Dixon Diversion in place, more water would be stored in Bradley Lake for release during the winter period. During wet years, the incremental energy would be spread over the year to reduce the likelihood of spillage. The Bradley Lake Project facility uses approximately 2,500 MWh annually.

Power generated at the Bradley Lake Project provides power to the Alaska Railbelt region. The Railbelt electrical grid is defined as the service areas of five regulated public utilities that extend from Fairbanks to Anchorage and the Kenai Peninsula. These public utilities are Golden Valley Electric Association; Chugach Electric Association; Matanuska Electric Association; Homer Electric Association; and the City of Seward Electric System. Seventy-five percent of the Alaskan population lives within the Railbelt region.

The proposed Project would allow the Bradley Lake Project to increase average annual generation from approximately 436,000 MWh[7] to 601,000 MWh, which would help the Railbelt region meet its current and forecasted loads. The energy generated from the Bradley Lake Expansion is expected to offset 1.5 billion cubic feet of natural gas per year, accounting for 7.5 percent of the unmet demand in 2030.

[7] The long-term average was derived from the past 10 years of releases from Bradley Lake plus the average of the WFUBC Diversion added to the dataset as if the WFUBC Diversion had been online the entire 10-year period. The actual energy produced from the Bradley Lake Project 2021–2025 is about 420,000 MWh.

# 4.0 PLANS FOR FUTURE DEVELOPMENT

AEA does not currently have any plans for future development of the Bradley Lake Project during the current license term.

# 5.0 REFERENCES

DOWL. 2023. Dixon Diversion Conceptual Study Hydrology Report. Prepared for the Alaska Energy Authority. November 29, 2023.

