Spring 2021

Environmental Impact Assessment: Nuyakuk River Small Scale Hydroelectric Project

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My contributions to this project were researching possible adverse effects that this proposed project could have on the plants and animals, air quality, and soil characteristics. I also wrote the executive summary. To determine how this proposed hydropower project would affect these potential environmental I found online information and sources of the current conditions for these three environmental conditions. Then we speculated how the proposed project might alter these current conditions. I then suggest special mitigation measures to the proposed project that might lessen or bypass the proposed project's impacts.

Environmental Impact Assessment

Nuyakuk River Small Scale Hydroelectric Project

ESCI 493, Winter 21

Western Washington University

Authors: Amy Owen, Reed Squier, Jessica Ngo-Ly, Tyler Sanderson

Figure 1: Aerial photo of Nuyakuk River Falls, AK.

Environmental Impact Assessment

Huxley College of the Environment

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Signature _____ Signature ____ _____

(Tyler Sanderson) (Jessica Ngo-Ly)

Signature _____ _____ Signature _____ _

(Reed Squier) (Amy Owen)

Date _____March 12th. 2021_____

Dear Concerned Citizen,

The Nuyakuk River Small Scale Hydroelectric Project Environmental Impact Assessment is enclosed for your review. The project was proposed and is being developed by, the Nushagak Cooperative. In this assessment you will find information and analysis of the proposed hydroelectric project for the Nuyakuk River, located in the Wood-Tikchik State Park in Southwestern Alaska.

The purpose of this EIA is to determine the potential sources of environmental harm in the Nushagak Cooperative's Hydroelectric project proposal to build a 12 MW run of river small scale hydroelectric plant on the Nuyakuk River. The Nuyakuk River is located in the Wood-Tikchik State Park and is a tributary of the Nushagak River. The plant is projected to provide electricity and optical fiber to the communities of Aleknagik, Koliganek, New Stuyahok, Elwok, and Levelock (Nuyakuk River, 2021). The plant will also be supporting the electrical needs of Bristol Bay's wild salmon industry (Nuyakuk River, 2021).

An alternative action was considered for this project, with the alternative action remaining the same as the proposed action, but with special mitigation measures towards protecting native plants and wildlife in the affected area.

After extensive research and analysis, our team determined that there are no significant impacts from the construction or maintenance of this project.

Signed,

Amy Owen
Reed Squier
Jessica Ngo-Ly
Tyler Sanderson

Nushagak Cooperative's Nuyakuk River Small-Scale Hydroelectric Project

Prepared for:

Dr. Leo Bodensteiner

Environmental Impact Assessment

ESCI 493

Huxley College of the Environment Western Washington University

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This report represents a class project that was carried out by students of Western Washington University, Huxley College of the Environment. It has not been undertaken at the request of any persons representing local governments or private individuals, nor does it necessarily represent the opinion of positions of individuals from government or the private sector

Fact Sheet

Project Title

Environmental Impact Assessment: Nuyakuk River Small Scale Hydroelectric Project

Description of Project
Nushagak Cooperative proposes to build a run of river project that will generate up to 12 MWs of power year round on the Nuyakuk River, a tributary of the Nushagak River located within the Wood-Tikchik State Park, in Southwestern Alaska. This proposed run of river hydro project would generate electricity and optical fiber to six communities in the area and support Bristol Bay's salmon industry (Nushagak Cooperative, 2019).

Legal Description of Location

Oxbow bend of the Nuyakuk River, located within the Dillingham Census Area, Alaska.

Proponent

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Tyler Sanderson: Fact Sheet, Table of Contents, Cover Page, Dear Concerned Citizen, Decision Matrix, Water Element, Transportation Element, Maintenance Element, Formatting, Technical Terms.
Jessica Ngo-Ly: Air, Environmental Health Element, Formatting
Reed Squier: Executive Summary, Plants and Animals Element, Air Element, Earth Element,, Recommended Action, Formating
Amy Owen: Land and Shoreline Use Element, Decision Matrix, Formatting, Public Services and Utilities Element, Helped with Water Element
Distribution List

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Issue Date
March 12th, 2021.

Public presentation date and time
March 8th, 2021 at 1:30 pm PST.

