Susitna-Watana Hydroelectric Project Document
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SUSITNA-WATANA HYDRO

Table X – Operational Uncertainties Issue Comparison

Table X presents a summary of the comparative operational uncertainties associated with developing the Chakachamna and Susitna (Low Watana Impervious Core Rockfill Dam(ICRD)) Hydroelectric Projects.

Issue and likelihood of occurrence within next 100 years	Chakachamna Hydroelectric Project	Susitna (Low Watana ICRD) Hydroelectric Project
	Issue Notes/Requirements	Issue Notes/Requirements
Earthquake Risk		
Immediate damage due to fault movement Studies show 700-year return period for significant earthquakes (magnitude 6 to 7), last such earthquake approximately 650 years ago.	• Castle Mountain fault, approximately 11 miles from the lake, magnitude 7+, displacements of up to 6 ft, only 4500 ft from powerhouse site. • Infrastructure near the fault include; powerhouse and bridge over Chakachatna River. • Power tunnel intersects numerous smaller faults. Seismic event may cause localized collapse in the fault zone if not lined. Lack of information about whether movement could occur on any of these smaller faults.	• Castle Mountain Fault located 65 miles from powerhouse, intake, lake, magnitude 7+, • Denali Fault located 45 miles , magnitude 8.5, • Inter-plate subduction zone located 40 miles, magnitude 9.2 • Dam could experience high seismic loads (known seismic zone, EQ design case should consider loading)
Secondary effects	• Landslide and avalanche potential into lake and onto access road.	• Potential landslides and avalanches along access roads.
Hydrological Risk –		
Generation	• USGS record at site 11 years of data, correlation with 4 streams. • Understanding of the hydrology • There is potential during events such as floods or glacial activity for down cutting of the glacial moraine at the end of the lake which could reduce head and storage in the project • Smaller basin will cause greater deviations from average hydrological flow and energy generation. • Drought (Not sure if needed, see above) • Tunnel roughness may increase with time due to wear which will reduce generation.	• USGS record at site 54 years of data on Susitna River. • Understanding of the hydrology vis a vis climate change effects.

Issue and likelihood of occurrence within next 100 years	Chakachamna Hydroelectric Project	Susitna (Low Watana ICRD) Hydroelectric Project
	Issue **Notes/Requirements**	**Issue** **Notes/Requirements**
Climate Change		
Glacier recession	• Increase in flows as the glaciers melt (>100 yrs), followed by reduced and more "flashy" flows at the project.	• Increase flow for a period with glacier recession (>100 yrs) followed by decreased flow.
Vulcanism		
Effects on Project Facilities and Features	• Mt Spurr is located immediately adjacent to the project, Redoubt volcano is approx. 50 miles to the west. • Explosive eruption at Mt. Redoubt 2009 • Previous eruption on Mt. Spurr was a side blowout. • Debris flows similar to those that occurred in 1953 and 1992 eruptions of Crater Peak could dam Chakachatna River. The debris dams might erode progressively or may burst abruptly. • Lava flows could dam the Chakachatna River and raise Chakachamna Lake. • Large floods would be produced by surging and melting of glacial ice during an eruption. • Glacier movement (melting at base) is probable. Ice flow on Barrier Glacier may surge, dam the lake, raise water level and erode through, typically below the glacier in material. • Access road may become blocked or destroyed by mud or erosion (high flows in river from melting glacier or glacial dam breakout). • Effects on river bridges from debris flow • Ash effects on transmission • Poison gas cloud could affect the powerhouse (unlikely with distance & powerhouse location) • Communications may be disrupted by volcano.	• Mt Spurr is the most easterly active volcano in the Aleutian arc to the Watana site and has 6 eruption events since 1953. It is too far away for pyroclastic flows to affect Watana. However, depending on wind conditions, ash could reach the transmission line route. • Mt Wrangell is located to the East and is closer to Watana than Mt Spurr. Mt Wrangell is in a non-eruptive active state at present but with history of 9 reported possible eruptions since 1760, most recently 1930; steaming at present. Ash could reach the Watana project and transmission lines depending on wind conditions. Pyroclastic flows are unlikely to affect Watana due to distance and intervening terrain.

