a. Magnitude of GHG Reductions from 2025-2030 (20 points)

The Dixon Diversion project is scheduled to be completed and commissioned by early 2030. This will capture a full water year in 2030 and associated greenhouse gas reductions from that water. In these systems water typically starts flowing in late April / early May. A minimum instream flow (MIF) will be established through the FERC licensing process, and once flows exceed the MIF, excess water will be diverted through the Dison Diversion tunnel into Bradley Lake. The water year typically ends in late October / early November once temperatures consistently drop below freezing and there is not enough flow to divert water anymore. The project is expected to be commissioned before spring break-up so the magnitude of greenhouse gas reductions from 2025-2030 would be equivalent to the energy produced from a full water year.

Based on synthetic flows of the Martin River averaged over the previous decade, accounting for expected minimum instream flow requirements and the capacity of the 14-foot diameter diversion tunnel, the Dixon Diversion project will produce 190,800 MWh of electricity annually.

EPA's 2022 eGRID conversion factor for the Alaska Railbelt (AKGD – ASCC Alaska Grid subregion) nonbaseload rates gives an accurate estimation of CO2e reductions for projects that displace electricity generation. For the Railbelt the eGRID subregion annual CO2e non-baseload output emission rate is 1,232.508 lb/MWh.

$$190{,}800\, MWh \times 1{,}232.508\, \frac{lb\, CO2e}{MWh} \times \frac{1\, MT}{2204.62\, lb} = 106{,}668\, MT\, CO2e$$

Magnitude of GHG Reductions from 2025-2030 = 106,668 MTCO2e

b. Magnitude of GHG Reductions from 2025-2050 (10 points)

To estimate the magnitude of GHG Reductions from 2025-2050, the same annual energy output from Dixon will be used over a 25-year period. It is likely that the energy numbers over this period could be even higher, due to an observable trend of higher flows in recent years due to warmer summers melting the source glaciers at a faster rate.

$$106{,}668\, MTCO2e \times 25\, years = 2{,}666{,}701\, MTCO2e$$

c. Documentation of GHG Reduction Assumptions (15 points)

Annual greenhouse gas reductions resulting from the Dixon Diversion project are calculated from offsets of expected energy production from the hydroelectric project. To develop estimations of energy produced from the Dixon Diversion project, it is critical to accurately measure the discharge of the Martin River. The Martin River, which comes off the Dixon Glacier, is a fast moving, cold, and highly turbid river. Upon exiting the glacier, the Martin River quickly enters a canyon characterized by a series of waterfalls and deep canyon walls. Upon exiting the canyon, the river becomes highly braided and remains that way until the reaching tidewater.

Due to its remote nature, highly mobile bed load, and lack of defined channel, the Martin River is a challenge to accurately measure. In the summer of 2023, there was a large field effort to characterize the Martin River. The United States Geological Survey (USGS) installed and operates a stage gage on the Martin River around where it first exits the canyon (USGS 15238951). AEA hired a contractor to install additional stream gages on the Martin River, with the primary gage located at the “Constriction”. The contractor performed 10 site visits between April and September to gather discharge measurements. These measurements were used to build a stage-discharge relationship for both gage locations, and from there the daily flow could be estimated over the summer.

A hydrograph was created for the summer 2023 season using a combination of the two established gage sites on the Martin River.

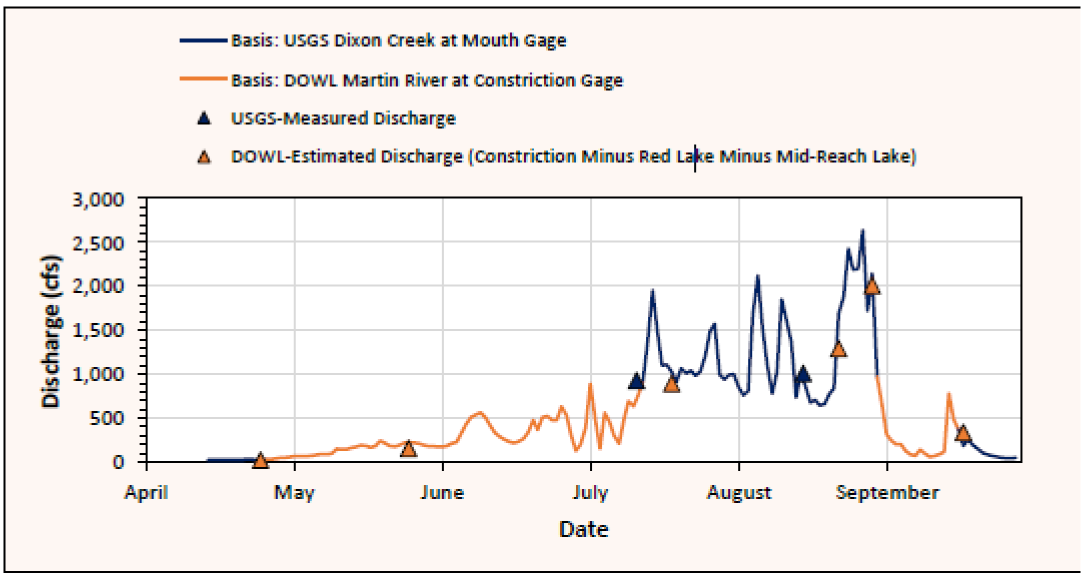

Figure 5: Hydrograph of discharge on Martin River, 2023 Water Year

Although the gage records on Martin River only go back 1 year, a synthetic flow was created by establishing a relationship between stage heights on the Martin River and the Upper Bradley River near Nuka Glacier. The Upper Bradley River at Nuka Glacier USGS gage has a 40-year record, and the Nuka and Dixon glaciers are adjacent and at similar elevations, which allows a fair comparison of discharge in the two basins.