# APPENDIX B-1

## MONTHLY FLOW DURATION CURVES DEVELOPED FROM BRADLEY LAKE INFLOWS (2021-2025) AND PROPOSED DIXON DIVERSION OPERATIONS

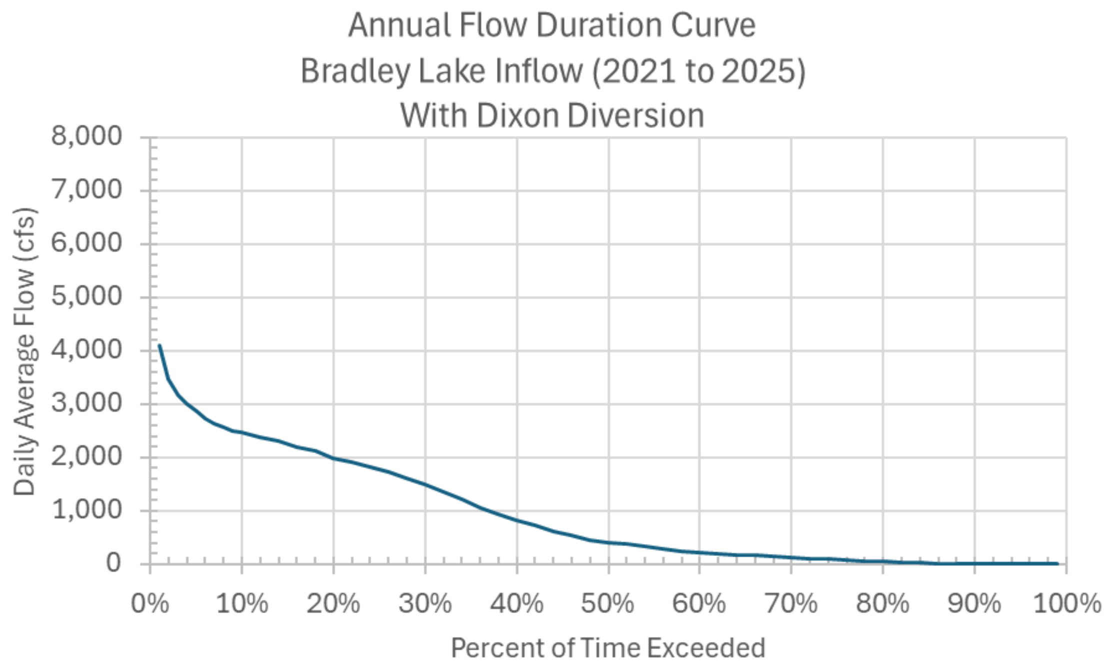


**Figure B1-1 Annual flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

