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Community Energy Action Plan

Tanacross, AK

Tanana Chiefs Conference

February 2021

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Executive Summary

This Community Energy Action Plan (CEAP) is funded through a US Department of Energy – Office of Indian Energy technical support grant to Tanana Chiefs Conference. The objective of this document is to identify energy projects and priorities that will reduce the long-term cost of energy and dependence on fossil fuels in Tanacross. The process is designed to look at both electricity and heating needs, along with energy efficiency and conservation opportunities. The intent is for this document to inform project development initiatives, community decision making, and support future grant applications.

During the development of the CEAP, previous community and regional energy goals, current energy costs, and all pertinent project development documents were reviewed to identify the energy projects that were completed in the last few years and evaluate future energy development opportunities for Community Energy Champions. Community leaders were interviewed to understand community values and to identify and prioritize future projects important to the community members in Tanacross.

Summary of Recommendations

Focus Area	Goal	Actions
Fire Hydrant Heat Tape	20% reduction in electric cost for heat tape on fire hydrants.	▪ Identify funding for hydrant replacement ▪ Replace fire hydrants with Arctic Hydrants
Installation of solar/battery "behind the meter" system on community buildings.	Reduce the cost of power for the MUF and WTP by 20%	▪ Execute the installation of the "behind the meter" system on the MUF and WTP. ▪ Monitor performance to share learnings with other communities ▪ Work with GRID and TCC to train local people on these systems
Energy efficiency audits - commercial and residential structures.	Implement energy audit recommendations in the WTP, resulting in a 10% reduction in energy costs. Complete weatherization of an additional 6 homes.	▪ Identify funding for implementation of 9 recommendations in the WTP ▪ Implement WTP recommendations ▪ Recruit 6-7 homes to apply to ACDC for residential weatherization.
Support the Development of the Roadbelt Intertie	Improve electrical system reliability and reduce cost of power.	▪ Seek out opportunities to advocate for continued analysis of this project. ▪ Participate in information sessions and community meetings; ensure Tanacross perspective is included in

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		the project.
Community Lighting Upgrades	Replace 24 streetlight fixtures with LED fixtures.	▪ Implement VEEP streetlighting replacement.
Biomass system operations and wood supply	Maximize the fuel displacement in the MUF and WTP	▪ Sign-up for AEA's cordwood system audit and operator training. ▪ Develop a wood pricing strategy that saves the community heating costs but also incentivizes wood harvest with support of AEA. ▪ Submit an application to The Alaska Wood Energy Development Task Group for a free prefeasibility study to investigate the expansion of the cordwood heating system. ▪ Encourage the School District to update their 2006 prefeasibility study through the same Alaska Wood Energy Development Task Group.
Community-wide oil boiler annual inspections and cleaning	Develop skills within the local community members to clean and inspect oil boilers.	▪ Organize an oil boiler maintenance class through UAF Construction Trades Technology to train community members to complete annual inspections. ▪ Annually inspect and clean all oil boilers in Tanacross.
Yerrick Creek Hydro	Quantify the economic opportunity of Yerrick Creek Hydro	▪ Continue to engage with AP&T to identify trigger points to revisit this project. For example: With a decision to pursue the Roadbelt Intertie or a significant spike in fuel oil prices, complete an updated capital cost estimate of the Yerrick Creek Hydro Project. ▪ Update benefit to cost analysis for the construction project.
Alternative heating systems for the School, Firehall and Garage, including biomass and solar thermal or solar PV.	20% reduction in diesel heating cost in community buildings	▪ Request a prefeasibility study through the AWEDTG for heating the school, firehall and/or garage with biomass. ▪ Confirm school does not have a functional cordwood heating system.

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Introduction

This Community Energy Action Plan (CEAP) is funded through a US Department of Energy – Office of Indian Energy technical support grant to Tanana Chiefs Conference. Tanana Chiefs Conference (TCC) is a Tribal Consortium comprised of 37 federally recognized Tribes, of which Tanacross Village Council (TVC) is a member. As a Tribal 501 (c)(3) non-profit organization based in Fairbanks and serving the Interior of Alaska, TCC's full Board of Directors consists of an elected Tribal member from each village and three Officers, for a total of 42 Directors. TCC provides various services including health care, realty, land and resource management, job training, and energy assistance.

The objective of this document is to identify energy projects and priorities that will reduce the long-term cost of energy and dependence on fossil fuels in Tanacross. The process is designed to look at both electricity and heating needs, along with energy efficiency and conservation opportunities. The intent is for this document to inform project development initiatives, community decision making, and support future grant applications. The first section of the document reviews the efforts to date on energy improvements in Tanacross. The second section reviews current energy cost and goals. The final section recommends potential projects to meet the community energy goals. Finally, the appendix contains feasibility studies and key reference documents to consolidate the energy development work to date in one location.

Background/Efforts to date

Tanacross is an Athabascan Indian community and the Tanacross Village Council (TVC) is a federally recognized tribe. TVC is the governing body of the Native Village of Tanacross, an IRA Constituted village established in 1942. There is no municipal government in Tanacross, which leaves the TVC with the responsibility of operating a broad range of programs, including revenue in excess of $2,000,000 per fiscal year. Tanacross has a population of 136 people; 82% of the population is Alaska Native. The village population increased from 80 people (1990) to 140 people (2000), creating an increased demand on housing and infrastructure services.

Tanacross is located on the bank of the Tanana River approximately 12 miles from the community of Tok, Alaska, 90 miles west of the Canadian border, and 200 miles southeast of Fairbanks. Tanacross is connected to the Alaska Highway by one and a half miles of unpaved access road. Extreme temperature changes occur throughout Alaska's interior. The Village's temperatures range from a winter low of -75 degrees Fahrenheit (°F) to a high of 90 °F. Average low in January is -22 °F, and the average high in July is 65 °F. Heating Degree Days have averaged 14,811 annually since 1957.

The Tribe is keenly aware of their difficult energy situation. The Denali Commission has classified Tanacross as a distressed community. Tanacross faced significant hardships when heating and electric costs spiked in 2008 and since then has focused on reducing utility costs for community members. Several community energy meetings were held between 1993 through 2016, instigated by high costs and the development of community energy goals. Tanacross was also an active participant in the development of the 2015 Interior Alaska Energy Plan. Alaska Power and Telephone (AP&T) is a privately owned electric utility that provides electric power to Tanacross.

Previously identified goals

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In the 2015 Interior Alaska Regional Energy Plan and community energy meetings, Tanacross identified the following goals for their energy future:

- Conduct Building Facility Energy Audits
- Complete the biomass heating system
- Add Renewable Energy to the Multiuse Facility (MUF), the Biomass Facility, and the Water Treatment Plant (WTP).
- Upgrade Outdoor Lighting
- Implement Energy Efficiency Recommendations in the Tanacross School and WTP
- Develop Community Solar photovoltaic (PV) Projects
- Complete Yerrick Creek Hydroelectric Project
- Install LED Light Conversions

Since 2015, there has been significant work on the biomass heating system and two energy audits have been performed – one at the school and one at the WTP/Washeteria. Additionally, a hydroelectric project at Yerrick Creek was explored, but a decision was made to abandon the project. The following sections will discuss the work completed to date.

Community Wide Energy Efficiency

The largest energy users in a community most often provide the biggest opportunity for energy efficiency savings. The two largest energy users in Tanacross are the Water Treatment Plant and the School, and both buildings have completed energy audits. No other community building energy audits have been identified.

Tanacross School

The Alaska Gateway School District owns and operates the K-8 Tanacross School. The school building is 7538 square feet and is occupied by 30 students and 2 teachers. In July 2012, Nortech completed the final report for the Tanacross School ASHRAE Level II Energy Audit and recommended 13 Energy Efficiency Measures to achieve $6891 annual cost savings for the school. The cost to implement the measures was estimated at $41,092 with a simple payback of 6 years.

The Alaska Gateway School District implemented the majority of the 13 recommendations with the exception of the gym thermostat and increased insulation in the crawl space. 93% of the savings opportunities were realized, resulting in an annual savings of over $37,000 per year.

Water Treatment Plant

The Tanacross Water Treatment Plant and Washeteria was audited by ANTHC in April of 2020 and identified nine recommendations that have a payback of less than 10 years. These nine recommendations have a total cost of $29,029 and will save $7,068 annually in energy and maintenance costs. ANTHC is currently pursuing Denali Commission funding for energy efficiency improvements in rural water treatment plants, including Tanacross. Funding availability will be communicated in the first half of 2021. The following table summarizes the nine most cost-effective recommendations identified in the WTP Audit.

Summary of Recommended Energy Efficiency Measures for the Tanacross WTP/Washeteria Rank						
#	**Feature**	**Recommendation**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio**	**Simple Payback (Years)**
1	Programmable Thermostat: Washeteria	Replace existing manual t-stats with programmable t-stats. Replace the plastic protective cases. Set a temp set back of 60°F- 65°F when unoccupied.	$633	$600	14.13	0.9
2	Water Pressure System	Relocate the pressure switch tree to the high-pressure pump pressure switch location. Program the pressure pumps to operate as lead and lag. Isolate and drain the pressure tanks. Adjust the tank pre-charge pressure if needed.	$731	$2,625	3.32	3.6
3	Lighting: Washeteria	Replace existing four-foot, ceiling-mounted fluorescent bulbs with direct-wire, energy-efficient LED bulbs.	$79 + $19 Maint. Savings	$460	3.28	4.7
4	Lighting: Outdoor Lighting	Replace existing exterior lighting fixtures with LED wall packs with dusk-to-dawn photosensors.	$109 + $16 Maint. Savings	$880	2.97	7
5	Attic Insulation	Add R-30 fiberglass batts to the attic	$381	$3,146	2.80	8.3
6	Heating and Domestic Hot Water	Replace the existing electronically commutated pump in the biomass building that sends heat to the WTP with a Magna3 40-120F. Repair the oil-fired boiler return line. Clean and tune all boilers. Install a Tigerloop on the biomass building oil-fired boiler fuel line.	$558	$5,500	1.76	9.9
7	Lighting: WTP Process Room	Replace existing four-foot, ceiling-mounted fluorescent bulbs with direct-wire, energy-efficient LED bulbs.	$87 + $49 Maint. Savings	$1,188	1.74	8.7
8	Water Storage Tank (WST) Heat Add	Install isolation valves and thermometers on the heat exchanger glycol supply and return lines. Install a sight flow indicator on the glycol return line. Upgrade the heat add control and solenoid valve to a modulating valve and control. Replace the water-side thermometers with digital models. Flush the heat exchanger.	$551	$4,880	1.53	8.9
9	Water Distribution Loop Heat Add	Replace water loop heat add heat exchanger, thermometers, and pressure gauge. Upgrade heat add controls and install a modulating motorized valve.	-$1,355 + $2,500 Maint. Savings	$9,750	1.17	8.5

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Residential Housing

The 2010 US Census data shows that Tanacross has 73 total housing units with 53 of the units occupied. Between 2008 and 2014, 30 homes participated in the Alaska Housing Finance Corporation Weatherization Program through the Alaska Community Development Corporation. Depending on the condition of the homes, the investments ranged from $3,000 to $30,000 per home with an average investment of $11,000. The work that was completed included upgraded heating systems, hot water heaters, building envelope improvements, LED lighting, and appliance upgrades.

Tanacross Biomass Heating System

The Native Village of Tanacross began pursuing a biomass heating project in 2008 with a prefeasibility study through the Alaska Wood Energy Development Task Group. This study indicated a good biomass resource and significant heating loads that could be economically met with local cordwood. In 2012 TVC received $420,000 for the design and construction of a cordwood heating system to supply heat to the new clinic/community multi-use facility (MUF) and the Water Treatment Plant. Design and construction work began on the biomass project, but the project ran short of funds. TVC applied for a Power Project Loan (PPLF) from the Alaska Energy Authority and received a $200,000 loan to complete construction and commissioning. The cordwood heating system was completed and began operating in 2018.

The system consists of three Garn 2000 boilers in a centrally located metal building. Each boiler has an output of about 350,000 Btu/hr. These boilers have a combustion chamber that is surrounded by 2,000 gallons of water that acts like a heat battery. The boilers burn very hot, fast, and efficient, and the heat is transferred to the water storage. When a building demands heat, the hot water is circulated via piping as needed. Because these boilers operate with batch combustion, the temperature of the water fluctuates between approximately 180ºF and 150ºF, when another load of cordwood is burned.

The system was predicted to displace approximately 22,000 gallons of fuel heating in the MUF and Water Treatment Plant. Because the MUF is not yet fully utilized, the fuel displacement is less than predicted. This results in less cost savings than was predicted as well.

TVC employs one operator who is paid for 8 hours each weekday to operate the Cordwood Heating System. Because the biomass system runs every day of the heating system, it requires stoking of the boilers on weekends and holidays. Currently, the operator is not paid for operating the boilers on weekends and holidays. Operator tasks include managing the wood supply, stoking the boiler, completing daily inspections, and performing required maintenance such as removing the ash after multiple firings. The wood is supplied by community members, and the current price is $200/cord. As of February 2021, the wood heating system is currently operating with 2 of the three boilers. The operator has been in contact with Garn and parts are on order for the 3rd unit. Chris Denny has plans to purchase more wood. In the first full year of operation, the boilers used approximately 75 cords of wood and this is expected to increase to as much as 180 cords when the MUF is completed and fully operational.

In February 2019, TVC hosted a Cordwood Operator Training Workshop. This weeklong workshop trained 13 operators from around the state. The Tanacross biomass system was very effective for the workshop because there are three boilers that can be used for hands-on training for operations and maintenance tasks. The community is also on the road system and in close proximity to hotels in Tok, Alaska which were able to accommodate all of the participants and instructors.

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Yerrick Creek Hydro

Yerrick Creek was identified as a 1500 kW, 4.9 million kWh/year hydro project that was estimated to cost $20 million for construction. The project feasibility was completed in 2009 and showed a viable project. AP&T pursued funding for the design and construction of the project and received $4 million through the State of Alaska's Renewable Energy Fund with a match of $15 million in 2012 for final design and construction and an additional $500,000 through the USDA REAP program in 2015. Hydrology data collection took place and 5 miles of transmission lines were constructed. After leadership changes at AP&T, the 2017 annual report stated that priorities at AP&T were shifting from renewable energy to an intertie with Golden Valley Electric Cooperative. AP&T returned all unspent grant funds to the granting agencies and abandoned the Yerrick Creek Hydro project.

Summary of Yerrick Creek Hydro Work Completed to Date:

1. Stream gaging - Gaging began in 2007 by AP&T personnel who installed a gage below the diversion location. Flow has shown that there is sufficient water there to operate a hydro project perhaps all twelve months of the year, depending on the fall rains and coldness of winter.
2. Fish & Wildlife surveys - ADF&G subsequently issued a habitat permit for construction of this project on August 5, 2009
3. Wetland Delineation - A wetland delineation was conducted by HDR Alaska out of Anchorage in August 2008. Their report defined where wetlands were in relation to the project features and would enable pursuit of a Corp of Engineer permit. Wetlands will be impacted by the Project, but to a lesser degree than thought primarily because of the glacial till providing drainage and the amount of uplands found on site.
4. Threatened, Endangered & Sensitive (TES) plant species - A TES plant survey was conducted by HDR Alaska while they were conducting the wetland delineation. No TES plants were encountered or identified in the area surveyed. Most plant species observed in the project area are considered common and widespread in interior Alaska.
5. Water Quality Testing - Water quality sampling and a baseline hydrology survey were conducted by Travis/Peterson Environmental Consulting out of Fairbanks. Historical hydrologic data for Yerrick Creek indicates that every two years there is a peak flow event of 1102 cfs, and every five years a peak flow event of 1575 cfs. Hundred year events are estimated to be as high as 3093 cfs.
6. Archaeological survey - One site was found (TNX-074) that could be eligible for the National Register but isn't listed at this time. The site can easily be avoided by the Project because of its small size.

When the project was abandoned, the design was in progress with approximately 35% complete and topographic mapping was complete. Permitting was in progress.

Please see the attached project files for more information on this project.

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Energy Cost Summary

Electrical Generation

Tanacross is serviced by Alaska Power Company, a subsidiary of Alaska Power and Telephone (AP&T) for their electricity needs. AP&T is located in Tok and is an employee-owned for-profit company based in Port Townsend, WA and also services Prince of Wales Island, Haines/Skagway, and Slana/Mentasta.

According to the 2019 PCE report published by Alaska Energy Authority, the Tanacross electric rate before PCE is $.39/kWh. PCE paid $.20 /kWh resulting in an effective residential rate of $.19/kWh for the first 500 kWh per month. Because Tanacross is part of a distribution network that covers Dot Lake, Tok, Tetlin, Northway, and Tanacross, specific electric usage in Tanacross is not available.

AP&T generates approximately 9.2 million kWh per year in this inter-connected electric grid of which Tanacross is a part. AP&T does not currently have any renewable energy on the utility scale for this location. Diesel generator efficiency is 14.62 kWh per gallon. The biggest opportunity for improvement with AP&T is line loss. AP&T has a line loss of 16.1%. The RCA sets a maximum line loss of 12% for full PCE reimbursement.

In addition to the first 500 kWh of residential power usage, PCE also subsidizes the rate of qualified community buildings. The maximum allowable monthly PCE reimbursement for community buildings is based on the populations of the area served and is 70 kWh per person per month. The Tok/Tanacross service area has a population of 1,313, which equates to a monthly allowable reimbursement of 91,910 kWh /month. Only approximately 21,000 kWh are being reimbursed per month, significantly less than the maximum allowable. It is recommended that Tanacross confirm which community buildings are receiving PCE reimbursement and qualify any other eligible buildings. Tanacross will have to work with AP&T to understand this opportunity, which may provide a substantial cost savings to specific buildings and facilities within the Tanacross community.

Heating Costs

Heating fuel and cordwood are the heating technologies of choice in Tanacross. The U.S. Census's American Community Survey estimates that over 50% of residences use heating fuel as their primary heating source and more than 35% use cordwood in wood stoves as their primary heating source. Other fuels include coal and propane, making up less than 10% of the heating fuel usage.

In 2020, Vitus Energy opened a fuel depot in Tok, Alaska providing local competition for fuel distribution for the first time in many years. Northern Energy was the sole fuel distributor in Tok until 2020.

Most heating fuel is trucked to Tanacross from Tok for both residential and commercial usage. Because there is no delivery cost added for Tanacross, Vitus estimated 95% of Tanacross consumers have the heating fuel delivered. The remaining 5% pick-up their heating fuel in Tok.

The price of heating fuel in the region as of December 2020 was $2.10/gallon on orders between 50 and 199 gallons. On orders over 200 gallons, the price is $2.06 per gallon.

Cordwood can be personally harvested on local, state, and tribal land with wood cutting permits. There are also a few wood suppliers in the Tok area that sell a cord of wood between $200 and $300 per cord, depending on the moisture and if the cordwood is cut and split.

Inventory of Energy Infrastructure

Powerplant and Bulk Fuel– the power generation is provided from the AP&T powerplant in Tok, Alaska. As a result, there is no power generation or bulk fuel infrastructure in Tanacross. The main power-related AP&T infrastructure in Tanacross are distribution lines, which are the responsibility of AP&T to operate and maintain.

2021 Community Energy Opportunities and Goals

A meeting was held with community leader Chris Denny to review previous energy goals and to discuss the community's interest in future energy projects. The major areas of interest for TVC are:

- Reduction in electric cost for heat tape on fire hydrants.
- Investigate alternative heating systems for the School, Firehall and Garage, including biomass and solar thermal.
- Installation of solar/battery "behind the meter" system on community buildings.
- Implementation of energy efficiency audit recommendations and conduct additional audits in commercial and residential structures.
- Fine tune the biomass system, biomass supply, and investigate potential expansion.
- Community Lighting Upgrades
- Understand if Yerrick Creek is a viable project for future power generation expansion opportunities.
- Support the development of the Roadbelt Intertie.

Fire Hydrant Heat Tape

The community is experiencing extremely high electric costs on the heat tape that is installed to keep the Fire Hydrants from freezing. ANTHC is proposing two options that will allow the heat tape to be turned off.

Option 1 – Regular maintenance and inspection

Pressure test and inspect all valves for correct sealing. Top off the lubricating oil under the operating nut once per year.

Turn off the heat tape and perform monthly inspections (or more often in extremely cold weather) to verify that there is no water/ice in the hydrant bodies. If there is ice present, the heat tape will have to be turned on to melt the ice and then the thawed water has to be pumped out.

There would be difficulties implementing this option due to the monthly detailed inspections and vigilance required and overall personnel time and effort necessary to keep this system functioning.

Option 2 – Replace the existing hydrants with arctic hydrants.

This is the preferred technology for new installations. ANTHC is developing a cost estimate for this option.

Recommendation - The most enduring solution would be to pursue Option 2. It is recommended to continue to work with ANTHC to identify funding for this project.

Solar Power Heating Opportunities

There are two distinct solar technologies that can replace fossil fuels for heating: solar thermal and solar photovoltaic (PV). Where solar PV systems use the sun's energy to generate electricity for your home (like your refrigerator or lights), solar thermal heating systems pump hot water, heated by the sun, into your home. In the past, solar thermal was an economic option for supplying hot water in some homes and small community buildings. However, as the prices of solar PV panels have continued to decrease and the technology reliability continues to improve, the emerging consensus is that solar PV is more cost efficient by powering an electric heater or a heat pump than installing a separate solar thermal system.

Because Tanacross is on a small, isolated grid, the addition of renewable energy to this grid is challenging. AP&T has stringent policies about customers adding renewable energy generation. These policies, called net metering policies, limit the amount of solar PV that can be installed in Tanacross. AP&T allows on-site generation systems that are 25kW or less to be installed on their grid. This is available on a first-come, first-served basis until the total generating capacity of all retail net metered systems equals 1.5 percent of the Company's average retail system demand. AP&T also limits net metering installations in portions of its distribution system that are necessary to address system stability constraints or other operational issues.

The Tok grid (Tok, Tanacross, Tetlin, and Dot Lake) is already at capacity for net metering customers, so any PV installations would have to be “behind-the-meter”. In other words, any PV installation would not be able to sell power back to the AP&T grid, but only reduce the amount of power that the customer purchases from AP&T.

If renewable energy capacity were to become available on the AP&T grid and a customer wanted to install renewable generation, they would need to fill out the Alternate Generation Interconnection Application. AP&T would inspect the installation to ensure there won’t be any issues between the customer’s system and AP&T’s grid such as back feeding during a power outage. An interconnection application and AP&T’s net metering policies are included in the Appendix.

Solar/Battery “Behind the Meter” Project

Tanana Chiefs Conference in partnership with TVC has received $294,000 in funding from Wells Fargo Foundation and the Tribal Solar Accelerator Fund through Grid Alternative (GRID) to install 74 kW of “behind-the-meter” solar PV on a combination of 2 public buildings – the Tribal Clinic/Community Hall/Multi-Use Facility (MUF) and the Water Treatment Plant (WTP). The MUF building will have approximately 26kW worth of solar PV along with a 30.4 kWh battery storage system. The WTP will have about 21kW worth of solar PV and 38kWh of storage on a pre-wired climate controlled connex unit from Box Power. The goals of this project are to reduce costs, increase energy security, and provide job training on solar PV and related clean energy technologies to the community of Tanacross and surrounding Alaska Native villages.

The addition of this solar/battery project will directly offset the electricity costs for two tribally owned community buildings and provide back-up power to the MUF so it can serve as an emergency shelter and secure community gathering point. Currently, TVC buys power from AP&T at an annual cost of roughly $15,000 for the two buildings. The addition of the solar arrays and battery bank would generate about 50% of the current energy demand, freeing up to $7,500 annually for TVC to dedicate to other tribal programs.

MUF houses a mid-level primary care facility and the roof mount array and lithium-ion battery installation will allow the MUF to serve as a standalone facility in case of a natural disaster or if the 12-mile powerline between Tanacross and Tok is damaged.

This project will bring staff from GRID Alternatives to Tanacross to provide community-wide education on the new solar infrastructure. GRID anticipates hiring community members for the construction of the roof and ground mounts and the PV panel installation, providing job training in solar energy development, especially essential as communities across Alaska look for opportunities to add green technologies to their energy infrastructure and reduce energy costs. Safety will be a focus of the training. TCC will assist TVC with performance monitoring of the system and provide technical assistance as needed and manage the grant.

Energy Efficiency - Implementation of Audit Recommendations – Water Treatment Plant

The cost savings opportunities from the water treatment plant are summarized earlier in this report. It is recommended that Tanacross continue to work with ANTHC to identify funding for the implementation of the top 9 recommendations that will require about $30,000 for the implementation and will result in about $7,000/year in savings.

Residential Energy Audits

The State of Alaska's funding for the Weatherization program is minimal, but Alaska Community Development Corporation has Federal Funding for Weatherization for low income homeowners. Applications are available for ACDC, and 6-7 homeowners will need to apply to the program before Tanacross can be considered for additional weatherization work. Applications can be found at http://www.alaskacdc.org

Community-wide Oil Boiler Maintenance

Oil boilers are the backbone of heating systems in remote Alaska. Usually when renewable heating systems are installed, the oil boilers are left in place to serve as a back-up heating source. Because it is unlikely that oil boilers will be replaced in the near future, periodic cleaning and inspection of these boilers should be scheduled on an annual basis. While individual boilers have specific maintenance requirements, there are general recommendations for regular cleaning and inspection activities:

1. Replace all wear parts affected by use, including gaskets to re-seal the combustion inspection covers that were removed to clean the fireside.

2. Inspect the fireside of the heat exchanger and clean any fouling.

3. Remove the burner and thoroughly wash and clean the mesh. This should be done even if the burner appears to be clean. After washing the burner, reinstall it and use the fan test option to blow dry the burner. DO NOT fire the burner while wet.

4. Replace old igniter, flame rod and gaskets

5. Select the right water treatment to prevent scale. Water side scale is equivalent to having a thin film of insulation between the furnace gases and boiler water. It can drop a boiler's efficiency by as much as 12% - 21%.

6. Re-start the equipment and adjust combustion using a calibrated analyzer. A water tube manometer will be necessary to check for proper draft readings.

7. Inspect electrical connections for corrosion and proper connection.

8. Clean the condensate trap

NOTE: Refer to the manufacturer specific manual for the recommended inspections and maintenance of individual oil boilers before performing annual inspection.

Michael Hirt, Program Head of the Construction Trades Technology at the University of Alaska Fairbanks offers a weeklong oil boiler maintenance workshop. He periodically offers the course in Tok but is willing to host a specific class for Tanacross if 10 people are in attendance. This class includes hands on training with community boilers, and attendees will be qualified to conduct annual boiler inspection and cleaning services.

Biomass System Improvements and Expansion Opportunities

The wood supply for the first couple of years of operation for the Cordwood Heating System was harvested during the construction phase of the project. Standing dead trees near Tanacross from a recent wildfire provided much of this supply. In recent years, the wood supply has been a challenge due to low heating fuel prices and wood supplies being farther from the community. At the current price of heating fuel just over $2.00/gallon, the equivalent cost of a cord of wood is about $275/cord. If the community is paying more than $275/cord, it would be less expensive to burn fuel oil.

It is recommended that TVC create procedures and a separate account for the purchase of wood from local suppliers for the cordwood heating system. Wood should be purchased at least one year in advance of usage so that it has time to properly dry. These procedures should include a process to track the current cordwood inventory to identify when the purchase of additional wood is needed.

The Alaska Wood Energy Development Task Group developed a calculator to help communities set a price for cordwood purchases that are fair to both the buyer and the seller, based on the cost of harvest and the cost of heating fuel. ***We recommend using this calculator to set a realistic price for cordwood purchases and also when to make the decision to utilize heating oil as the fuel source.***

> Please contact Taylor Asher at tasher@akenergyauthority.org for more information of price setting for cordwood purchases.

Most cordwood heating systems operate with 2 operators that share the part-time workload of the daily stoking of the boilers. Some communities have the pair of operators work one-week-on and one-week-

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off. Other communities use a 2-week-on and 2-week-off schedule. The third option is to hire an employee to stoke the boiler on weekends and holidays. It is strongly recommended that TVC hire a back-up operator to provide additional support for the current operator.

In April of 2019, several issues with the piping in the MUF were identified and Jonathan Fitzpatrick, Dave Frederick, Dave Messier, and Devany Plentovich identified piping changes that would resolve the issues. Jim Chowaniec was contacted to correct the piping, but there is no confirmation that this work was completed. It is recommended to complete this work, if not already performed, to optimize the heating system in the MUF.

Alaska Energy Authority is offering a program in which all of the cordwood systems in the state can be audited by an experienced mechanic and additional training can be provided to the operator during the audit. The mechanic contracted to complete this work is Jonathan Fitzpatrick, who has worked on the Tanacross system in the past. ***It is strongly recommended that Tanacross schedule this audit/training, and Jonathan can confirm that the piping corrections were made.***

> Please contact Taylor Asher at tasher@akenergyauthority.org for more information on the biomass technical assistance and training program.

Opportunities for Increased Wood Heating of Community Facilities

There are two obvious opportunities for increased wood heating in Tanacross. The first is heating the Tanacross School with cordwood or chips. The Alaska Gateway School District is the most experienced owner/operator of wood chip heating systems, with operational systems at the Tok and Mentasta Schools. They are also pursuing an additional system in Northway. A prefeasibility study was performed in 2006 and indicated that a biomass system could displace up to 6,000 gallons of fuel oil.

The second opportunity for increasing wood heating in Tanacross would be to expand the existing heating system that heats the MUF and the Water Treatment Plant could be expanded to heat the Tribal Hall, Firehouse, and/or Garage. There is room in the existing biomass building for adding additional cordwood boilers.

The Alaska Wood Energy Development Task Group offers free prefeasibility studies to investigate the viability of wood heating systems. Tanacross could submit an application to investigate the expansion of the existing cordwood heating system and encourage the Alaska Gateway School District to submit an application for an update of their 2006 prefeasibility study. The application process is very simple and should require less than 2 hours to complete. The application Statement of Interest can be found at the following link:

http://www.alaskawoodenergy.com/sites/alaskawoodenergy.com/files/Statement%20of%20interest%202017.pdf

Community Building Lighting Upgrades

To date there has not been extensive work with lighting upgrades in Tanacross. TCC has recently received funding for replacement of community streetlights with LED fixtures through the State of Alaska Village Energy Efficiency Program. This project is anticipated to replace 24 streetlights with an investment of $19874 from the VEEP program with a community match of $3975.

Yerrick Creek Hydroelectric

122 1st Avenue
Fairbanks, AK 99701
907-452-8251
www.tananachiefs.org

Audrey Alstom, the Alaska Energy Authority (AEA) Project Manager and Jason Custer from AP&T discussed the potential for continuing the development of the Yerrick Creek Hydro Project. Audrey reported that significant technical issues were identified during the Yerrick Creek geotechnical assessment. Suitable bedrock was not found at the proposed impoundment site, so construction of a diversion structure with proper sealing would be extremely expensive. She also stated that winter hydrology data was not conclusive that the hydro project would be able to operate throughout the wintertime when demands are highest. Jason stated that the hydro delivery profile did not match with the regional load demand profile, so the output of the hydro could not be fully utilized. He recommended only revisiting the viability of Yerrick Creek if fuel prices reached the levels of the 2007-2009 timeframe and the Roadbelt Intertie from Fairbanks to Tok was constructed so that the output of the hydro project could be fully utilized. The first step to revisit the project should be an updated capital budget and economic analysis to understand the economic viability – the biggest challenge of the project. Jason stated that recent work on a similar hydro project on Prince of Wales Island has identified some cost savings ideas that could be incorporated into the Yerrick Creek Hydro Project.

Support the Development of the Roadbelt Intertie

The Roadbelt Intertie Project is an electrical transmission project that will complete a loop along the Alaska Road System. This project proposes that new 230 kV transmission lines would be built from Sutton to Glennallen to Tok to Delta Junction, interconnecting islanded road system power utilities and creating a parallel path between the two most populated Roadbelt areas. The Denali Commission recently released a high level technical feasibility study to develop a preliminary project cost estimate. The reconnaissance-level engineering evaluation concluded that the project is technically feasible. The project would increase Department of Defense facility resilience and electric power reliability throughout the Alaska road system. It is not known if this project would reduce cost of power in the currently islanded communities.

Recommended next steps for further evaluation of the Roadbelt Intertie Project include:

• Conduct system-wide economic evaluation of potential power cost impacts for all interconnected communities and DoD facilities.
• Perform quantitative cost/benefit evaluation of economic feasibility.
• Study and select optimal utility interconnection configuration (topology).
• Develop a range of transmission line route options satisfying the optimal topology.
• Design and perform environmental studies and engineering investigations, with public input in accordance with the National Environmental Policy Act (NEPA).
• Select transmission line route.
• Perform detailed design.

It is recommended that Tanacross look for opportunities to advocate for continued analysis of this project and participate in information sessions and community meetings to become informed about the potential benefits and risks if this project moves forward to construction.

Tanana Chiefs Conference

122 1st Avenue
Fairbanks, AK 99701
907-452-8251
www.tananachiefs.org

Appendices

- Water Treatment Plant Energy Audit
- Tanacross School Energy Audit Final Report
- Yerrick Creek Hydro - Feasibility
- Biomass Prefeasibility Study
- 7-Mile Ridge Wind Resource Assessment
- Alaska Energy Authority, Affordable Energy Strategy – Tanacross Dashboard
- 2019 PCE Data
- AP&T Alternate Generation Interconnection Application
- AP&T Power Tariff – Alternate Generation Technology

Alaska Power Company (APC)
Alternate Generation Interconnection Application

This Application is complete when it provides all applicable and correct information required below and includes all items indicated on the checklist at the end of this form.

Applicant:

Name: ____

Mailing Address: ____

City, State, Zip: ____

Telephone (Day): ________________________(Evening):________________________________

Fax:__________________________ E-Mail Address: ____________________________________

Customer Account Number: ____

Inverter Manufacturer:________________________Model:_________________________________

Nameplate Rating: (kW) (kVA) (AC Volts)____

Single Phase __________ Three Phase __________ (check one)

Prime Mover: Photovoltaic / Turbine / Fuel Cell / Other _______

Energy Source: Solar / Wind / Hydro / Other

(describe)____

Wind: rated peak output: _______kw at _______ mph wind speed; anticipated average: _____mph

Is the equipment UL1741 Listed? Yes_______ No_______

If Yes, attach evidence of UL1741 listing.

List components of the Interconnection Equipment Package that are certified:

	Equipment Type	Certifying Entity
1.	___________________________________	_____________________________________
2.	___________________________________	_____________________________________
3.	___________________________________	_____________________________________

If required by APC, attach a one-line diagram of the Generating Facility. Operation is contingent on Utility approval to interconnect the Generating Facility.

Applicant Signature

I hereby certify that, to the best of my knowledge, the information provided in this application is true. I agree to abide by the terms and conditions for a Level 1 Interconnection Agreement, provided on the following pages.

Signed: ____

Title: ____ Date: ___________________

Alaska Power Company Signature

Interconnection of the Generating Facility is approved contingent upon the terms and conditions for a Level 1 Interconnection Agreement, provided on the following pages ("Agreement").

Utility Signature: ____

Title: ____ Date: ____________________

Application ID number: _________________________________

Utility waives inspection/witness test? Yes _______ No _____________

Terms and Conditions

1.0 Construction of the Generating Facility

After APC executes the Interconnection Agreement by signing the Applicant's Alternate Generation Interconnection Application, the Applicant may construct the Generating Facility, including interconnected operational testing not to exceed two hours.

2.0 Interconnection and Operation

The Applicant may operate the Generating Facility and interconnect with APC's Electric Delivery System once all of the following have occurred:

2.1 The Generating Facility has been inspected and approved by the appropriate local electrical wiring inspector with jurisdiction, and the Applicant has sent documentation of the approval to the Utility, and

2.2 The Utility has either:

2.2.1 Inspected the Generating Facility and has not found that the Generating Facility fails to comply with a Level 1 technical screen or a UL and IEEE standard; or

2.2.2 Waived its right to inspect the Generating Facility by not scheduling an inspection in the allotted time; or

2.2.3 Explicitly waived the right to inspect the Generating Facility.

3.0 Safe Operations and Maintenance

The Interconnection Customer shall be fully responsible to operate, maintain, and repair the Generating Facility as required to ensure that it complies at all times with IEEE Standard 1547.

4.0 Access

APC shall have access to the metering equipment of the Generating Facility at all times. APC shall provide reasonable notice to the Interconnection Customer when possible prior to using its right of access.

5.0 Disconnection

APC may temporarily disconnect the Generating Facility upon the following conditions:

5.1 For scheduled outages upon reasonable notice.

5.2 For unscheduled outages or emergency conditions.

5.3 If the Generating Facility does not operate in the manner consistent with these terms and conditions of the Agreement.

5.4 The Utility shall inform the Interconnection Customer in advance of any scheduled disconnection, or as is reasonable after an unscheduled disconnection.

6.0 Indemnification

Each Party shall at all times indemnify, defend, and save the other Party harmless from, any and all damages, losses, claims, including claims and actions relating to injury to or death of any person or damage to property, demand, suits, recoveries, costs and expenses, court costs, attorney fees, and all other obligations by or to third parties, arising out of or resulting from the indemnified Party's action or inactions of its obligations under this Agreement on behalf of the indemnifying Party, except in cases of gross negligence or intentional wrongdoing by the indemnified Party.

7. 0 Insurance

The Interconnection Customer is required to maintain standard general liability insurance coverage as part of this Agreement and is required to provide proof of insurance. Standard homeowners insurance coverage is defined as coverage sufficient to replace your home and its contents.

8.0 Limitation of Liability

Each Party's liability to the other Party for any loss, cost, claim, injury, liability, or expense, including reasonable attorney's fees, relating to or arising from any act or omission in its performance of this Agreement, shall be limited to the amount of direct damage actually incurred. In no event shall either Party be liable to the other Party for any indirect, incidental, special, consequential, or punitive damages of any kind whatsoever, except as allowed under paragraph 6.0.