Executive Summary

This document presents the analysis of potential environmental impacts of the proposed Nuyakuk River Project submitted by the Nushagak Electric & Telephone Collective (NETC) to the Federal Energy Regulatory Commission (FERC) to be built on the Nuyakuk River, a tributary of the Nushagak River located Wood-Tikchik state park in southwestern Alaska. The proposed project would be a small-scale hydroelectric power plant, generating up to 12 MW of electricity, as well as providing fiber optic internet to the communities of Dillingham, Aleknegik, Koliganek, New Stuyahok, Ekwok and Levelock and supplying electricity and internet the fishing industry of Bristol Bay. While the proposed project is located in Alaska, this analysis follows the environmental analysis procedures prescribed in the Washington State Environmental Protection Act (SEPA).

The proposed project would be located along a series of falls dropping 28ft in elevation along a 2,500ft stretch of the river. The proposed project will not require the damming of the Nuyakuk River, nor will it divert the original course of the river. Rather the power plant will be constructed on the inside of an oxbow bend in the river. Water will be taken upstream of the bend and run 1,500ft on land though the power plant. The water force of the water will spin a turbine generating electricity, to where it will then be released back into the river. Around 30% of the river's flow will be diverted for the power plant. The proposed project is located downstream of a vast system of lakes acting as 1544 square miles of watershed.

The intent of this document is to analyze all possible impacts of the proposed project on natural and built elements of the environment of the proposed action’s project area. The possible significant impacts on these elements by the proposed action were determined. Only elements which were deemed to be at risk of significant impacts of change by the proposed project were included in an in-depth analysis. An alternative action of the original proposed project with special mitigation measures that lessen the impact of the proposed project on the natural and built elements are also analyzed throughout this document.

After analysis we have given the Nuyakuk River Project a determination of **nonsignificance.**

Decision Matrix

Positive Impact: (+)
Zero Impact: (0)
Negative Impact: (-)

Table 1: Included Natural Environment Element Decision Matrix.

Natural Environment Elements	Proposed Action	Alternative Action	No Action Alternative
Earth			
Soils	-	-	0
Water			
Surface water	0	0	0
Runoff/absorption	-	-	0
Floods	-	-	0
Groundwater movement quantity/quality	0	0	0
Public water supplies	0	0	0
Energy and Natural Resources	+	+	0
Plants and Animals			
Vegetation	-	-	0
Fish Species	-	0	0
Other Animals	-	0	0
Unique Species	-	0	0
Total	-6	-4	0

Table 2: Included Built Environment Elements Decision Matrix.

Built Environment Elements	Proposed Action	Alternative Action	No Action
Built Environment	-	0	0
Environmental Health			
Noise	-	0	+
Risk of Contamination	-	-	0
Risk of Explosion	0	0	0
Land and Shoreline use			
Relationship to Existing Land Plans	0	0	0
Aesthetics	-	-	0
Housing	0	0	0
Recreation	-	0	0
Historic & Cultural Preservation	-	-	0
Public Services and Utilities			
Parks or Other Recreational Facilities	-	-	0
Maintenance	-	-	0
Communications	+	+	0
Transportation			
Transportation Systems	+	+	0
Vehicular Traffic	0	0	0
Waterborne, Rail & Air Traffic	+	+	0
Parking	0	0	0
Movement and	+	+	0

Circulation of People or Goods			
Total	-4	-1	1

Table 3: Cumulative Included Environmental Element Decision Matrix.

	Proposed Action	Alternative Action	No Action
Natural Environment	-6	-4	0
Built Environment	-4	-1	0
Grand Total	-10	-5	1

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Figure 1. Aerial photo of the proposed project area

*Figure 2***.** Data taken from the Alaska Department of Fish and Game website. The figure presents the annual cumulative fish counts for 2003-2006 for migrating sockeye salmon (*Oncorhynchus nerka*) on the Nuyakuk River.

Table 1. USGS Water Data on the Nuyakuk River

Technical Terms - Glossary, Acronyms & Abbreviations

Oxbow bend: A U-shaped curve in a stream or river.

Streamflow: flow of water in a river or stream.

Bypass reach: Area affected by a diversion in stream flow.

Run-of-river hydroelectric plant: More commonly known as a diversion plant - utilizes the natural and consistent stream flow and elevation drops to generate power.

Discharge: volume of water that flows through a stream or river at one time.