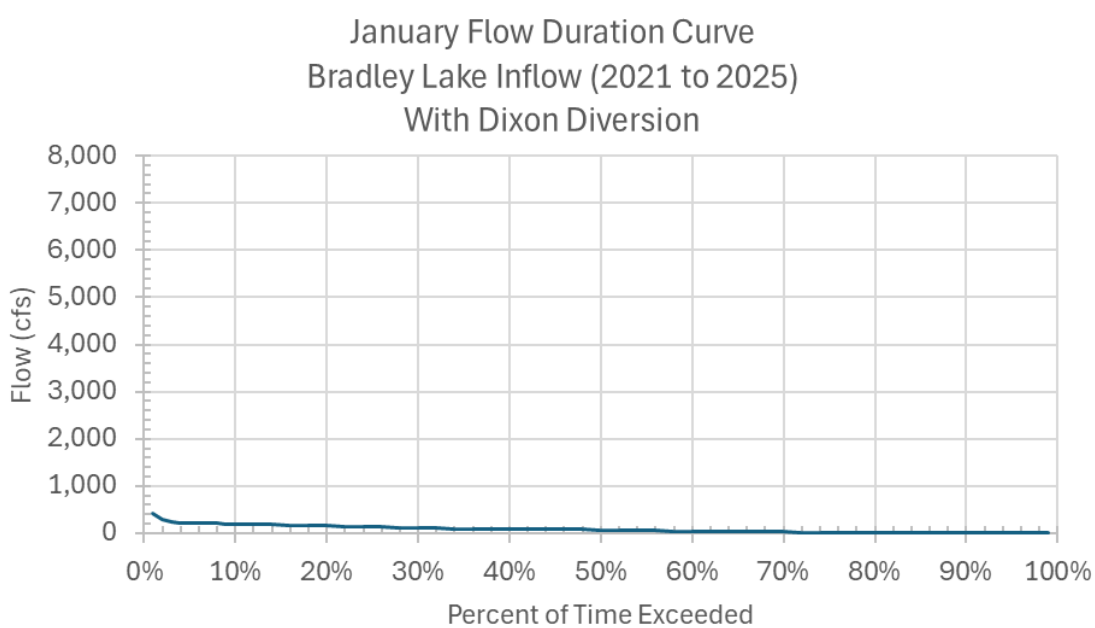


**Figure B1-2 January flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

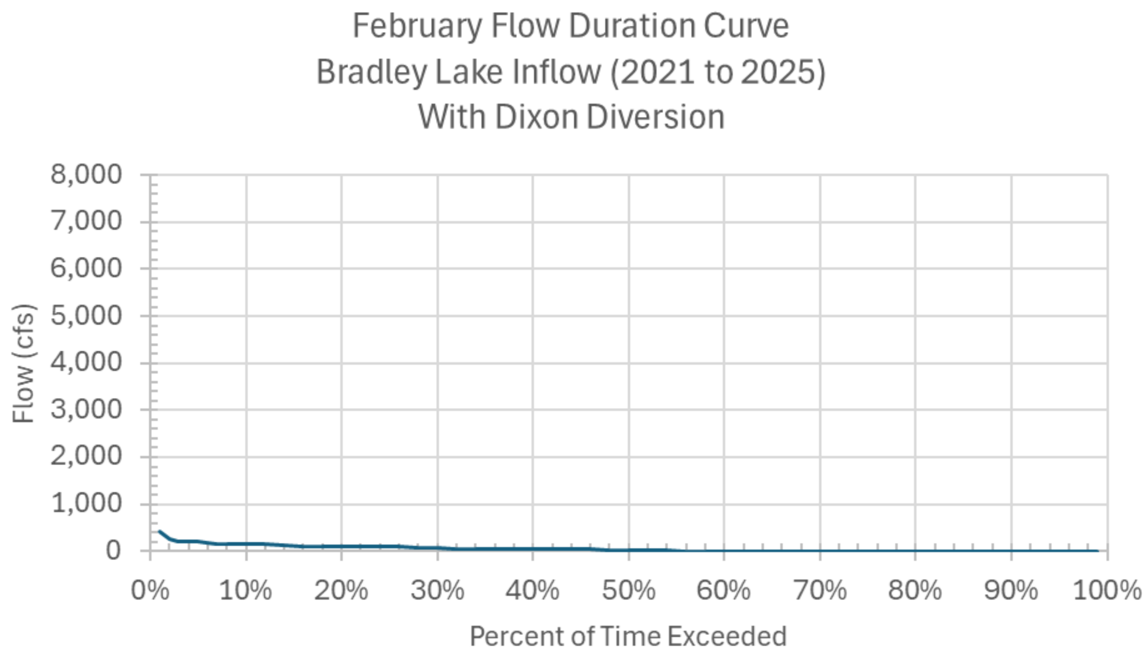


**Figure B1-3 February flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

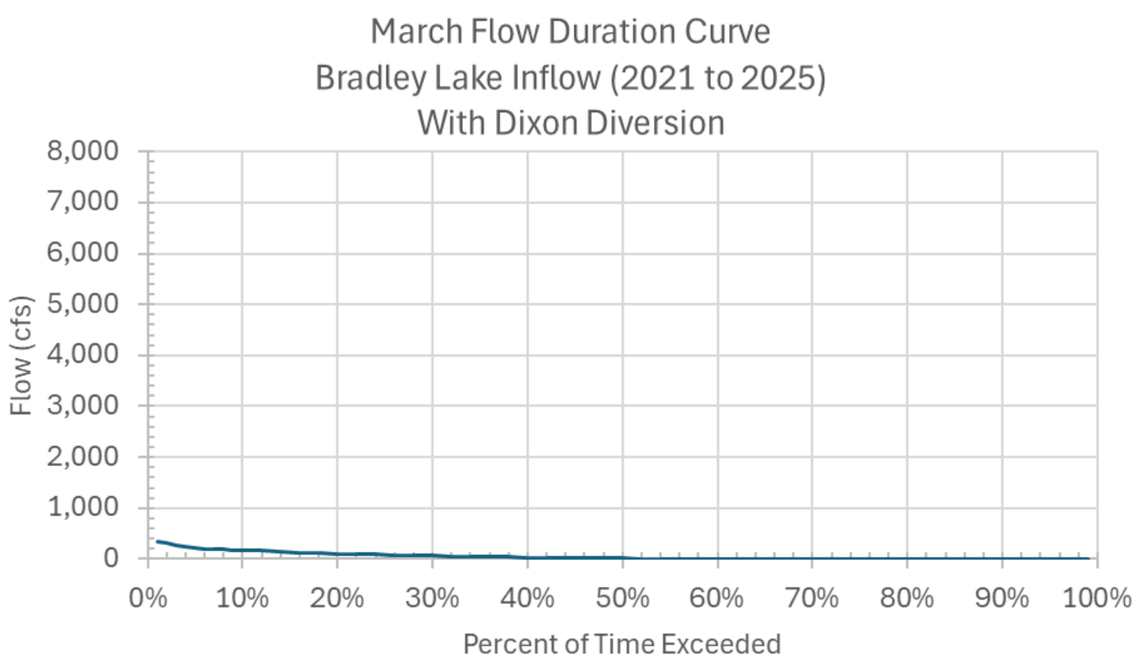