9.0 Termination

9.1 This Agreement may be terminated under the following conditions:

9.1.1 By the Interconnection Customer: By providing written notice to APC.

9.1.2 By APC: If the Generating Facility fails to operate for any consecutive 12-month period or the Interconnection Customer fails to remedy a violation of these terms and conditions of the Agreement.

9.2 Permanent Disconnection: In the event the Agreement is terminated, APC shall have the right to disconnect its facilities or direct the Interconnection Customer to disconnect its Generating Facility.

9.3 Survival Rights: This Agreement shall continue in effect after termination to the extent necessary to allow or require either Party to fulfill rights or obligations that arose under the Agreement.

1st Revision	Sheet No.	126	
Cancelling:			
Original	Sheet No.	126	

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REGULATORY COMMISSION OF ALASKA

Alaska Power Company

SECTION 13 - NET METERING SERVICE
(Applicable to Eligible On-Site Generation Systems 25 kW or Less)

Available on a first-come, first served basis to retail customers that operate and own or lease eligible on-site generation system(s) that are interconnected and operate in parallel with the Company's distribution facilities. Generation systems shall contain a nameplate capacity of 25 kW or less per customer premises and be used primarily to offset part or all of the consumer's electric energy requirements.

Service under this schedule is available until the cumulative nameplate generating capacity of all retail net metered systems equals 1.5 percent of the Company's average retail system demand. The Company may limit net metering installations in portions of its distribution system that are reasonably necessary to address system stability constraints or other operational issues.

Monthly Rates

Electric bills for net metered consumers shall be computed in accordance with the applicable retail service rates contained in this operating tariff, with electric energy (kWh) calculated as follows:

1) If the Company furnished more electric energy to the consumer than the consumer supplied to the Company during the monthly billing period, the Company shall bill the consumer for the number of kWh of net electric energy supplied by the Company to the consumer at the applicable retail rates contained in the operating tariff; or

2) If the consumer supplied more electric energy to the Company than the Company supplied to the consumer during the monthly billing period, the Company shall credit the consumer's account with an amount derived by multiplying the kWh of net electric energy supplied by the consumer to the Company by the Net Metering power rate contained on Tariff Sheet No.'s 118.1, 119.1 and 120.1 as appropriate. T

Dollar amounts credited to the account of a net metered consumer shall be used to reduce amounts owed by the consumer in subsequent monthly billing periods. Dollar amounts credited do not expire or otherwise revert to the Company. Unused credits will be paid to the consumer in the event electric service is terminated.

Tariff Advice Number 856-2 Effective: July 25, 2016

Issued by: Alaska Power Company
By: Mary Jo Quandt
Mary Jo Quandt Title: Senior Director Regulatory Affairs/Customer Srv

Original	Sheet No. 127	RECEIVED
Cancelling:	Sheet No.	APR 30 2012
		STATE OF ALASKA REGULATORY COMMISSION OF ALASKA

Alaska Power Company

SECTION 13 - NET METERING SERVICE

(Applicable to Eligible On-Site Generation Systems 25 kW or Less)

N

Conditions

1) Non-Utility Generator may not commence Parallel Operation of generation facilities without final written approval from the Company.

2) Installation and operation of Non-Utility Generators must be in conformance with the Company requirements and all applicable federal, state and local safety codes and regulations. At a minimum, interconnections must be consistent with the most current interconnection standards approved by the Commission and IEEE 1547 standards.

3) All customer on-site generation systems interconnected and operating in parallel with the Company's electric system shall be in compliance with the interconnection and operating guidelines contained on Tariff Sheet No. 36, 52 and the Company's Interconnection Requirements for NET Metering Power Producers in the Appendix of the Company's tariff.

4) Any customer applying for net metering service shall submit a completed application Net Metering Facility Not Greater than 25 kW contained in the Appendix the Company's operating tariff.

5) To be eligible for interconnection under a net metering program, a consumer generation system must:

a. Include an electric generator and its accompanying equipment package;

b. Be physically interconnected to the consumer's side of the meter from which the Company provides electric service to the consumer;

N

Tariff Advice Number 822-2 Effective: JUNE 14, 2012

Issued by: Alaska Power Company

By: Michael Garrett

Michael Garrett Title: Executive Vice President

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REGULATORY COMMISSION OF ALASKA

SECTION 13 - NET METERING SERVICE

(Applicable to Eligible On-Site Generation Systems 25 kW or Less)

N

Conditions (Continued)

c. Generate electric energy from one or more of the following sources:
Solar photovoltaic and solar thermal energy;
Wind energy;
Biomass energy, including landfill gas or biogas produced from organic matter, wastewater, anaerobic digesters, or municipal solid waste;
Hydroelectric, geothermal, hydrokinetic energy or ocean thermal energy; and,
Other sources as may be approved by the Regulatory Commission of Alaska that generally have similar environmental impacts.

d. Be operated and either owned or leased by the consumer, and
(A) Have a total nameplate capacity of no more than 25 kilowatts per consumer premises;
(B) Be located on the consumer premises;
(C) Be used primarily to offset part or all of the consumer's requirements for electric energy; and
(D) Include an inverter adequate to ensure the generated power is compatible with the the Company system.

6) The Company reserves the right to refuse net metering service to a customer if interconnection causes the total nameplate capacity of all eligible consumer generation systems participating in net metering to exceed 1.5 percent of the Company's average retail demand.

7) The Company will not terminate net metering service to any customer in the event the Company's average retail demand decreases such that the nameplate capacity of existing net metered customers exceeds 1.5 percent of the Company's average retail demand. N

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Alaska Power Company

SECTION 13 - NET METERING SERVICE
(Applicable to Eligible On-Site Generation Systems 25 kW or Less)

Conditions (Continued)

8) The Company may request by tariff advice letter to adjust the limit on total nameplate capacity of eligible consumer generation systems participating in the net metering program above 1.5 percent of the electric utility's average retail demand.

9) The Company reserves the right to limit net metering installations in portions of its distribution system that are reasonably necessary to address system stability constraints or other operational issues. The Company shall notify the Commission no later than 30 days after refusal to interconnect with a consumer requesting net metering service.

10) The Company may require the installation of additional metering equipment for net metering consumers, including the metering of individual generating facilities. For these installations, the Company is responsible for all costs related to the purchase, installation, and maintenance of the additional metering equipment and the customer shall not be assessed any recurring charges for the additional metering equipment. Additional equipment required because of changes in standards or regulation are the responsibility of the customer.

11) Pursuant to 3 AAC 50.910 (d), below is a summary of the Company's average retail demand, maximum allowed nameplate capacity of eligible net metered generation facilities on the system, and total nameplate capacity of net metered customers:

Rate Group	2019 Retail Sales (kWh)	Average Retail Demand (kW)	1.5% of ARD (kW)	# of Systems	Nameplate Capacity (kW)	C
RG 1	26,372,361	3,011	45.2	2	14.5	C
RG 2	26,580,329	3,034	45.5	0	0	C
RG 4	8,289,918	946	23.4*	4	23.4	C

* RG 4 - 1.5% of ARD is 14.2 kW. The waiver requested in TA830-2 allows for the higher limit of 23.4kW. C

Each of these rates groups is an independent eletrical system. These 3 rate groups meet the 5,000,000 limit.

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breakers, and relays to adequately protect the customer's equipment.

The Company shall not be held liable for any loss or damage to persons or property resulting from any contacts with, or defects in, the customer's installation or equipment, or the delivery of elecric energy thereto.

6.13 Interconnection of Customer Owned Alternate Technology and Fossil Fuel Standby Generation Equipment (Under 100 kw Installed Capacity)

Alternate Technology Generation

(1) The Company will permit the interconnection and operation of alternate technology generation facilities that are determined to be a "qualifying facility" (QF) as prescribed by Section 201 of the Public Utility Regulatory Policies Act upon compliance by the customer with the following provisions:

(a) The customer shall make written application to the Company at least 45 days prior to the date on which any connection will occur in any way to electric *circuitry common to the Company's integrated distribution system.*

(b) The customer shall submit to the Company along with the request for interconnection complete documentation of the alternate technology generation equipment including, but not limited to, schematics, wiring diagrams, performance specifications, descriptions of energy storage devices, circuit protection equipment, regulation equipment, automatic disconnect equipment and any other proprietary device provided by the equipment manufacturer.

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Public Utilities Commission

(c) Upon approval of the interconnection by the Company, the customer shall agree to pay the cost of any special metering equipment or circuit modifications determined by the Company as necessary to accomplish the interconnection.

(d) See Section 4 of this tariff for safety standards regarding the interconnection of qualifying facilities to the Company's system.

Fossil Fuel Standby Generation

The Company will not permit the interconnection and operation by customers of fossil fuel standby generation facilities, such as diesel or gasoline engine driven generators, with its integrated distribution system under any circumstances. Fossil fuel standby generators shall be connected to the customer's load only through a double throw switch that will prevent parallel operation with the Company's distribution system.

6.14 Customer Power Outage

If a power outage occurs, the customer should attempt to determine if fuses have been blown, breakers tripped, or equipment is at fault before calling the Company. If the customer determines the fault to be the Company's equipment, the Company will send a serviceman out to investigate the reported outage. If the cause of the outage is determined to be the failure of the Company's equipment, the Company will correct the problem and restore service as soon as possible. However, if it is determined that the customer's equipment is at fault, a charge may be made for the serviceman's visit to the customer's service location (See Schedule of Fees and Charges).

Community Facility Listing
Tok/Tanacross

No	Name
1	TANACROSS VILLAGE COUNCIL - HYDRANT #12-BY DALE PAUL
2	TANACROSS VILLAGE COUNCIL - HYDRANT #3-BY LOGAN LUKE
3	TANACROSS VILLAGE COUNCIL - W/S PROJECT HEAT TRACE
4	TANACROSS VILLAGE COUNCIL - TANACROSS COMMUNITY HALL-1ST AVE.
5	TANACROSS VILLAGE COUNCIL - HYDRANT #10-BY LORI SAM
6	TANACROSS VILLAGE COUNCIL - NEW SVC BESIDE OFFICE
7	TANACROSS VILLAGE COUNCIL - MULTI USE FACILITY- 3 PHASE/CLINIC
8	TANACROSS VILLAGE COUNCIL - TANACROSS CLINIC BLDING
9	TANACROSS VILLAGE COUNCIL - TANACROSS BIOMASS BOILER T1431
10	TANACROSS VILLAGE COUNCIL - HYDRANT #11-BY LENORA PAUL
11	TANACROSS VILLAGE COUNCIL - HYDRANT #9-BY KEITH JONATHAN
12	TANACROSS VILLAGE COUNCIL - HYDRANT #8-BY RAY THOMAS
13	TANACROSS VILLAGE COUNCIL - HYDRANT #7-BY LORITA PAUL
14	TANACROSS VILLAGE COUNCIL - HYDRANT #5-BY FRANKLIN PAUL SR
15	TANACROSS VILLAGE COUNCIL - SAFEHOUSE LLA
16	TANACROSS VILLAGE COUNCIL - LAUNDRY HS.
17	TANACROSS VILLAGE COUNCIL - HYDRANT #4-BY ALICE BREAN
18	TANACROSS VILLAGE COUNCIL - HYRDANT #2-BY K THOMAS SR
19	TANACROSS VILLAGE COUNCIL - TANACROSS FIREHALL SERVICE
20	TANACROSS VILLAGE COUNCIL - HYDRANT #6-BY LEE HENRY
21	TANACROSS VILLAGE COUNCIL - HYDRANT #1-BY WILLIE THOMAS
22	TANACROSS VILLAGE COUNCIL - LIFT STATION
23	TOK CHAMBER OF COMMERCE - CIVIC CENTER-LOG BLDG
24	TOK COMMUNITY LIBRARY - LOG BLDG ON CRN CENTER ST & HW
25	TOK MEMORIAL PARK - TOWN PARK ACROSS FROM POST OFFICE
26	TOK VOLUNTEER FIRE DEPT. - TRUCK GARAGE #1
27	TOK VOLUNTEER FIRE DEPT. - TRUCK GARAGE #2
28	TANACROSS VILLAGE COUNCIL - HYDRANT #9-BY KEITH JONATHAN
29	TANACROSS VILLAGE COUNCIL - SEC LIGHTS FOR HOCKEYRINK-TANACROSS
30	TANACROSS VILLAGE COUNCIL - CONNEX BY FIREHALL-CODE RED
31	TANACROSS VILLAGE COUNCIL - VPSO NEXT TO POST OFFICE
32	TANACROSS VILLAGE COUNCIL - MENTAL HEALTH CLINIC
33	TANANA CHIEFS CONFERENCE INC. - JACKIE CIRCLE DUPLEX
34	TANANA CHIEFS CONFERENCE UTHC - MAIN CLINIC TOK CUTOFF

Community Facility Listing
Tok/Tanacross

No	Name
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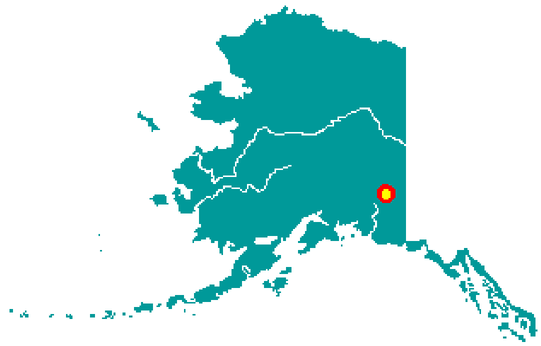
Tok; Tanacross PCE

Utility: ALASKA POWER COMPANY

Reporting Period: 07/01/18..06/30/19

Community Population	1331
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	765
Community Facility Customers	30
Other Customers (Non-PCE)	189
Fiscal Year PCE Payments	**$742,378**



PCE Statistical Data			
PCE Eligible kWh - Residential Customers	2,729,729	Average Annual PCE Payment per Eligible Customer	$934
PCE Eligible kWh - Community Facility Customers	229,466	Average PCE Payment per Eligible kWh	$0.25
Total PCE Eligible kWh	*2,959,195*	Last Reported Residential Rate Charged (based on 500 kWh)	$0.39
Average Monthly PCE Eligible kWh per Residential Customer	297	Last Reported PCE Level (per kWh)	$0.20
Average Monthly PCE Eligible kWh per Community Facility Customer	637	Effective Residential Rate (per kWh)	$0.19
Average Monthly PCE Eligible Community Facility kWh per Person	14	PCE Eligible kWh vs Total kWh Sold	39.4%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	9,269,400	Fuel Used (Gallons)	634,286
Non-Diesel kWh Generated	0	Fuel Cost	$1,659,409
Purchased kWh	0	Average Price of Fuel	$2.62
Total Purchased & Generated	*9,269,400*	Fuel Cost per kWh sold	$0.22
		Annual Non-Fuel Expenses	$1,724,961
		Non-Fuel Expense per kWh Sold	$0.23
		Total Expense per kWh Sold	$0.45

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	3,662,520	Consumed vs Generated (kWh Sold vs Generated-Purchased)	80.9%
Community Facility kWh Sold	229,816	Line Loss (%)	16.9%
Other kWh Sold (Non-PCE)	3,611,012	Fuel Efficiency (kWh per Gallon of Diesel)	14.61
Total kWh Sold	*7,503,348*	PH Consumption as % of Generation	2.2%
Powerhouse (PH) Consumption kWh	200,920		
Total kWh Sold & PH Consumption	*7,704,268*		

Comments

**The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.*

Tanacross CEAP Appendices

- Water Treatment Plant Energy Audit
- Tanacross School Energy Audit Final Report
- Yerrick Creek Hydro - Feasibility
- Biomass Prefeasibility Study
- 7-Mile Ridge Wind Resource Assessment
- Alaska Energy Authority, Affordable Energy Strategy – Tanacross Dashboard
- 2019 PCE Data and Eligible Community Facilities Listing
- AP&T Alternate Generation Interconnection Application
- AP&T Power Tariff – Alternate Generation Technology

Dashboards Summary

Community
Tanacross

Year
2016

Avg. Residential Rate	Avg. Effective rate for PCE-eligible kWh	Total sales	Avg. Average kW	Diesel generation efficiency (kWh/gal)	Line loss
$0.34	$0.24	7,540,461	1,069	14.4	18%

Percent diesel generation	Percent hydro generation	Percent wind generation	Percent solar generation	Percent purchased power
100%	0%	0%	0%	0%

Utility Name
Alaska Power & Telephone Company

Installed wind capacity (kW)	Installed hydro capacity (kW)	Installed solar capacity (kW)

Intertie Name	PCE community name
Tok	Dot Lake, Dot Lake Village
	Tetlin
	Tok, Tanacross

Year	Total Population
2012	131
2013	137
2014	110
2015	108
2016	110
2017	108

Prepaid meters installed	Year of Date Insta
No	Null

Defined as "Distressed" by Denali Comission
Yes

Each dashboard is organized around a specific topic with a number of charts and/or tables that are useful in identifying potential improvements. A short description is provided for each dashboard that describes the charts/tables and ways in which the data can be used for energy planning. All the charts and tables included in the dashboards are based on reported data.

Additional:
1. Hovering over a chart will provide a pop-up window with further info
2. The workbook and alll associated data is available for download. Further data analysis can be done using Tableau's free public software (https://public.tableau.com/en-us/s/)
3. Some charts allow you to zoom in and/or filter for individual fields, such as years.

If you are interested in projections for much of the data included in these dashboards (including population, fuel prices, generation, etc.) and/or economic analysis of potential infrastructure projects, please see the Alaska Affordable Energy Model (http://www.akenergyinventory.org/energymodel).

Data available through the dashboards:
1. General community info
2. Electricity generation
3. Energy consumption characteristics
4. Utility financial data and analysis
5. Energy prices
6. Previous work and investigations in community
7. Technical assistance and training from state and federal agencies
8. Bulk Fuel info

If you need assistance with interpreting any of the charts, desire more or different analysis performed, or want to develop implementation plans, please contact the Alaska Energy Authority (907-771-3000).

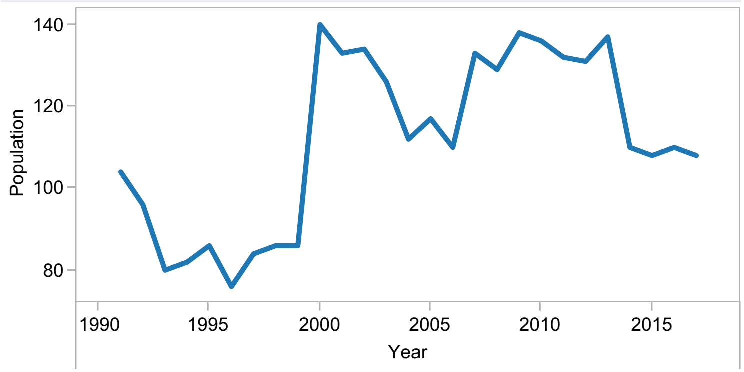
ALASKA ENERGY AUTHORITY

[Funding for the development of the dashboards was provided by the Denali Commission]

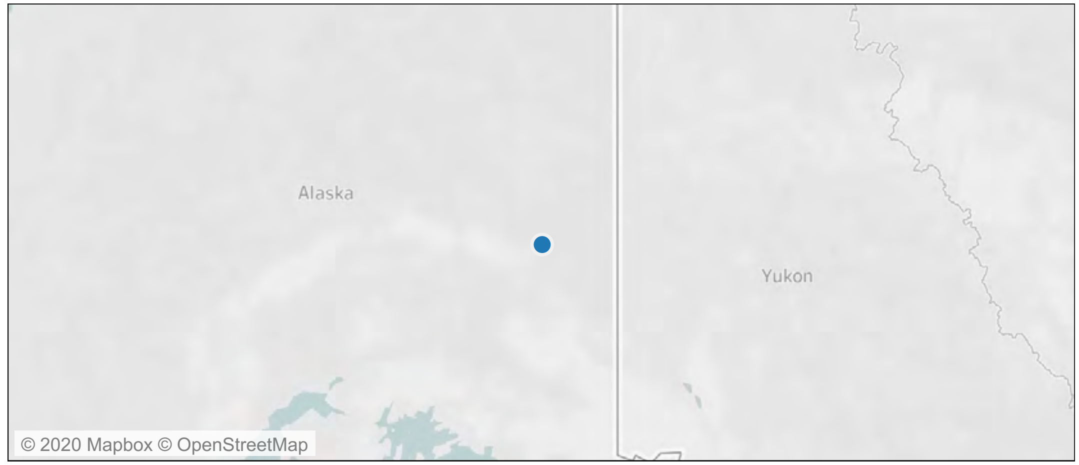
General community information

Community
Tanacross

Population of Tanacross for Years 1991 to 2017



Source: Department of Labor & Workforce Development
Accessed from: Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)



Erosion/climate risks

ANCSA & Tribal

Name of Federally Recognized Tribe	ANCSA Village/Urban Corporation	Alaska Native Regional Corporation	ANCSA Regional Non-Profit	Native Regional Health Care Provider
Native Village of Tanacross	Tanacross Incorporated	Doyon, Limited	Tanana Chiefs Conference	Tanana Chiefs Conference, Department of Health Services

Community Energy Goals

Source	Year	Priority
Regional Plan	2015	add solar PV to community buildings & homes
		biomass system almost operating for multiuse building
		Energy efficiency audits and upgrades of homes and commercial buildings
		Yerrick Creek hydro

Election district

House District	Senate	District Description
6	C	Eielson/Denali/ Upper Yukon/Border

Heating degree-days

Heating degree-days
14,811

Defined as "Distressed" by Denali Comission
Yes

Median income

Median Household Income	Margin of Error	Min Estimated Income	Max Estimated Income
$19,125	$2,618	$16,507	$21,743

Source: 2016 American Community Survey

Utility generation and fuel consumption overview

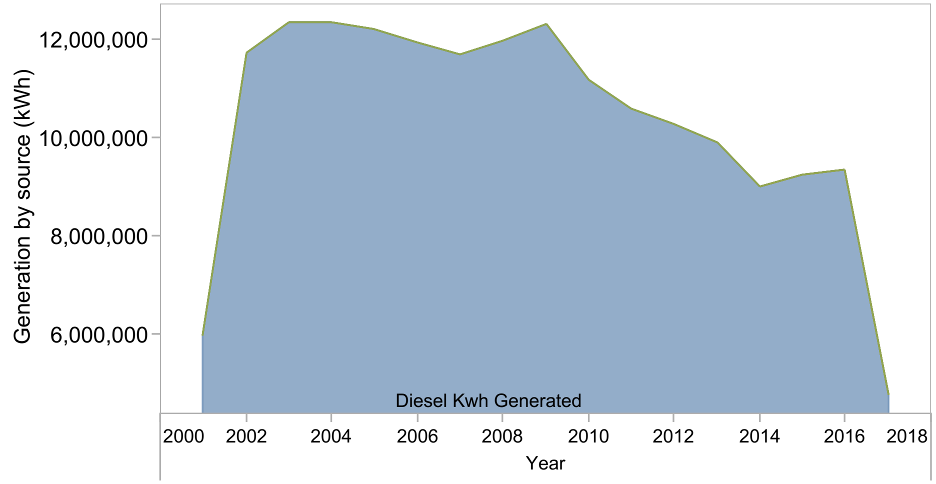
Community
Tanacross

Generation by energy source [top right]
1. How much electricity was produced historically
2. The chart can be used to look at trends for amount of generation needed in the future
3. The chart can be used to analyze trends for amount of generation by source. For example, has hydropower been consistent?

Generation by source by month [bottom left]
The monthly difference can be used to identify opportunities for flattening the load over the year and/or understanding how a new energy source might integrate with the current sources.

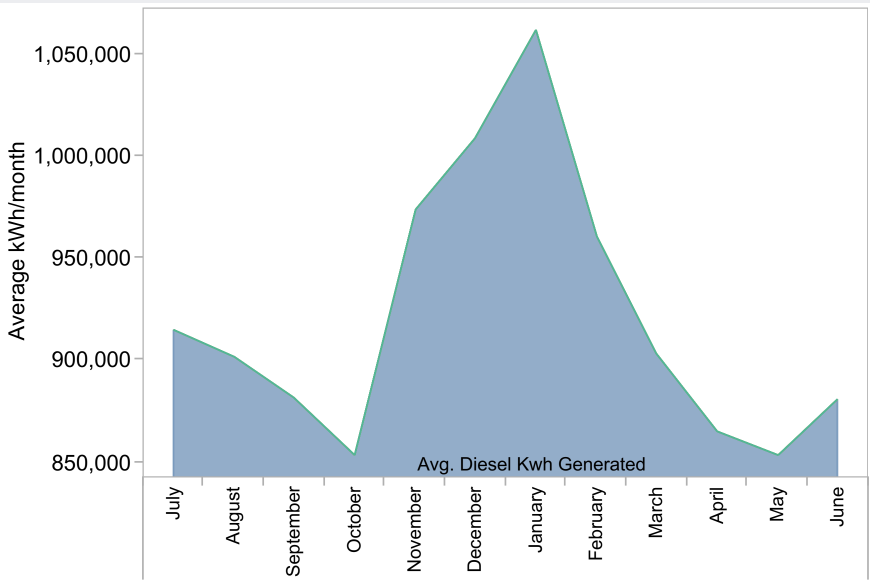
Utility Diesel Consumption [bottom right]
The trend for consumption can be used to estimate the next year's fuel need or track if efficiency or renewable energy measures have been effective in reducing consumption.

Generation by energy source



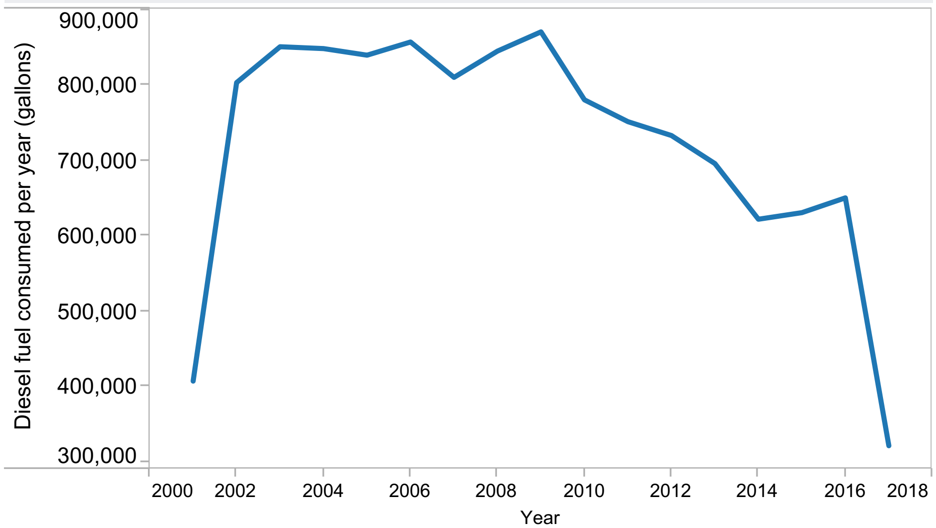
Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Generation by source by month



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Utility diesel consumption



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Utility generation loads

Community
Tanacross

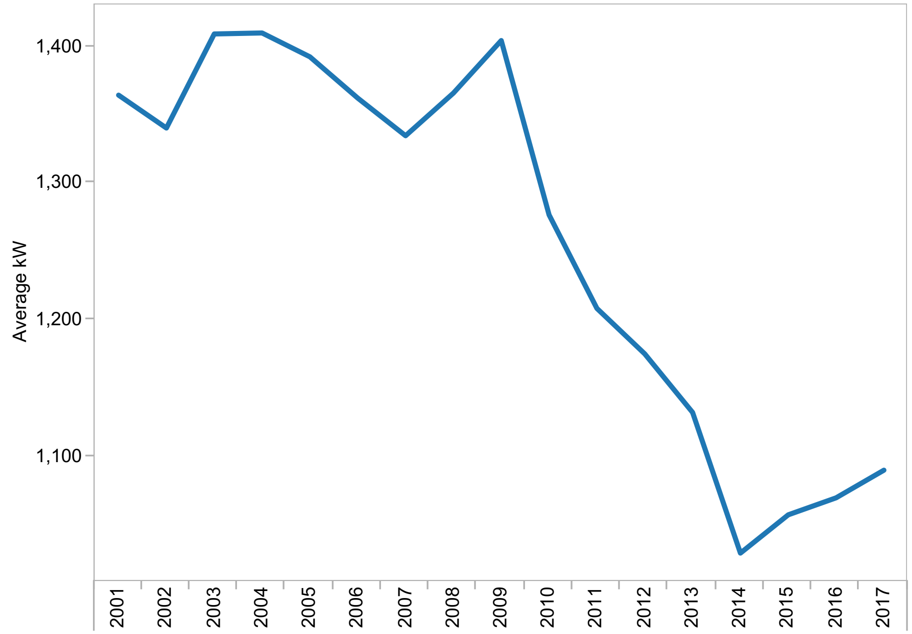
This dashboard can help to size new generation infrastructure. It is particularly important to size new or replacement diesel and renewable generation infrastructure to the needs of the community.

Average community electrical load [top]
1. Diesel engines should generally be sized for the "sweet spot" in the engine efficiency curve. Additionally, utilities should plan for sufficient redundancy to provide power if the primary unit(s) fail unexpectedly.
2. The trend of the average load can be used to plan for when new larger or smaller increments of generation may be needed.
3. The average load helps to size renewable capacity (for example, wind 100-150% of average load)

Note: The load includes any line losses. Reducing line loss could reduce the generation capacity needed.

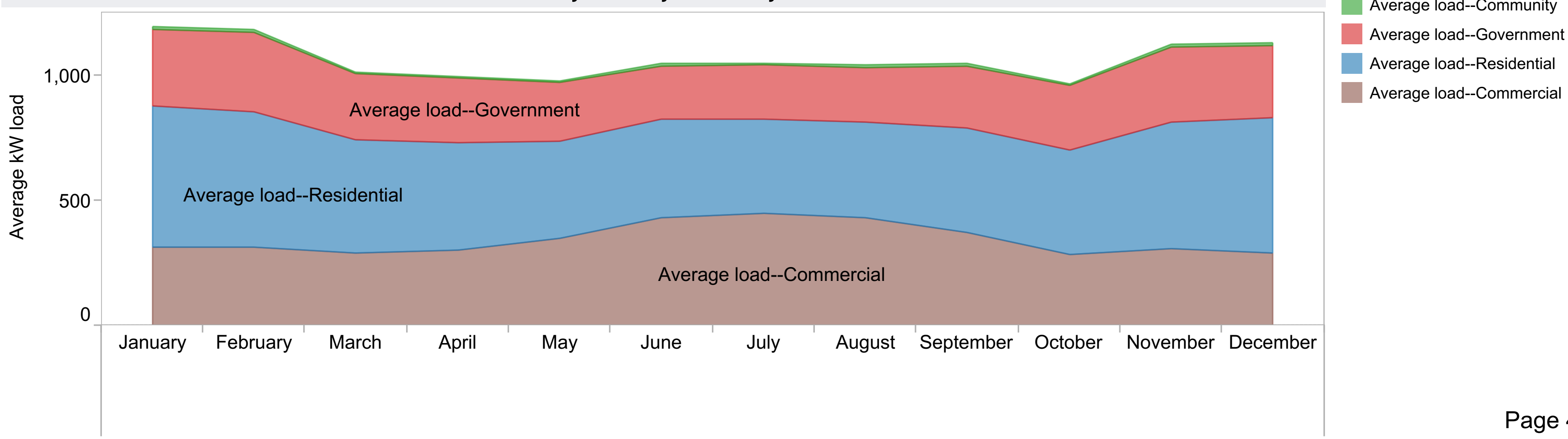
Electricity load by sector by month
Presents the average kW load for each customer class. The chart can provide some guidance on how much additional generation capacity is needed to cover changing loads by customer type and if a demand charge or other way to recover capacity costs would be appropriate.

Average community electrical load



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Electricity Load by sector by month



Power generation Infrastructure

Community
Tanacross

ALASKA ENERGY AUTHORITY

Generation and Distribution infrastructure

Primary/ Secondary diesel generation plant	Plant functional	Control Switchgear	Distribution Phases	Distribution voltage (in volts)
Primary	Yes	Manually synchronizing switchgear	Null	7200

Source: Alaska Energy Authority (2012)

Diesel infrastructure

Diesel Genset Position Number	Diesel Engine Make/Model	Generator End Capacity (kW)	Diesel Engine Tier
1	Caterpillar 3512C	1,050	

Source: Alaska Energy Authority (2017-2018)

Heat recovery

Solar

Source: Alaska Energy Authority

Energy storage

Storage type	Storage sub-type	Power (kW)
Null	Null	Null

Source: Alaska Energy Authority

Hydro infrastructure

Source: Alaska Energy Authority

Wind infrastructure

Source: Alaska Energy Authority

Diesel infrastructure performance

Community
Tanacross

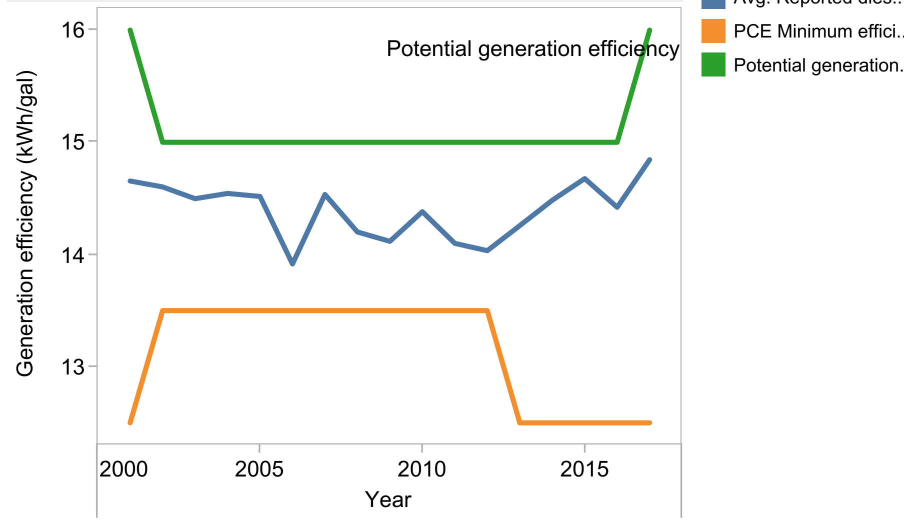
This dashboard addresses the efficiency of generating electricity with diesel. Improving the efficiency of generation and minimizing station service will reduce the amount of fuel purchased.

Generation efficiency [right]
1. The generation efficiency, reported in the kWhs produced per gallon of diesel (kWh/gal), is a basic measure of utility performance.
2. The reported efficiency is compared against the associated minimum efficiency for the PCE program and a potential generation efficiency determined by the average community load.

Potential diesel efficiency savings [bottom left]
Based on an potential generation efficiency in the previous chart, the chart shows the potential historical fuel cost savings.

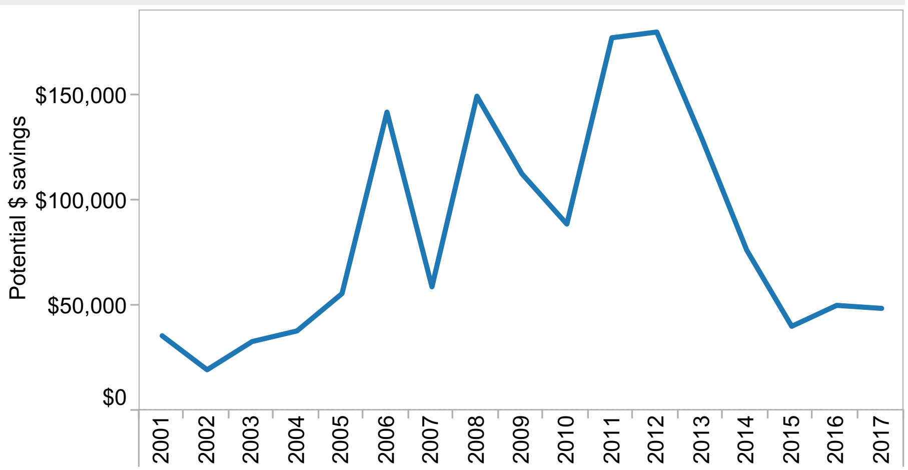
Station service [bottom right]
1. The chart shows two pieces of data: the percentage of the total generation consumed by station service and the fuel cost of that consumption.
2. There is no standard for station service, but every kWh consumed at powerplant must be produced, costing the utility money. Most buildings can be made more efficient with improved lighting, controls, and fans without sacrificing service.