Tunneling and Foundation Conditions		
Dam	• Small structure on rock foundation. • Material of the natural dam, believed to be moraine, could contain significant quantities of ice, lahar material, or volcanic ash that could affect the permanence of the natural dam.	• Geotechnical exploration indicates favorable foundation conditions on bedrock • Foundation (permafrost). Melting permafrost in the rock could lead to increased permeability of foundation that may require additional grouting associated with project site. • River diversion tunnels • Large spillway
Power tunnel(s)	• Extensive underground construction will be expensive to shut down for inspection and repair if necessary. • Very hard rock along tunnel alignment – more than 35,000 psi	• Competent rock conditions for dam and tunnel construction, studies date to 1982. • Very short power tunnel(s) – 1.0 mile max, and shallow and surface power tunnel, therefore less risk of delay in construction. • Limited number of geotechnical fault zones to pass through, due to location and short length of tunnels, provided "Fingerbuster" and "Fin" zones are avoided.
Glacier Activity		
Dam and Intake	• Unpredictability regarding the interaction of glaciers with the volcanic activity, including possible melting at the base of the ice that would cause glacial pulses or surges. • An advance of Barrier Glacier at the Chakachamna Lake outlet, initiated by heat from below the ice, could dam the outlet and raise the lake level. When the ice nose decayed, a large volume of water would be released that could erode the lake outlet and lower the lake below its present level. There is potential during events such as floods, glacial activity for down cutting of the glacial moraine at the end of the lake which could reduce head and storage in the project. Lowering the lake would reduce the submergence of the power inlet below what is acceptable. Breakout in 1971 one of Alaska's largest recorded floods.	• N/A

Powerhouse	• Blockade Glacier has been identified as a source of outburst floods on McArthur River	• N/A
Surging Glaciers	• Four glaciers in the Chakachamna study area have been identified as surging glaciers. They include Pothole Glacier and Harpoon Glacier in the Nagishlamina River Valley and Capps Glacier on the eastern slope of Mt Spurr.	• N/A
Outburst Glaciers	• Glacier damming of the Nagishlamina Valley by a surging glacier may result in outburst conditions at the outlet from Chakachamna Lake. A sudden influx of water into Chakachamna Lake could produce significant changes including lowering of the lake outlet.	• N/A
Other		
Intake	• Lake tap would need fish screens • Volcano eruption may affect power tunnel intake.	• N/A
Access Road	• Landslide, avalanche danger part of the route.	• Avalanche danger over a portion of the route.
Transmission Line	• 42 miles of new transmission line to Beluga Sub Station. • Submarine cable across Cook Inlet subject to marine environment risks such as currents, scour, dragging anchors.	• 58 miles of new transmission line.
Operation & Maintenance		
Operations & Maintenance	• Long tunnel intersecting numerous faults susceptible to rock-falls over time and maintenance requirements • Rock entrained in tunnel flow could damage turbines • Long tunnel has higher risk of collapse, blockage • Long tunnel will require planned outages for inspection and maintenance over life of project, higher risk of interruption.	• Multiple short tunnels allows for more regular inspection and maintenance without prolonged outages and impact to operations
Load Stability		
Powerhouse location with respect to load centers	• Off the end of the railbelt load center, not easy to stabilize (brown-out/black-out).	• Location between Anchorage and Fairbanks means project is closer to center of load, easier to stabilize grid using reactive potential.

Hydrological Risk - Water Shortage		
Drought	• Small catchment mainly fed by meltwater from glaciers, which make this site more susceptible to water shortages and less dependable as a source of energy.	• Catchment is less susceptible to drought.