Channel Tailrace: Channel that carries water away from a hydroelectric plant after the water has been used to generate power and is returned to the body of water it originates from.

Riparian: An ecological zone located on the banks of a body of water, most commonly referred to as the area bordering the banks of a stream or river.

Entrainment: The physical injury of fish caused by hydropower plants turbines.

Optical Fiber: Transparent fiber made from plastic or glass used in the transmission of information.

Biome: the plants and animals based on the environment they live in.

Penstock: Large tubes of water with valves at the ends which control the amount of water entering the power plant.

Elements of the Environment

Natural Elements

Water

Existing conditions: The Nuyakuk River is a 36 -mile -long tributary of the Nushagak River, with the project being located on the Nuyakuk River within the Dillingham Census Area, Alaska. The river's peak streamflow was 58 cubic feet per second, with a daily discharge of 21514 cubic feet (USGS, 2020). Lowest flow rates typically occur in April. In 2020, the minimum flow rate during April was 1,277 cubic feet per second. The average flow rate across seasons in 2020 was 4,312 cubic feet per second (AAOS, 2021). The river has no developments around or within, and the river has uninterrupted flow at all points of the year.

Data Type	**Begin Date**	**End Date**	**Count**
Current / Historical Observations (availability statement)	1987-10-06	2021-01-12	
Daily Data			
Temperature, water, degrees Celsius	2013-09-30	2021-01-03	7175
Discharge, cubic feet per second	1953-03-11	2020-12-01	21568
Daily Statistics			
Temperature, water, degrees Celsius	2013-09-30	2020-10-08	2332

Discharge, cubic feet per second	1953-03-11	2020-10-08	21514
Monthly Statistics			
Temperature, water, degrees Celsius	2013-09	2020-10	
Discharge, cubic feet per second	1953-03	2020-10	
Annual Statistics			
Temperature, water, degrees Celsius	2013	2021	
Discharge, cubic feet per second	1953	2021	
Peak streamflow	1954-06-14	2019-11-13	58
Field measurements	1953-05-10	2020-10-09	221
Field/Lab water-quality samples	1954-09-01	2020-10-09	88
Water-Year Summary	2007	2020	14
Revisions			

Table 1. USGS Water Data on the Nuyakuk River

Surface water

Proposed action:
The project's plan is to reroute 30% of the available stream flow of the Nuyakuk River. The hydroelectric project would use the vertical fall of the river topography to divert this stream flow into the intake structures, creating a bypass reach around the oxbow bend. A 30% reduction in flow would impact a short segment of the river (Nuyakuk River, 2019). By diverting flow over the natural drop within the river, the flow of the river is largely unaffected once the project is completed (Nushagak Cooperative, 2019). The reported 30% of stream flow will fluctuate with seasonal changes and its effect on flow (Nuyakuk River, 2019). The flow would enter the intake structure and pass through conveyance tunnels that would deliver the streamflow into a 100-foot-long by 50-foot-wide by 300-foot-high powerhouse containing two 5-MW Kaplan style turbine generators (Nushagak Cooperative, 2020). This 30% of the stream flow would be returned to the river half a mile downstream of the intake structure via a 100-150 foot-wide, 450-foot-long open channel tailrace once the water has been used to generate power (Nushagak Cooperative, 2020).

Alternative action:
Alternative impacts will be the same as the proposed action.

No action:
Nuyakuk River will continue to flow undisturbed and flow around the oxbow bend will not be affected. There will be no development of a hydroelectric project on the Nuyakuk River.

Mitigation Measures:
No mitigation measures are required.

Runoff/Absorption

Proposed action: There may be possible impacts on the river during the construction and after the completion of the hydroelectric project due to an increase in impermeable surfaces around the oxbow bend of the river. More information would be required to quantify the possible impacts the project would have with increased precipitation and runoff in the Nuyakuk River.

Alternative Action:
Alternative action is the same as the proposed action.

No Action Alternative:
Runoff from precipitation rates and permeable surfaces will continue to allow for water to enter the Nuyakuk River.

Mitigation Measures:
No mitigation measures are required.

Floods

Proposed Action: There is a possibility of floods from increased levels of precipitation and the creation of impermeable surfaces of the plant during the construction and the initial completion of the hydroelectric project, but the upstream lake system acts as a natural sediment trap, leaving the chances of flooding to be relatively low (Nushagak Cooperative, 2021).