**Figure B1-4 March flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

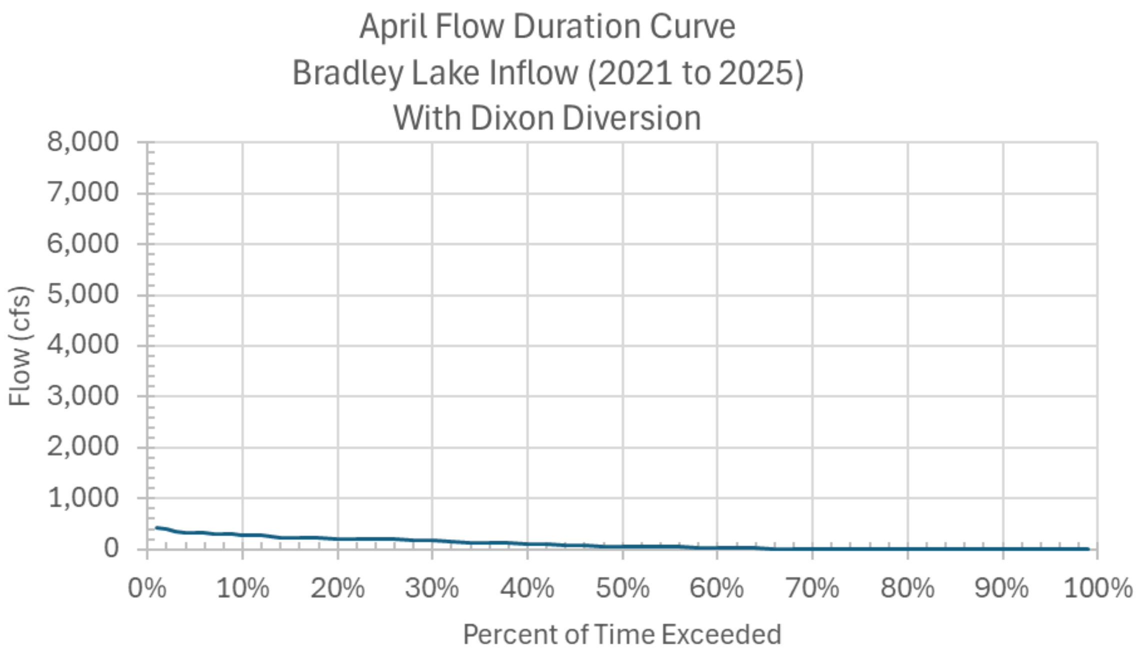


**Figure B1-5 April flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

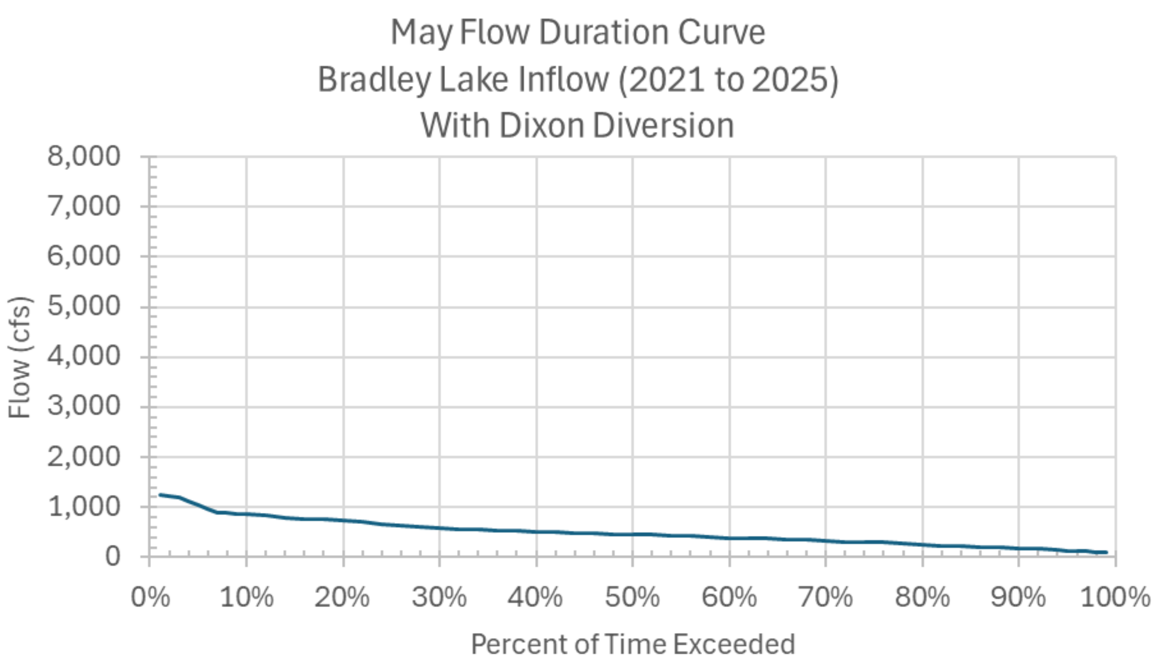