Generation efficiency



Source: Diesel efficiency as reported to PCE program
Alaska Energy Authority PCE data
Accessed from: Alaska Energy Data Gateway
(https://akenergygateway.alaska.edu/)

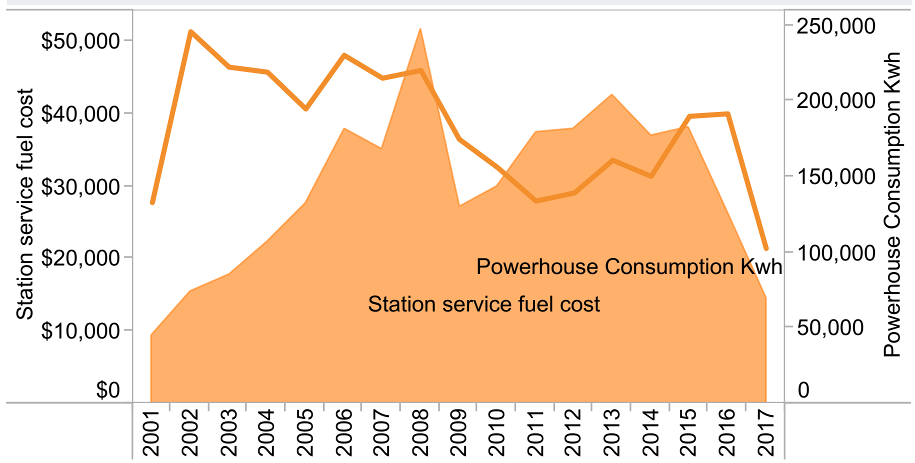
Potential diesel efficiency savings



Note: Assumes that efficiency is raised to 15.000 to 16.000 kWh/gallon

Source: Calculation based on data from Alaska Energy Authority Power Cost Equalization program
Accessed for Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Station service



Source: Alaska Energy Authority PCE data
Accessed from: Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Renewable infrastructure performance

Community
Tanacross

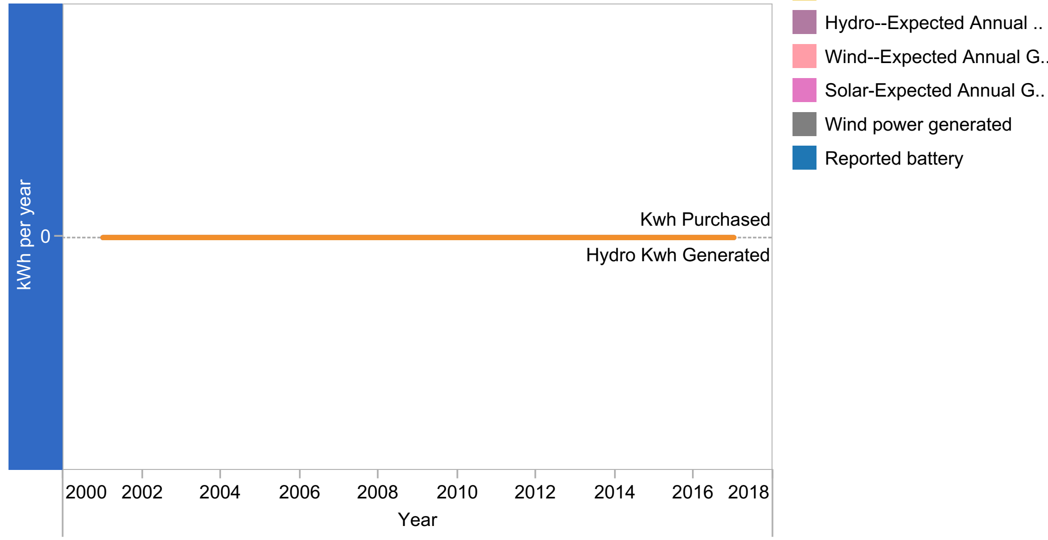
While renewable energy (RE) projects do not consume diesel fuel, it is still important that they perform as designed. Even if the RE project was grant funded, performance below the expectation creates excess fuel costs to the utility.

While RE resource can be impacted by the natural daily, seasonal, and yearly variations in weather and climate, diagnosing the source of inefficiencies within a system frequently requires specialized training.

Renewable energy project actual against expected
1. The expected generation is based on project data, while the actual generation comes through PCE reports.
2. System performance might be underreported. Anecdotally, RE systems with "excess" electricity generation sometimes do not report the sales of "excess" electricity to PCE-eligible customers.
3. The chart may include years prior to the installation of the project

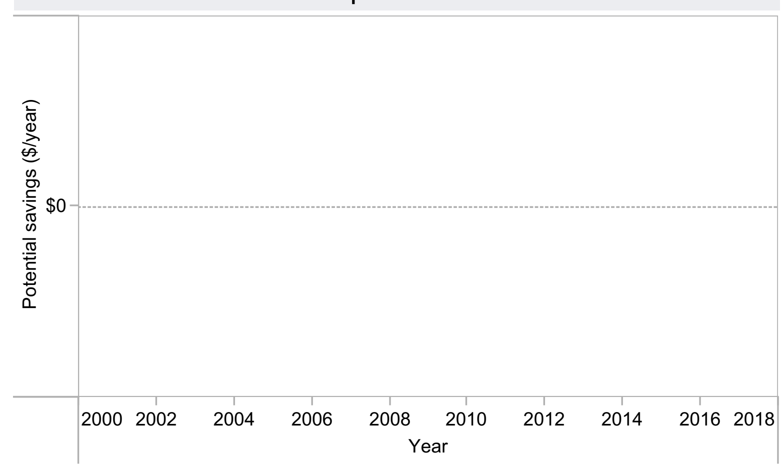
Potential savings if renewable energy project performed to expectation
1. The chart assumes that if the RE project were to perform to expectation that all kWhs would displace diesel-generated kWh.
2. The chart may include analysis for the years before the project was installed.

Renewable energy project actual against expected yearly generation



Sources: Alaska Energy Authority PCE data and other AEA data
Accessed from: Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Potential savings if renewable energy project performed to expectation



Sources: Alaska Energy Authority PCE data and other AEA data
Accessed from: Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Line loss analysis

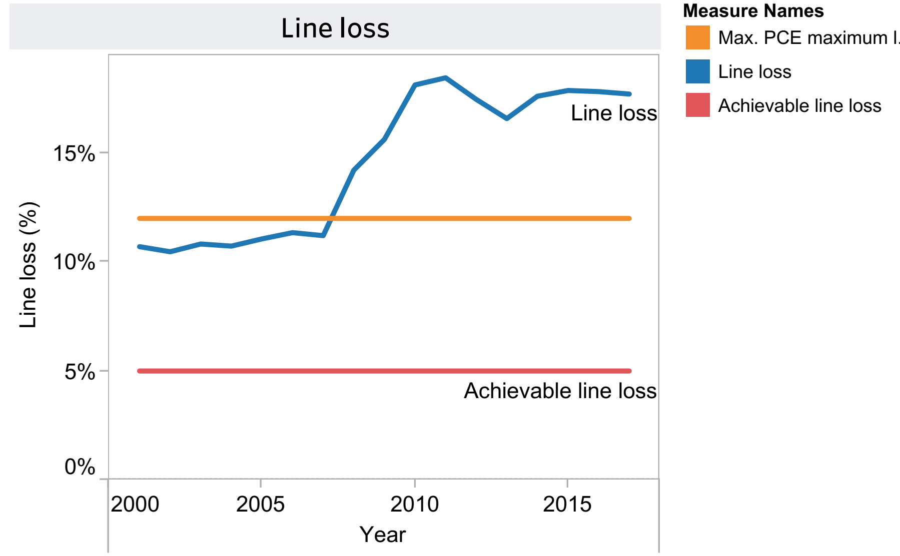
Community
Tanacross

The line loss figures reported by the PCE program are calculated as the difference between generation and sales, and not a measure of the physical losses in a system. Because of this, line loss can either be due to physical losses in wires, transformers, etc. or due to reading, billing, and metering issues, or a combination.

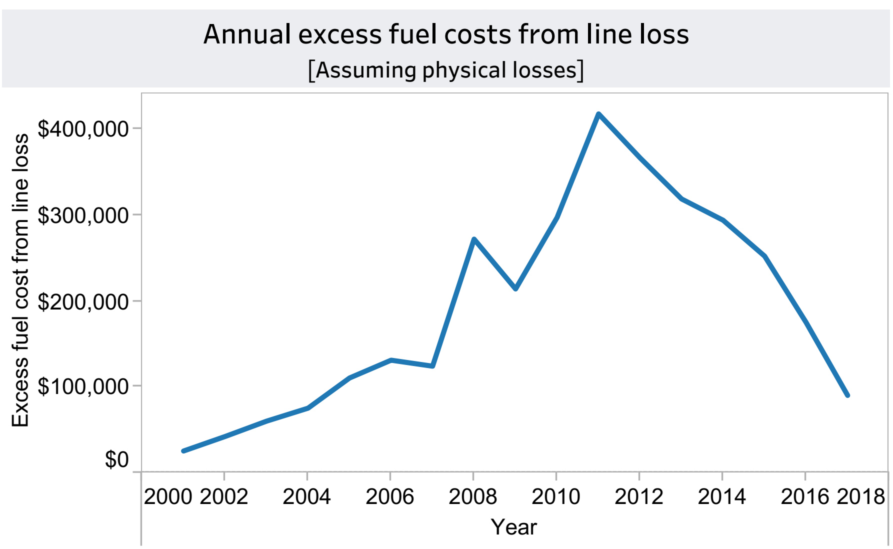
Line loss [right]
The line loss is compared against two benchmarks.
1. The first benchmark is the maximum allowable line loss set by the RCA for the PCE program. Line loss figures above this standard limits the amount of reimbursement to PCE-eligible customers
2. The second benchmark is the industry standard reported by the US Energy Information Administration, a value that is achieved in many PCE-eligible communities.

Annual excess fuel costs from line loss [bottom left]
Using the 5% line loss standard, the chart assumes that line loss is due to physical losses in the distribution system. The chart displays the historical amount of fuel costs from excess line loss.

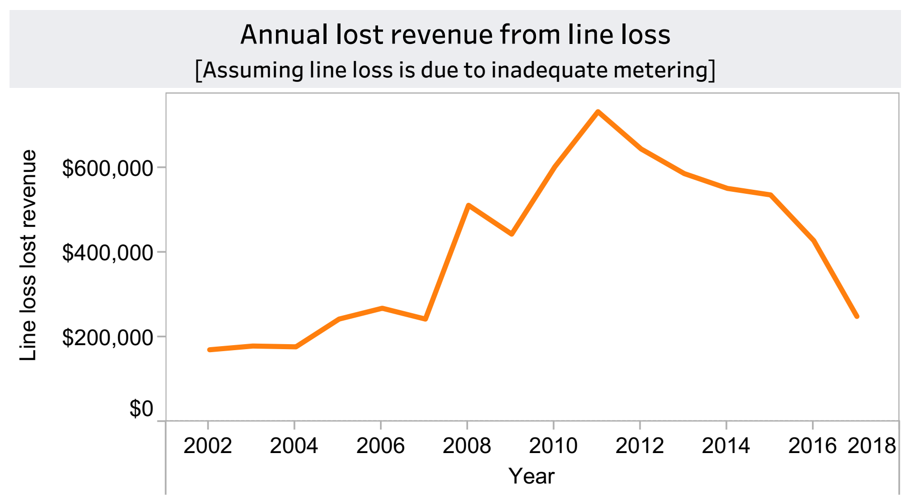
Annual lost revenue from line loss [bottom right]
This chart assumes that the line loss is from improperly metered electricity delivered to customers. This chart shows the amount of revenue that the utility lost each year based on the residential rate.



Source: Alaska Energy Authority PCE data and EIA
Accessed from: Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/) and US Energy Information Administration (https://www.eia.gov/tools/faqs/faq.php?id=105&t=3)



Source: Calculations based on AEA Power Cost Equalization data
Assuming 5% achievable line loss



Source: Calculations based on AEA Power Cost Equalization data
Assuming 5% achievable line loss

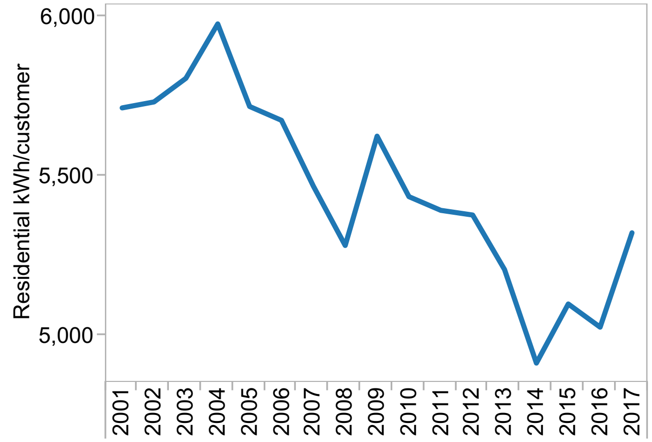
Electricity consumption

Community
Tanacross

Tracking yearly and monthly electricity consumption is important for both understanding the utility's potential revenue and the amount of generation needed to cover the community's needs. Since consumption can change on a monthly basis, it is important to know that if a community is interested in installing an intermittent resource, such as wind, solar, or hydro, that the energy output of the new resource must be matched up against the expected consumption.

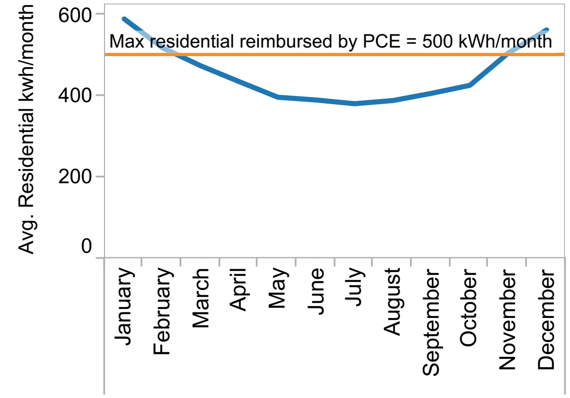
Besides providing description of the electricity consumption in a community by the customer class, the charts can provide some ways to check to see if the current sales figures are reasonable. Since meters can go bad and new meters may not be read properly in all cases, checking historical data can help to determine if a customer class is too high or low.

Annual electricity consumption per residential customer



Source: Calculations based on AEA Power Cost Equalization data

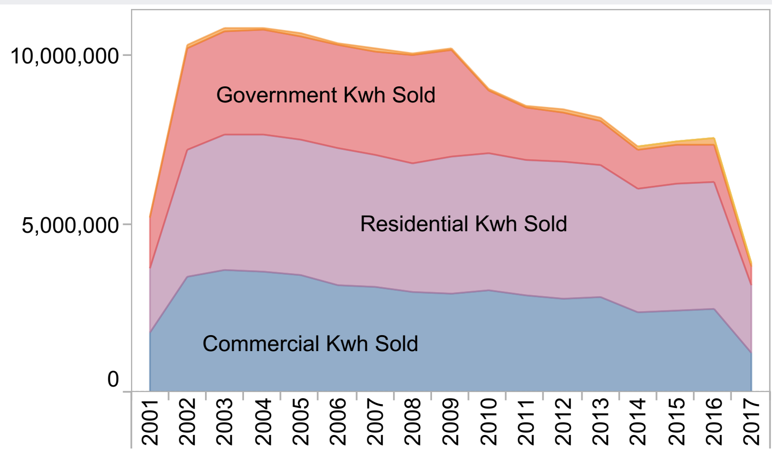
Average monthly residential electricity consumption



Source: Calculation based on AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway
(https://akenergygateway.alaska.edu/)

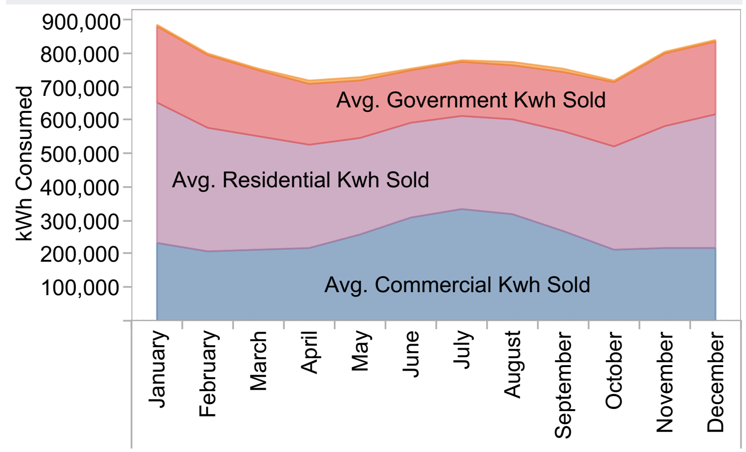
Measure Names
- Avg. Community Kwh Sold
- Avg. Government Kwh Sold
- Avg. Residential Kwh Sold
- Avg. Commercial Kwh Sold

Electricity consumption by sector



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Electricity Consumption by month by sector



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

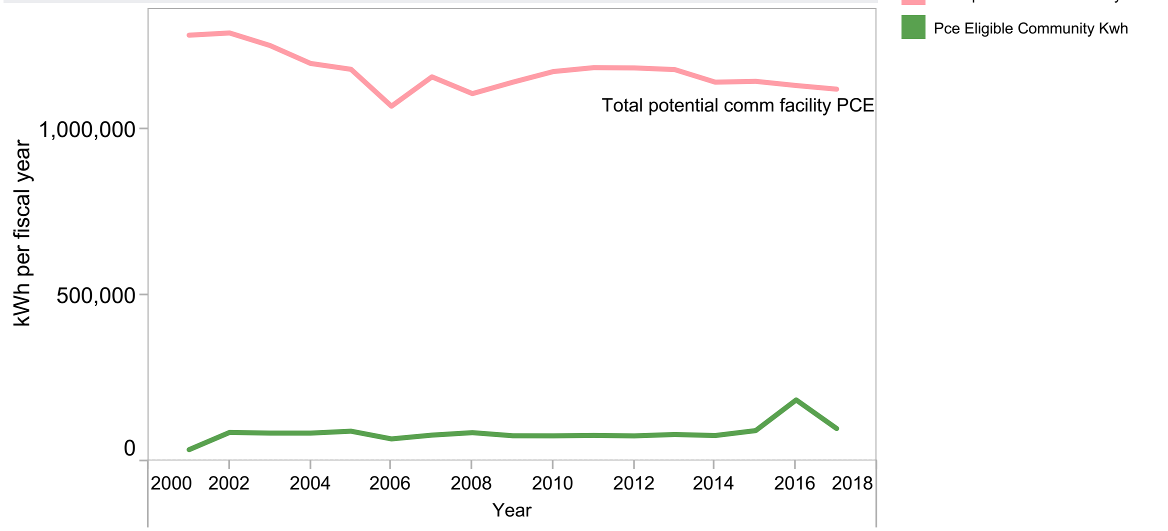
Power Cost Equalization-eligible sales

Community
Tanacross

Power Cost Equalization (PCE) is an AEA program that provides a subsidy to residential and some community facilities customers. While PCE does not directly subsidize a utility, since it does not provide additional revenue to the utility, the utility's operational and accounting practicies can affect how much the customers get reimbursed by the state.

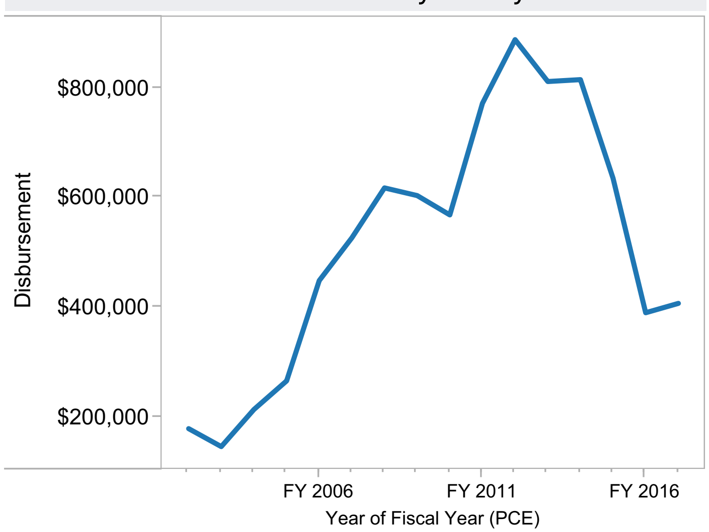
Community facilities are can be subsidized up 70 kWh per community resident per month, if the utility properly identifies and accounts for the sales. While some communities may have enough electricity consumed by community facilities to maximize the reimbursement, not all communities will have sufficient community facilities and consumption to maximize the reimbursement.

PCE community facility utilitization



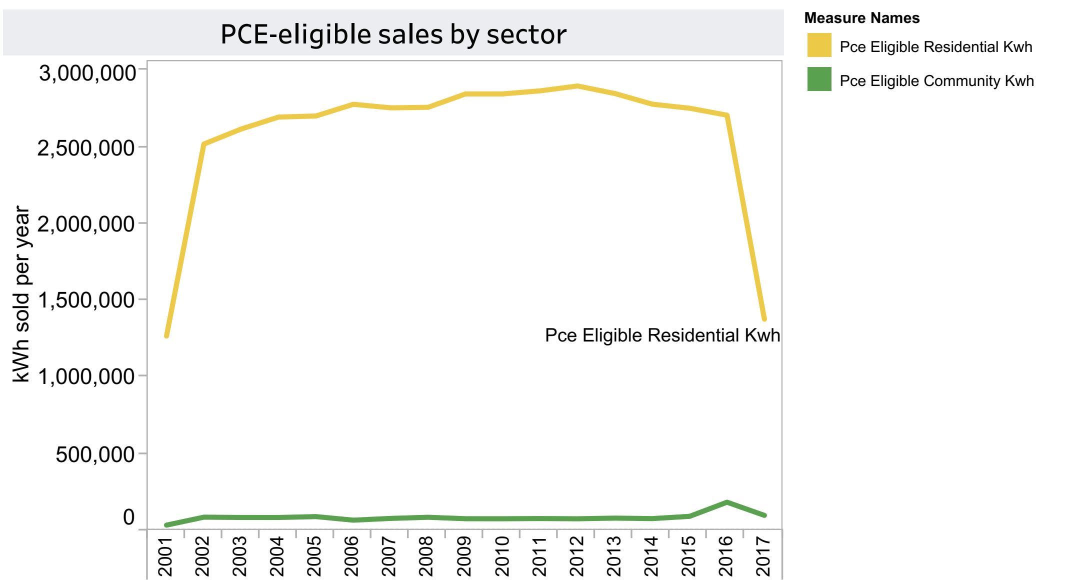
Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

PCE reimbursement by fiscal year



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

PCE-eligible sales by sector



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

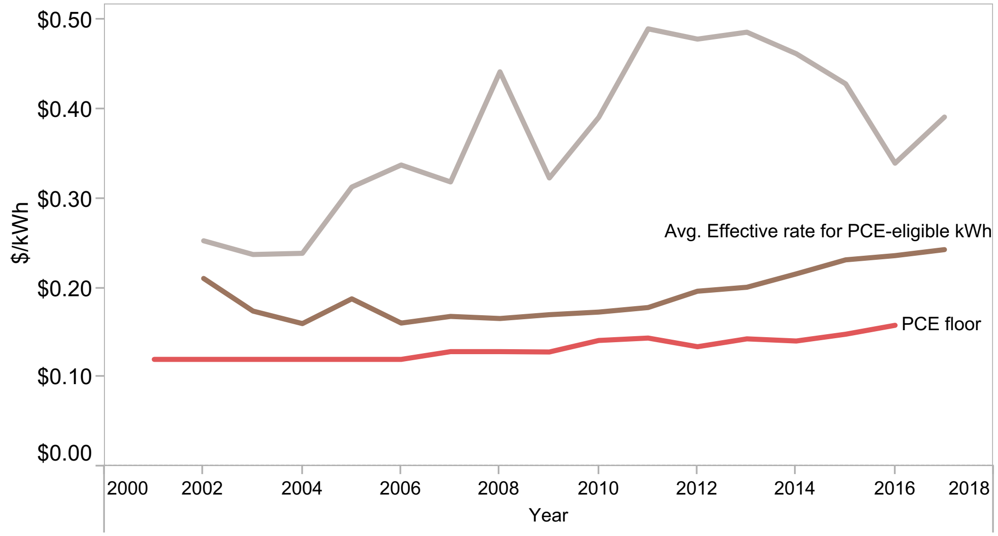
Residential electricity rates

Community
Tanacross

For PCE-eligible communities, residential customers generally do not pay for the full price of electrical service. The residential rate is subsidized by the state and the customers pay the Effective Rate. The effective rate is determined by the utility's operational and accounting performance. If a utility is operating within the operational standards for generation efficiency and line loss and providing adequate proof of expenses to justify the residential rate, the effective rate should be within a few cents of the PCE floor. An effective rate much greater than the PCE floor is a likely indicator that the utility has significant accounting and reporting issues.

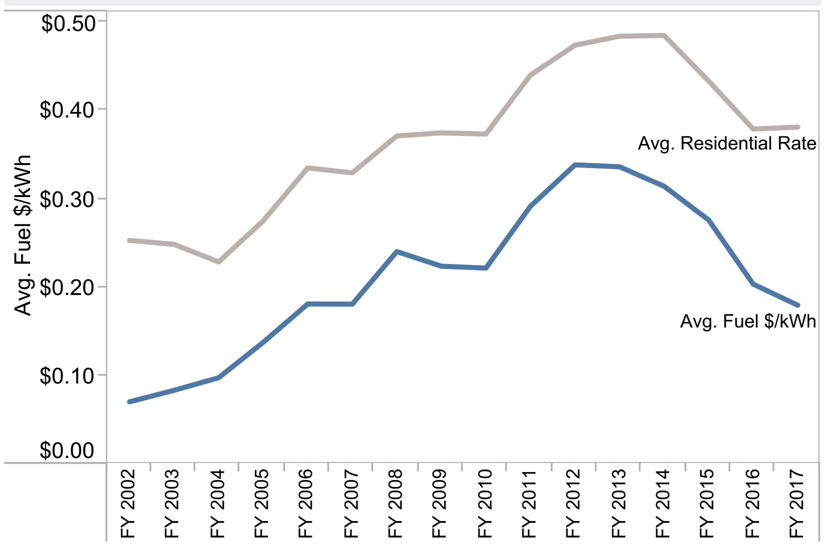
Additional PCE reimbursement from cost-based residential rate
1. Calculation based on difference between effective rate an PCE floor and total kWh sales eligible for reimbursement.
2. Assumes that residential rate can be justified by expenses. Must be submitted and approved by RCA.

Residential rates



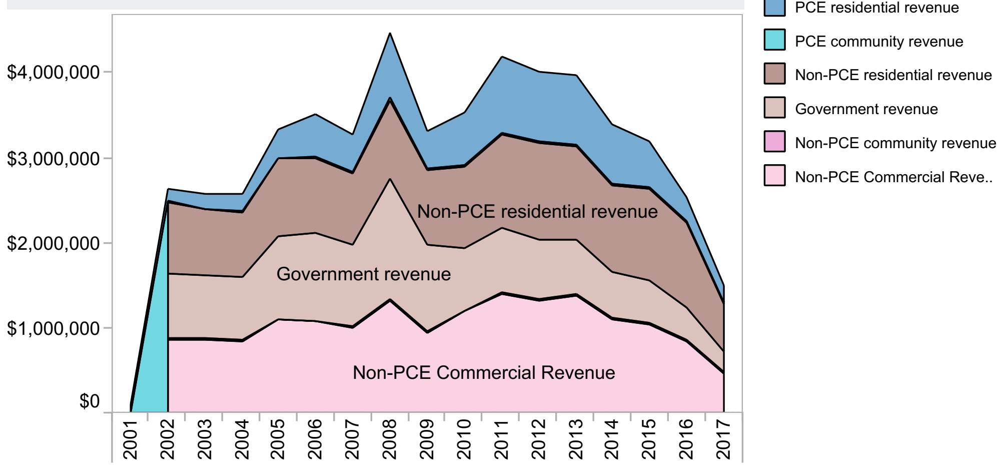
Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Fuel cost vs. Residential rate



Source: Alaska Energy Authority Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Source of revenue from customer rates



Source: AEA's Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)
NOTE: Assumes that all customers pay the residential rate

Non-residential buildings

Community
Tanacross

This page provides an overview of the identified non-residential buildings in a community. Individual buildings are not specifically identified, although in some cases that data is available. It will be seen that there for most buildings, there is not much data available for the consumption of electricity and/or heating fuels. Additional data should be available from the local electric utility and potentially from the local fuel distributor. For most communities, this list is not comprehensive.

If audits are available for buildings and were paid for through with public funds, they can frequently be found under the "Reports" tab.

Some communities may have buildings that are either heated with biomass or with recovered heat from the powerhouse.

Identified non-residential buildings

Building Type	Size known	Total Square Feet	Number of Records
Other	No		3
Office	No		1
Public Assembly	No		3
Education - K - 12	Yes	7,538	1
Public Safety	No		1
Water & Sewer	No		1

Sources: Alaska Housing Finance Corp.'s Alaska Retrofit Information System (ARIS) and Alaska Energy Authority data

Buildings with audits and/or retrofits completed

Building Type	Percent audited
Other	0%
Office	0%
Public Assembly	0%
Education - K - 12	0%
Public Safety	0%
Water & Sewer	0%

Water & Wastewater

System Type	System component	kWh/yr	HF Used	Biomass or heat recovery
Circulating/ Gravity	Null	Null	Null	No biomass or heat recovery installed

Buildings heated with biomass

Biomass SystemType	Manufacturer	Building heated with biomass
cordwood	Garn	Community Center

Source: Alaska Energy Authority data

See the "Reports" page for links to individual audits

Residential buildings

Community
Tanacross

This page provides some high-level characteristics of housing in the community. There is information about the Weatherization and Home Energy Rebate programs, the age of housing in the community, and average building size based on buildings that have gone through either Weatherization or the Home Energy Rebate.

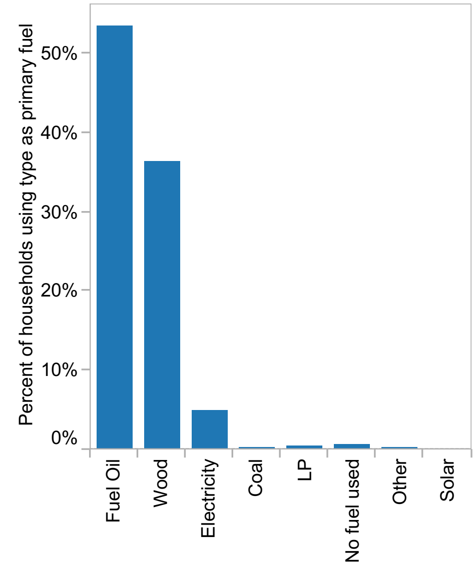
Additional information can be found through the Alaska Housing Finance Corporation's most recent housing assessment, available through AHFC's website.

Housing occupancy

Total Housing Units	Total Occupied Housing Units	Total Vacant Housing Units	Owner occupied total	Renter occupied total
73	53	20	43	10

Source: 2010 US Census data
Accessed from Alaska Community Database Online (https://www.commerce.alaska.gov/dcra/dcraexternal/)

Primary fuel consumed for heat in residences



Source: American Communtiy Survey

Weatherization Program Residences Served Per Year

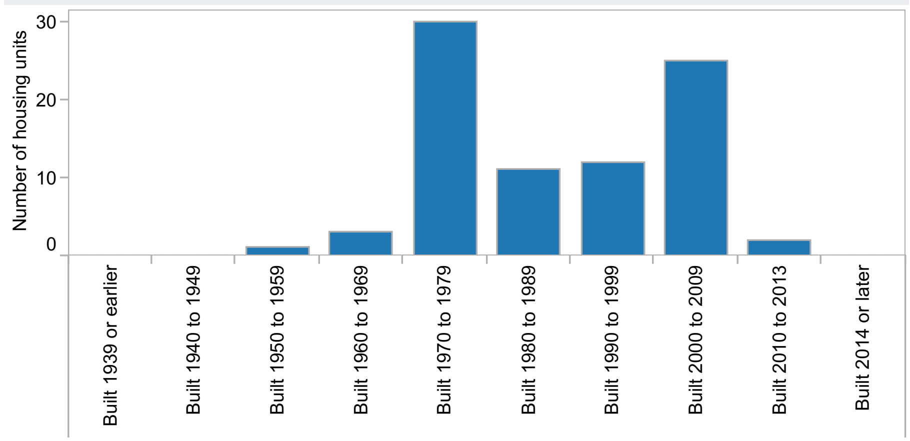
Year	
2008	12
2009	1
2010	3
2011	0
2012	6
2013	7
2014	1
2015	0

Source: Alaska Housing Finance Corporation

Home Energy Rebate Program

Source: Alaska Housing Finance Corporation

Age of housing



Source: US Census Bureau, 2012-2016 American Community Survey, B25034 Year Structure Built

Heating fuels prices

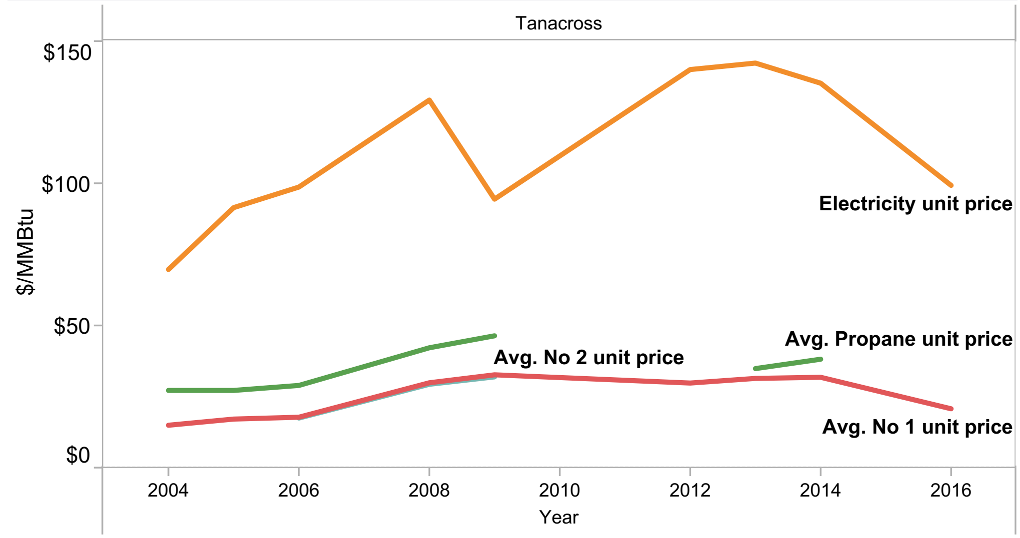
Since heating fuels are sold often sold in different units (gallons, kWh, cords, pounds, etc.) and/or there are different amounts of energy per unit, it can be difficult to know which fuel is the best deal. This page provides a way to understand the relative cost of energy using the same unit.

The cost of heating fuels are all calculated by converting from usual unit of sale to the price per million British thermal units (Btus). A million Btu is about the equivalent of seven gallons of diesel.

The page also provides a comparison of the price of a gallon of No. 1 and No. 2 fuel oil and the price that the utility pays for diesel. Since No. 1 fuel oil, No. 2 fuel oil, and diesel are very similar products with similar costs, the difference between the price the utility pays for diesel and retail price for No. 1 and/or No. 2 fuel oil gives an indication of the local markup from the fuel retailer.

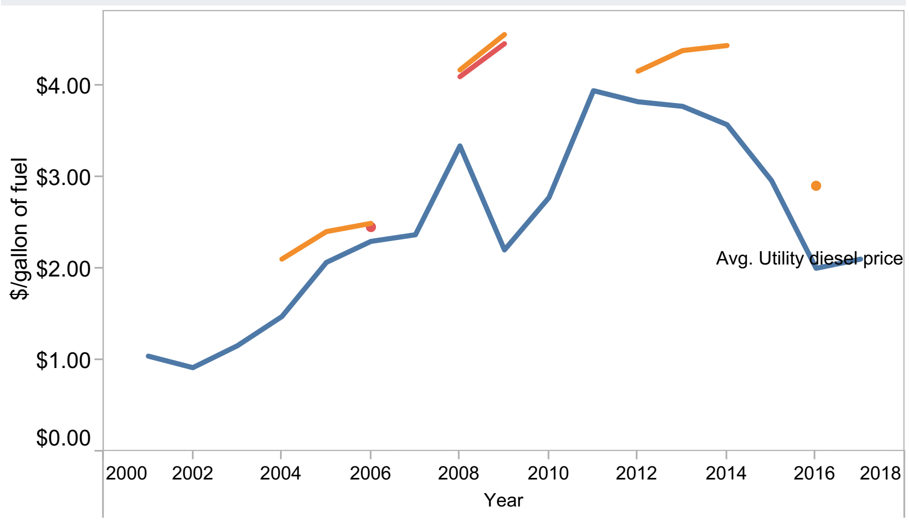
The Low income Home Energy Assistance Program (LIHEAP) is a federal program that subsidizes heating fuels, while the Alaska Heating Assistance Program (AKHAP) was a state program that subsidized heating fuel until it was unfunded several years ago.

Heating fuel unit price comparison



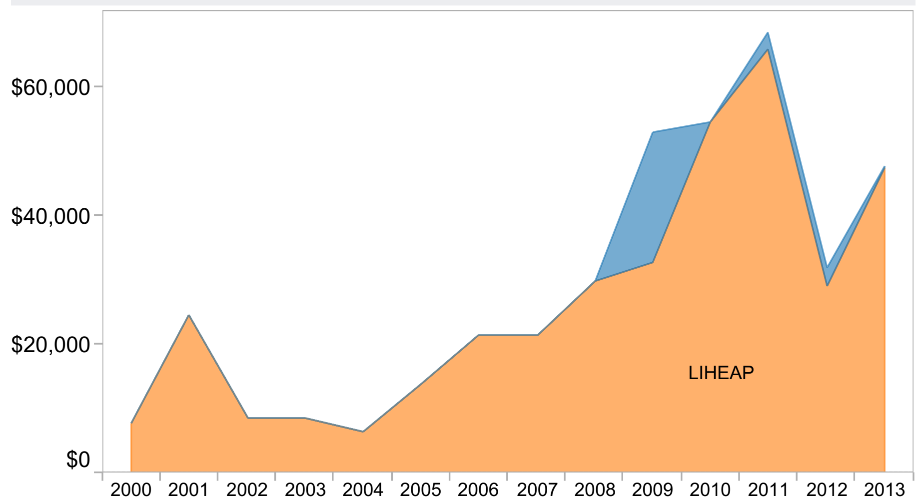
Sources: Alaska Housing Finance Corporation and Division of Community and Regional Affairs data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

Diesel fuel price comparison



Sources: Alaska Housing Finance Corporation, Division of Community and Regional Affairs, and Alaska Enery Authority Power Cost Equalization data
Accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)

LIHEAP & AKHAP Funding



Source: Dept. of Health and Social Services

Reports

Community
Tanacross

Title	Report topic list	Report URL
Interior Alaska Regional Energy Plan	Biomass, Energy Efficiency, Geothermal, Heat Recovery, Hydro, Solar, Transmission, ..	http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Interior%20Alas 20Regional%20Energy%20Plan.pdf?ver=2016-06-09-200432-767
Mansfield Village	Hydro	http://akenergyinventory.org/hyd/SSH-1982-0367.pdf
Tanacross (Yerrick Creek)	Hydro	http://akenergyinventory.org/hyd/SSH-1982-0367.pdf
Tanacross Preliminary Feasibility Assessment for High Efficiency Low Emission Wood Heating	Biomass	http://www.akenergyauthority.org/Content/Programs/AEEE/Biomass/Documents/PDF/ Tanacross2008_AWEDTG.pdf
Tanacross School Energy Audit Final Report	Energy Efficiency	http://www.akenergyefficiency.org/wp-content/uploads/2013/05/DOYON-Nortech-TSG_Tanacros School.pdf
Yerrick Creek	Hydro	http://akenergyinventory.org/hyd/SSH-2009-0002.pdf

Topic
All

Topic	
Biomass	2
Energy Efficiency	2
Geothermal	1
Heat Recovery	1
Hydro	4
Solar	1
Transmission	1
Wind	1

Projects in community

Community
Tanacross

This is a non-comprehensive list of projects that have been completed or are in progress in the community.