Alternative Impact:
The alternative action is the same as the proposed action.

No Action Alternative:
Flood waters will continue to flow throughout the Nuyakuk River unaffected by developments in the area.

Mitigation Measures:
No mitigation measures are required.

Groundwater movement/quantity/quality

Proposed Action:
Ground water is not projected to be affected by the creation of a small scale hydroelectric plant on the Nuyakuk River, but further studies and a survey of the landscape would be required to understand the possible impacts.

Alternative Action:
Alternative action is the same as the proposed action.

No Action Alternative:
Groundwater resources in the area will continue to be undisturbed.

Mitigation Measures:
No mitigation measures are required.

Public water supplies

Proposed Action:

The Nuyakuk River is not currently under use as a public water supply and will not be affected by the creation of a hydroelectric plant on the Nuyakuk River.

Alternative Action:
The alternative action is the same as the proposed action.

No Action Alternative:
The Nuyakuk River is not used as a public water source.

Mitigation Measures:
No mitigation measures are required.

Land and Shoreline Use

The Nuyakuk River is located within Wood-Tikchik state park and supports a variety of activities from fishing to hunting and gathering as well as recreational uses such as boat trips in Wood-Tikchik park. Due to the strong cultural ties surrounding hunting-gathering and foraging in Alaska, the proposal of a new hydroelectric project on the Nuyakuk River has been met with concern from indigenous people in the area.

Relationship to existing land plans and to estimated population
Existing development: one cabin (ADF&G fish counting camp, abandoned since the 1990s). Most of the upper portion of the Nuyakuk River corridor is owned by the state (Wood-Tikchik State Park) while the majority of the lower portions are owned by Koliganek Natives, Ltd (Alaska Department of Natural Resources).

Housing
Disrupting housing that already exists will not be an issue. There is one abandoned fish counting cabin near the river (Chaney, 2021).

Aesthetics
The Nuyakuk River Hydroelectric project would create a run -of -the -river diversion that collects water from the river but does not impede its flow, which is different from a hydroelectric dam. These diversions do not hold back water in reservoirs but allow the natural flow rate of the river to generate power by channeling part of the river through canals or and penstocks.

Recreation
The proposed project will not dam up the river and create a reservoir. Ideally the diversion method to be applied on the Nuyakuk will not adversely affect salmon fishing in the area or boating trips down the system of rapids.

Historic and cultural preservation
The Nuyakuk river supports hunting and gathering practices of the surrounding villages. The hunter-gatherer lifestyle has been a part of native Alaskan communities for hundreds of years.

Potential Impacts of Proposed Project:

Existing Land Plans and Existing Population
The proposed project will not affect existing land plans and population.
Housing
The proposed project will not disrupt any housing.
Aesthetics
The proposed project will create a diversion of the river through a channel that will run along the surrounding land. Potential impacts include disrupting land habitat including plants, soil, and animals.
Recreation

There is concern that the river diversion will adversely impact salmon fishing in the Nuyakuk River. The river is an important run for Chinook Salmon.

Plants and Animals

The Nuyakuk River is a tributary of the Nushagak River, which hosts an important salmon run in Alaska. Alaskan salmon are a critical resource for recreational, subsistence, and economic purposes. The Yup'ik and Cup'ik peoples have relied on the Nushagak and Nuyakuk River's salmon runs for thousands of years for subsistence fishing and cultural purposes (Andrews, 1989). Salmon are an integral part of these ecosystems. The project's primary concern is the possible impact the rerouting of streamflow could have on the salmon runs within the Nuyakuk river. The project would divert up to 30% of the stream flow into the generating power station, removing that water from over a roughly 2000-foot stretch of river. (Ross, 2019)

Existing conditions:

Vegetation: The proposed project exists in a boreal biome and will be constructed along a riparian zone. The proposed projects' area is dominated by coniferous trees and an under canopy of woody shrubbery. The conifer species are dominated by Black Spruce (*Picea mariana*), White Spruce (*Picea glauca)*,) and Western Hemlock (*Tsuga heterophylla*). The understory for the region is predominantly dominated by Alaskan alder (*Alnus crispa*) and Willow (*Salix alaxensis*), while Resin Birch (*Betula glandulosa*), Buffalo Berry (*Shepherdia canadensis*), Horsetail (*Equisetum arvense*), Wood Fern (*Dryopteris*), and Prickly Rose (*Rosa acicularis* Lindl) are also present (*Viereck et al. 1992).* The Yup'ik peoples use many of these plants found along the river and in the proposed project area for medicinal purposes, such as Alder (*Alnus spp*), Horsetail (*Equisetum arvense*), and Woodfern (*Dryopteris*) (Vierek, 1992)

Fish Species: The Nuyakuk river is home to white fish such as least cisco (*Coregonus sardinella*). The Alaska Department of Fish and Game has only recorded a sockeye salmon (*Oncorhynchus nerka*) migration route in the Nuyakuk River. (Alaska Department of Fish and Game 2006*)*. The Alaska Department of Fish and Game only has fish count data from the years 2003-2006. Other data sources for more recent fish counts are not made publicly available. The most recent publicly available fish counts from the Alaska Department of Fish and Game come from 2006. July 6, 2016, a total of 170,760 total sockeye salmon (*Oncorhynchus nerka*) had been counted in the Nuyakuk River (Alaska Department of Fish and Game, 2006*)*.

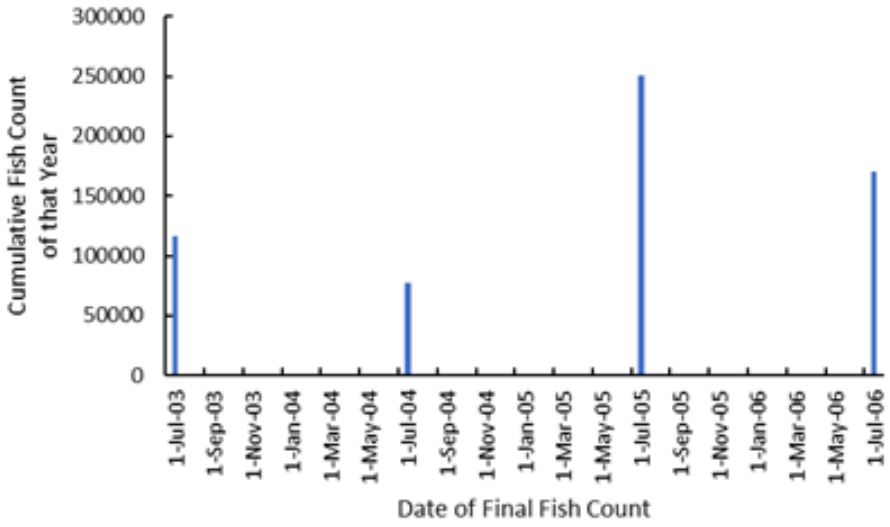

*Figure 2***.** Data taken from the Alaska Department of Fish and Game website. The figure presents the annual cumulative fish counts for 2003-2006 for migrating sockeye salmon (*Oncorhynchus nerka*) on the Nuyakuk River.

Other Animals: The proposed project is located in the Wood-tikchik State park, which is home to both black bears (*Ursus americanus*) and brown bears (*Ursus arctos gyas*), black-tailed deer (*Odocoileus hemionus sitkensis*), moose (*Alces alces gigas*), caribou (*Rangifer tarandus granti*), wolverines (*Gulo gulo*), river otters (*Lutra canadensis*), porcupines (*Erethizon dorsatum*), beavers (*Castor canadensis*), and red foxes (*Vulpes vulpes*). Bald eagles (*Haliaeetus leucocephalus*), which are culturally significant to Yup'ik peoples, are known to nest near the proposed project area (Nushagak-Mulchatna Watershed Council, 2007).

Unique Species: The sockeye salmon (*Oncorhynchus nerka*), while not endangered, are extremely important to protect because of their cultural significance to the Yup'ik peoples and because of their economic value (Nushagak-Mulchatna Watershed Council, 2007).

Potential Impacts of Proposed Action:

Vegetation: The construction of the power plant will require the removal of vegetation. The removal of vegetation in the riverbank in the riparian zone can increase the risk of erosion, increasing the rivers' turbidity. A decrease in riverbank stability through vegetation removal could leave the power plant more vulnerable to floods or landslides.