**Figure B1-6 May flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

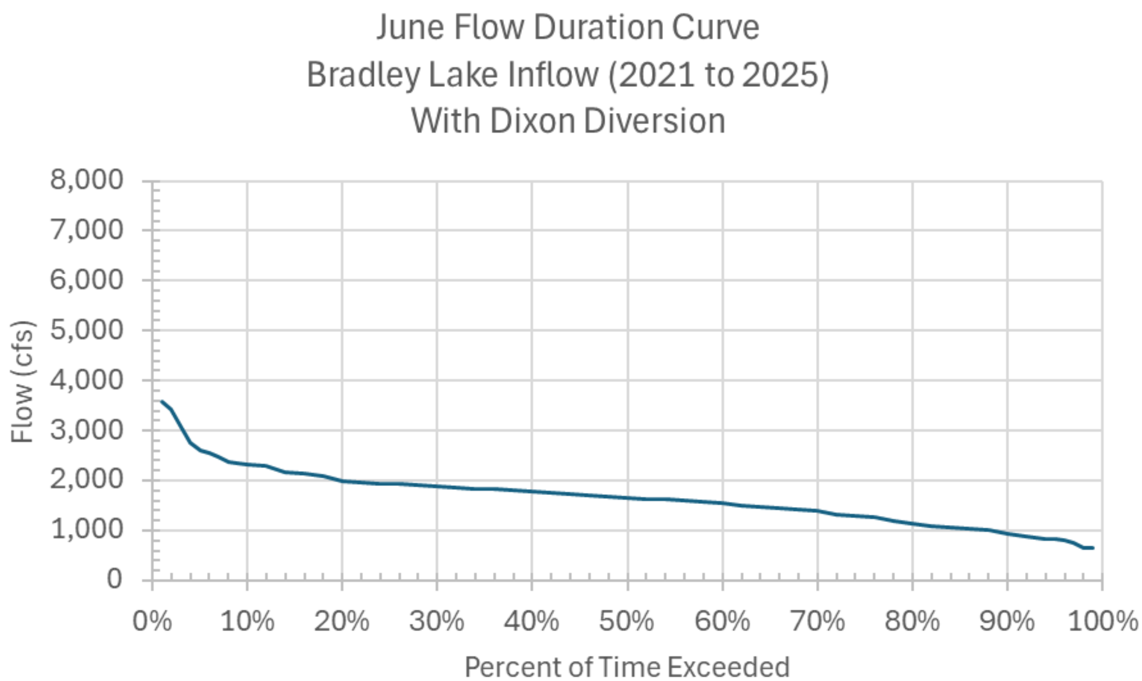


**Figure B1-7  June flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

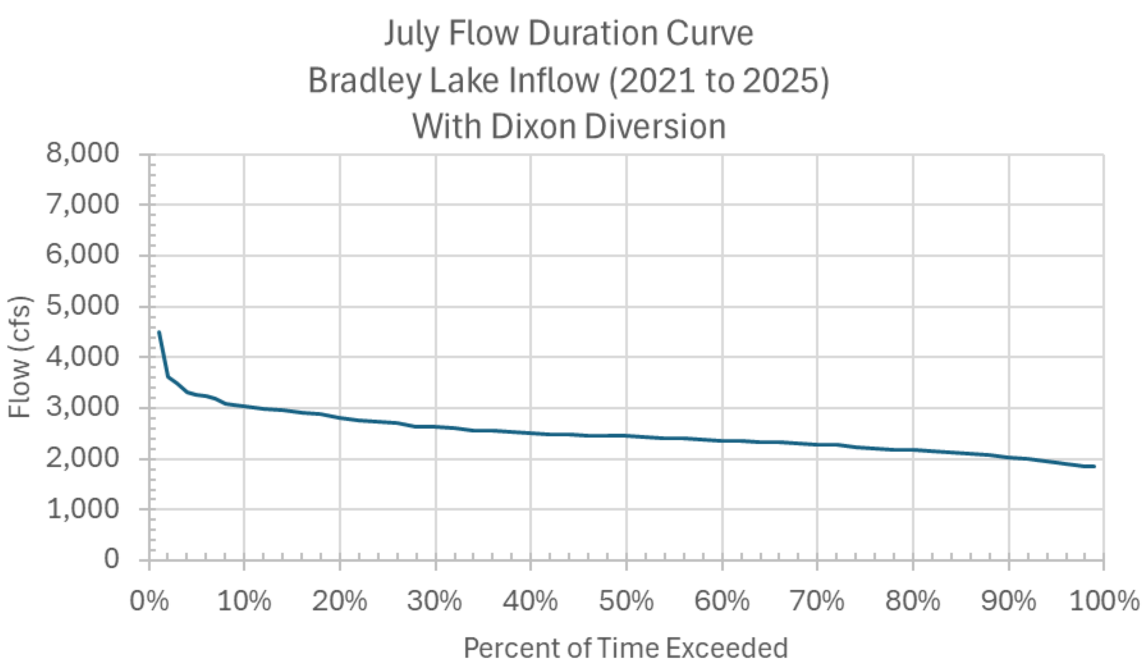