Village Energy Efficiency Program

Source: Alaska Energy Authority data

USDA funded

Program	Fiscal Year	Project/Item Description	Recipient	Funding source	Multiple communities	Funding type	Funding amount amount
Rural Energy for America P..	2015	Hydro Energy Generation	Upper Tanana Energy LLC	Applicant	No	Local Match	$18,500,0..
				USDA	No	grant	$500,000

Denali Commission projects

Renewable Energy Fund Projects

Technology Type	REF Round	Title	Phase	Year of Expect..	Year of Com
BIOMASS	2	Tanacross Biomass Feasibility	Construction	2016	Null
	5	Tanacross Woody Biomass Community Facility Space Heating Project	Construction	2016	Null

Renewable energy resource data

Community
Tanacross

This page provide high-level data about renewable energy resources near or in the the community.

If a potential project has been studied in the community, a short summary is generally provided on this page. See the "Reports" page for additional reports.

Biomass: Resource data

Sufficient Biomass for 30% of Non-..	Productive Forest (H,M,L)	Existing project (Y,N)
Yes	High	Yes

Source: Alaska Energy Authority

Hydropower: Potential projects

Phase Completed	Project	Capacity (kW)	Generation (kWh)	Total Construction Cost
Design	Yerrick Creek Hydropower Pr..	1,500	4,900,000	$20,744,264

Solar resource

Output per 10kW Solar PV	Nearest Reference Communi..	Source
8,017	NORTHWAY	NREL PVWatts (2015)

Wind potential

Estimated Wind Class	Wind project
2	

Source: Alaska Energy Authority data
Scale is 1-7, with 1 being low and 7 being high.

See "Reports" for additional information

This page provide a non-comprehensive look at the technical assistance and training provided to the community from state and federal agencies.

Electrical Emergencies responded to by AEA

Source: Alaska Energy Authority

Training provided by AEA

Source: Alaska Energy Authority

Circuit Rider assistance

DOE Office of Indian Energy Technical Assistance

Source: US Dept. of Energy Office of Indian Energy (https://energy.gov/indianenergy/completed-request-technical-assistance)

Bulk fuel

Community
Tanacross

This page provides some information about bulk fuel in the community. The list of facilities' bulk fuel capacity is not complete for all communities, and may be blank.

The fuel spills is based on reports to the Alaska Department of Environmental Conservation. In addition to the potential environmental harm, given the cost of cleaning up spills and lost product, it is important that communities have qualified and trained staff to oversee the bulk fuel facilities.

Bulk fuel capacity

Source: Alaska Energy Authority

Fuel delivery modes

Community	Mode of fuel transport
Tanacross	Road

Source: University of Alaska Fairbanks Alaska Center for Energy and Power

Fuel spills reported to Alaska Department of Environmental Conservation

Cause Type	Cause1	Substance Sub Type	Year of Spill Date	Count of Qty Released	Qty Released
Structural/Mecha..	Equipment Failure	Diesel	2012	1	300
	Line Failure	Diesel	2012	1	300

ENERGY AUDIT – FINAL REPORT

TANACROSS SCHOOL
1 Mile Tanacross Road
Tanacross, Alaska

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July 11, 2012

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APPENDICES

1.0 EXECUTIVE SUMMARY

NORTECH has completed an ASHRAE Level II Energy Audit of the Tanacross School, a 7,538 square foot facility. The audit began with benchmarking which resulted in a calculation of the energy consumption per square foot. A site inspection was completed on October 26, 2011 to obtain information about the lighting, heating, ventilation, cooling and other building energy uses. The existing usage data and current systems were then used to develop a building energy consumption model and potential savings using AkWarm.

Once the model was calibrated, a number of Energy Efficiency Measures (EEMs) were developed from review of the data and observations. EEMs were evaluated and ranked on the basis of both energy savings and cost using a Savings/Investment Ratio (SIR). While these modeling techniques were successful in verifying that many of the EEMs would save energy, not all of the identified EEMs were considered cost effective based on the hardware, installation, and energy costs at the time of this audit.

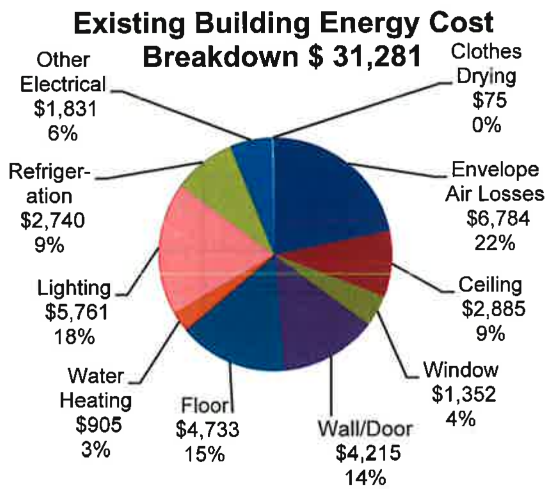
While the need for a major retrofit can typically be identified by an energy audit, upgrading specific systems often requires collecting additional data and engineering and design efforts that are beyond the scope of the Level II energy audit. The necessity and amount of design effort and cost will vary depending on the scope of the specific EEMs planned and the sophistication and capability of the entire design team, including the building owners and operators. During the budgeting process for any major retrofit identified in this report, the building owner should add administrative and supplemental design costs to cover the individual needs of their own organization and the overall retrofit project.

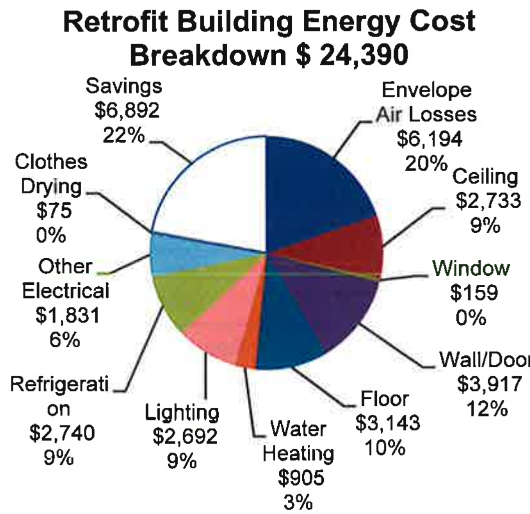
The following table, from AkWarm, is a summary of the recommended EEMs for the Tanacross School. Additional discussion of the modeling process can be found in Section 3. Details of each individual EEM can be found in Appendix A of this report. A summary of EEMs that were evaluated but are not currently recommended is located in Appendix B.

PRIORITY LIST – ENERGY EFFICIENCY MEASURES (EEMs)						
Rank	**Feature/ Location**	**Improvement Description**	**Estimated Annual Energy Savings**	**Estimated Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**
1	Setback Thermostat: Tanacross School	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Tanacross School space.	$1,332	$350	52	0.3
2	Lighting: 2 Exterior Lights	Replace with 2 LED 20W Module StdElectronic	$110	$110	17	1.0
3	Setback Thermostat: Gymnasium	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Gymnasium space.	$412	$350	16	0.9
4	Lighting: Class 104, 107 Girls Locker, 108 Boys Locker, 113	Replace with 6 FLUOR CFL, A Lamp 15W	$26	$18	12	0.7

PRIORITY LIST – ENERGY EFFICIENCY MEASURES (EEMs)						
5	On- or Below-Grade Floor, Perimeter: Crawlspace Perimeter	Install R-19 Fiberglass Batts on the Perimeter 4 feet of the Crawl Space Floor.	$798	$2,441	7.7	3.1
6	Lighting: 109, 110, 111, 114	Replace with 10 LED (2) 17W Module StdElectronic	$415	$1,750	3.3	4.2
7	Lighting: Room 120	Replace with 9 LED (2) 17W Module StdElectronic	$270	$1,575	2.4	5.8
8	Lighting: Exterior	Replace with 7 LED 35W Module StdElectronic	$548	$4,550	2.1	8.3
9	Lighting: Room 122	Replace with 16 LED (2) 17W Module StdElectronic	$385	$2,800	1.9	7.3
10	HVAC And DHW	replace furnace 1 motor with a more efficient and furnace 2 motor with a smaller sized motor, install vent damper, apply mastic to ducts in crawlspace	$1,086	$10,000	1.9	9.2
11	Lighting: Rooms 101, 107 Girls Locker, 108 Boys Locker, 119, 121	Replace with 46 LED (2) 17W Module StdElectronic	$841	$8,050	1.5	9.6
12	Window/Skylight: Sinlge Pane Wood Other	Replace existing window with U-0.22 vinyl window	$435	$5,721	1.3	13
13	Window/Skylight: Single Pane Wood South	Replace existing window with U-0.22 vinyl window	$234	$3,377	1.2	14
TOTAL, cost-effective measures			$6,891	$41,092	2.7	6.0

Modeled Building Energy Cost Breakdown





The charts are a graphical representation of the calculated Energy Cost Breakdown for the Tanacross School and the calculated Savings from Energy Efficiency Measures that are previously discussed.

On the existing building, the greatest portions of energy are in Envelope Air Losses and lighting. This indicates that the greatest savings can probably be found in reducing air leakage up the chimney and supply ducts and from upgrading lighting. Detailed improvements for ventilation, air leakage, lighting and other cost effective measures can be found in Appendix A.

The charts breaks down energy cost into the following use categories:

- Envelope Air Losses—the cost to provide heated fresh air to occupants, air leakage, heat lost in air through the chimneys and exhaust fans, heat lost to wind and other similar losses.
- Envelope
  - Ceiling—quantified heat loss transferred through the ceiling portion of the envelope.
  - Window—quantified heat loss through the window portion of the envelope.
  - Wall/Door—quantified heat loss through the wall and door portions of the envelope.
  - Floor—quantified heat loss through the floor portion of the envelope.
- Water Heating—energy cost to provide domestic hot water.
- Fans—energy cost to run ventilation, and exhaust fans.
- Lighting—energy cost to light the building.
- Refrigeration—energy costs to provide refrigerated goods for the occupants.
- Other Electrical—includes energy costs not listed above including cooking loads, laundry loads, other plug loads and electronics.

2.0 INTRODUCTION

NORTECH contracted with the Alaska Housing Finance Corporation to perform ASHRAE Level II Energy Audits for publically owned buildings in Alaska. This report presents the findings of the utility benchmarking, modeling analysis, and the recommended building modifications, and building use changes that are expected to save energy and money.

The report is organized into sections covering:

- description of the facility,
- the building's historic energy usage (benchmarking),
- estimating energy use through energy use modeling,
- evaluation of potential energy efficiency or efficiency improvements, and
- recommendations for energy efficiency with estimates of the costs and savings.

2.1 Building Use, Occupancy, Schedules and Description

2.1.1 Building Use

Tanacross School is used as a K-8 school and is composed of classrooms, a gymnasium, and offices.

2.1.2 Building Occupancy and Schedules

This building is occupied by 30 students and 2 teachers during the school year from the middle of August to the end of May. Students primarily occupy the building from 8:00 am to 3:30 pm Monday through Friday and faculty occupies the building from 7:30 am to 4:00 pm.

2.1.3 Building Description

Tanacross School is a one story wood framed building on a crawlspace, constructed in 1982.

Building Envelope

Building Envelope: Walls			
Wall Type	**Description**	**Insulation**	**Notes**
Above-grade walls	Wood-framed with 2x10 studs spaced 16-inches on center.	R-30 fiberglass batt.	No signs of insulation damage.
Crawlspace walls	Wood-framed with 2x6 studs spaced 16-inches on center.	R-19 fiberglass batt 2-inches of foam	No signs of insulation damage.

Building Envelope: Floors			
Floor Type	**Description**	**Insulation**	**Notes**
Below Grade Floor	Closed crawl space with 6 mil poly vapor barrier	None	-

Building Envelope: Roof			
Roof Type	**Description**	**Insulation**	**Notes**
All Roofs	Cold roofs framed with wood trusses.	R38 + R19 fiberglass batt.	No signs of insulation damage.

Building Envelope: Doors and Windows			
Door and Window Type	**Description**	**Estimated R-Value**	**Notes**
All Doors	Metal 2-inch: Foam Core	5.0	-
Window Type 1	Wood: Double Pane	2.0	Window would benefit from window film in winter months
Window Type 2	Wood: Single Pane	1.1	Window would benefit from window film in winter months

Heating and Ventilation Systems

The heat to this building is provided by two #2 oil fired furnaces:

- Furnace-1 provides heat to classrooms and miscellaneous rooms
- Furnace-2 provides heat to the gym area

The heat from these furnaces is controlled by one manual thermostat each. The thermostat for Furnace-1 has a day and night setting.

A unit heater in the shop/craft room has been removed from the building.

Air Conditioning System

No air condition system is installed in the building.

Energy Management

This building does not have any formal energy management equipment.

Lighting Systems

Primary lighting in Tanacross School is provided by fluorescent ceiling mounted fixtures with T12 lamps (1.5-inch diameter, 4-foot long). The gymnasium uses ceiling mounted fixtures with 175 watt metal halide lamps.

Domestic Hot Water

Domestic hot water is provided by an oil fired hot water heater.

2.2 Benchmarking

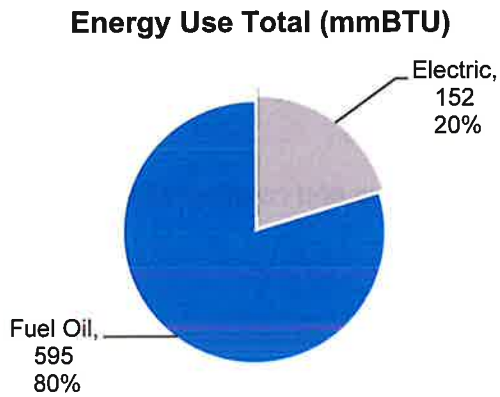
Benchmarking building energy use consists of obtaining and then analyzing two years of energy bills. The original utility bills are necessary to determine the raw usage, and charges as well as to evaluate the utility's rate structure. The metered usage of electrical and natural gas consumption is measured monthly, but heating oil, propane, wood, and other energy sources are normally billed upon delivery and provide similar information. During benchmarking, information is compiled in a way that standardizes the units of energy and creates energy use and billing rate information statistics for the building on a square foot basis. The objectives of benchmarking are:

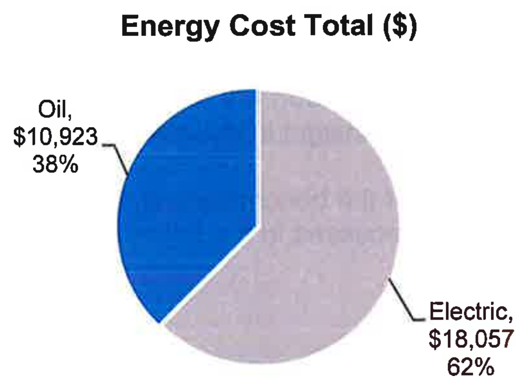
- to understand patterns of use,
- to understand building operational characteristics,
- for comparison with other similar facilities in Alaska and across the country, and
- to offer insight in to potential energy savings.

The results of the benchmarking, including the energy use statistics and comparisons to other areas, are discussed in the following sections.

2.2.1 Total Energy Use and Cost of 2010

The energy use profiles below show the energy and cost breakdowns for the Tanacross School. In 2010, the total annual energy cost for the building was $ 28,980 per year and consumption was 747,000,000 BTUs including both Fuel Oil and Electricity kWh converted to BTU's. These charts show the portion of use for a fuel type and the portion of its cost.





The above charts indicate that the highest portion of energy use is for fuel oil and the highest portion of cost is for electricity. Fuel oil consumption correlates directly to space heating and domestic hot water while electrical use can correlate to lighting systems, plug loads, and HVAC equipment. The energy type with the highest cost often provides the most opportunity for savings.

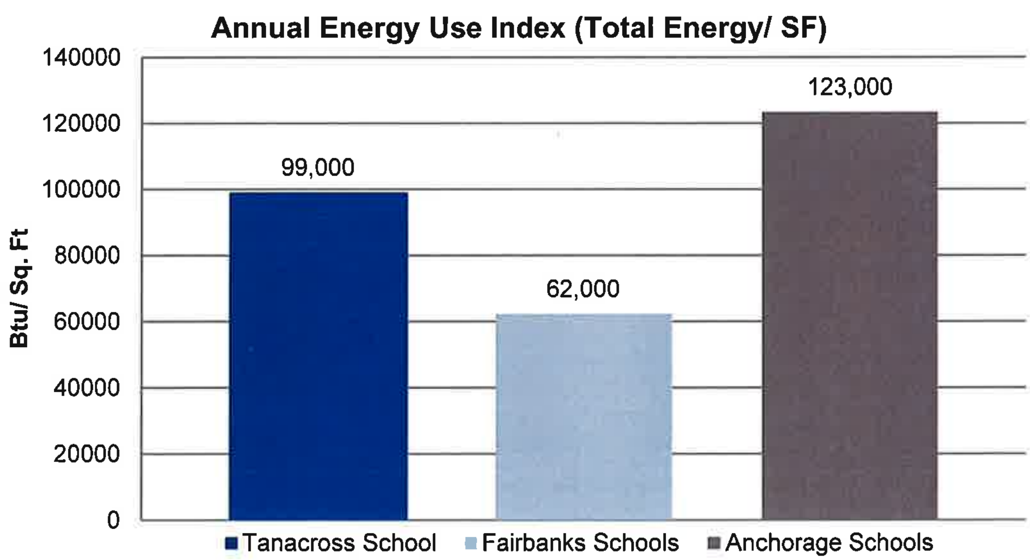
2.2.2 Energy Utilization Index of 2010

The primary benchmarking statistic is the Energy Utilization Index (EUI). The EUI is calculated from the utility bills and provides a simple snapshot of the quantity of energy actually used by the building on a square foot and annual basis. The calculation converts the total energy use for the year from all sources in the building, such as heating fuel and electrical usage, into British Thermal Units (BTUs). This total annual usage is then divided by the number of square feet of the building. The EUI units are BTUs per square foot per year.

The benchmark analysis found that in 2010, the Tanacross School had an EUI of 99,000 BTUs per square foot per year.

The EUI is useful in comparing this building's energy use to that of other similar buildings in Alaska and in the Continental United States. The EUI can be compared to average energy use in 2003 found in a study by the U.S. Energy Information Administration of commercial buildings (abbreviated CBECS, 2006). That report found an overall average energy use of about 90,000 BTUs per square foot per year while studying about 6,000 commercial buildings of all sizes, types, and uses that were located all over the Continental U.S. (see Table C3 in Appendix I).

In a recent and unpublished state-wide benchmarking study sponsored by the Alaska Housing Finance Corporation, schools in Fairbanks averaged 62,000 BTUs per square foot and schools in Anchorage averaged 123,000 BTUs per square foot annual energy use. The chart below shows the Tanacross School relative to these values. These findings are discussed further in Appendix H.



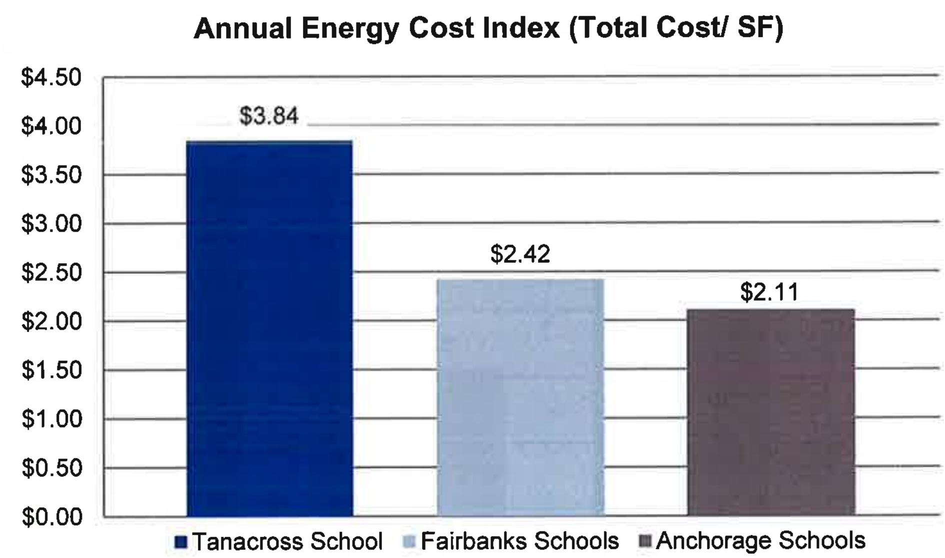
2.2.3 Cost Utilization Index of 2010

Another benchmarking statistic that is useful is the Cost Utilization Index (CUI), which is the cost for energy used in the building on a square foot basis per year. The CUI is calculated from the cost for utilities for a year period. The CUI permits comparison of buildings on total energy cost even though they may be located in areas with differing energy costs and differing heating and/or cooling climates. The cost of energy, including heating oil, natural gas, and electricity, can vary greatly over time and geographic location and can be higher in Alaska than other parts of the country.

The CUI for Tanacross School is about $3.84. This is based on utility costs from 2010 and the following rates:

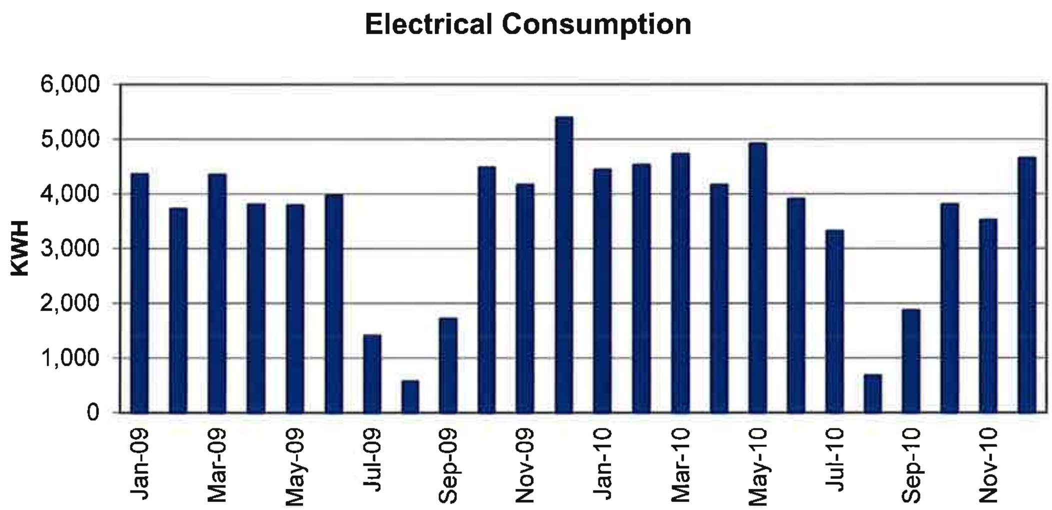
Electricity	at	$0.41/ kWh	($12.01 / Therm)
# 2 Fuel Oil	at	$2.63 / gallon	($1.88 / Therm)

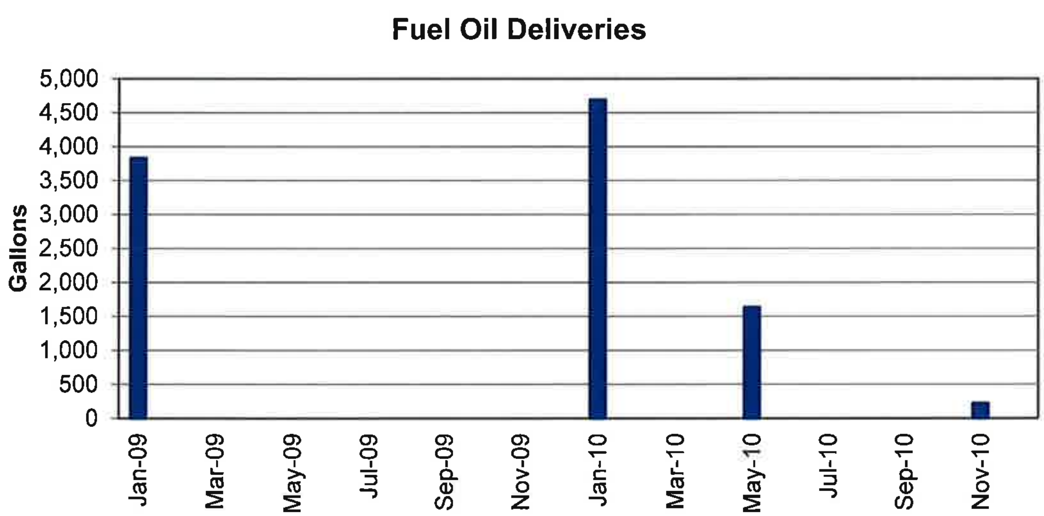
The Department of Energy Administration study, mentioned in the previous section (CBECS, 2006) found an average cost of $2.52 per square foot in 2003 for 4,400 buildings in the Continental U.S (Tables C4 and C13 of CBDES, 2006). Schools in Fairbanks have an average cost for energy of $2.42 per square foot while Anchorage schools average $2.11 per square foot. The chart below shows the Tanacross School relative to these values. More details are included in Appendix H.



2.2.4 Seasonal Energy Use Patterns

Energy consumption is often highly correlated with seasonal climate and usage variations. The graphs below show the electric and fuel consumption of this building over the course of two years. The lowest monthly use is called the baseline use. The electric baseline often reflects year round lighting consumption. The clear relation of increased energy usage during periods of cold weather can be seen in the months with higher usage.





The fuel deliveries at Tanacross School do not directly relate to the annual fuel consumption. Analysis of deliveries indicates that tanks are kept partially filled throughout the year to ensure that the school does not run out of fuel. Based on calculations with Tok heating degree days (HDDs), the average fuel consumption is around 4,250 gallons/year. The AkWarm model was modeled to match this value.

2.2.5 Future Energy Monitoring

Energy accounting is the process of tracking energy consumption and costs. It is important for the building owner or manager to monitor and record both the energy usage and cost each month. Comparing trends over time can assist in pinpointing major sources of energy usage and aid in finding effective energy efficiency measures. There are two basic methods of energy accounting: manual and automatic. Manual tracking of energy usage may already be performed by an administrative assistant: however if the records are not scrutinized for energy use, then the data is merely a financial accounting. Digital energy tracking systems can be installed. They display and record real-time energy usage and accumulated energy use and cost. There are several types which have all of the information accessible via Ethernet browser.

3.0 ENERGY CONSUMPTION AND MODELING RESULTS

After benchmarking of a building is complete and the site visit has identified the specific systems in the building, a number of different methods are available for quantifying the overall energy consumption and to model the energy use. These range from relatively simple spreadsheets to commercially available modeling software capable of handling complex building systems. ***NORTECH*** has used several of these programs and uses the worksheets and software that best matches the complexity of the building and specific energy use that is being evaluated.

Modeling of an energy efficiency measure (EEM) requires an estimate of the current energy used by the specific feature, the estimated energy use of the proposed EEM and its installed cost. EEMs can range from a single simple upgrade, such as light bulb type or type of motor, to reprogramming of the controls on more complex systems. While the need for a major retrofit can typically be identified by an energy audit, the specific system upgrades often require collecting additional data and engineering and design efforts that are beyond the scope of the Level II energy audit.

Based on the field inspection results and discussions with the building owners/operators, auditors developed potential EEMs for the facility. Common EEMs that could apply to almost every older building include:

- Reduce the envelope heat losses through:
  - increased building insulation, and
  - better windows and doors
- Reduce temperature difference between inside and outside using setback thermostats
- Upgrade inefficient:
  - lights,
  - motors,
  - refrigeration units, and
  - other appliances
- Reduce running time of lights/appliances through:
  - motion sensors,
  - on/off timers,
  - light sensors, and
  - other automatic/programmable systems

The objective of the following sections is to describe how the overall energy use of the building was modeled and the potential for energy savings. The specific EEMs that provide these overall energy savings are detailed in Appendix A of this report. While the energy savings of an EEM is unlikely to change significantly over time, the cost savings of an EEM is highly dependent on the current energy price and can vary significantly over time. An EEM that is not currently recommended based on price may be more attractive at a later date or with higher energy prices..

3.1 Understanding How AkWarm Models Energy Consumption

NORTECH used the AkWarm model for evaluating the overall energy consumption at Tanacross School. The AkWarm program was developed by the Alaska Housing Finance Corporation (AHFC) to model residential energy use. The original AkWarm is the modeling engine behind the successful residential energy upgrade program that AHFC has operated for a number of years. In the past few years, AHFC has developed a version of this model for commercial buildings.

Energy use in buildings is modeled by calculating energy losses and consumption, such as:

- Heat lost through the building envelope components, including windows, doors, walls, ceilings, crawlspaces, and foundations. These heat losses are computed for each component based on the area, heat resistance (R-value), and the difference between the inside temperature and the outside temperature. AkWarm has a library of temperature profiles for villages and cities in Alaska.
- Window orientation, such as the fact that south facing windows can add heat in the winter but north-facing windows do not.
- Inefficiencies of the heating system, including the imperfect conversion of fuel oil or natural gas due to heat loss in exhaust gases, incomplete combustion, excess air, etc. Some electricity is also consumed in moving the heat around a building through pumping.
- Inefficiencies of the cooling system, if one exists, due to various imperfections in a mechanical system and the required energy to move the heat around.
- Lighting requirements and inefficiencies in the conversion of electricity to light; ultimately all of the power used for lighting is converted to heat. While the heat may be useful in the winter, it often isn't useful in the summer when cooling may be required to remove the excess heat. Lights are modeled by wattage and operational hours.
- Use and inefficiencies in refrigeration, compressor cooling, and heat pumps. Some units are more efficient than others. Electricity is required to move the heat from inside a compartment to outside it. Again, this is a function of the R-Value and the temperature difference between the inside and outside of the unit.
- Plug loads such as computers, printers, mini-fridges, microwaves, portable heaters, monitors, etc. These can be a significant part of the overall electricity consumption of the building, as well as contributing to heat production.
- The schedule of operation for lights, plug loads, motors, etc. is a critical component of how much energy is used.

AkWarm adds up these heat losses and the internal heat gains based on individual unit usage schedules. These estimated heat and electrical usages are compared to actual use on both a yearly and seasonal basis. If the AkWarm model is within 5 % to 10% of the most recent 12 months usage identified during benchmarking, the model is considered accurate enough to make predictions of energy savings for possible EEMs.

3.1.1 AkWarm Calculated Savings for the Tanacross School

Based on the field inspection results and discussions with the building owners/operators, auditors developed potential EEMs for the facility. These EEMs are then entered into AkWarm to determine if the EEM saves energy and is cost effective (i.e. will pay for itself). AkWarm calculates the energy and money saved by each EEM and calculates the length of time for the savings in reduced energy consumption to pay for the installation of the EEM. AkWarm makes recommendations based on the Savings/Investment Ratio (SIR), which is defined as ratio of the savings generated over the life of the EEM divided by the installed cost. Higher SIR values are better and any SIR above one is considered acceptable. If the SIR of an EEM is below one, the energy savings will not pay for the cost of the EEM and the EEM is not recommended. Preferred EEMs are listed by AkWarm in order of the highest SIR.

A summary of the savings from the recommended EEMs are listed in this table.

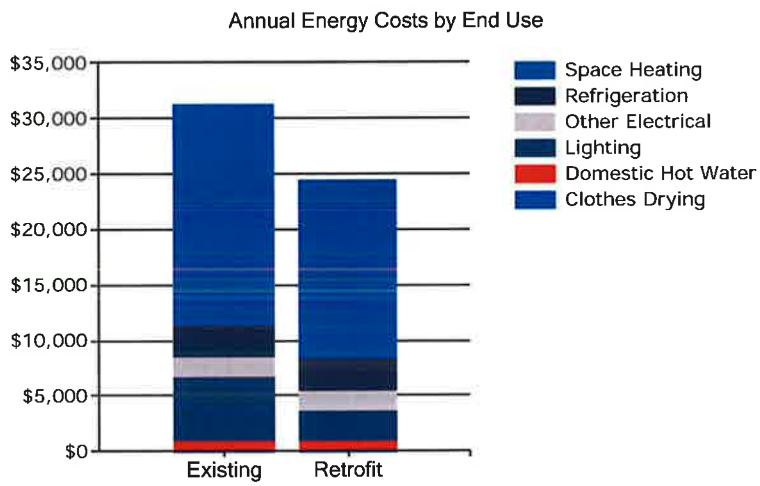
Description	Space Heating	Water Heating	Lighting	Refrigeration	Other Electrical	Clothes Drying	Total
Existing Building	$19,969	$905	$5,761	$2,740	$1,831	$75	**$31,281**
With All Proposed Retrofits	$16,146	$905	$2,692	$2,740	$1,831	$75	**$24,390**
Savings	$3,823	$0	$3,069	$0	$0	$0	**$6,891**

Savings in these categories do not reflect interaction with other categories. So, for example, the savings in lighting does not affect the added space heating cost to make up for the heat saved in replacing less-efficient lights with more-efficient lights that waste less heat.

3.1.2 AkWarm Projected Energy Costs after Modifications

The AkWarm recommended EEMs appear to result in significant savings in space heating and lighting. The energy cost by end use breakdown was provided by AkWarm based on the field inspection and does not indicate that all individual fixtures and appliances were directly measured. The current energy costs are shown below on the left hand bar of the graph and the projected energy costs, assuming use of the recommended EEMs, are shown on the right.

This graphical format allows easy visual comparison of the various energy requirements of the facility. In the event that not all recommended retrofits are desired, the proposal energy savings can be estimated from visual interpretation from this graph.



3.2 Energy Efficiency Measures Calculated Outside AkWarm

The AkWarm program effectively models wood-framed and other buildings with standard heating systems and relatively simple HVAC systems. AkWarm models of more complicated mechanical systems are sometimes poor due to a number of simplifying assumptions and limited input of some variables. Furthermore, AKWarm is unable to model complex HVAC systems such as variable frequency motors, variable air volume (VAV) systems, those with significant digital or pneumatic controls or significant heat recovery capacity. In addition, some other building methods and occupancies are outside AkWarm capabilities.

This report section is included in order to identify benefits from modifications to those more complex systems or changes in occupant behavior that cannot be addressed in AkWarm.

The Tanacross School could be modeled well in AKWarm. Retrofits for the HVAC system were adequately modeled in AkWarm and did not require additional calculations.

4.0 BUILDING OPERATION AND MAINTENANCE (O & M)

4.1 Operations and Maintenance

A well-implemented operation and maintenance (O & M) plan is often the driving force behind energy savings. Such a plan includes preserving institutional knowledge, directing preventative maintenance, and scheduling regular inspections of each piece of HVAC equipment within the building. Routine maintenance includes the timely replacement of filters, belts and pulleys, the proper greasing of bearings and other details such as topping off the glycol tanks. Additional benefits to a maintenance plan are decreased down time for malfunctioning equipment, early indications of problems, prevention of exacerbated maintenance issues, and early detection of overloading/overheating issues. A good maintenance person knows the building's equipment well enough to spot and repair minor malfunctions before they become major retrofits.

Operations and Maintenance staff implementing a properly designed O & M plan will:

- Track and document
  - Renovations and repairs,
  - Utility bills and fuel consumption, and
  - System performance.
- Keep available for reference
  - A current Building Operating Plan including an inventory of installed systems,
  - The most recent available as-built drawings,
  - Reference manuals for all installed parts and systems, and
  - An up-to-date inventory of on-hand replacement parts.
- Provide training and continuing education for maintenance personnel.
- Plan for commissioning and re-commissioning at appropriate intervals.

Commissioning of a building is the verification that the HVAC systems perform within the design or usage ranges of the Building Operating Plan. This process ideally, though seldom, occurs as the last phase in construction. HVAC system operation parameters degrade from ideal over time due to incorrect maintenance, improper replacement pumps, changes in facility tenants or usage, changes in schedules, and changes in energy costs or loads. Ideally, re-commissioning of a building should occur every five to ten years. This ensures that the HVAC system meets the potentially variable use with the most efficient means.

4.2 Building Specific Recommendations

The occupants of Tanacross School report uneven heat distribution to the classrooms. The heating system needs to be rebalanced. This can be done by having a balancing contractor permanently adjusting air flow through the floor registers in order to distribute heated air as necessary.

It is recommended that exposed heating ducts in the crawlspace be sealed with mastic in order to reduce the amount of possible heat leakage.

Weather-stripping on the doors and windows should be regularly inspected and replaced as needed.

APPENDICES

Appendix A Recommended Energy Efficiency Measures

A number of Energy Efficiency Measures (EEMs) are available to reduce the energy use and overall operating cost for the facility. The EEMs listed below are those recommended by AkWarm based on the calculated savings/investment ration (SIR) as described in Appendix E. AkWarm also provides a breakeven cost, which is the maximum initial cost of the EEM that will still return a SIR of one or greater.

This section describes each recommended EEM and identifies the potential energy savings and installation costs. This also details the calculation of breakeven costs, simple payback, and the SIR for each recommendation. The recommended EEMs are grouped together generally by the overall end use that will be impacted.

A.1 Temperature Control

Two programmable thermostats should be installed in Tanacross School. Programmable electronic thermostats allow for automatic temperature setback, which reduce usage more reliably than manual setbacks. Reduction of the nighttime temperature set point in the classrooms and gymnasium will decrease the energy usage.