Fish species: The proposed power plant will divert a considerable amount of water from the Nuyakuk River. The project would divert roughly 30% of the stream flow into the generating power plant over an approximate 2000-foot stretch of river (Ross, 2019). This decrease in flow could make the river more vulnerable to an increase in water temperature, which could decrease the rivers' dissolved oxygen concentration, resulting in adverse health effects such as

impairing the embryonic and juvenile development of salmon (Carter, 2005). A reduced flow rate resulting in lower water levels could also make fish populations more exposed to predators. The reduction in flow of the falls, which are located along the proposed project site, could reduce the amount of energy migrating salmon need to swim up the falls, making migration easier. The removal of vegetation where the proposed site is located could increase erosion and thus the water's turbidity. Increased turbidity could decrease the fish population's fitness. There is also the possibility of fish entrainment. Fish can swim into the water intake and are crushed by the turbines, resulting in the injury or death of fish that pass through the turbines (Rytwinski et.al 2017).

Other animals: The reduction of vegetation from the proposed site will reduce habitat for rodents and other small mammals. The removal of trees will reduce potential nesting sites for birds. The loss of large trees will result in the loss of shade, which would affect which plants can thrive. Plants that do well with more direct sunlight will outcompete those that prefer shade. This change in plant population could affect the population of insects that are present.

Mitigation Measures:
We recommend that a screen be installed on the power plant's water intake, which would prevent fish entrainment of resident and migratory fish. The prevention of entrainment would prevent mortal and non-mortal injury of fish. (Rytwinski et.al 2017). A mixture of fast-growing native plants and trees such as Willow (*Salix alaxensis*) and Alder (*Alnus spp.*) could be re-planted along the river bank to prevent erosion. Wildlife bridges could be constructed over the penstocks to allow easy passage for small mammals to travel over the built structures. Platforms could be erected in the surrounding area to provide easy nesting for bald eagles to offset the reduction in potential nesting areas.

Impacts of No-Action Alternative:
The non-action alternative will maintain the current conditions.

Air

Existing Conditions:
The proposed project is located 25 km away from the nearest town of Dillingham. The US AQI if Dillingham is a 3 giving it a rating of “Good” air quality. Because the proposed project is 25km away from the nearest town which has a AQI of 3 we are assuming that the air quality of the site is either equal or better (IQAir, 2021)

The proposed power plant once operational will not be producing any pollutants. The plant's operational energy demands will be met with the power it produces which is pollutant free (Nushagak Cooperative, 2019).

Due to the current good air quality and the conclusion that the plant will not produce any air pollutants once operational and air quality will remain at “Good” conditions, we have decided not to include Air in our analysis.

Earth

Existing Conditions:

The proposed project's soil composition is composed primarily of silt loam from 5 to 71 inches in depth. This silt loam composition is 40% sand (particle size>63 µm), 40% silt (particle size >2µm), and 20% clay (particle size<2 µm). The soil drains quite well and doesn't hold water for long periods of time. Water which is absorbed, drains into the water table which is located about 39in to 59in below the surface. Some areas may have a different soil composition, being composed of peat from 0 to 22in in depth, mucky peat 22 to 28in in depth, and very fine sandy loam 28 to 71in. This type drains very poorly unlike the other type of soil present. (US Geological Survey, 2021).

Impacts of Proposed Project:

For the construction of the power plant several tons of soil will need to be removed. The removal of the soil will be done with heavy machinery. The use of the heavy machinery will cause erosion and possibly increase the turbidity of the river during the duration of construction. The removed soil will be transported to an undetermined location via heavy machinery. The US Geological Survey gives the soil in the proposed project area a "high" rating for the corrosion of concrete and steel. Due to the chemical and physical nature of the soil steel and concrete are likely to corrode at a fast rate if exposed to the soil (US Geological Survey, 2021).

Mitigation Measures:

Removed soil and sediment should *not* be dumped into the river, which will actually increase the turbidity. Nor should the removed soil be dumped onto nearby vegetation. The topsoil removed for the construction of the power plant should be transported either to a site which has already been predetermined for sediment dumping, such as a gravel pit. Highly dense concrete and steel should be used for any section of the power plant which will be exposed to the corrosive soils. While this will not stop the corrosion of the building materials, using dense materials will extend time periods between the replacement of those materials. We do not recommend using building materials such as chemical additives to concrete or steel, as these chemicals could leach into the soil and ground water over time.