**Figure B1-8  July flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

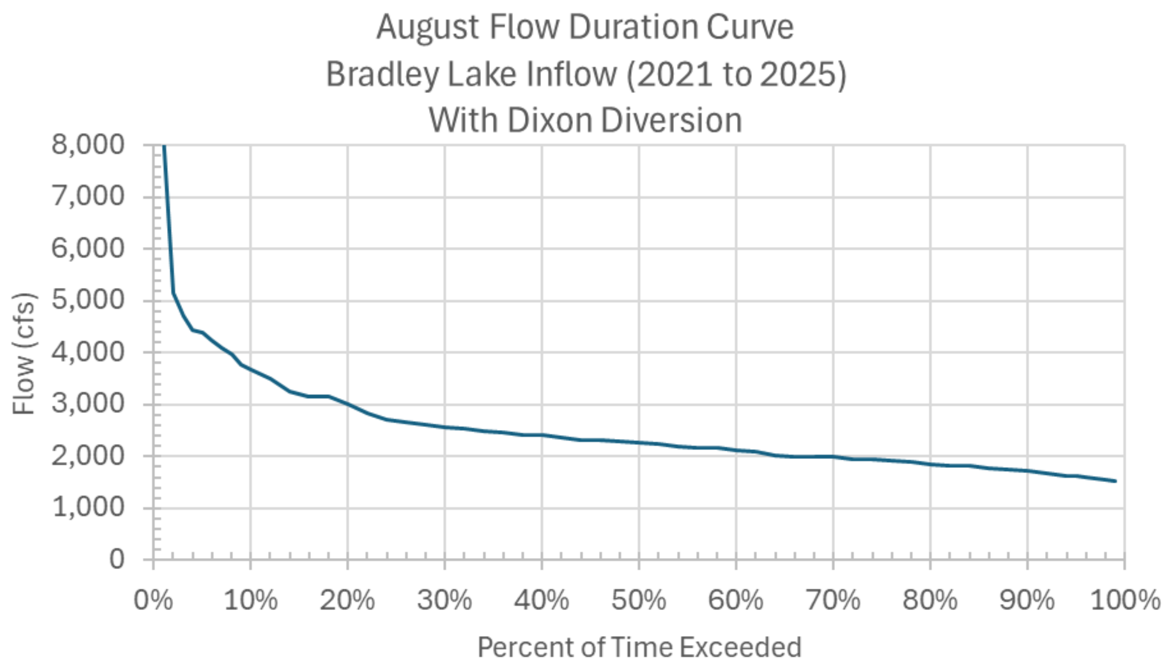


**Figure B1-9 August flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

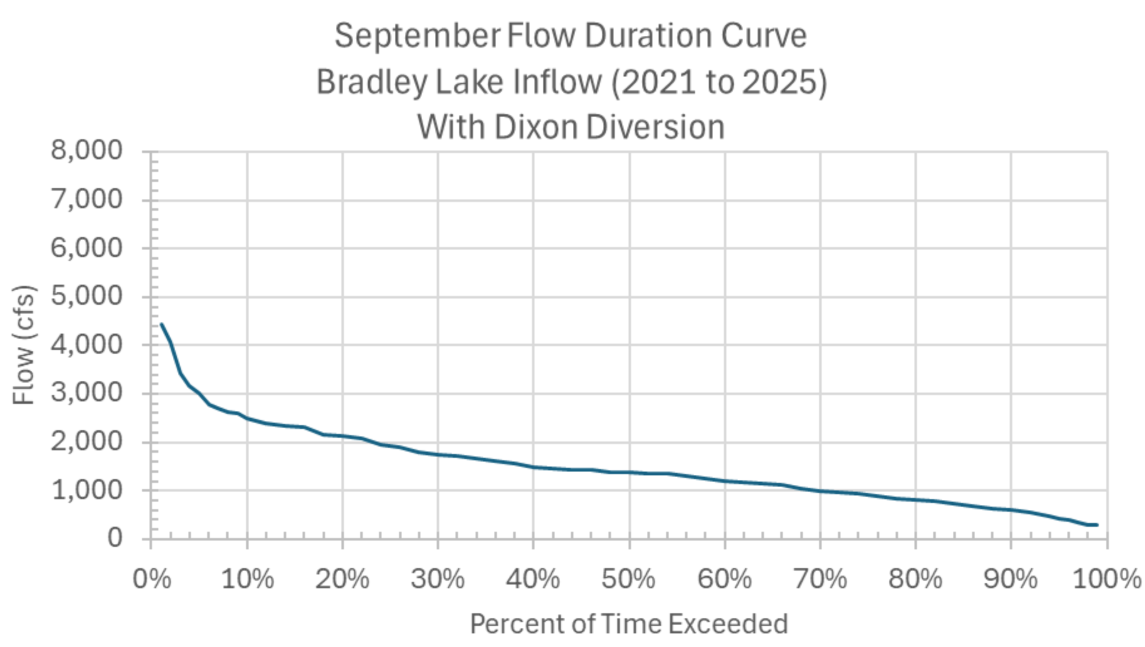