Rank	Building Space		Recommendation		
1	Tanacross School		Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Tanacross School space.		
Installation Cost	$350	Estimated Life of Measure (yrs)	15	Energy Savings (/yr)	$1,332
Breakeven Cost	$18,061	Savings-to-Investment Ratio	52	Simple Payback yrs	0

Rank	Building Space		Recommendation		
3	Gymnasium		Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Gymnasium space.		
Installation Cost	$350	Estimated Life of Measure (yrs)	15	Energy Savings (/yr)	$412
Breakeven Cost	$5,580	Savings-to-Investment Ratio	16	Simple Payback yrs	1

A.2 Electrical Loads

A.2.1 Lighting

The electricity used by lighting eventually ends up as heat in the building. In areas where electricity is more expensive than other forms of energy, or in areas where the summer temperatures require cooling; this additional heat can be both wasteful and costly. Converting to more efficient lighting reduces cooling loads in the summer and allows the user to control heat input in the winter. The conversion from T12 (one and a half inch fluorescent bulbs) to T8 (one inch), T5 (5/8 inch), Compact Fluorescent Lights (CFL), or LED bulbs provides a significant increase in efficiency. LED bulbs can be directly placed in existing fixtures. The LED bulb bypasses the ballast altogether, which removes the often irritating, "buzzing" noise that magnetic ballasts tend to make.

The existing exterior lights use high amounts of wattage and should be replaced. A common retrofit for exterior lighting is LED wall packs. These fixtures will allow or similar levels of light at a much lower energy use.

Rank	Location		Existing Condition		Recommendation	
2	Exterior		2 INCAN A Lamp, Halogen 75W with Manual Switching		Replace with 2 LED 20W Module StdElectronic	
Installation Cost		$110	Estimated Life of Measure (yrs)	25	Energy Savings (/yr)	$110
Breakeven Cost		$1,882	Savings-to-Investment Ratio	17	Simple Payback yrs	1

Rank	Location		Existing Condition		Recommendation	
8	Exterior		7 HPS 100 Watt StdElectronic with Manual Switching		Replace with 7 LED 35W Module StdElectronic	
Installation Cost		$4,550	Estimated Life of Measure (yrs)	25	Energy Savings (/yr)	$548
Breakeven Cost		$9,346	Savings-to-Investment Ratio	2.1	Simple Payback yrs	8

All instances of incandescent lamps should be replaced with more efficient compact fluorescent lamps (CFLs). CFLs offer similar lighting as much lower energy use.

Rank	Location		Existing Condition		Recommendation	
4	Class 104, 107 Girls Locker, 108 Boys Locker, 113		6 INCAN A Lamp, Halogen 75W with Manual Switching		Replace with 6 FLUOR CFL, A Lamp 15W	
Installation Cost		$18	Estimated Life of Measure (yrs)	10	Energy Savings (/yr)	$26
Breakeven Cost		$217	Savings-to-Investment Ratio	12	Simple Payback yrs	1

The primary existing lighting in the majority of the school is ceiling mounted fluorescent fixtures with T12 lamps. Tanacross School experiences high costs of electricity and these inefficient lamps should be replaced. Along with the high energy usage, most of the rooms in the school are over-lit. The existing 34 watt T12 lamps can easily be replaced with 17 watt LED lamps. LED lamps result in a light difference of about 10 percent when compared to current 40 watt T12 lamps, but this should not be an issue with the current lighting levels.

Rank	Location		Existing Condition		Recommendation	
6	109, 110, 111, 114		10 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 10 LED (2) 17W Module StdElectronic	
Installation Cost		$1,750	Estimated Life of Measure (yrs)	20	Energy Savings (/yr)	$415
Breakeven Cost		$5,781	Savings-to-Investment Ratio	3.3	Simple Payback yrs	4

Rank	Location		Existing Condition		Recommendation	
7	Room 120		9 FLUOR (2) T12 4' F40T12 34W Energy-Saver EfficMagnetic with Manual Switching		Replace with 9 LED (2) 17W Module StdElectronic	
Installation Cost		$1,575	Estimated Life of Measure (yrs)	20	Energy Savings (/yr)	$270
Breakeven Cost		$3,748	Savings-to-Investment Ratio	2.4	Simple Payback yrs	6

Rank	Location		Existing Condition		Recommendation	
9	Room 122		16 FLUOR (2) T12 4' F40T12 34W Energy-Saver EfficMagnetic with Manual Switching		Replace with 16 LED (2) 17W Module StdElectronic	
Installation Cost		$2,800	Estimated Life of Measure (yrs)	20	Energy Savings (/yr)	$385
Breakeven Cost		$5,352	Savings-to-Investment Ratio	1.9	Simple Payback yrs	7

Rank	Location		Existing Condition		Recommendation	
11	Rooms 101, 107 Girls Locker, 108 Boys Locker, 119, 121		46 FLUOR (2) T12 4' F40T12 34W Energy-Saver EfficMagnetic with Manual Switching		Replace with 46 LED (2) 17W Module StdElectronic	
Installation Cost		$8,050	Estimated Life of Measure (yrs)	20	Energy Savings (/yr)	$841
Breakeven Cost		$11,736	Savings-to-Investment Ratio	1.5	Simple Payback yrs	10

A.2.2 Other Electrical Loads

No EEMs are recommended in this area as there aren't any significant plug loads in Tanacross School.

A.3 Building Envelope: Recommendations for change

A.3.1 Exterior Walls

No EEMs are recommended in this area because additional insulation is not economical at this time.

A.3.2 Foundation and/or Crawlspace

Tanacross School can save energy by insulating the perimeter of the crawlspace floor. This is a method recently developed to save additional energy and keep the crawlspace warmer.

Rank	Location		Existing Condition		Recommendation	
5	On- or Below-Grade Floor, Perimeter: Crawlspace Perimeter		Insulation for 0' to 2' Perimeter: None Insulation for 2' to 4' Perimeter: None Modeled R-Value: 12.4		Install R-19 Poly-Wrapped Fiberglass Batts on the Perimeter 4 feet of the Crawl Space Floor.	
Installation Cost		$2,441	Estimated Life of Measure (yrs)	30	Energy Savings (/yr)	$798
Breakeven Cost		$18,899	Savings-to-Investment Ratio	7.7	Simple Payback yrs	3

A.3.3 Roofing and Ceiling

No EEMs are recommended in this area because the existing roof already has a sufficient amount of roof insulation and additional insulation is not economical at this time.

A.3.4 Windows

Window retrofits typically do not pay off as they are costly to install. However, Tanacross School has a few single pane windows. These should be replaced as they off very little insulation value and produce significant air leakage.

Rank	Location		Existing Condition		Recommendation	
12	Window/Skylight: Single Pane Wood Other		Glass: Single, Glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.52		Replace existing window with U-0.22 vinyl window	
Installation Cost		$5,721	Estimated Life of Measure (yrs)	20	Energy Savings (/yr)	$435
Breakeven Cost		$7,569	Savings-to-Investment Ratio	1.3	Simple Payback yrs	13

Appendix G References

Although not all documents listed below are specifically referenced in this report, each contains information and insights considered valuable to most buildings.

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Appendix H Typical Energy Use and Cost – Fairbanks and Anchorage

This report provides data on typical energy costs and use on selected building in Fairbanks and Anchorage, Alaska for comparative purposes only. The values provided by the US Energy Information Administration CBECS study included a broader range of building types for the Continental U.S. are not necessarily good comparatives for buildings and conditions in Alaska. An assortment of values from CBECS may be found in Appendix I.

The Alaska data described in this report came from a benchmarking study NORTECH and other Technical Services Providers (TSPs) completed on publicly owned buildings in Alaska under contract with AHFC. This study acquired actual utility data for municipal buildings and schools in Alaska for the two recent full years. The utility data included costs and quantities including fuel oil, electricity, propane, wood, steam, and all other energy source usage. This resulted in a database of approximately 900 buildings. During the course of the benchmarking study, the comparisons made to the CBECS data appeared to be inappropriate for various reasons. Therefore, this energy use audit report references the average energy use and energy cost of Anchorage and Fairbanks buildings as described below.

The Alaska benchmarking data was evaluated in order to find valid comparison data. Buildings with major energy use information missing were eliminated from the data pool. After detailed scrutiny of the data, the most complete information was provided to NORTECH by the Fairbanks North Star Borough School District (FNSBSD) and the Anchorage School District (ASD). The data sets from these two sources included both the actual educational facilities as well as the district administrative buildings and these are grouped together in this report as Fairbanks and Anchorage schools. These two sources of information, being the most complete and reasonable in-state information, have been used to identify an average annual energy usage for Fairbanks and for Anchorage in order to provide a comparison for other facilities in Alaska.

Several factors may limit the comparison of a specific facility to these regional indicators. In Fairbanks, the FNSBSD generally uses number two fuel oil for heating needs and electricity is provided by Golden Valley Electric Association (GVEA). GVEA produces electricity from a coal fired generation plant with additional oil generation upon demand. A few of the FNSBSD buildings in this selection utilize district steam and hot water. The FNSBSD has recently (the last ten years) invested significantly in envelope and other efficiency upgrades to reduce their operating costs. Therefore a reader should be aware that this selection of Fairbanks buildings has energy use at or below average for the entire Alaska benchmarking database.

Heating in Anchorage is through natural gas from the nearby natural gas fields. Electricity is also provided using natural gas. As the source is nearby and the infrastructure for delivery is in place, energy costs are relatively low in the area. As a result, the ASD buildings have lower energy costs, but higher energy use, than the average for the entire benchmarking database.

These special circumstances should be considered when comparing the typical annual energy use for particular buildings.

Appendix I Typical Energy Use and Cost – Continental U.S.

Released: Dec 2006

Next CBECS will be conducted in 2007

Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003

	All Buildings*			Sum of Major Fuel Consumption			
	Number of Buildings (thousand)	Floor space (million square feet)	Floor space per Building (thousand square feet)	Total (trillion BTU)	per Building (million BTU)	per Square Foot (thousand BTU)	per Worker (million BTU)
All Buildings*	4,645	64,783	13.9	5,820	1,253	89.8	79.9
Building Floor space (Square Feet)							
1,001 to 5,000	2,552	6,789	2.7	672	263	98.9	67.6
5,001 to 10,000	889	6,585	7.4	516	580	78.3	68.7
10,001 to 25,000	738	11,535	15.6	776	1,052	67.3	72.0
25,001 to 50,000	241	8,668	35.9	673	2,790	77.6	75.8
50,001 to 100,000	129	9,057	70.4	759	5,901	83.8	90.0
100,001 to 200,000	65	9,064	138.8	934	14,300	103.0	80.3
200,001 to 500,000	25	7,176	289.0	725	29,189	101.0	105.3
Over 500,000	7	5,908	896.1	766	116,216	129.7	87.6
Principal Building Activity							
Education	386	9,874	25.6	820	2,125	83.1	65.7
Food Sales	226	1,255	5.6	251	1,110	199.7	175.2
Food Service	297	1,654	5.6	427	1,436	258.3	136.5
Health Care	129	3,163	24.6	594	4,612	187.7	94.0
Inpatient	8	1,905	241.4	475	60,152	249.2	127.7
Outpatient	121	1,258	10.4	119	985	94.6	45.8
Lodging	142	5,096	35.8	510	3,578	100.0	207.5
Retail (Other Than Mall)	443	4,317	9.7	319	720	73.9	92.1
Office	824	12,208	14.8	1,134	1,376	92.9	40.3
Public Assembly	277	3,939	14.2	370	1,338	93.9	154.5
Public Order and Safety	71	1,090	15.5	126	1,791	115.8	93.7
Religious Worship	370	3,754	10.1	163	440	43.5	95.6
Service	622	4,050	6.5	312	501	77.0	85.0
Warehouse and Storage	597	10,078	16.9	456	764	45.2	104.3
Other	79	1,738	21.9	286	3,600	164.4	157.1
Vacant	182	2,567	14.1	54	294	20.9	832.1

This report references the Commercial Buildings Energy Consumption Survey (CBECS), published by the U.S. Energy Information Administration in 2006. Initially this report was expected to compare the annual energy consumption of the building to average national energy usage as documented below. However, a direct comparison between one specific building and the groups of buildings outlined below yielded confusing results. Instead, this report uses a comparative analysis on Fairbanks and Anchorage data as described in Appendix F. An abbreviated excerpt from CBECS on commercial buildings in the Continental U.S. is below.

Appendix J List of Conversion Factors and Energy Units

1 British Thermal Unit	is the energy required to raise one pound of water one degree F°
1 Watt	is approximately 3.412 BTU/hr.
1 horsepower	is approximately 2,544 BTU/hr.
1 horsepower	is approximately 746 Watts
1 "ton of cooling"	is approximately 12,000 BTU/hr., the amount of power required to melt one short ton of ice in 24 hours

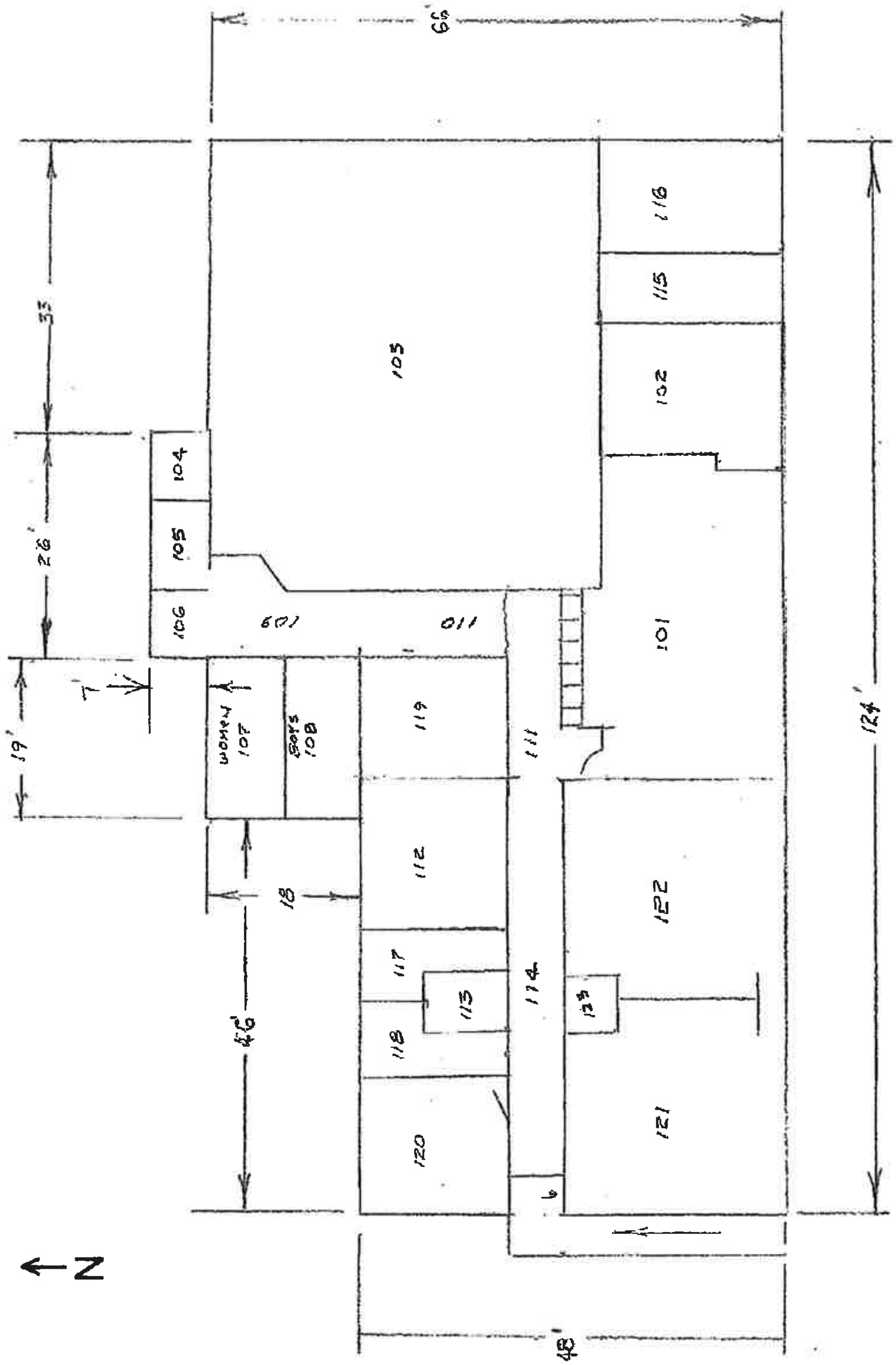
1 Therm	= 100,000 BTU
1 KBTU	= 1,000 BTU
1 KWH	= 3413 BTU
1 KW	= 3413 BTU/Hr.
1 Boiler HP	= 33,400 BTU/Hr.
1 Pound Steam	= approximately 1000 BTU
1 CCF of natural gas	= approximately 1 Therm
1 inch H2O	= 250 Pascal (Pa) = 0.443 pounds/square inch (psi)
1 atmosphere (atm)	= 10,1000 Pascal (Pa)

BTU	British Thermal Unit
CCF	100 Cubic Feet
CFM	Cubic Feet per Minute
GPM	Gallons per minute
HP	Horsepower
Hz	Hertz
kg	Kilogram (1,000 grams)
kV	Kilovolt (1,000 volts)
kVA	Kilovolt-Amp
kVAR	Kilovolt-Amp Reactive
KW	Kilowatt (1,000 watts)
KWH	Kilowatt Hour
V	Volt
W	Watt

Appendix K List of Acronyms, Abbreviations, and Definitions

ACH	Air Changes per Hour
AFUE	Annual Fuel Utilization Efficiency
Air Economizer	A duct, damper, and automatic control system that allows a cooling system to supply outside air to reduce or eliminate the need for mechanical cooling.
Ambient Temperature	Average temperature of the surrounding air
Ballast	A device used with an electric discharge lamp to cause the lamp to start and operate under the proper circuit conditions of voltage, current, electrode heat, etc.
CO_2	Carbon Dioxide
CUI	Cost Utilization Index
CDD	Cooling Degree Days
DDC	Direct Digital Control
EEM	Energy Efficiency Measure
EER	Energy Efficient Ratio
EUI	Energy Utilization Index
FLUOR	Fluorescent
Grade	The finished ground level adjoining a building at the exterior walls
HDD	Heating Degree Days
HVAC	Heating, Ventilation, and Air-Conditioning
INCAN	Incandescent
NPV	Net Present Value
R-value	Thermal resistance measured in BTU/Hr.-SF-F (Higher value means better insulation)
SCFM	Standard Cubic Feet per Minute
Savings to Investment Ratio (SIR)	Savings over the life of the EEM divided by Investment capital cost. Savings includes the total discounted dollar savings considered over the life of the improvement. Investment in the SIR calculation includes the labor and materials required to install the measure.
Set Point	Target temperature that a control system operates the heating and cooling system
Simple payback	A cost analysis method whereby the investment cost of an EEM is divided by the first year's savings of the EEM to give the number of years required to recover the cost of the investment.

Appendix L Building Floor Plan



Floor plan drawn by *NORTECH* based on field measurements

Preliminary Feasibility Assessment for High Efficiency, Low Emission Wood Heating In Tanacross, Alaska

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Submitted June 20, 2008

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Key words: HELE, LEHE, bulk fuel, cordwood

ABSTRACT

The potential for heating various facilities in Tanacross, Alaska with high efficiency, low emission (HELE) wood-fired boilers is evaluated for the Tanacross Village Council (TVC).

Early in 2007, organizations were invited to submit a Statement of Interest (SOI) to the Alaska Wood Energy Development Task Group (AWEDTG). Task Group representatives reviewed all the SOIs and selected projects for further review based on selection criteria presented in Appendix A. AWEDTG representatives visited Tanacross during the summer of 2007 and information was obtained for the various facilities. Preliminary assessments were made and challenges identified. Potential wood energy systems were considered for the projects using AWEDTG, USDA and AEA objectives for energy efficiency and emissions. Preliminary findings are reported.

SECTION 1. EXECUTIVE SUMMARY

1.1 Goals and Objectives

- Identify facilities in Tanacross as potential candidates for heating with wood
- Evaluate the suitability of the facilities and sites for siting a wood-fired boiler
- Assess the type(s) and availability of wood fuel(s)
- Size and estimate the capital costs of suitable wood-fired system(s)
- Estimate the annual operation and maintenance costs of a wood-fired system
- Estimate the potential economic benefits from installing a wood-fired heating system

1.2 Evaluation Criteria, Project Scale, Operating Parameters, General Observations

- This project meets the AWEDTG objectives for petroleum fuel displacement, use of hazardous forest fuels or forest treatment/processing residues, sustainability of the wood supply, community support, and project implementation, operation and maintenance.

- Given annual fuel oil consumption estimates of 8,000 gallons (water plant), 10,000 gallons (Upper Tanana Regional Training Center), and 14,000 gallons (planned multi-purpose facility) these projects would be considered "medium" in terms of their relative sizes.

- Medium and large energy consumers have the best potential for feasibly implementing a wood-fired heating system. Where preliminary feasibility assessments indicate positive financial metrics, detailed engineering analyses are usually warranted.

- Cordwood systems are generally appropriate for applications where the maximum heating demand ranges from 100,000 to 1,000,000 Btu per hour. "Bulk fuel" systems are generally applicable for situations where the heating demand exceeds 1 million Btu per hour. However, these are general guidelines; local conditions can exert a strong influence on the best system choice.

- Efficiency and emissions standards for Outdoor Wood Boilers (OWB) changed in 2006, which could increase costs for small systems.

1.3 Assessment Summary and Recommended Actions

Three facilities are considered in this report:

1.3.1. Tanacross Water Plant

• Overview. It was reported that the Tanacross water plant heats very cold incoming well-water about 14 degrees before distributing the water to residences on the city water system. Currently that amounts to approximately 20,000 gallons of water per day, requiring approximately 2,337,000 net Btu. This heat is provided by three Weil-McLain Gold P-WGO-5 boilers, rated at 152,000 Btu/hr net (each), with a firing rate of 1.45 gallons per hour (each).

• Fuel Consumption. Assuming that the water plant heats 20,000 gallons per day by 14 degrees Fahrenheit, and operates 365 days per year, the annual fuel consumption would be approximately **8,000 gallons**.

• Potential Savings. At the projected price of about $5.00 per gallon, the Tanacross water plant spends approximately $40,000 per year for fuel oil. The HELE *cordwood* fuel equivalent of 8,000 gallons of #1 fuel oil is approximately **94 cords**, and at $125 per cord represents a potential **annual fuel cost savings of $28,250** (debt service and non-fuel OM&R costs notwithstanding).

• Required boiler capacity. The estimated required boiler capacity (RBC) to heat the water at the Tanacross water plant is dependent on the amount of water to be heated per hour. The installed capacity at the plant is currently 456,000 Btu (the combined capacity of the three existing boilers). If the plant operates 10 hours per, and total daily production amounts to 20,000 gallons, then the minimum RBC would be approximately **234,000** Btu/hr.

• Recommended action regarding a cordwood system. Given the initial assumptions and cost estimates for the alternatives presented in this report, this project appears to be cost-effective and operationally viable. Further consideration is warranted. (See Section 6)

• Recommended action regarding a bulk fuel wood system. Given the heating demand, lack of fuel supply, and the probable costs of such a project, a “bulk fuel” system is not cost-effective for the Tanacross water plant.

1.3.2. Upper Tanana Regional Training Center

• Overview. The Upper Tanana Regional Training Center (UTRTC) is being developed at the old Tok school building in Tok, AK. TVC has renovated a portion of the facility (the gymnasium and adjacent spaces) for use as a construction trades training center, a manufactured home facility and office space. This space occupies approximately 10,000 square feet. Heat is provided by two Weil-McLain series 78 boilers (model 778?) rated at 625,000 Btu/hr (net, each), with a maximum burner rate of 6.5 gallons per hour (each). Whether or not the remainder of the building gets renovated and utilized remains to be seen.

• Fuel Consumption. Fuel consumption at the UTRTC was not known. The estimated consumption of **10,000 gallons** per year is based on a projected average consumption of 1 gallon per square foot per year.

• Potential Savings. At the projected price of about $5.00 per gallon, the UTRTC spends approximately $50,000 per year for fuel oil (based on the assumed 10,000 gpy). The HELE *cordwood* fuel equivalent of 10,000 gallons of #1 fuel oil is approximately **117 cords**, and at $125 per cord represents a potential annual fuel cost savings of $35,375 (debt service and non-fuel OM&R costs notwithstanding).

• Required boiler capacity. The estimated required boiler capacity (RBC) to heat the UTRTC is approximately **345,793** Btu/hr during the coldest 24-hour period (based on the assumed 10,000 gpy).

• Recommended action regarding a cordwood system. Given the initial assumptions and cost estimates for the alternatives presented in this report, this project appears to be cost-effective and operationally viable. Further consideration is warranted. (See Section 6)

• Recommended action regarding a bulk fuel wood system. Given the heating demand, lack of fuel supply, and the probable costs of such a project, a "bulk fuel" system is not cost-effective for the UTRTC.

1.3.3. Tanacross Village Council, Multi-Purpose Facility (MPF)

• Overview. Tanacross Village Council is developing a 14,000 square foot Multi Purpose Community Services Center (MPF) that will host a mid-level community health center, Headstart center, social services offices and large meeting area. TVC has developed the facility site, installed a concrete foundation and piped/water services to the building foundation. TVC plans to complete the building in 2007/2008.

• Fuel Consumption. Since this is a new facility, fuel consumption at the TVC MPF is not known. The estimated consumption of **14,000 gallons** per year is based on a projected average consumption of 1 gallon per square foot per year..

• Potential Savings. At the projected price of about $5.00 per gallon, TVC MPF will spend approximately $70,000 per year for fuel oil. The HELE *cordwood* fuel equivalent of 14,000 gallons of #1 fuel oil is approximately **164 cords**, and at $125 per cord represents a potential annual fuel cost savings of $49,500 (debt service and non-fuel OM&R costs notwithstanding).

• Required boiler capacity. The estimated required boiler capacity (RBC) to heat the TVC MPF would be approximately 483,854 Btu/hr during the coldest 24-hour period, based on an annual consumption projection of 14,000 gallons.

• Recommended action regarding a cordwood system. Given the initial assumptions and cost estimates for the alternatives presented in this report, this project appears to be cost-effective and operationally viable. Further consideration is warranted. (See Section 6)

• Recommended action regarding a bulk fuel wood system. Given the heating demand, lack of fuel supply, and the probable costs of such a project, a "bulk fuel" system is not cost-effective for the TVC MPF.

SECTION 2. EVALUATION CRITERIA, IMPLEMENTATION, WOOD HEATING SYSTEMS

The approach being taken by the Alaska Wood Energy Development Task Group (AWEDTG) regarding biomass energy heating projects follows the recommendations of the Biomass Energy

Resource Center (BERC), which advises that, "[*T*]*he most cost-effective approach to studying the feasibility for a biomass energy project is to approach the study in stages*." Further, BERC advises "*not spending too much time, effort, or money on a full feasibility study before discovering whether the potential project makes basic economic sense*" and suggests, "[*U*]*ndertaking a pre-feasibility study . . . a basic assessment, not yet at the engineering level, to determine the project's apparent cost-effectiveness*". [Biomass Energy Resource Center, Montpelier, Vermont. www.biomasscenter.org]

2.1 Evaluation Criteria

The AWEDTG selected projects for evaluation based on criteria listed in Appendix A. The Tanacross projects meet the AWEDTG criteria for potential petroleum fuel displacement, use of forest residues for public benefit, use of local processing residues, sustainability of the wood supply, community support, and the ability to implement, operate and maintain the project. In the case of a cordwood boiler system, the potential to supply wood from local forests appears adequate and matches the application.

One of the objectives of the AWEDTG is to support projects that would use energy-efficient and clean burning wood heating systems, i.e., high efficiency, low emission (HELE) systems.

2.2 Successful Implementation

In general, four aspects of project implementation have been important to wood energy projects in the past: 1) a project "champion", 2) clear identification of a sponsoring agency/entity, 3) dedication of and commitment by facility personnel, and 4) a reliable and consistent supply of fuel.

In situations where several organizations are responsible for different community services, it must be clear which organization would sponsor and/or implement a wood-burning project. (NOTE: This is not necessarily the case with the projects in Tanacross but this issue should be addressed.)

With manual systems, boiler stoking and/or maintenance is required for approximately 10 to 20 minutes per boiler several times a day (depending on the heating demand), and dedicating personnel for the operation is critical to realizing savings from wood fuel use. For this report, it is assumed that new personnel would be hired or existing qualified personnel would be assigned as necessary, and that "boiler duties" would be included in the responsibilities and/or job description of facility personnel.

The forest industry infrastructure in/around Tanacross and the upper Tanana Valley is fairly well-developed. For this report, it is assumed that wood supplies are sufficient to meet the demand.

2.3 Classes of Wood Heating Systems

There are, basically, two classes of wood heating systems: manual cordwood systems and automated "bulk fuel" systems. Cordwood systems are generally appropriate for applications where the maximum heating demand ranges from 100,000 to 1,000,000 Btu per hour, although smaller and larger applications are possible. "Bulk fuel" systems are systems that burn wood chips, sawdust, bark/hog fuel, shavings, pellets, etc. They are generally applicable for situations where the heating demand exceeds 1 million Btu per hour, although local conditions, especially fuel availability, can exert strong influences on the feasibility of a bulk fuel system.

Usually, an automated bulk fuel boiler is tied-in directly with the existing oil-fired system. With a cordwood system, glycol from the existing oil-fired boiler system would be circulated through a heat exchanger at the wood boiler ahead of the existing oil boiler. A bulk fuel system is usually designed to replace 100% of the fuel oil used in the oil-fired boiler, and although it is possible for a cordwood system to be similarly designed, they are usually intended as a supplement, albeit a large supplement, to an oil-fired system. In either case, the existing oil-fired system would remain in place and be available for peak demand or backup in the event of downtime in the wood system.

SECTION 3. THE NATURE OF WOOD FUELS

3.1 Wood Fuel Forms and Current Utilization

Currently, wood fuels in Tanacross will generally be in the form of cordwood and/or large unprocessed sawmill residues (slabs, edgings). Residential use of cordwood has increased significantly in the past 18 months due to sharply higher fuel oil costs. Given that higher demand, prices for firewood have gone up accordingly.

3.2 Heating Value of Wood

Wood is a unique fuel whose heating value is quite variable, depending on species of wood, moisture content, and other factors. There are also several recognized 'heating values': high heating value (HHV), gross heating value (GHV), recoverable heating value (RHV), and deliverable heating value (DHV) that may be assigned to wood at various stages in the calculations.

For this report, white spruce cordwood at 30 percent moisture content (MC30) calculated on the wet weight basis (also called green weight basis), is used as the benchmark. [It should be noted that other species are also present, including black spruce, white birch, cottonwood/poplar, willow and aspen. And although white spruce is used as the "benchmark", any species of wood can be burned in a cordwood system; the most critical factor being moisture content, not species.]

The HHV of white spruce at 0% moisture content (MC0) is 8,890 Btu/lb[1]. The GHV at 30% moisture content (MC30) is 6,223 Btu/lb.

The RHV for white spruce *cordwood* (MC30) is calculated at 12.22 million Btu per **cord**, and the DHV, which is a function of boiler efficiency (assumed to be 75%), is 9.165 million Btu per cord. The delivered heating value of 1 **cord** of white spruce cordwood (MC30) equals the delivered heating value of **85.5** gallons of #1 fuel oil or **83.0** gallons of #2 fuel oil when the wood is burned at 75% conversion efficiency.

A more thorough discussion of the heating value of wood can be found in Appendix B and Appendix D.

SECTION 4. WOOD-FUELED HEATING SYSTEMS

4.1 Low Efficiency High Emission (LEHE) Cordwood Boilers

Outdoor wood boilers (OWBs) are relatively low-cost and can save fuel but most have been criticized for low efficiency and smoky operation. These could be called low efficiency, high emission (LEHE) systems and there are dozens of manufacturers. The State of New York instituted a moratorium in 2006 on new LEHE OWB installations due to concerns over emissions and air quality[5]. Other states are also considering or have implemented new regulations[6,7,8,9]. But since there are no federal standards for OWBs (wood-fired boilers and furnaces were exempted from the 1988 EPA regulations[10]), OWB ratings are inconsistent and can be misleading. Standard procedures for evaluating wood boilers do not exist, but test data from New York, Michigan and elsewhere showed a wide range of apparent [in]efficiencies and emissions among OWBs.

In 2006, a committee was formed under the American Society for Testing and Materials (ASTM) to develop a standard test protocol for OWBs[11]. The standards included uniform procedures for determining performance and emissions. Subsequently, the ASTM committee sponsored tests of three common outdoor wood boilers using the new procedures. The results showed efficiencies as low as 25% and emissions **more than nine times** the standard for industrial boilers. Obviously, these results were deemed unsatisfactory and new OWB standards were called for.

In a news release dated January 29, 2007[12], the U.S. Environmental Protection Agency announced a new voluntary partnership agreement with 10 major OWB manufacturers to make cleaner-burning appliances. The new, Phase 1 standard calls for emissions not to exceed 0.60 pounds of particulate emissions per million Btu of heat **input**. The Phase 2 standard, which will follow 2 years after Phase 1, will limit emissions to 0.30 pounds per million Btus of heat **delivered**, thereby creating an efficiency standard as well.

To address local and state concerns over regulating OWB installations, the Northeast States for Coordinated Air Use Management (NeSCAUM), and EPA have developed model regulations that recommend OWB installation specifications, clean fuel standards and owner/operator training. (http://www.epa.gov/woodheaters/ and http://www.nescaum.org/topics/outdoor-hydronic-heaters)

Implementation of the new standard will improve air quality and boiler efficiency but will also increase costs as manufacturers modify their designs, fabrication and marketing to adjust to the new standards. As a result, some low-end models will no longer be available.

4.2 High Efficiency Low Emission (HELE) Cordwood Boilers

In contrast to low efficiency, high emission cordwood boilers there are a few units that can correctly be considered high efficiency, low emission (HELE). These systems are designed to burn cordwood fuel cleanly and efficiently.

Table 4-1 lists four HELE cordwood boiler suppliers, two of which have units operating in Alaska. HS Tarm/Tarm USA has a number of residential units operating in Alaska, and a Garn boiler manufactured by Dectra Corporation is used in Dot Lake, AK to heat several homes and the washeteria, replacing 7,000 gallons per year (gpy) of #2 fuel oil.[14] Two Garn boilers were recently installed in Tanana, AK (on the Yukon River) to provide heat to the washeteria and water plant, and two were installed near Kasilof on the Kenai Peninsula.

Table 4-1. HELE Cordwood Boiler Suppliers

	Btu/hr ratings	Supplier
EKO-Line	85,000 to 275,000	New Horizon Corp www.newhorizoncorp.com
Tarm	100,000 to 198,000	HS Tarm/Tarm USA www.tarmusa.com/wood-gasification.asp
Greenwood	100,000 to 300,000	Greenwood www.GreenwoodFurnace.com
Garn	350,000 to 950,000	Dectra Corp. www.garn.com

Note: Listing of any manufacturer, distributor or service provider does not constitute an endorsement.

Table 4-2 shows the results for a Garn WHS 1350 boiler that was tested at 157,000 to 173,000 Btu/hr using the new ASTM testing procedures, compared with EPA standards for wood stoves and boilers. It is important to remember that wood fired boilers are not entirely smokeless; even very efficient wood boilers may smoke for a few minutes on startup.[4,15]

Table 4-2. Emissions from Wood Heating Appliances	
Appliance	Emissions (grams/1,000 Btu delivered)
EPA Certified Non Catalytic Stove	0.500
EPA Certified Catalytic Stove	0.250
EPA Industrial Boiler (many states)	0.225
GARN WHS 1350 Boiler*	0.179
Source: Intertek Testing Services, Michigan, March 2006. Note: *With dry oak cordwood; average efficiency of 75.4% based upon the high heating value (HHV) of wood	

4.3 Bulk Fuel Boiler Systems

The term "bulk fuel" as used in this report refers, generically, to sawdust, wood chips, shavings, bark, pellets, etc. Since the availability of bulk fuel is essentially non-existent around Tanacross, the cost of bulk fuel systems is so high (i.e., $1 million and up), and the relatively small heating demand for the projects under consideration, the discussion of bulk fuel boiler systems has been omitted from this report.

SECTION 5. SELECTING THE APPROPRIATE SYSTEM

Selecting the appropriate heating system is, primarily, a function of heating demand. It is generally not feasible to install automated bulk fuel systems in/at small facilities, and it is likely to be impractical to install cordwood boilers at very large facilities. Other than demand, system choice can be limited by fuel availability, fuel form, labor, financial resources, and limitations of the site.

The selection of a wood-fueled heating system has an impact on fuel economy. Potential savings in fuel costs must be weighed against initial investment costs and ongoing operating, maintenance and repair (OM&R) costs. Wood system costs include the initial capital costs of purchasing and installing the equipment, non-capital costs (engineering, permitting, etc.), the cost of the fuel storage building and boiler building (if required), the financial burden associated with loan interest, the fuel cost, and the other costs associated with operating and maintaining the heating system, especially labor.

5.1 Comparative Costs of Fuels

Table 5-1 compares the cost of #1 and #2 fuel oil to white spruce *cordwood* (MC30) In order to make reasonable comparisons, costs are provided on a "per million Btu" (MMBtu) basis.