Impacts of Non-Action Alternative:

The non-action alternative will maintain the current conditions.

Built Environment

Existing conditions
The proposed location of the hydroelectric project is a tributary of the Nushagak River in the Wood-Tikchik State Park. The project site experiences some disturbances to the otherwise natural setting by people due to recreational water-related activities including boating and fishing (Jettmar, 2008 (Jettmar, 2008). Beyond that, the site is not a site of logging and thus does not have disturbances due to the operation of large machinery. The natural topographic and hydrologic characteristics of the river are minimally disturbed at the project site (Nushagak Cooperative; Nuyakuk Hydro).

Environmental health

Noise

Proposed Action Impacts:
There may be some long-term noise as a result of the placement of the hydroelectric project. Environmental noise from hydroelectric power plants, however, are not hazardous to community noise levels and should not be a significant hazard to the surrounding area (Maria Luiza de Ulhôa Carvalho, 2005)

Much of the transporting of materials to the project site will be done via aircraft from the nearby airport with the possibility of some boat access via the river itself (Nushagak Cooperative Project Kickoff, 2019). Given that most of the access will be by air, there will be substantial noise disturbances to the air from the planes and helicopters transporting personnel and resources in. In particular, aviation noise and mechanical noise will cause some disturbance to the area, especially during landing (Frazer, 2008).

As the project is located in a state park, there are no residential areas or other types of areas available to the public nearby, thus no noise complaints should occur, although nearby campers may experience some disturbances throughout the construction of the project.

Noise created by heavy machinery may temporarily cause disturbances to nearby wildlife, especially those that inhabit the river itself. The heavy vibration and caused by the placement of the hydroelectric project may also cause disturbances to fish inhabiting the river as well as other wildlife inhabiting nearby areas (Johnson et al, 2014).

Alternative Action impacts:
The Alternative Action impacts will be the same as for the proposed action.

No Action Alternative impacts:
No noise is created and no wildlife is disturbed. So no impact, right?

Mitigation measures:
No mitigation measures are required.

Risk of contamination

Proposed Action Impacts:
There could be some contamination of the river during construction. Contaminants could include gasoline or other chemicals from any of the vehicles used in the construction of the powerplant. In terms of potential long-term contaminants, the generators require regular oil changes during maintenance. It is a possibility that this oil could be spilled or leaked into the river during maintenance or as a result of catastrophic failure.

Alternative Action impacts:
The Alternative Action impacts will be the same as for the proposed action.

No Action Alternative impacts:
The alternative action will not t cause a risk of contamination.

Mitigation measures:
No mitigation measures are required.

Risk of explosion

Proposed Action Impacts:
Construction and operation of the project does not require any sort of combustion, thus the chance of an explosion occurring is low (Energy.gov).

Alternative Action impacts:
The alternative action will have no effect on explosion risk.

No Action Alternative impacts:
There continues to be no risk of explosion.

Mitigation measures:
No mitigation measures are required.

Transportation:

Existing Conditions:
There are currently no developments for transportation along the Nuyakuk River. The only forms of transportation in the vicinity of the proposed action are watercraft and hiking. The Wood-Tikchik State park has a philosophy of nodevelopment in the area, with no transportation systems in place within the state park and few other developments in the entire park.

Transportation systems

Proposed Action:
An airstrip is to be constructed adjacent to the hydroelectric plant site in order to allow for the transportation of materials and personnel for the duration of the construction and the transportation of personnel for maintenance and check-ups of the plant. A roughly half mile long access road will link the airstrip and the hydroelectric plant (Nushagak Cooperative, 2019).

Alternative Action:
The Alternative Action impacts will be the same as for the Proposed Action.

No Action Alternative:
There will be no construction of an airstrip and the only forms of transportation in the area will be recreational boating and hiking.

Mitigation Measures:
No mitigation measures are required.

Vehicular Traffic

Proposed Action
A half-mile long access road will be constructed linking the airstrip and the hydroelectric plant together, allowing transport of materials and personnel to and from the airstrip to the plant. This access road will see heavy traffic during the initial construction of the hydroelectric plant but would see infrequent use for the transport of maintenance personnel around the plant after construction is completed.