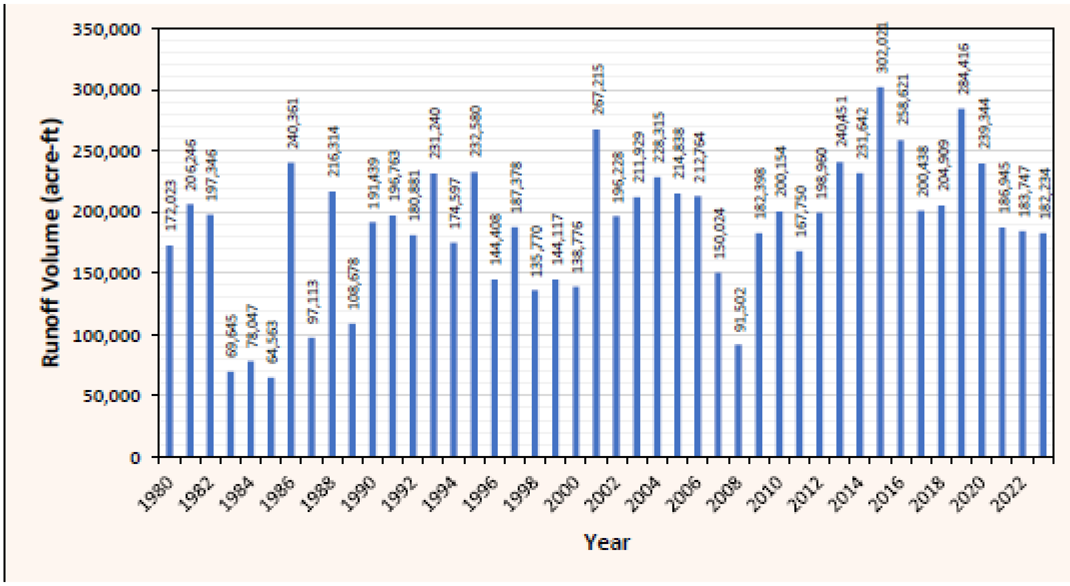

Figure 6: Synthetic 40 year annual runoff volume (acre-ft) from Dixon Glacier

A 10 year average of synthetic flow was used to estimate discharge from the Dixon glacier. This was done to capture the increase in flows from recent years due to higher summer temperatures resulting in an increased contribution of flow from ice melt. It was also assumed that the first 100 cfs of flow would always go downstream to account for future minimum instream flow stipulations. The Dixon Diversion Tunnel will be 14 feet in diameter and has a modeled capacity of 1,400 cfs, so any flood flows in excess of 1,400 cfs were assumed to go downstream on the Martin River rather than divert to Bradley Lake and would not contribute to the energy numbers for the project. Using the 10-year synthetic flow record, 238,500 acre-ft of runoff is predicted annually from the Martin River from rainfall, snow melt, and glacier melt. A majority of this flow will occur in July and August. The minimum instream flow (MIF) will account for 32,100 acre-ft, or 13% of the total runoff. Flood flows will account for 22,200 acre-ft or 10% of the total runoff, leaving 182,800 acre-ft diverted to Bradley Lake. At the Bradley Lake hydroelectric project, the efficiency of the generators gives a conversion of acre-ft to MWh of almost exactly 1:1 (ranges from 0.95-1.05). For modeling purposes, it is assumed a 1:1 ratio and 182,800 acre-ft of diverted water will account for an additional 182,800 MWh of renewable energy generation.

The proposed 14-foot dam raise would increase the capacity of Bradley Lake and raise lake levels which would in turn raise head pressure at the Bradley Lake hydroelectric plant. The increased head pressure will increase efficiency of the two 60 MW generators and account for ~8,000 MWh of electric generation annually. Combining the values of 10-year average annual diverted water with the increased head pressure from a higher reservoir gives an average annual increase in energy from the Dixon Diversion project of 190,800 MWh.

EPA's 2022 eGRID data was used to estimate the greenhouse gas reductions that will result from the Dixon Diversion project. Generation data from the Alaska Railbelt is represented by the AKGD – ASCC Alaska Grid Subregion. As mentioned earlier, electricity produced on the Railbelt is primarily through natural gas fired generators. The eGRID nonbaseload rates will give an accurate representation of CO2e reductions for projects that displace electricity generation. The eGRID factors consider the differences in baseload generation vs peaking generation, and for the Railbelt eGRID subregion the annual CO_2e non-baseload output emission rate is 1,232.508 lb/MWh. Multiplying the AKGD non-baseload output emission rate with the expected energy production from Dixon and converting to metric tons produces a result of 106,668 $MTCO_2e$ annual reduction in greenhouse gas produced in Alaska.