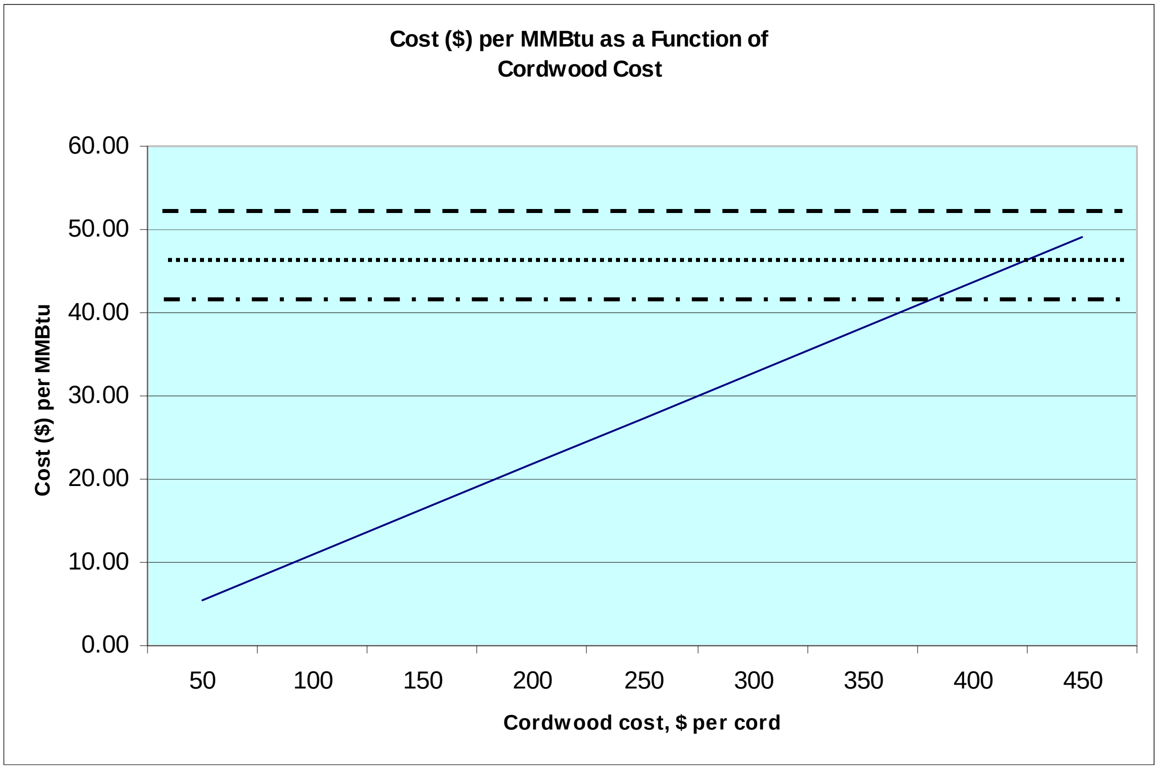
Table 5-1. Comparative Cost of Fuel Oil vs. Wood Fuels					
FUEL	RHV[a] (Btu)	Conversion Efficiency[a]	DHV[a] (Btu)	Price per unit ($)	Cost per MMBtu (delivered, ($))
Fuel oil, #1, (per 1 gallon)	134,000	80%	107,200 per gallon	4.50/gal	41.978
				5.00	46.642
				5.50	51.306
Fuel oil, #2, (per 1 gallon)	138,000	80%	110,400 per gallon	4.50/gal	40.761
				5.00	45.29
				5.50	49.819
White spruce, (per 1 cord, MC30)	12.22 million	75%	9.165 million	100/cord	10.911
				125	13.639
				150	16.367

Notes:
[a] from Appendix D

5.2(a) Cost per MMBtu Sensitivity – Cordwood

Figure 5-1 illustrates the relationship between the price of white spruce cordwood (MC30) and the cost of delivered heat, (the slanted line). For each $10 per *cord* increase in the price of cordwood, the cost per million Btu increases by $1.091. The chart assumes that the cordwood boiler delivers 75% of the RHV energy in the cordwood to useful heat and that oil is converted to heat at 80% efficiency. The dashed lines represent #1 fuel oil at $4.50, $5.00 and $5.50 per gallon ($41.978, $46.642 and $51.306 per million Btu respectively).

At high efficiency, heat from white spruce cordwood (MC30) at $427.47 per cord is equal to the cost of #1 fuel oil at $5.00 per gallon (i.e., $46.642 per MMBtu), before considering the cost of the equipment and operation, maintenance and repair (OM&R) costs. At 75% efficiency and $125 per cord, a high-efficiency cordwood boiler will deliver heat at about 29% of the cost of #1 fuel oil at $5.00 per gallon ($13.639 versus $46.642 per MMBtu). Figure 5-1 indicates that, at a given efficiency, savings increase significantly with decreases in the delivered price of cordwood and/or with increases in the price of fuel oil.



Fuel Oil at $5.50 per gallon
Fuel Oil at $5.00 per gallon
Fuel Oil at $4.50 per gallon

Figure 5-1. Effect of White Spruce Cordwood Price on Cost of Delivered Heat

5.2(b) Cost per MMBtu Sensitivity – Bulk Fuels

Not included in this report

5.3 Determining Demand

Table 5-2 shows the reported approximate amount of fuel oil used by various facilities in Tanacross, Alaska.

Table 5-2. Reported Annual Fuel Oil Consumption, Tanacross, AK

Facility	**Reported Annual Fuel Consumption**	
	Gallons	*Cost ($) @ $5.00/gallon*
Water plant	8,000	40,000
UTRTC	10,000	50,000
TVC MPF	14,000	70,000
TOTAL	**32,000**	**160,000**

Wood boilers, especially cordwood boilers, are often sized to displace only a portion of the heating load since the oil system will remain in place, in standby mode, for “shoulder seasons” and peak demand. Fuel oil consumption for the Tanacross facilities (except the water plant) was compared with heating demand based on heating degree days (HDD) to determine the required boiler capacity (RBC) for heating only on the coldest 24-hour day (Table 5-3). While there are many factors to consider when sizing heating systems it is clear that, in most cases, a wood system of less-than-maximum size could still replace a substantial quantity of fuel oil and save money.

Typically, installed oil-fired heating capacity at most sites is two-to-four times the demand for the coldest day. It appears that the Tanacross facilities fall within this range, although the heating capacity of the of the heating system ay the TVC MPF is unknown (non-existent; new construction).

Manual HELE cordwood boilers equipped with special tanks for extra thermal storage can supply heat at higher than their rated capacity for short periods. For example, while rated at 950,000 Btu/hr (heat into storage), a Garn WHS 4400 can store nearly three million Btu, which, theoretically, would be enough to heat for the UTRTC during the coldest 24-hour period for about 8½ hours (2,932,000 ÷ 345,793).

Table 5-3. Estimate of Heat Required in Coldest 24-Hour Period

Facility	Fuel Oil Used gal/year[a]	Heating Degree Days[d]	Btu/DD[c]	Design Temp[d] F	RBC[e] Btu/hr	Installed Btu/hr[a]
Water plant	8,000		NA		234,000 (estimated)	525,000 (gross) 456,000 (net)
UTRTC	10,000	15,400 (Gulkana data)	69,610	-54	345,793	1,250,000
TVC MPF	14,000		208,831		483,854	unknown

Table 5-3 Footnotes:

[a] From SOI and site visit; net total Btu/hr

[b] NOAA, July 1, 2005 through June 30, 2006: ftp://ftp.cpc.ncep.noaa.gov/htdocs/products/analysis_monitoring/cdus/degree_days/archives/Heating%20degree%20Days/Monthly%20City/2006/jun%202006.txt

[c] Btu/DD= Btu/year x oil furnace conversion efficiency (0.85) /Degree Days

[d] Alaska Housing Manual, 4th Edition Appendix D: Climate Data for Alaska Cities, Research and Rural Development Division, Alaska Housing Finance Corporation, 4300 Boniface Parkway, Anchorage, AK 99504, January 2000.

[e] RBC = Required Boiler Capacity for the coldest Day, Btu/hr= [Btu/DD x (65 F-Design Temp)+DD]/24 hrs

According to these calculations (Table 5-3), it appears that the Tanacross facilities could each, technically, supply 100% of their heating needs with one or more high efficiency low emission cordwood boilers. Consultation with a qualified engineer is justified and strongly recommended.

5.4 Summary of Findings and Potential Savings

Table 5-4 summarizes the findings thus far: annual fuel oil usage, range of annual fuel oil costs, estimated annual wood fuel requirement, range of estimated annual wood fuel costs, and potential gross annual savings for the facilities in Tanacross. [Note: potential gross annual fuel cost savings <u>do not</u> consider capital costs and non-fuel operation, maintenance and repair (OM&R) costs.]

Table 5-4. Estimate of Total Wood Consumption, Comparative Costs and Potential Savings

	Fuel Oil Used gal/year[a]	Annual Fuel Oil Cost (@ $ ___ /gal)			Approximate Wood Requirement[b]	Annual Wood Cost (@ $ ___ /unit)			Potential Gross Annual Fuel Cost Savings ($)		
CORDWOOD SYSTEMS		*4.50/gal*	*5.00/gal*	*5.50/gal*	W. spruce, MC30, CE 75%	*100/cord*	125/cord	*150/cord*	*Low*	*Medium*	*High*
Water plant	8,000	36,000	40,000	44,000	**94 cds**	9,400	11,750	14,100	21,900	28,250	34,600
UTRTC	10,000	45,000	50,000	55,000	**117 cds**	11,700	14,625	17,550	27,450	35,375	43,300
TVC MPF	14,000	63,000	70,000	77,000	**164 cds**	16,400	20,500	24,600	38,400	49,500	60,600
Total	32,000	144,000	160,000	176,000	**375 cds**	37,500	46,875	56,250	87,750	113,125	138,500

NOTES:
[a] From Table 5-2
[b] From Table D-3, Appendix D

SECTION 6. ECONOMIC FEASIBILITY OF CORDWOOD SYSTEMS

6.1 Initial Investment Cost Estimates

DISCLAIMER: Short of having an actual Design & Engineering Report prepared by a team of architects and/or professional engineers, actual costs for any particular system at any particular site cannot be positively determined. Such a report is beyond the scope of this preliminary assessment. However, several hypothetical, though hopefully realistic, system scenarios are offered as a means of comparison. Actual costs, assumptions and "guess-timates" are identified as such, where appropriate. Recalculations of financial metrics, given different/updated cost estimates, are relatively easy to accomplish.

Wood heating systems include the cost of the fuel storage building (if necessary), boiler building (if necessary), boiler equipment (and shipping), plumbing and electrical connections (including heat exchangers, pumps, fans, and electrical service to integrate with existing distribution systems), installation, and an allowance for contingencies.

Before a true economic analysis can be performed, all of the costs (investment and OM&R) must be identified, and this is where the services of qualified experts are necessary.

Table 6-1 (next page) presents hypothetical scenarios of initial investment costs for cordwood systems in medium-sized heating demand situations. One scenario is presented for each facility. It should be noted, however, that these scenarios are strictly hypothetical. The solutions presented here are not necessarily the best or correct or only choices; consultation with qualified professionals is strongly recommended.

Buildings and plumbing/connections are the most significant costs besides the boiler(s). Building costs deserve more site-specific investigation and often need to be minimized to the extent possible. Piping from the wood-fired boiler is another area of potential cost saving. Long plumbing runs and additional heat exchangers substantially increase project costs. The exorbitant cost of hard copper pipe normally used in Alaska now precludes its use in most applications. If plastic or PEX® piping is used significant cost savings may be possible.

Allowance for indirect non-capital costs such as engineering and contingency are most important for large systems that involve extensive permitting and budget approval by public agencies. This can increase the cost of a project by 25% to 50%. For the examples in Table 6-1, a 25% contingency allowance was used.

NOTES:

a. With the exception of the list prices for Garn boilers, all of the figures in Table 6-1 are gross estimates.

b. The cost estimates presented in Table 6-1 do not include the cost(s) of any upgrades or improvements to the existing heating/heat distribution system currently in place.

Table 6-1. Initial Investment Cost Scenarios for Hypothetical HELE Cordwood Systems				
Fuel oil consumption, gallons per year		8,000 (water plant)	10,000 (UTRTC)	14,000 (TVC MPF)
Required boiler capacity (RBC), Btu/hr		234,000 (?)	345,793	483,854
Cordwood boiler	Garn model	(2) Garn WHS 2000	(1) WHS 4400	(2) WHS 3200
	Rating -Btu/hr [e]	850,000	950,000	1,900,000
	Btu stored	2,544,000	2,932,000	4,128,000
		Building and Equipment (B&E) Costs, **$** (for discussion purposes only)		
Fuel storage building[a] (fabric bldg, gravel pad, $20 per sf)		37,600 (94 cds @ 20 sf/cd)	46,800 (117 cds @ 20 sf/cd)	65,600 (164 cds @ 20 sf/cd)
Boiler building @ $125 per sf (minimum footprint w/concrete pad)[b]		32,000 (16'x16')	27,500 (10'x22')	50,000 (20'x20')
Boilers				
Base price[c]		29,800	40,000[f]	65,800
Shipping[d]		5,000	4,500	8,000
Bush delivery [d]		NA	NA	NA
Plumbing and electrical[d]		15,000	15,000	15,000
Installation[d]		10,000	10,000	10,000
Subtotal - B&E Costs		**129,400**	**143,800**	**214,400**
Contingency (25%)[d]		**32,350**	**35,950**	**53,600**
Grand Total		**161,750**	**179,750**	**268,000**

Notes:

[a] A cord occupies 128 cubic feet. If the wood is stacked 6½ feet high, the area required to store the wood is 20 square feet per cord.

[b] Does not allow for any fuel storage within the boiler building

[c] List price, Alaskan Heat Technologies, April 2008

[d] "guess-timate"; for illustrative purposes only

[e] Btu/hr into storage is extremely fuel dependent. The data provided for Garn boilers by Dectra Corp. are based on the ASTM standard of split, 16-inch oak with 20 percent moisture content and reloading once an hour.

[f] Published list price not available; this represents the current list price for WHS 3200 + $7,100

6.2 Operating Parameters of HELE Cordwood Boilers

A detailed discussion of the operating parameters of HELE cordwood boilers can be found in Appendix F.

6.3 Hypothetical OM&R Cost Estimates

The primary operating cost of a cordwood boiler, other than the cost of fuel, is labor. Labor is required to move fuel from its storage area to the boiler building, fire the boiler, clean the boiler and dispose of ash. For purposes of this analysis, it is assumed that the boiler system will be operated every day for 210 days (30 weeks) per year between mid-September and mid-April. Table 6-2 presents labor/cost estimates for various HELE cordwood systems. A detailed analysis of labor requirement estimates can be found in Appendix F.

Table 6-2. Labor/Cost Estimates for HELE Cordwood Systems			
System	(2) WHS 2000 (combined capacity) (94 cds/yr)	(1) WHS 4400 (117 cds/yr)	(2) WHS 3200 (combined capacity) (164 cds/yr)
Total Daily labor (hrs/yr)[a] (hrs/day X 210 days/yr)	317.27	229.53	273.61
Total Periodic labor (hrs/yr)[b] (hrs/wk X 30 wks/yr)	47.0	58.5	82.0
Total Annual labor (hrs/yr)[c]	40	20	40
Total labor (hrs/yr)	404.27	308.03	395.61
Total annual labor cost ($/yr) (total hrs x $20)	**8,085.40**	**6,160.60**	**7,912.20**

Notes:
a Appendix F, Table F-2
b Appendix F, Table F-3
c Appendix F

There is also an electrical cost component to the boiler operation. An electric fan creates the induced draft that contributes to boiler efficiency. The cost of operating circulation pumps and/or blowers would be about the same as it would be with the oil-fired boiler or furnaces in the existing heating system.

Lastly there is the cost of wear items, such as fire brick, door gaskets, water treatment chemicals, etc. For the following examples, a value of $1,000 per boiler is used.

Table 6-3. Summary of Total Annual Non-Fuel OM&R Cost Estimates			
Item	Cost/Allowance ($)		
	(2) WHS 2000 (combined capacity) (94 cds/yr)	(1) WHS 4400 (117 cds/yr)	(2) WHS 3200 (combined capacity) (164 cds/yr)
Labor[a]	8,085.40	6,160.60	7,912.20
Electricity[b]	836.89	333.40	467.78
Maintenance/Repairs	2,000.00	1,000.00	2,000.00
Total non-fuel OM&R ($)	**10,922.29**	**7,494.00**	**10,379.98**

Notes:
a From Table 6-2
b Electrical cost based on a formula of horsepower x kWh rate x operating time. Assumed kWh rate = $0.32

6.4 Calculation of Financial Metrics

Biomass heating projects are viable when, over the long run, the annual fuel cost savings generated by converting to biomass are greater than the cost of the new biomass boiler system plus the additional operation, maintenance and repair (OM&R) costs associated with a biomass boiler (compared to those of an oil- or gas-fired boiler or furnace).

Converting from an existing boiler to a wood biomass boiler (or retrofitting/integrating a biomass boiler with an existing boiler system) requires a greater initial investment and higher annual OM&R costs than for an equivalent oil or gas system alone. However, in a viable project, the savings in fuel costs (wood vs. fossil fuel) will pay for the initial investment and cover the additional OM&R costs in a relatively short period of time. After the initial investment is paid off, the project continues to save money (avoided fuel cost) for the life of the boiler. Since inflation rates for fossil fuels are typically higher than inflation rates for wood fuel, increasing inflation rates result in greater fuel cost savings and thus greater project viability.[17]

The potential economic viability of a given project depends not only on the relative costs and cost savings, but also on the financial objectives and expectations of the facility owner. For this reason, the impact of selected factors on potential project viability is presented using the following metrics:

Simple Payback Period
Present Value (PV)
Net Present Value (NPV)
Internal Rate of Return (IRR)

Total initial investment costs include all of the capital and non-capital costs required to design, purchase, construct and install a biomass boiler system in an existing facility with an existing furnace or boiler system.

A more detailed discussion of Simple Payback Period, Present Value, Net Present Value and Internal Rate of Return can be found in Appendix E.

6.5 Simple Payback Period for HELE Cordwood Boilers

Table 6-4 presents a Simple Payback Period analysis for hypothetical multiple HELE cordwood boiler installations.

Table 6-4. Simple Payback Period Analysis for HELE Cordwood Boilers

	(2) WHS 2000 (combined capacity) (94 cds/yr)	(1) WHS 4400 (117 cds/yr)	(2) WHS 3200 (combined capacity) (164 cds/yr)
Fuel oil cost, $ per year @ $5.00 per gallon	40,000 (8,000 gal)	50,000 (10,000 gal)	70,000 (14,000 gal)
Cordwood cost $ per year @ $125 per cord	11,750 (94 cds)	14,625 (117 cds)	20,500 (164 cds)
Annual Fuel Cost Savings, $/yr	28,250	35,375	49,500
Total Investment Costs [b], $	161,750	179,750	268,000
Simple Payback[c], yrs	**5.73**	**5.08**	**5.41**
Annual, Non-fuel OM&R costs[a]	10,922	7,494	10,380
Net Annual Savings ($) (Annual Cash Flow)	17,328	27,881	39,120

Notes:
a From Table 6-3
b From Table 6-1
c Total Investment Costs divided by Annual Fuel Cost Savings

6.6 Present Value (PV), Net Present Value (NPV) and Internal Rate or Return (IRR) Values for Various HELE Cordwood Boiler Installation Options

Table 6-5 presents PV, NPV and IRR values for hypothetical various HELE cordwood boiler installations.

Table 6-5. PV, NPV and IRR Values for Various HELE Cordwood Boilers Options

	(2) WHS 2000 (combined capacity) (94 cds/yr)	(1) WHS 4400 (117 cds/yr)	(2) WHS 3200 (combined capacity) (164 cds/yr)
Discount Rate[a] (%)	3		
Time, "t", (years)	20		
Initial Investment ($)[b]	161,750	179,750	268,000
Annual Cash Flow($)[c] (Net Annual Savings)	17,328	27,881	39,120
Present Value (of expected cash flows, $ at "t" years)	257,797	414,799	582,007
Net Present Value ($ at "t" years)	96,047	235,049	314,007
Internal Rate of Return (% at "t" years)	8.69	14.47	13.42
See Note #__ below	1	2	3

Notes:
[a] real discount (excluding general price inflation) as set forth by US Department of Energy, as found in NIST publication NISTIR 85-3273-22 (Rev 5/08), Energy Price Indices and Discount Factors for Life Cycle Cost Analysis, April 2008
[b] From Table 6-1
[c] Equals annual cost of fuel oil minus annual cost of wood minus annual non-fuel OM&R costs (i.e., Net Annual Savings)

Note #1. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $257,797 today (PV), which is greater than the initial investment of $161,750. The resulting NPV of the project is $96,047 and the project achieves an internal rate of return of 8.69% at the end of 20 years. Given the assumptions and cost estimates, this alternative appears financially and operationally feasible.

Note #2. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $414,799 today (PV), which is greater than the initial investment of $179,750. The resulting NPV of the project is $235,049 and the project achieves an internal rate of return of 14.47% at the end of 20 years. Given the assumptions and cost estimates, this alternative appears financially and operationally feasible.

Note #3. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $582,007 today (PV), which is greater than the initial investment of $286,000. The resulting NPV of the project is $314,007 and the project achieves an internal rate of return of 13.42% at the end of 20 years. Given the assumptions and cost estimates, this alternative appears financially and operationally feasible.

SECTION 7. ECONOMIC FEASIBILITY OF BULK FUEL SYSTEMS

The discussion of bulk fuel systems is not included in this report

SECTION 8. CONCLUSIONS

This report discusses conditions found "on the ground" at various facilities in Tanacross, Alaska, and attempts to demonstrate, by use of realistic, though hypothetical, examples the feasibility of installing high efficiency, low emission cordwood boilers to heat these facilities.

The facilities in Tanacross consist of three distinct entities and are described in greater detail in Section 1.3. They include:

1. Tanacross water plant
2. Upper Tanana Regional Training Center (UTRTC) at the old Tok school building
3. Tanacross Village Council Multi-Purpose Facility (new, planned, partly constructed)

In terms of sites, none of the proposed project sites appear to present any significant geo-physical constraints for the construction of individual wood-fired heating plants. In fact, the conditions in the general area of the projects appear to be quite favorable for construction projects.

Each of the facilities under consideration could be heated with a HELE cordwood boiler system; none of the facilities appears too small and none appears too large.

Typically, the greater the fuel oil replacement the better the cost-effectiveness, but all of the proposed projects in Tanacross show strong financial metrics. However, all of these metrics are predicated on two assumptions: 1) that sufficient volumes of wood can be provided at a reasonable cost and 2) that someone will tend the boilers. Failure on either count will compromise the success of the project(s).

APTC's Tok 0051 Met Tower Wind Resource Report

APTC photo

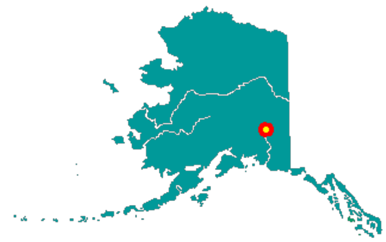
May 7, 2012

Douglas Vaught, P.E.
V3 Energy, LLC
Eagle River, Alaska

V3 Energy LLC
Eagle River, Alaska 907.350.5047

Summary

The wind resource measured at the Tok 0051 met tower site is good with measured wind power class 4 by measurement of wind power density and wind speed. The site experiences very low wind shear which is ideal for constructability as lower hub heights are possible. On the other hand, Venturi effect speed up of wind occurs at lower elevations at the met tower site, which yielded higher calculated extreme wind probability at 20 meter level than the 40 meter level. Site turbulence is moderately low and less than one might be expect in a mountain environment. Site temperatures are typical for inland Alaska with cool summers and cold winters, although lowest recorded temperatures are not as cold as experienced in the nearby community of Tok.



Met tower data synopsis

Data dates	September 15, 2009 to April 3, 2012 (31 months); status: operational
Wind power class	Class 4 (good)
Wind power density mean, 50 m	410 W/m^2
Wind speed mean, 50 m	6.88 m/s (15.3 mph)
Max. 10-min wind speed	31.5 m/s
Maximum 2-sec. wind gust	42.4 m/s (94.5mph), February 2011
Weibull distribution parameters	k = 1.54, c = 7.18 m/s
Wind shear power law exponent	0.049 (very low)
Roughness class	0.00 (description: smooth)
IEC 61400-1, 3rd ed. classification	Class II-C at 40 meters; Class I-C at 20 meters
Turbulence intensity, mean (at 40 m)	0.100 (at 15 m/s)
Calm wind frequency (at 50 m)	32% (< 4 m/s) (31 mo. measurement period)

Test Site Location

A 50 meter NRG Systems, Inc. tubular-type meteorological (met) tower was installed at the Tok 0051 met tower site in September 2009. The location is on a mountain ridge approximately 19 km (12 miles) straight-line distance southwest of Tok, Alaska and 9.7 km (6.0 miles) northwest of Alaska Highway 1 that connects Tok to Anchorage and the Kenai Peninsula. Alaska Energy Authority's high resolution wind map predicts Class 5 (of 7 named wind classes) at this location (refer to wind map below).

Site information

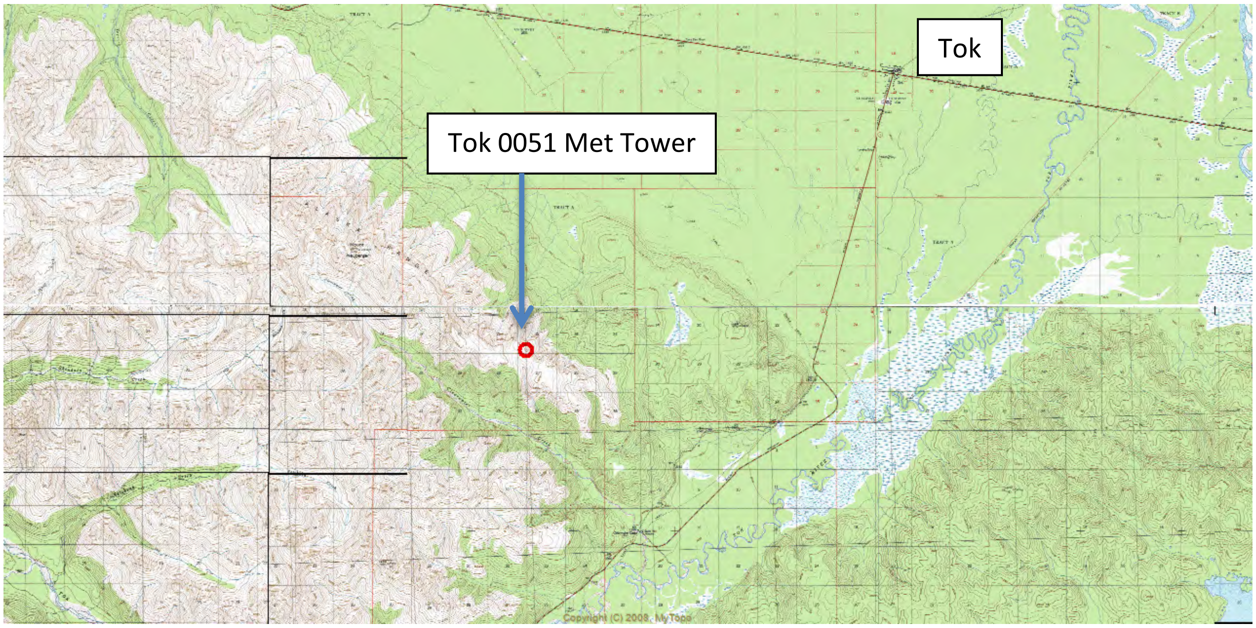
Site number	0051
Latitude/longitude	N 63° 14.008" W 143° 17.485"
Time offset	-9 hours from GMT (Yukon/Alaska time zone)
Site elevation	1,503 meters (4,930 ft.)
Datalogger type	NRG SymphoniePlus, 10 minute time step
Tower type	Tubular XHD tall tower, 50 meter height

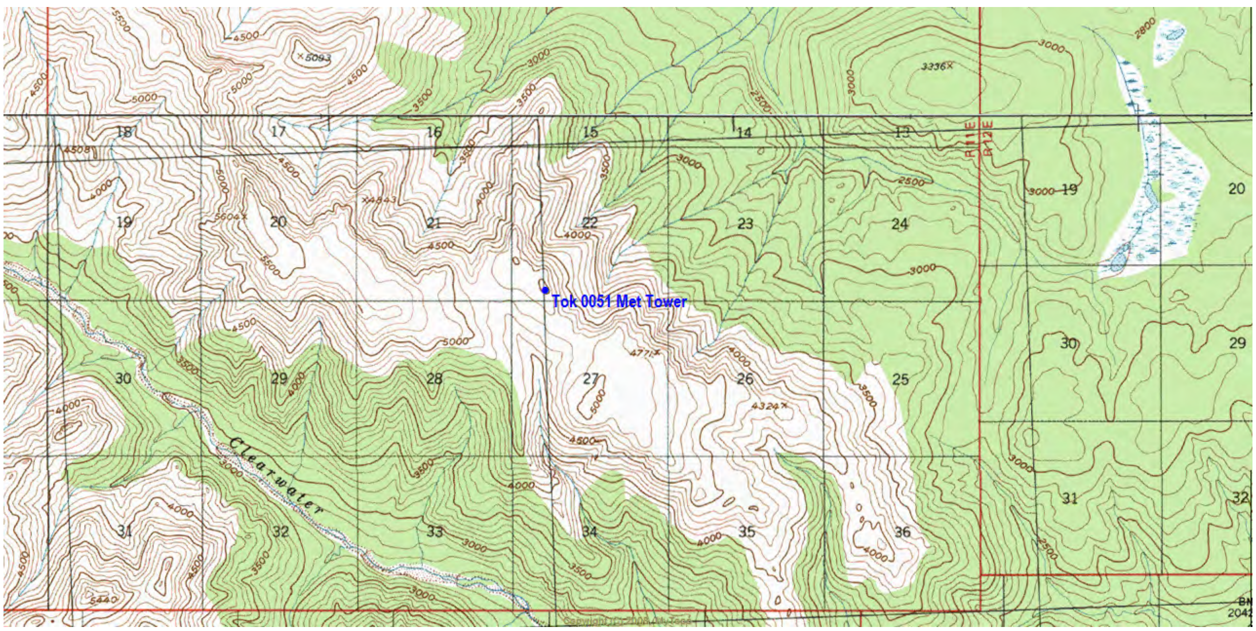
Tower sensor information

Channel	Sensor type	Serial Number	Height (m)	Multiplier	Offset	Orientation
1	NRG #40C anemometer	111409sw	50.3	0.760	0.34	SW
2	NRG #40C anemometer	112119se	49.7	0.759	0.35	NE
3	NRG #40C anemometer	112187sw	39.6	0.757	0.36	SW
7	NRG #200P wind vane	n/a	50.7	0.351	146	NW
8	NRG #200P wind vane	n/a	43.6	0.351	146	NW
9	NRG #110S Temp C	n/a	2	0.136	-86.3	
10	iPack Voltmeter	n/a	2	0.021	0	
13	NRG #40C anemometer	112198se	40.1	0.761	0.35	NE
14	NRG #40C anemometer	112183sw	32	0.760	0.34	SW
15	NRG #40C anemometer	111424sw	24.3	0.757	0.37	N

Google Earth image, Tok and Tok 0051 met tower site

Topographic maps





Data Quality Control

Data was filtered to remove presumed icing events that yield false zero wind speed data and non-variant wind direction data. Data that met criteria listed below were automatically filtered. In addition, data was manually filtered for obvious icing that the automatic filter didn't flag, invalid or low quality data for situations such as logger initialization and other situations, and tower shadowing effects (this latter filtering is only possible with paired anemometers, in other words, two anemometers at or near the same height on the met tower).

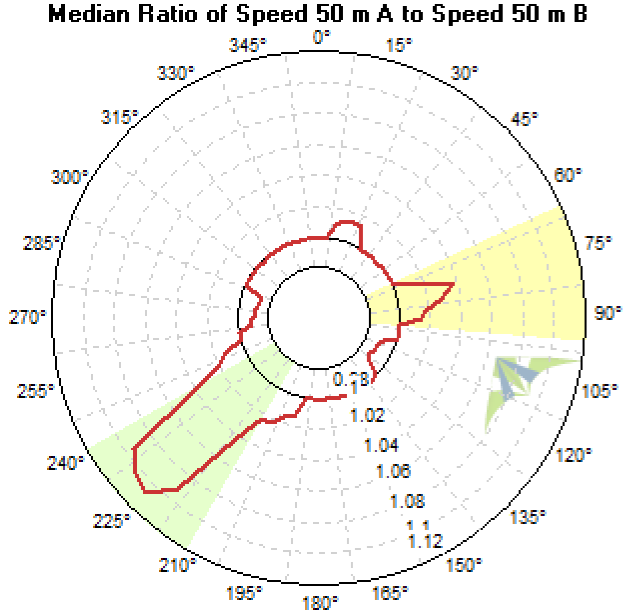
- Anemometer icing – data filtered if temperature < 1°C, speed SD = 0, and speed changes < 0.25 m/s for minimum 2 hours
- Vane icing – data filtered if temperature < 1°C and vane SD = 0 for minimum of 2 hours
- Tower shading of paired anemometers – refer to graphic below

In addition and for unknown reasons, both 50 meter anemometers have exhibited odd behavior, especially the 50 meter A anemometer on channel 1, with periods of zero or substantially reduced output, but then followed by apparent recovery and normal operation. Because the 50 m A anemometer was more problematic, a filtering algorithm was run to remove 50 m A data when the absolute difference between it and 50 m B data was greater than 1 m/s for one or more time steps.

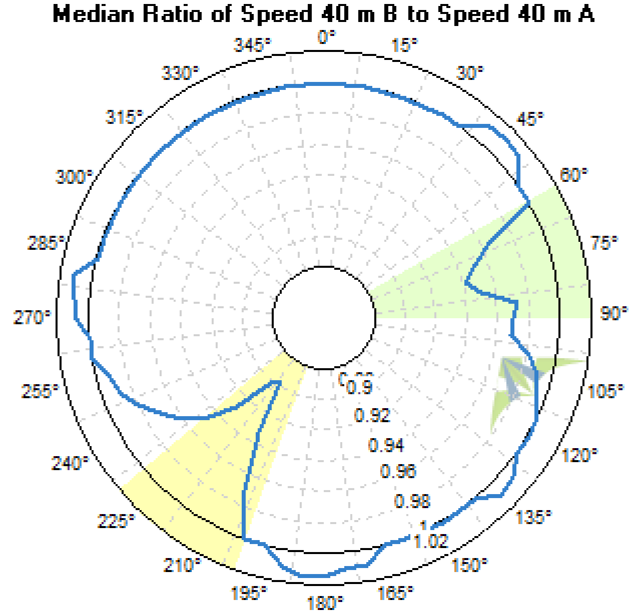
Note also that the icing filter flagged much more data from the 50 m A anemometer than the others. This is not indicative of enhanced icing conditions at that sensor; rather its performance issues in general.