**Figure B1-10 September flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

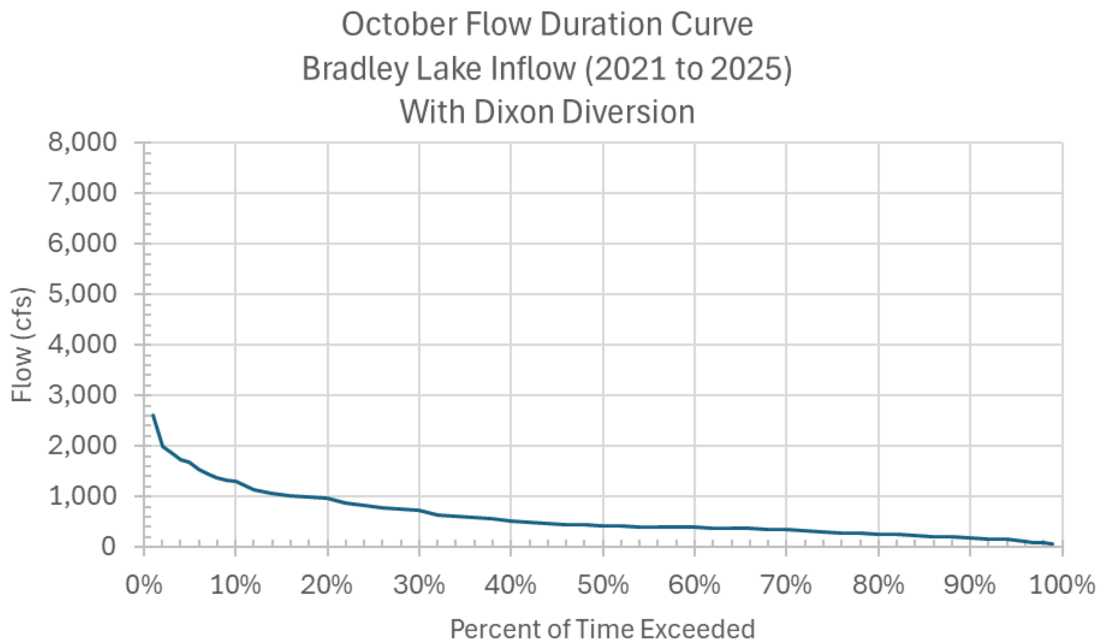


**Figure B1-11 October flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

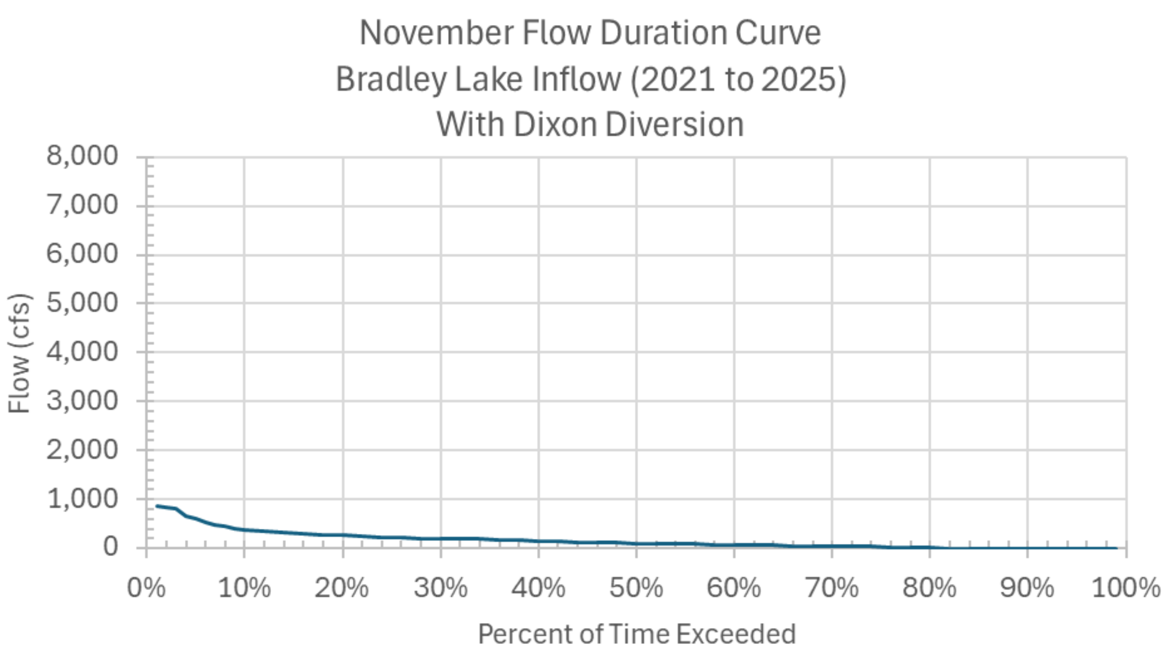