Alternative Action:
The Alternative impacts will be the same as the proposed.

No Action Alternative:
There will be no vehicular traffic along an access road, as there will be no access road developed in the area and no forms of transportation necessary.

Mitigation Measures:
No mitigation measures are required.

Waterborne, rail, and air traffic

Proposed Action: Air traffic will be increased during the construction of the hydroelectric plant, with an airstrip being installed adjacent to the plant for this purpose (Nushagak, 2019). Planes would become a frequent sight in the area as this would be the primary form of transportation to transport materials and personnel to the hydroelectric plant on the Nuyakuk River. Boating these materials is considered, but further research would be required in order to understand the feasibility for this mode of transportation.

Alternative Action:
The Alternative impacts will be the same as the proposed.

No Action Alternative:
There will be no air traffic in the area as no airstrip would be developed and the area would remain undisturbed.

Mitigation Measures:
No mitigation measures are required.

Parking

Proposed Action:
a parking lot will likely have to be created in order to park the vehicles used for transportation on the access roads.

Alternative Action:
The Alternative impacts will be the same as the proposed.

No Action Alternative:
No parking lot would be constructed, and the area would be left undisturbed.

Mitigation Measures:
No mitigation measures are required.

Movement/circulation of people or goods

Proposed Action:
In the initial stages of construction of the hydroelectric plant, there would be consistent movement of both personnel and materials to the site of the hydroelectric plant. After construction is completed, The Nuyakuk River Hydroelectric project would be producing

approximately 12 mw of power, and a hydroelectric plant of that size would require over 10 routine maintenance checkups each year, based on routine maintenance of other hydropower operations (Renewables First, 2017).

Alternative Action:
The Alternative impacts will be the same as the proposed.

No Action Alternative:
With no development of a hydroelectric plant on the Nuyakuk River, there would be no circulation of people in the area beyond the normal recreational activities that already occur.

Mitigation Measures:
No mitigation measures are required.

Traffic Hazards

Proposed Action:
The proposed action is unlikely to impact traffic hazards in the area, as transport via air within the air is limited.

Alternative Action:
The Alternative impacts will be the same as the proposed.

No Action Alternative:
The Nuyakuk River will remain without traffic hazards.

Mitigation Measures:
No mitigation measures are required.

Public Services & Utilities

Parks or Other Recreational Facilities

Proposed Action:
The proposed action will potentially impact fish counts which would have negative repercussions on recreational or commercial fishing on the Nuyakuk River.

Alternative Action:
The alternative impacts will keep fish from entering hydroelectric turbines and being killed or mortally wounded. Passing fish would still be at risk of colliding with the suggested screen. The alternative impacts would be less harmful for recreation than the proposed action.

No Action Alternative:
Recreation along the Nuyakuk River will remain the same.

Mitigation Measures:
No mitigation measures are required.

Maintenance

Proposed Action:
The proposed small-scale run-of-river hydroelectric plant will generate around 10-12 MW of power. Based on the size and generating capacity of the plant, the costs for maintenance of this type of plant would range from $1,000-20,000 USD/kW (Carrasco et al., 2020). Maintenance of the airstrip and access roads will also be needed. The transmission lines that stretch to each community will need increased maintenance needs to maintain their form and function.

Alternative Action:
The alternative action impacts would be the same as the proposed action impacts.

No Action Alternative:
No maintenance of any development in the Nuyakuk River area would be required.

Mitigation Measures:
No mitigation measures are required.

Communications

Proposed Action:

Some of the hydroelectric power generated from the Nuyakuk River project would go towards providing nearby communities (Dillingham, Aleknagik, Koliganek, New Stuyahok, Ekwok, Levelock and Bristol Bay) with optical fiber (Nushagak Cooperative, 2021).

Alternative Action:
The alternative action impacts would be the same as the proposed action impacts.

No Action Alternative:
No new optical fiber or communication technologies will be added to the communities of Dillingham, Aleknagik, Koliganek, New Stuyahok, Ekwok, Levelock and Bristol Bay.

Mitigation Measures
No mitigation measures are required.

Recommended Action

We recommend that the proposed project with special mitigation measures would be the best action and would result in the most negligible impact on the surrounding environment.

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