Tower shading filter plots

Median Ratio of Speed 50 m A to Speed 50 m B



Median Ratio of Speed 40 m B to Speed 40 m A

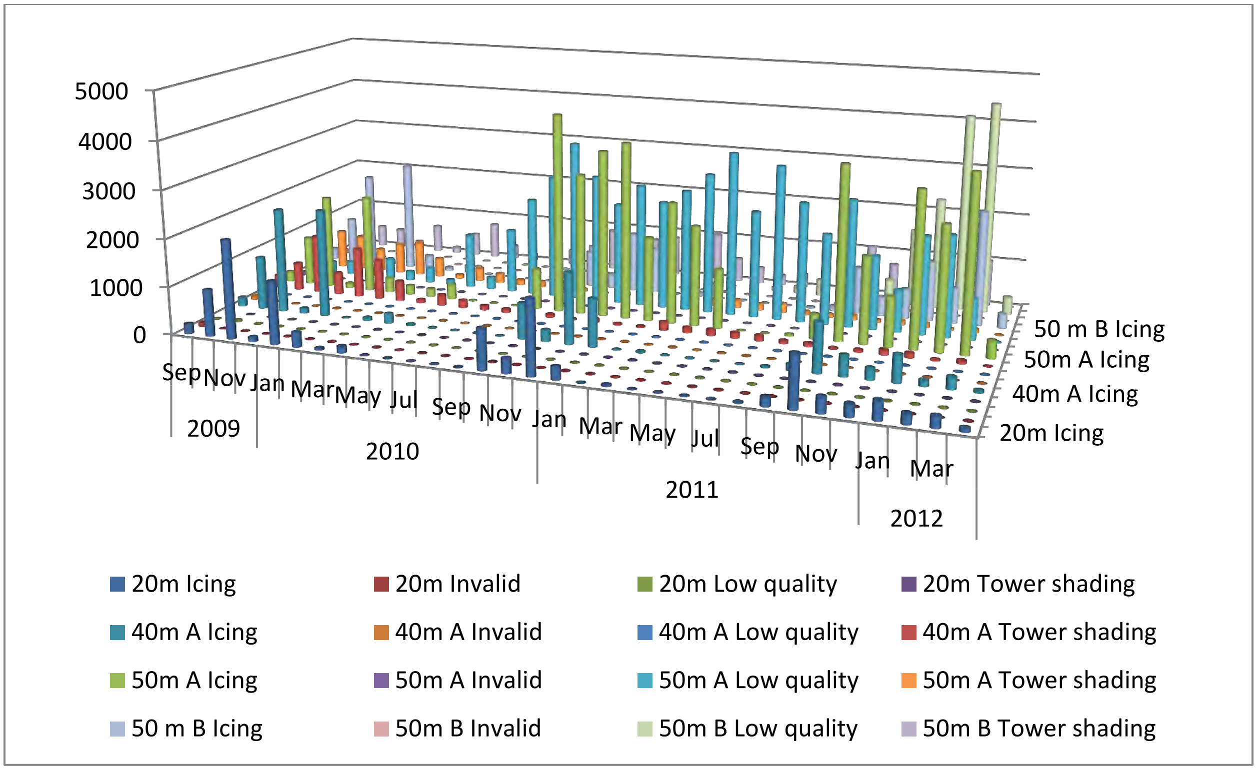


Sensor data recovery table

Label	Possible Records	Valid Records	Recovery Rate (%)	Unflagged data	Icing	Invalid	Low quality	Tower shading
Speed 50 m A	134,148	59,437	44.3	59,437	46,528	82	51,906	6,754
Speed 50 m B	134,148	92,762	69.2	92,762	16,679	82	14,551	18,011
Speed 40 m A	134,148	116,196	86.6	116,196	12,546	82	0	7,024
Speed 40 m B	134,148	105,934	79.0	105,934	9,534	82	0	19,843
Speed 30 m	134,148	121,401	90.5	121,401	12,566	82	33	0
Speed 20 m	134,148	123,115	91.8	123,115	10,854	82	33	0
Direction 50 m	134,148	127,799	95.3	127,799	6,193	81	0	0
Direction 40 m	134,148	126,098	94.0	126,098	7,894	81	0	0

Label	Possible Records	Valid Records	Recovery Rate (%)	Unflagged data	Icing	Invalid	Low quality	Tower shading
Temperature	134,148	133,904	99.8	133,904	0	88	0	0
Voltmeter	134,148	133,904	99.8	133,904	0	88	0	0

Data recovery graph, problems with 50 meter anemometers

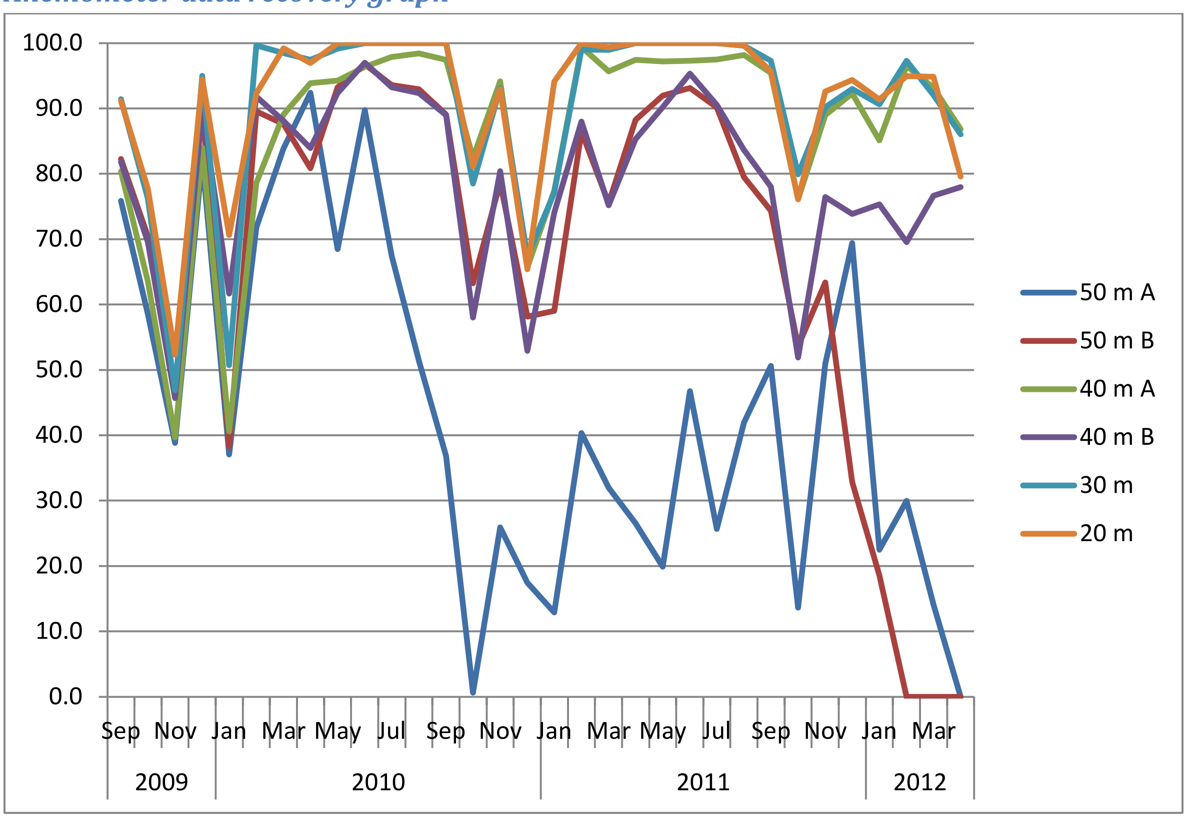


Sensor data recovery percentage by month

Year	Month	Anemometers 50 m A	50 m B	40 m A	40 m B	30 m	20 m	Vanes 50 m	40 m
	Sep	75.9	82.3	80.3	81.8	91.4	91.1	90.8	89.8
	Oct	58.5	70.4	63.6	69.6	76.2	77.7	73.2	80.9
	Nov	38.8	46.2	39.7	45.7	46.9	52.3	89.1	76.0
2009	Dec	82.3	90.4	84.0	89.9	95.0	94.5	93.9	92.8
	Jan	37.1	38.3	40.6	61.7	50.7	70.6	89.5	87.6
	Feb	71.8	89.6	78.6	91.8	99.6	92.3	95.8	95.2
	Mar	83.9	87.6	89.1	88.1	98.5	99.2	100.0	99.7
	Apr	92.4	80.8	93.8	83.9	97.4	96.9	96.6	97.8
	May	68.5	93.2	94.2	92.4	99.2	100.0	96.3	93.0
	Jun	89.8	96.8	96.3	97.0	100.0	100.0	100.0	100.0
	Jul	67.4	93.6	97.9	93.2	100.0	100.0	100.0	100.0
	Aug	51.4	92.9	98.4	92.3	100.0	100.0	100.0	100.0
	Sep	36.8	89.1	97.4	89.0	100.0	100.0	100.0	100.0
2010	Oct	0.6	63.2	82.4	58.0	78.5	81.1	85.2	80.1

		Anemometers						Vanes	
Year	Month	50 m A	50 m B	40 m A	40 m B	30 m	20 m	50 m	40 m
	Nov	25.9	78.7	94.1	80.4	93.1	92.9	93.4	90.0
	Dec	17.5	58.1	65.7	52.9	67.3	65.4	85.3	86.7
	Jan	12.9	59.0	77.4	74.1	77.1	94.1	95.4	88.1
	Feb	40.4	86.4	99.4	88.0	99.0	100.0	100.0	100.0
	Mar	32.0	75.5	95.7	75.2	99.0	99.3	99.7	99.4
	Apr	26.6	88.2	97.4	85.3	100.0	100.0	100.0	100.0
	May	19.9	92.0	97.2	90.2	100.0	100.0	100.0	98.3
	Jun	46.8	93.2	97.3	95.4	100.0	100.0	100.0	100.0
	Jul	25.7	90.1	97.5	90.6	100.0	100.0	100.0	100.0
	Aug	42.0	79.5	98.2	83.7	99.6	99.6	99.6	99.5
	Sep	50.6	74.4	95.4	78.0	97.3	95.7	93.2	96.5
	Oct	13.6	53.6	76.1	51.9	79.9	76.1	89.1	83.2
	Nov	51.0	63.4	89.0	76.4	90.2	92.6	93.8	94.2
2011	Dec	69.4	32.8	92.3	73.8	93.0	94.4	94.7	91.3
	Jan	22.5	18.6	85.1	75.3	90.6	91.4	100.0	99.5
	Feb	30.0	0.0	96.5	69.6	97.3	95.0	97.4	96.3
	Mar	14.1	0.0	93.2	76.7	92.0	94.8	99.7	98.4
2012	Apr	0.0	0.0	86.8	78.0	86.0	79.6	100.0	76.6
All data		44.3	69.1	86.6	79.0	90.5	91.8	95.3	94.0

Anemometer data recovery graph

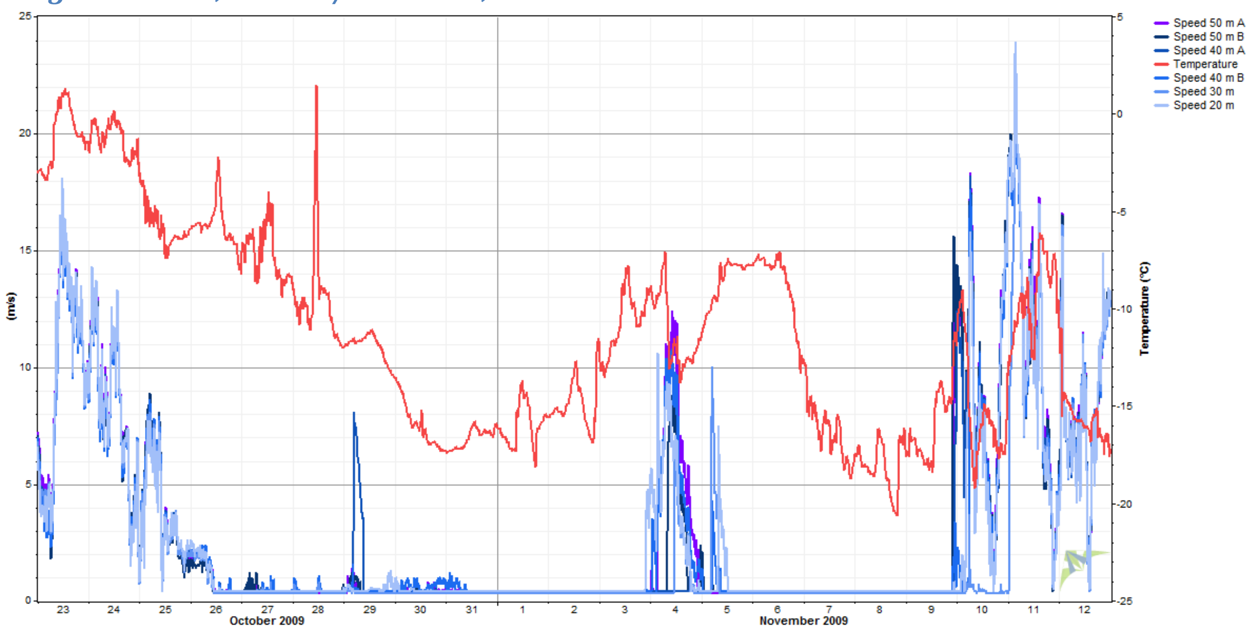


Documentation of Icing

Rime icing is more problematic for wind turbine operations than freezing rain (clear ice) given its tenacity and longevity in certain climatic conditions. It is not entirely clear from the data whether the icing data loss was from rime ice or other cold climate icing conditions such as freezing rain, sleet, etc. The met tower site is at sufficient elevation for rime icing to occur but may be too far from the coast for consistent exposure to maritime-type conditions. Relative humidity data would have been useful to determine this possibility, but the met tower was no equipped with a relative humidity sensor.

In any event, icing conditions were clearly identifiable in the data, and were concentrated somewhat in the autumn months. An icing event is shown below. Without humidity data, it is not certain that it was snowing at the beginning of data loss on October 26, 2009, but with a temperature at the time of -5° C and subsequent loss of anemometer function for two weeks, this is likely.

Icing Event Data, October/November, 2009



Wind Speed

Anemometer data obtained from the met tower, from the perspectives of both mean wind speed and mean wind power density, indicate a good wind resource. Note that cold temperatures contributed to a higher wind power density than standard conditions would yield for the measured mean wind speeds. Also note that poor data recovery from the 50 meter level anemometers casts some doubt on data from those sensors, although initial data recover y was good. Data recovery from the 40 meter A anemometer was very good and is used throughout this report to represent speed distribution and other parameters.

Anemometer data summary

Variable	Speed 50 m A	Speed 50 m B	Speed 40 m A	Speed 40 m B	Speed 30 m	Speed 20 m
Measurement height (m)	50.3	49.7	39.6	40.1	32	24.3
Mean wind speed (m/s)	6.91	6.32	6.46	6.36	6.26	6.19
MoMM wind speed (m/s)	6.88	6.31	6.45	6.37	6.25	6.20
Median wind speed (m/s)	5.90	5.40	5.50	5.40	5.30	5.10
Max wind speed (m/s)	30.1	29.7	30.2	29.6	30.8	31.5
Weibull k	1.39	1.52	1.54	1.48	1.48	1.46
Weibull c (m/s)	7.52	7.00	7.18	7.03	6.92	6.83
Mean power density (W/m²)	494	358	387	388	370	371
MoMM power density (W/m²)	488	356	384	388	368	372
Mean energy content (kWh/m²/yr)	4,329	3,139	3,386	3,400	3,237	3,252
MoMM energy content (kWh/m²/yr)	4,276	3,122	3,364	3,401	3,222	3,260
Energy pattern factor	2.73	2.61	2.61	2.75	2.75	2.86
Frequency of calms (%)	32.0	35.1	33.6	36.0	36.0	37.7
Data recovery rate (%)	44.3	69.2	86.6	79.0	90.5	91.8

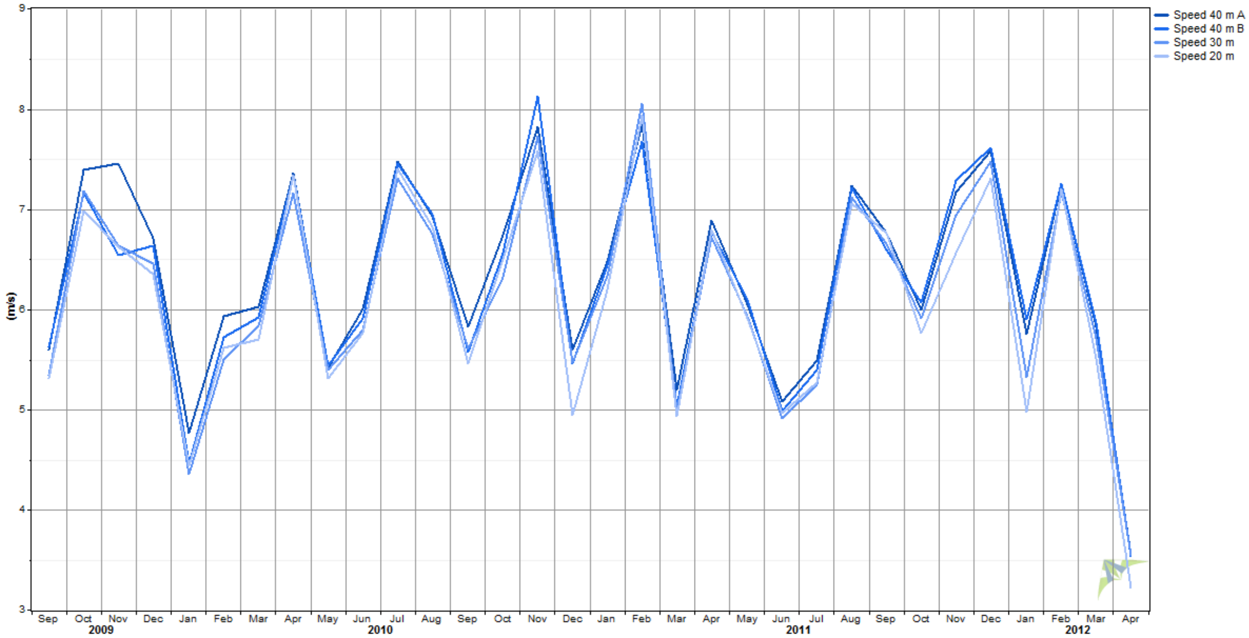
Time Series

Time series calculations indicate higher wind speeds during the winter months with more moderate wind speeds during summer months, although interestingly there is significant variation from month-to-month throughout the 31 month data set. This is indicative of the often temperamental nature of mountain winds. The daily wind profiles indicate relatively even wind speeds throughout the day with slightly higher wind speeds during night hours.

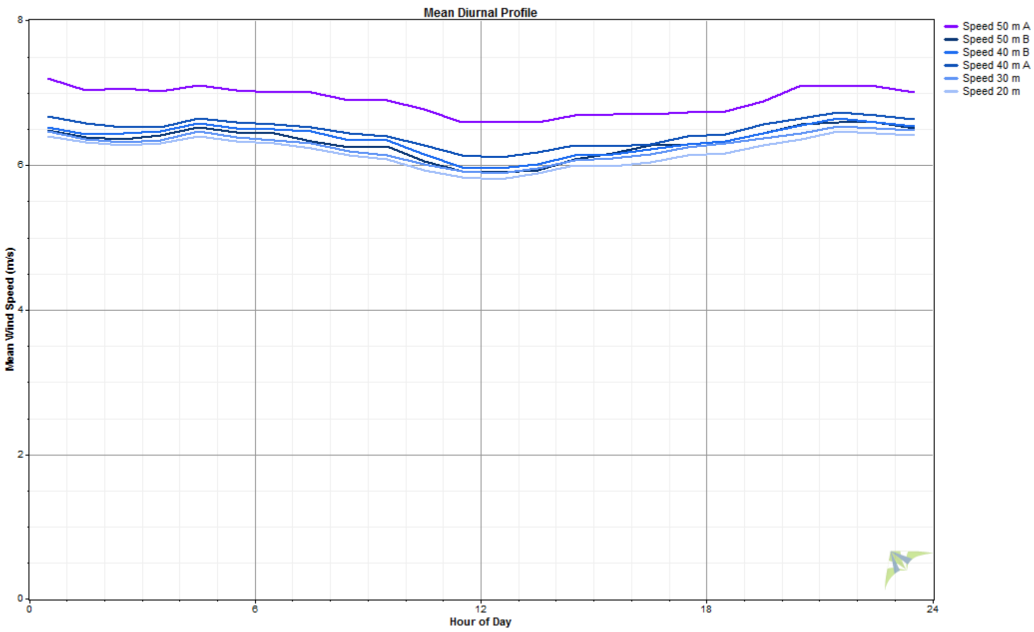
40 m A anemometer data summary

Month	Mean (m/s)	Median (m/s)	Max 10-min avg (m/s)	Max gust (2 sec.) (m/s)	Std. Dev. (m/s)	Weibull k (-)	Weibull c (m/s)
Jan	5.83	5.30	23.7	29.1	3.54	1.64	6.49
Feb	7.09	6.30	30.2	41.6	4.46	1.66	7.94
Mar	5.68	4.80	23.0	31.4	3.78	1.57	6.33
Apr	6.99	5.80	29.8	40.1	4.57	1.58	7.79
May	5.73	4.90	26.8	35.2	3.73	1.61	6.41
Jun	5.54	4.50	21.7	26.5	4.04	1.42	6.11
Jul	6.48	5.40	26.2	32.2	4.46	1.48	7.18
Aug	7.08	6.60	23.9	29.1	4.33	1.66	7.91
Sep	6.16	5.50	25.0	30.3	4.02	1.52	6.82
Oct	6.67	6.20	21.3	29.5	3.68	1.85	7.48
Nov	7.49	6.20	28.5	39.3	4.99	1.54	8.34
Dec	6.74	5.60	27.0	36.3	4.85	1.37	7.35
Annual	6.45	5.50	30.2	41.6	4.28	1.54	7.18

Monthly time series, mean wind speeds



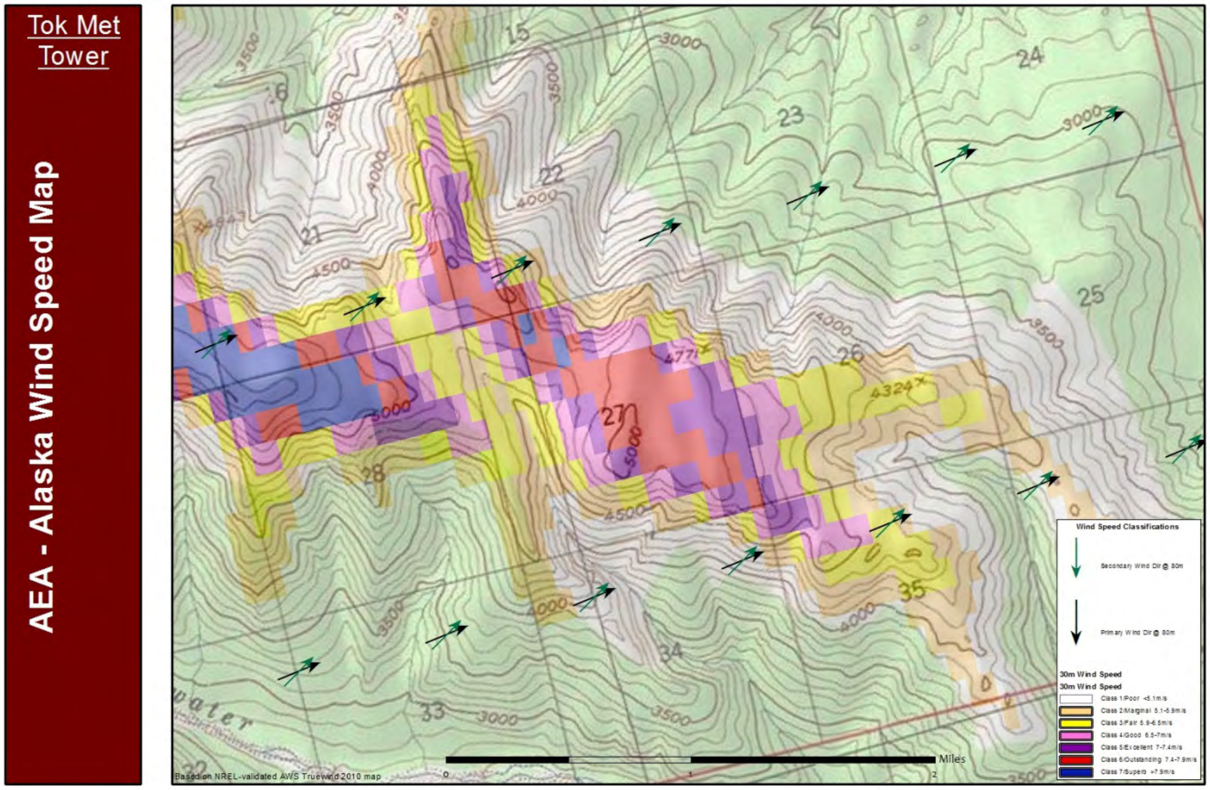
Daily wind profile



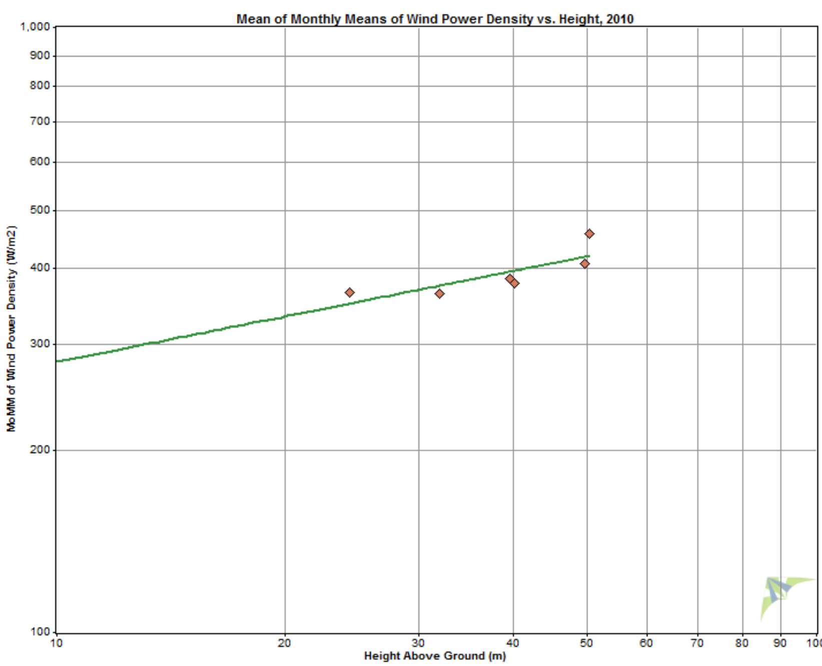
Wind Power Density

Wind power density at the Tok 0051 met tower site was predicted to be Class 6 (description: outstanding) by reference to Alaska Energy Authority high resolution wind map. This map was created with assistance from National Renewable Energy Laboratory to help guide efforts to prospect for wind resources in Alaska. Actual measured wind resource, though, appears to be Class 4 (description: good) by review of the 50 meter, 40 meter and 30 meter anemometer data. This is likely due to a modeling discrepancy with the high resolution wind map that over-predicted speed-up effects of the wind across the ridgeline where the site is located.

AEA high resolution wind map



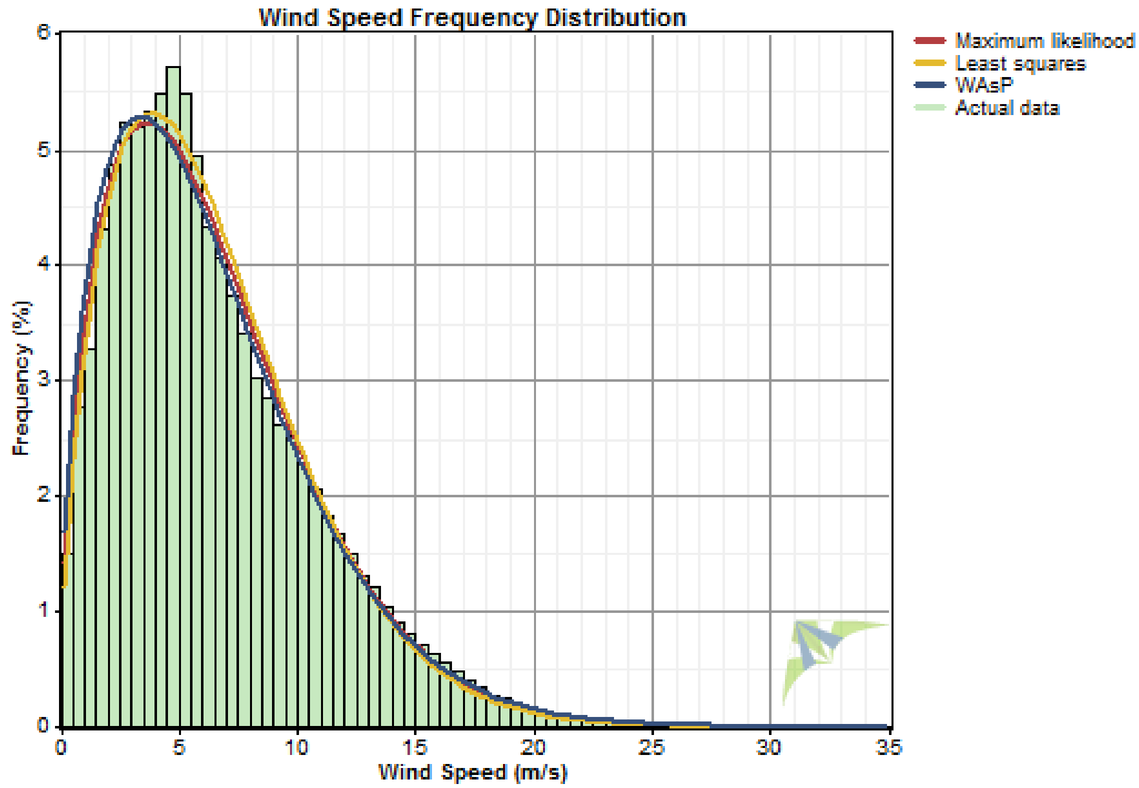
Met tower wind power density



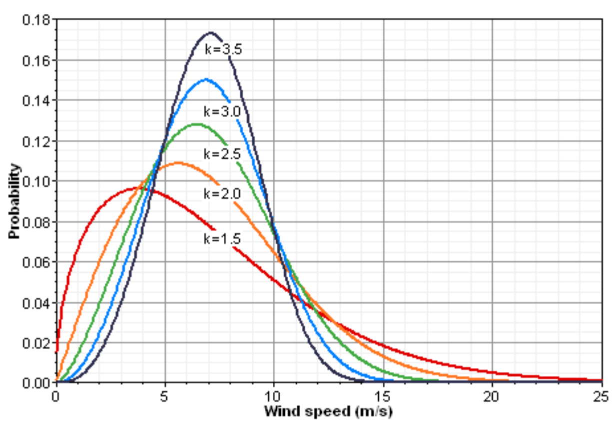
Probability Distribution Function

The probability distribution function (PDF), or histogram, of the Tok 0051 met tower site wind speed indicates a shape curve dominated by moderate to lower wind speeds compared to a "normal" shape curve, known as the Rayleigh distribution (Weibull k = 2.0), which is defined as the standard wind distribution for wind power analysis. As seen below in the wind speed distribution of the 40 meter A anemometer, the most frequently occurring wind speeds are between 2 and 6 m/s with very few wind events exceeding 25 m/s (the cutout speed of most wind turbines; see following wind speed statistical table).

PDF of 40 m A anemometer



Weibull k shape curve table



Weibull values table, 40 m A anemometer

Algorithm	Weibull k (-)	Weibull c (m/s)	Mean (m/s)	Proportion Above 6.460 m/s	Power Density (W/m2)	R Squared (-)
Maximum likelihood	1.544	7.18	6.46	0.428	430	0.992
Least squares	1.598	7.16	6.42	0.428	402	0.991
WAsP	1.496	7.05	6.37	0.416	431	0.991
Actual data	(116,196 time steps)		6.46	0.416	431	

Occurrence by wind speed bin (40 m A anemometer)

Bin Endpoints (m/s)		Occurrences			Bin Endpoints (m/s)		Occurrences		
Lower	Upper	No.	Percent	Cumul.	Lower	Upper	No.	Percent	Cumul.
0	1	4,971	4.3%	4.3%	16	17	1,214	1.0%	97.6%
1	2	8,806	7.6%	11.9%	17	18	884	0.8%	98.4%
2	3	11,725	10.1%	21.9%	18	19	603	0.5%	98.9%
3	4	12,218	10.5%	32.5%	19	20	432	0.4%	99.3%
4	5	13,018	11.2%	43.7%	20	21	276	0.2%	99.5%
5	6	12,107	10.4%	54.1%	21	22	170	0.1%	99.7%
6	7	9,752	8.4%	62.5%	22	23	131	0.1%	99.8%
7	8	8,288	7.1%	69.6%	23	24	81	0.1%	99.9%
8	9	6,818	5.9%	75.5%	24	25	45	0.0%	99.9%
9	10	5,961	5.1%	80.6%	25	26	44	0.0%	99.9%
10	11	5,028	4.3%	84.9%	26	27	30	0.0%	100.0%
11	12	4,076	3.5%	88.4%	27	28	20	0.0%	100.0%
12	13	3,279	2.8%	91.3%	28	29	11	0.0%	100.0%
13	14	2,633	2.3%	93.5%	29	30	13	0.0%	100.0%
14	15	1,987	1.7%	95.2%	30	31	1	0.0%	100.0%
15	16	1,574	1.4%	96.6%	31	32	0	0.0%	100.0%

Wind Shear and Roughness

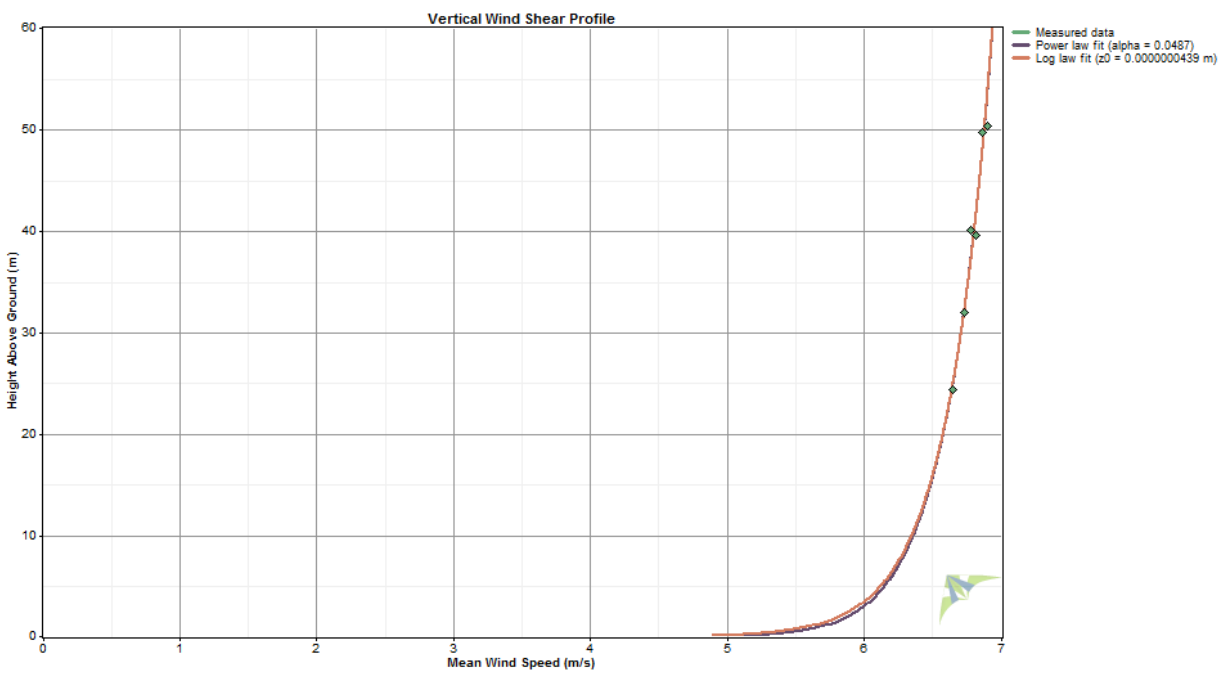
Wind shear at the Tok 0051 met tower site was calculated with *concurrent* data from all six standard anemometers. Noted in the quality control discussion were the problems with the 50 meter level anemometers. For this reason, plus other data loss including icing and tower shadow, only 45,545 data steps out of a possible 134,148 (34.0%) data steps in the entire data package were included in the shear calculations. This is interesting by itself in that it indicates a different view of mean wind speed than the individual anemometer averages that include more data, but with the highly variable anemometer data recovery from the met tower, seasonal representation in the data set, especially with the 50 meter anemometers, is not complete.

In any event, the calculated power law exponent of 0.049 indicates extremely low wind shear at the site, which is expected given the site location of a mountain ridgeline where little ground drag of the wind is possible. Calculated surface roughness at the site is 0 m (the height above ground where wind speed would be zero) for a roughness class of 0.00 (description: smooth). The practical consideration of this data is that wind turbines could be constructed at low hub heights and still generate nearly as much energy as would be possible at much higher hub heights.

Vertical wind shear data table

Wind Speed Sensor	Height (m)	Time Steps	Mean Wind Speed (m/s)
Speed 50 m A	50.3	45,545	6.91
Speed 50 m B	49.7	45,545	6.87
Speed 40 m B	40.1	45,545	6.78
Speed 40 m A	39.6	45,545	6.82
Speed 30 m	32.0	45,545	6.73
Speed 20 m	24.3	45,545	6.65

Vertical wind shear profile



Wind shear by direction sector table

Mean Wind Speed (m/s)

Direction Sector	Time Steps	Speed 50 m A	Speed 50 m B	Speed 40 m B	Speed 40 m A	Speed 30 m	Speed 20 m	Best-fit Power Law Exp	Surface Roughness (m)
345° - 15°	6,649	5.58	5.57	5.40	5.44	5.33	5.04	0.132	0.0179
15° - 45°	6,806	6.12	6.06	5.96	5.97	5.75	5.37	0.169	0.0907
45° - 75°	2,574	5.20	5.22	5.04	5.08	4.86	4.61	0.170	0.0954
75° - 105°	3,243	7.64	7.60	7.43	7.46	7.42	7.54	0.019	0.0000

Mean Wind Speed (m/s)

Direction Sector	Time Steps	Speed 50 m A	Speed 50 m B	Speed 40 m B	Speed 40 m A	Speed 30 m	Speed 20 m	Best-fit Power Law Exp	Surface Roughness (m)
105° - 135°	4,262	8.27	8.37	8.22	8.21	8.19	8.30	0.008	
135° - 165°	2,121	4.42	4.44	4.30	4.32	4.20	4.00	0.140	0.0276
165° - 195°	2,697	4.52	4.49	4.31	4.31	4.18	3.84	0.211	0.3014
195° - 225°	1,714	4.62	4.53	4.41	4.45	4.27	3.83	0.232	0.4476
225° - 255°	3,030	9.06	8.79	8.80	8.98	8.99	9.13	-0.031	
255° - 285°	8,784	10.58	10.48	10.59	10.61	10.64	10.92	-0.046	
285° - 315°	1,517	3.80	3.90	3.96	3.96	3.96	4.03	-0.060	
315° - 345°	1,652	2.87	2.94	2.75	2.82	2.67	2.53	0.192	0.1908

Extreme Winds

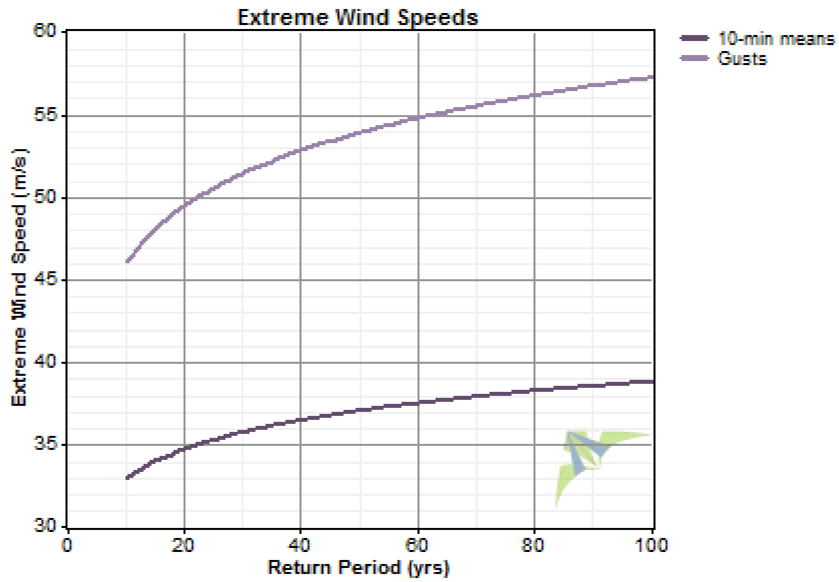
A modified Gumbel distribution analysis, based on monthly maximum winds vice annual maximum winds, was used to predict extreme winds at the Tok 0051 met tower site. The 40 meter A anemometer was chosen for this calculation because it is the highest elevation anemometer on the met tower with consistently good data recovery. With data available, the predicted Vref (maximum ten-minute average wind speed) in a 50 year return period (in other words, predicted to occur once every 50 years) is 39.7 m/s. This result classifies the site as Class II by International Electrotechnical Commission 61400-1, 3rd edition (IEC3) criteria. IEC extreme wind probability classification is one criteria – with turbulence the other – that describes a site with respect to suitability for particular wind turbine models. Note that the IEC3 Class II extreme wind classification, which applies to the Tok 0051 met tower site, indicates relatively energetic winds and turbines installed at this location should be IEC3 Class II rated.