**Figure B1-12 November flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**

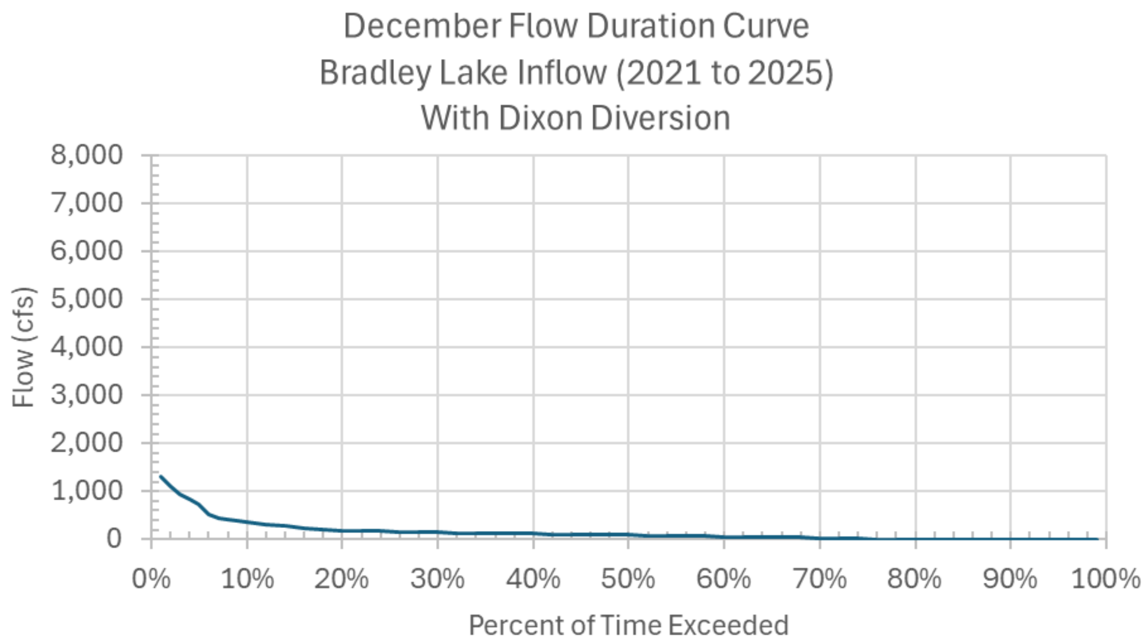


**Figure B1-13 December flow duration curve of Bradley Lake inflows (2021–2025) with proposed Dixon Diversion operating May through November.**