Interestingly, however, is consideration of extreme wind probability at 20 meters. Although 20 meters is well below the hub height of utility-scale wind turbines, significant topographic Venturi effect speed-up results in extreme wind probability calculations high enough to classify the site as IEC3 Class 1 at 20 meters elevation.

Site extreme wind probability table, 40 meter A data

Period (years)	V_{ref} (m/s)	Gust (m/s)	IEC 61400-1, 3rd ed. Class	V_{ref}, m/s
3	30.3	38.7	I	50.0
10	35.0	44.7	II	42.5
20	36.2	46.2	III	37.5
30	38.2	48.7	S	designer-specified
50	39.7	50.6		
100	41.7	53.2		
average gust factor:	1.28			

Extreme wind graph, 40 meter level, by annual method



Site extreme wind probability table, 20 meter data

Period (years)	V_{ref} (m/s)	Gust (m/s)	IEC 61400-1, 3rd ed. Class	V_{ref}, m/s
3	32.8	42.2	I	50.0
10	38.6	49.6	II	42.5
20	40.0	51.5	III	37.5
30	42.5	54.7	S	designer-specified
50	44.3	57.0		
100	46.8	60.1		
average gust factor:	1.29			

Temperature, Density, and Relative Humidity

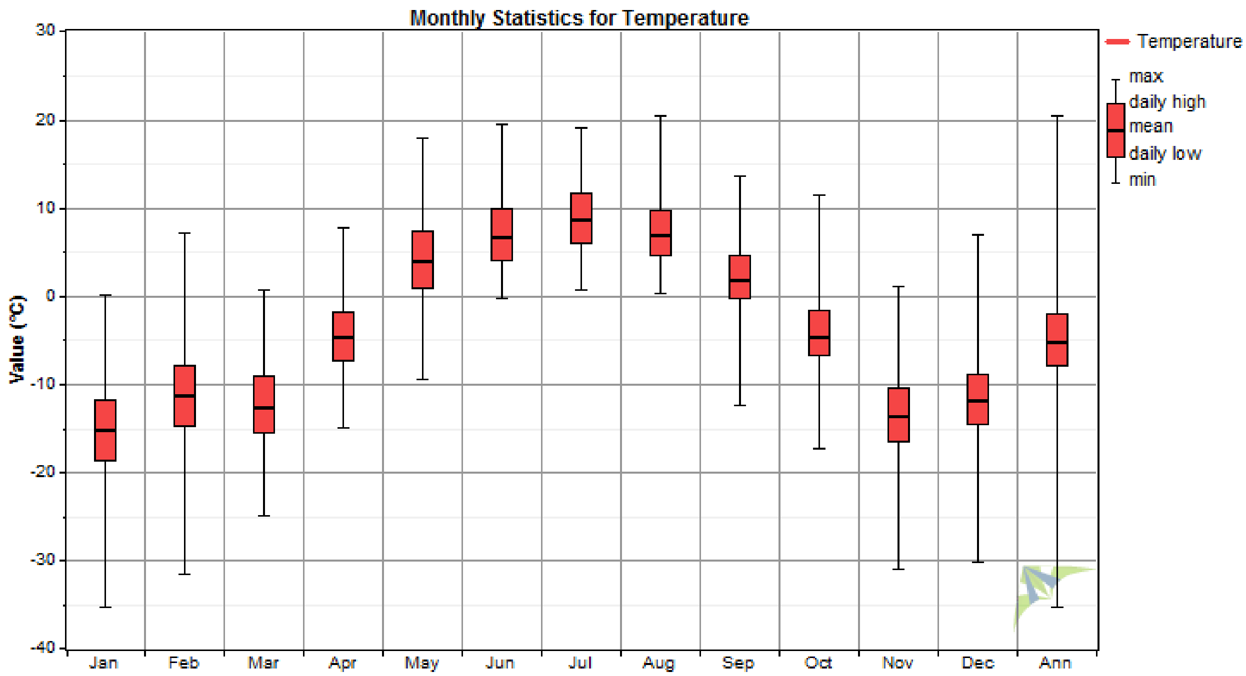
The Tok met tower site experiences cool summers and cold winters with resulting higher than standard air density. Calculated mean-of-monthly-mean (or annual) air density during the met tower test period exceeds the 1.058 kg/m^3 standard air density for a 1,503 meter elevation by 3.5 percent. This is advantageous in wind power operations as wind turbines produce more power at low temperatures (high air density) than at standard temperature and density.

Temperature and density table

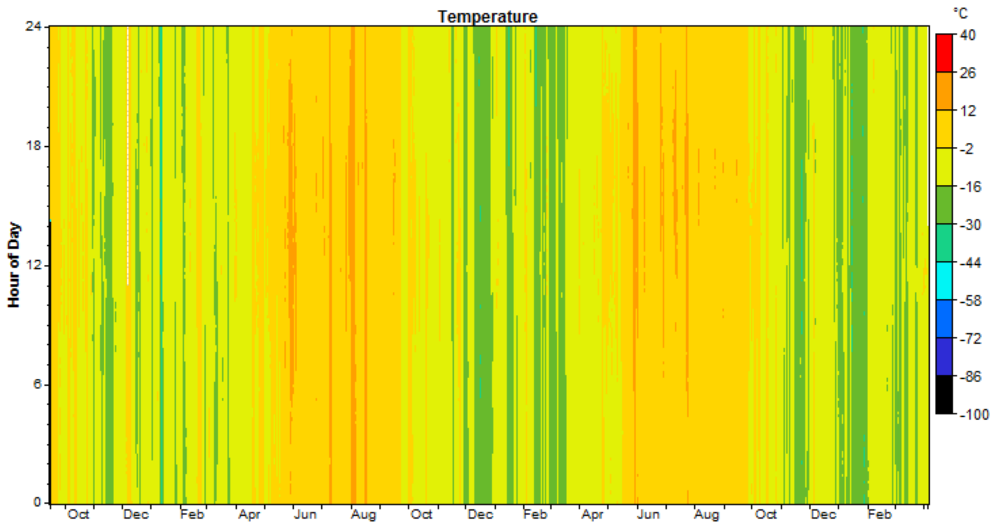
	Temperature						Density		
Month	Mean (°F)	Min (°F)	Max (°F)	Mean (°C)	Min (°C)	Max (°C)	Mean (kg/m³)	Min (kg/m³)	Max (kg/m³)
Jan	4.7	-31.5	32.2	-15.2	-35.3	0.1	1.143	1.078	1.239
Feb	11.8	-24.9	45.0	-11.2	-31.6	7.2	1.126	1.051	1.220
Mar	9.1	-13.0	33.1	-12.7	-25.0	0.6	1.132	1.076	1.187
Apr	23.6	5.0	46.0	-4.7	-15.0	7.8	1.098	1.049	1.141

Month	Temperature Mean (°F)	Min (°F)	Max (°F)	Mean (°C)	Min (°C)	Max (°C)	Density Mean (kg/m³)	Min (kg/m³)	Max (kg/m³)
May	39.2	15.1	64.2	4.0	-9.4	17.9	1.064	1.012	1.117
Jun	44.0	31.3	67.1	6.7	-0.4	19.5	1.053	1.007	1.080
Jul	47.5	33.1	66.2	8.6	0.6	19.0	1.046	1.009	1.076
Aug	44.5	32.4	68.7	7.0	0.2	20.4	1.052	1.004	1.078
Sep	35.2	9.5	56.5	1.8	-12.5	13.6	1.072	1.028	1.131
Oct	23.9	0.7	52.5	-4.5	-17.4	11.4	1.097	1.036	1.152
Nov	7.6	-24.0	33.8	-13.6	-31.1	1.0	1.136	1.075	1.217
Dec	10.7	-22.4	44.6	-11.9	-30.2	7.0	1.128	1.052	1.213
Annual	25.2	-31.5	68.7	-3.8	-35.3	20.4	1.095	1.004	1.239

Tok 0051 site temperature boxplot graph



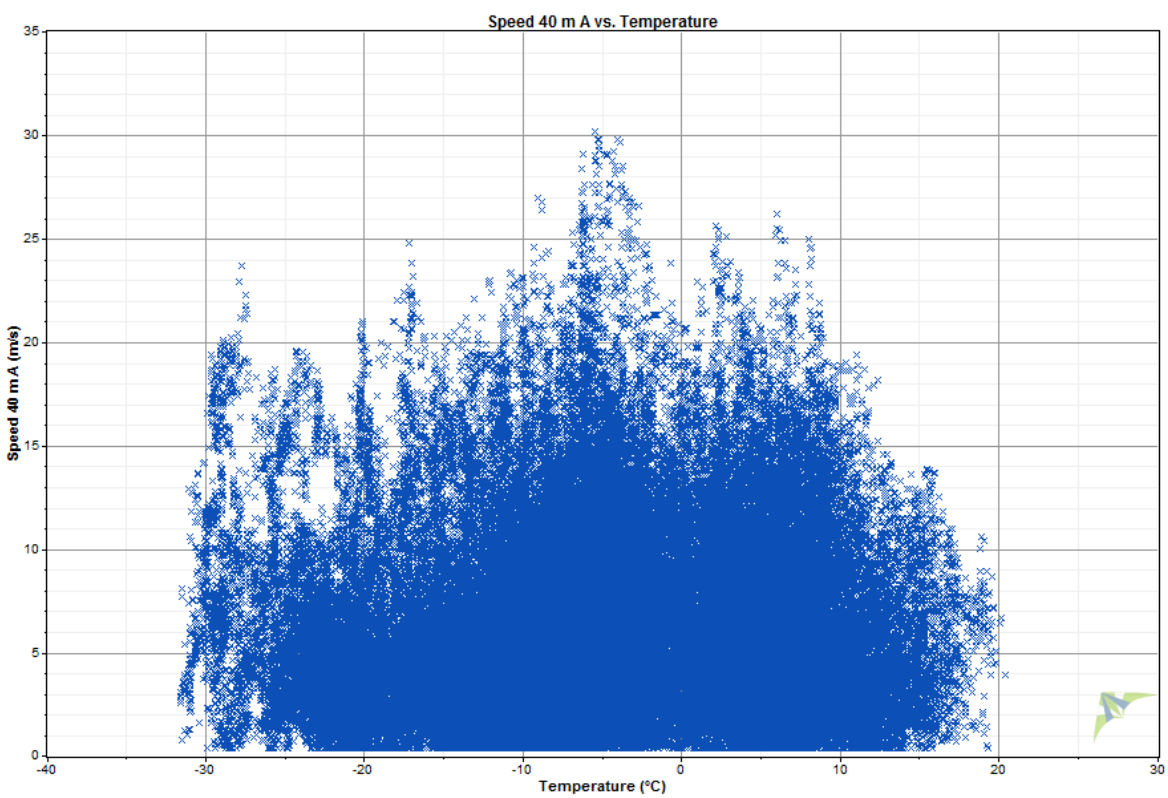
Temperature DMap



Wind Speed Scatterplot

The wind speed versus temperature scatterplot below indicates cold temperatures at the Tok met tower site with a preponderance of below freezing temperatures. During the met tower test periods, temperatures were often below -20° C (-4° F), the minimum operating temperature for most standard-environment wind turbines. Note that arctic-capable (ratings to -40°C) wind turbines would be required at this site.

Wind speed/temperature

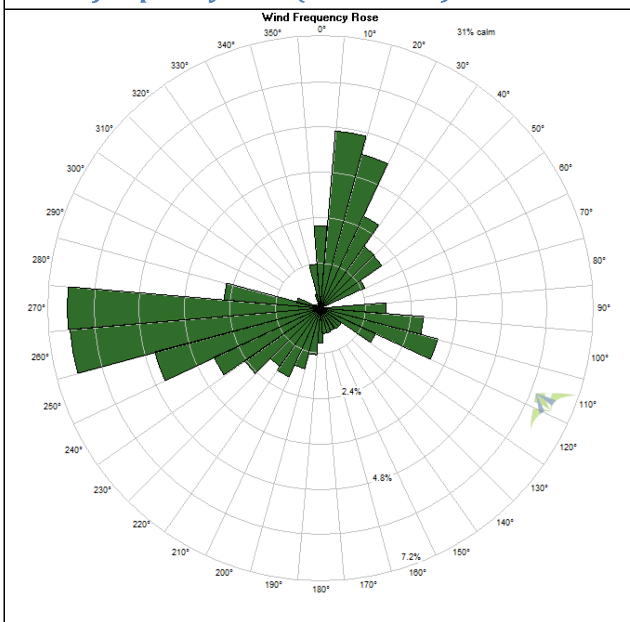
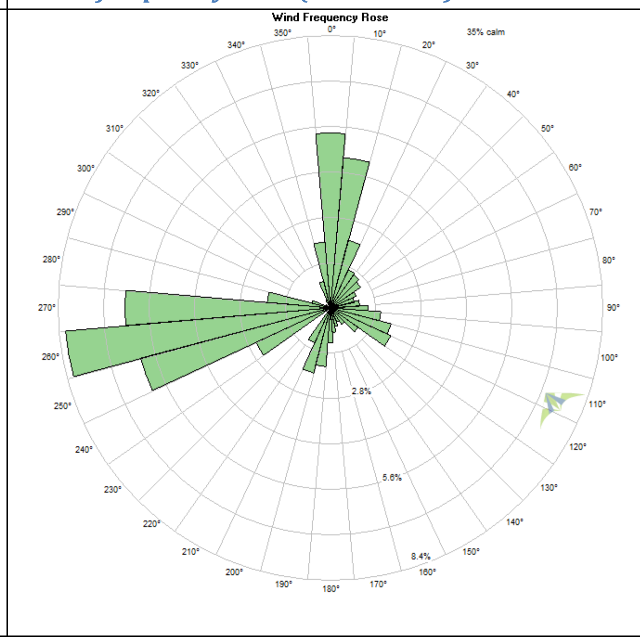


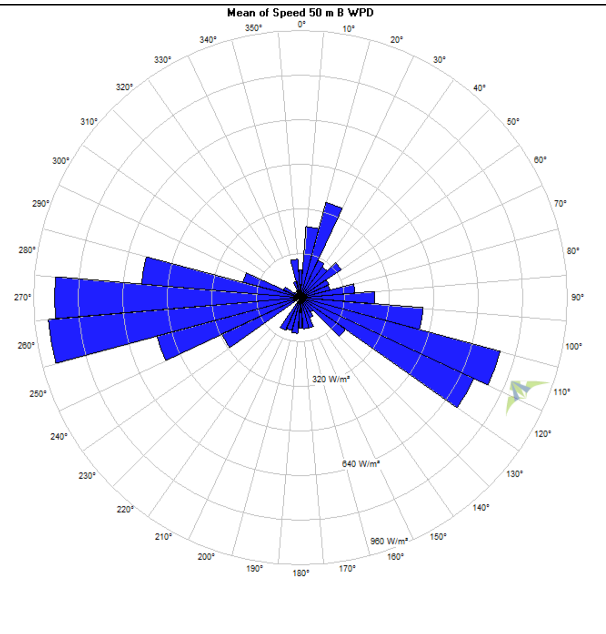
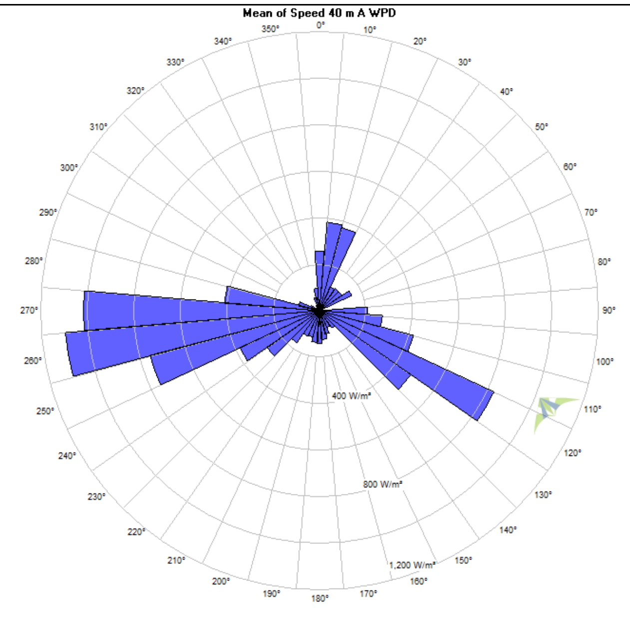
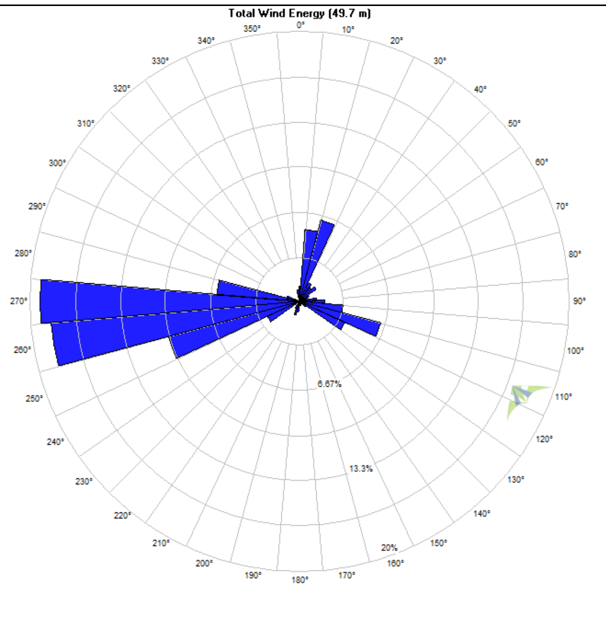
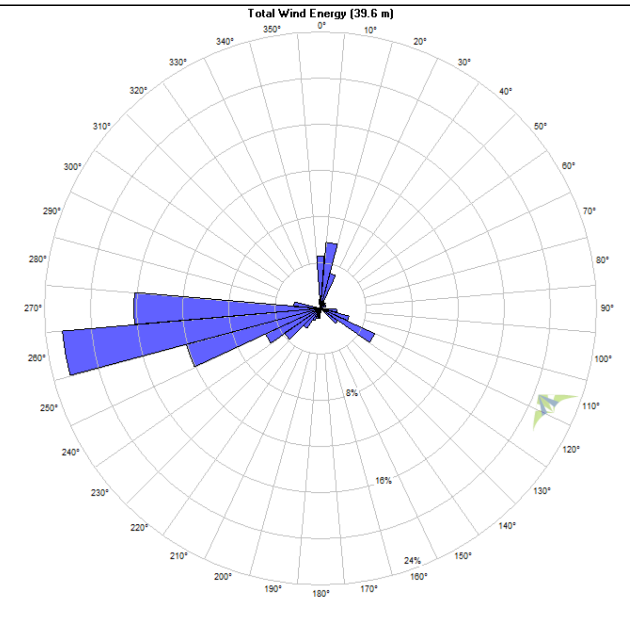
Wind Direction

Wind frequency rose data indicates that winds at the Tok 0051 met tower site are tri-directional, with predominately westerly winds and north-northeasterly and east-southeasterly winds to a lesser extent. The mean value rose indicates that westerly winds are also of the highest intensity although east-southeasterly winds, when they do occur, are of relatively high intensity. North-northeasterly winds, however, are of relatively low intensity. The wind energy roses indicate that a significant majority of the power-producing winds at the site are westerly.

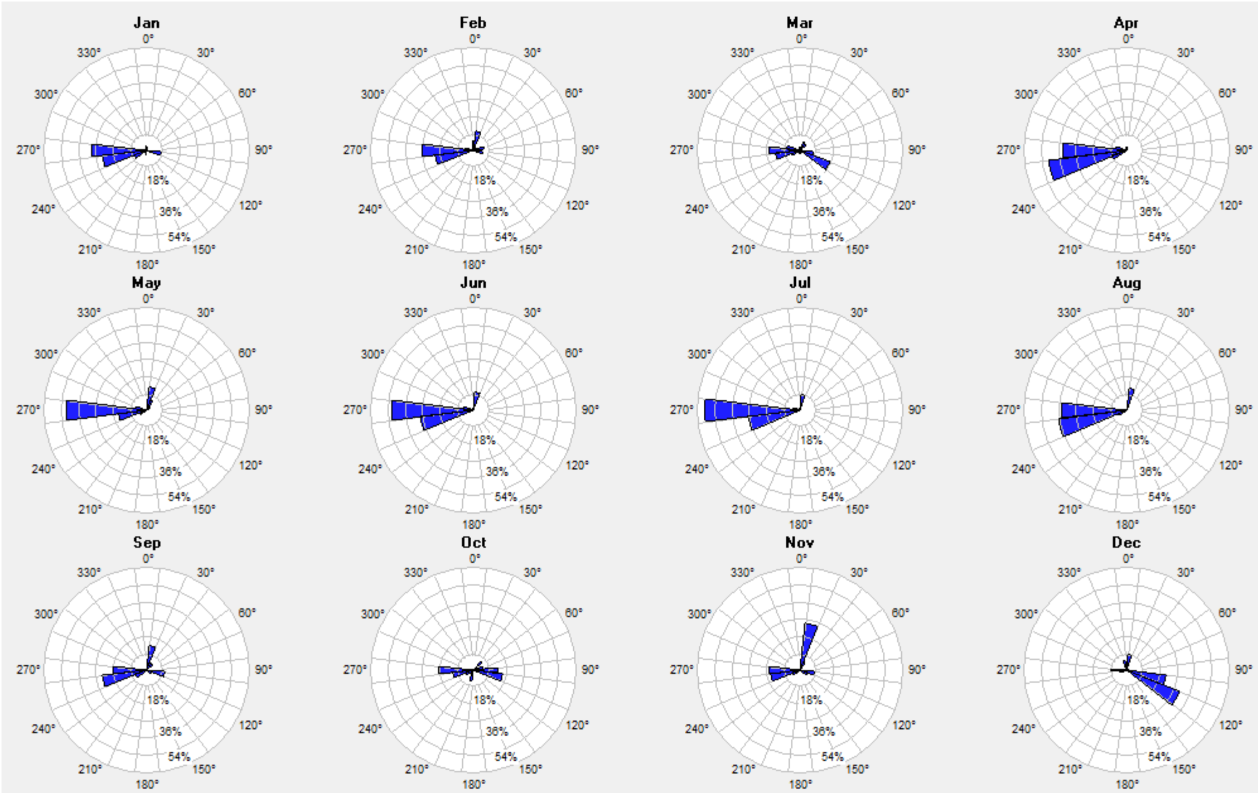
Calm wind frequency (the percent of time that winds at the 50 meter level are less than 4 m/s, a typical cut-in speed of larger wind turbines) was a moderate 31 percent during the 31 month test period. Calm wind frequency at the 40 meter level was a slightly higher 35 percent during the test period.

Note that the 50 meter and 40 meter wind roses don't exactly match each other. After an April, 2012 field check, both vanes were reported as facing 305° M, which after consideration of reported winds and magnetic declination, yields a 146° True offset (zero point of the vane), but in reality there likely is a slight offset error, probably less than ten degrees, with one or both wind vanes.

Wind frequency rose (50 m vane)	*Wind frequency rose (40 m vane)*
	

Mean value rose (50 m B anem.)	*Mean value rose (40 m A anem.)*
	
Wind energy rose (50 m B anem.)	*Wind energy rose (40 m A anem.)*
	

Wind density (50 meter height) roses by month (common scale)



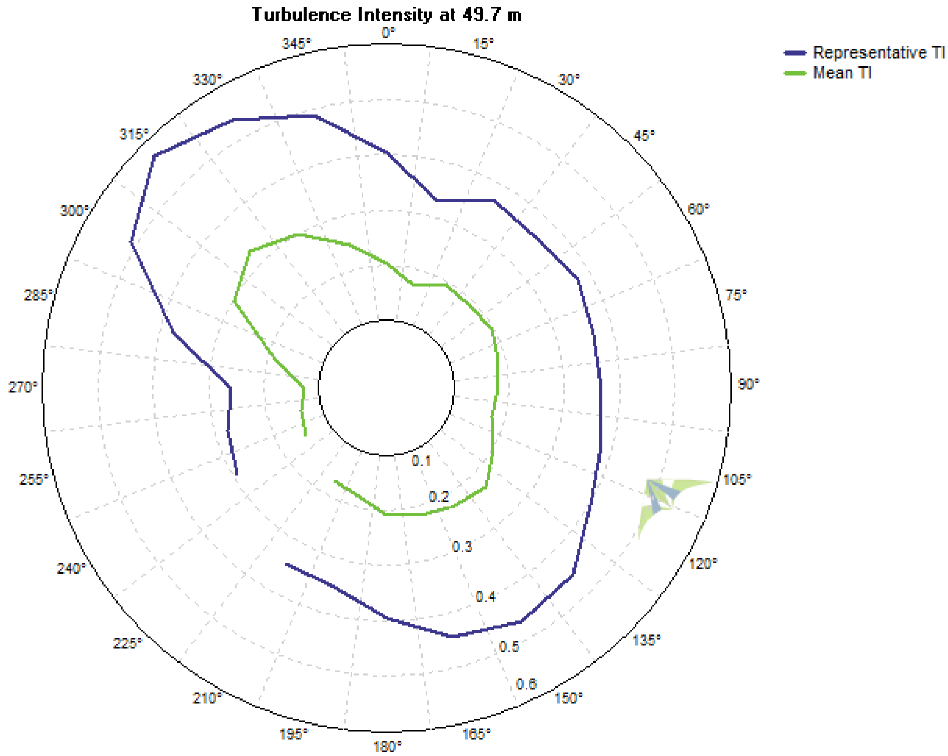
Turbulence

The turbulence intensity (TI) is acceptable with a mean turbulence intensity of 0.102 and a representative turbulence intensity of 0.159 at 15 m/s wind speed at 50 meters, indicating reasonably smooth air for wind turbine operations, especially in a mountain environment. This equates to an International Electrotechnical Commission (IEC) 3rd Edition (2005) turbulence category C, which is the lowest defined category. These data are shown in the turbulence intensity graph below. As seen, representative TI (90th percentile of the turbulence intensity values, assuming a normal distribution) at 15 m/s is well under IEC Category C criteria at the Tok 0051 met tower site.

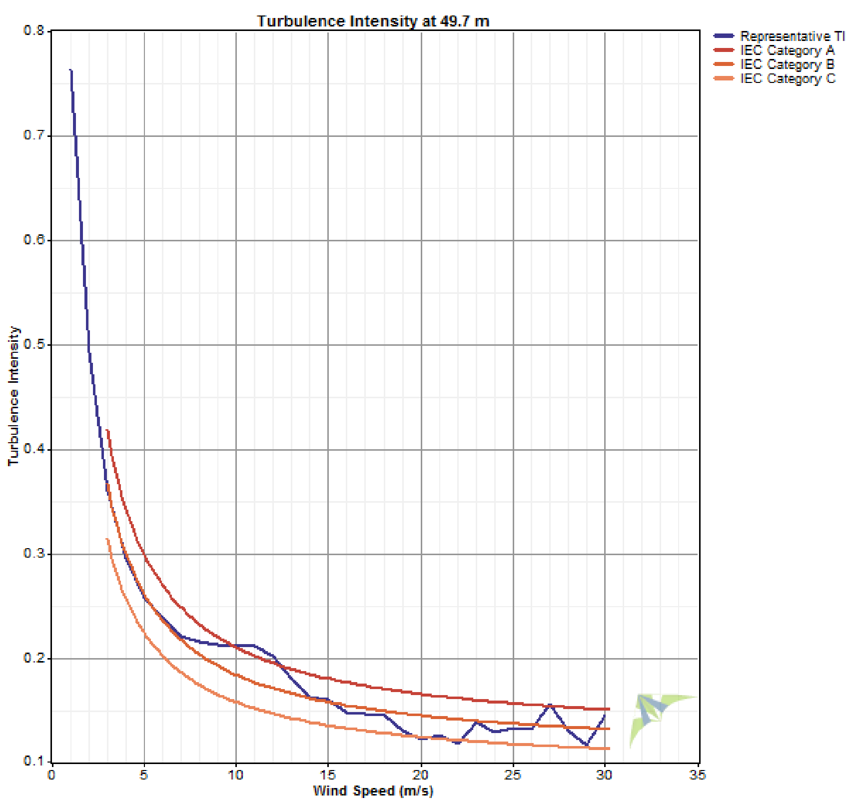
Turbulence synopsis

	50 m B anem.			40m A anem.			Legend	
Sector	Mean TI at 15 m/s	Repres. TI at 15 m/s	IEC3 Category	Mean TI at 15 m/s	Repres. TI at 15 m/s	IEC3 Category	IEC3 Categ.	Mean TI at 15 m/s
all	0.102	0.159	C	0.100	0.145	C	S	>0.16
315° to 045°	0.100	0.141	C	0.111	0.151	C	A	0.14-0.16
045° to 135°	0.100	0.149	C	0.097	0.143	C	B	0.12-0.14
135° to 225°	0.107	0.166	C	0.113	0.166	C	C	0-0.12
045° to 135°	0.102	0.166	C	0.098	0.143	C		

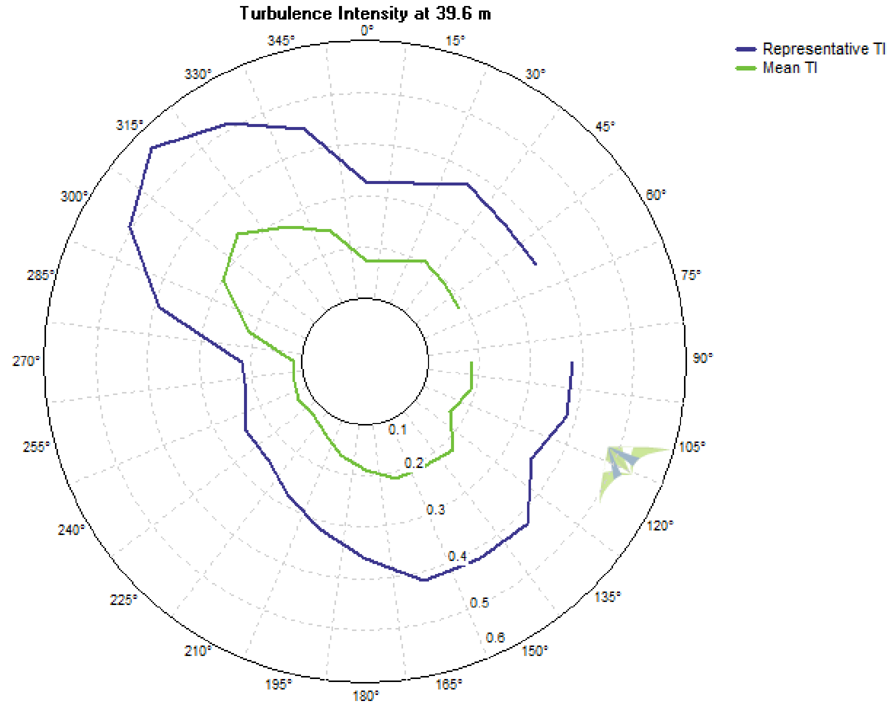
Turbulence rose, 50 m B anemometer, 50 m vane



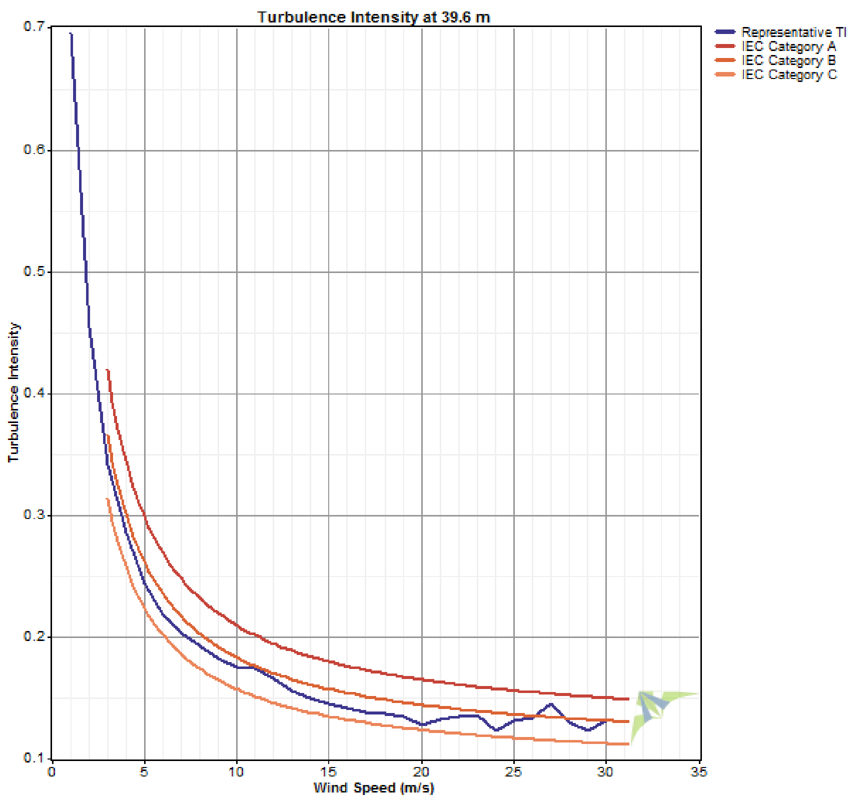
Turbulence intensity, 50 m B, all direction sectors



Turbulence rose, 40 m A anemometer, 40 m vane



Turbulence intensity, 40 m A, all direction sectors



Turbulence table, 40 m A data, all sectors

Bin Midpoint (m/s)	Bin Endpoints Lower (m/s)	Bin Endpoints Upper (m/s)	Records In Bin	Mean TI	Standard Deviation of TI	Representative TI	Peak TI
1	0.5	1.5	7,021	0.462	0.183	0.696	2.000
2	1.5	2.5	10,652	0.269	0.144	0.454	1.118
3	2.5	3.5	12,107	0.199	0.111	0.341	1.303
4	3.5	4.5	12,568	0.166	0.093	0.285	1.205
5	4.5	5.5	13,006	0.141	0.081	0.244	0.979
6	5.5	6.5	10,767	0.127	0.071	0.218	0.655
7	6.5	7.5	9,059	0.122	0.064	0.204	0.632
8	7.5	8.5	7,469	0.118	0.059	0.193	0.636
9	8.5	9.5	6,340	0.116	0.052	0.182	0.414
10	9.5	10.5	5,554	0.112	0.049	0.175	0.406
11	10.5	11.5	4,526	0.112	0.048	0.174	0.438
12	11.5	12.5	3,703	0.111	0.043	0.166	0.530
13	12.5	13.5	2,941	0.106	0.038	0.155	0.359
14	13.5	14.5	2,266	0.103	0.036	0.150	0.372
15	14.5	15.5	1,765	0.100	0.035	0.145	0.333
16	15.5	16.5	1,398	0.098	0.034	0.142	0.278
17	16.5	17.5	1,037	0.097	0.033	0.139	0.207
18	17.5	18.5	723	0.097	0.031	0.137	0.223
19	18.5	19.5	528	0.094	0.032	0.135	0.268
20	19.5	20.5	346	0.090	0.030	0.128	0.197
21	20.5	21.5	235	0.092	0.031	0.132	0.210
22	21.5	22.5	120	0.097	0.029	0.135	0.199
23	22.5	23.5	118	0.100	0.028	0.136	0.173
24	23.5	24.5	54	0.093	0.024	0.123	0.162
25	24.5	25.5	46	0.094	0.028	0.131	0.151
26	25.5	26.5	39	0.100	0.026	0.134	0.151
27	26.5	27.5	26	0.113	0.026	0.146	0.146
28	27.5	28.5	12	0.107	0.018	0.131	0.141
29	28.5	29.5	13	0.097	0.020	0.123	0.133
30	29.5	30.5	7	0.106	0.020	0.131	0.138
31	30.5	31.5	0				

Wind Turbine Production

Although not typically addressed in a wind resource report, annual energy production from a General Electric 1.5 sle (1.5 MW) wind turbine is included here for planning purposes. Note that a 95 percent turbine availability (percent of time the wind turbine is operational) is assumed.

GE 1.5 sle energy output, 95% turbine availability

Month	Hub Height Wind Speed (m/s)	Time At Zero Output (%)	Time At Rated Output (%)	Mean Net Power Output (kW)	Mean Net Energy Output (kWh/yr)	Net Capacity Factor (%)
Jan	5.97	23.5	0.5	312	232,110	20.8
Feb	7.25	16.6	3.1	420	281,922	28.0
Mar	5.98	22.9	1.1	298	221,879	19.9
Apr	6.93	19.9	2.9	401	288,439	26.7
May	5.82	23.5	0.9	263	195,737	17.5
Jun	5.62	30.5	1.2	267	192,535	17.8
Jul	6.51	26.4	2.0	364	270,509	24.2
Aug	7.09	21.7	1.6	438	325,671	29.2
Sep	6.30	25.4	0.8	350	252,085	23.3
Oct	6.79	18.9	0.8	394	293,159	26.3
Nov	7.76	18.3	7.4	488	351,066	32.5
Dec	7.18	21.6	4.1	448	333,395	29.9
Overall	6.60	22.4	2.2	370	3,238,507	24.7

YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

FOR:

ALASKA ENERGY AUTHORITY
813 W. NORTHERN LIGHTS BLVD.
ANCHORAGE, AK 99503

PREPARED BY:

ALASKA POWER & TELEPHONE COMPANY
P.O. BOX 3222
PORT TOWNSEND, WA 98368

AUGUST 2009

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YERRICK CREEK HYDRO ASSESSMENT
GRANT AGREEMENT NO. 2195345
FINAL REPORT

On January 13, 2009, a grant agreement from the Alaska Energy Authority was received in the amount of $100,000 to fund feasibility studies for the Yerrick Creek Hydroelectric Project, which is located approximately 20 miles west of Tok on the Alaska Highway.

Background:

AP&T proposes to construct the 2.0 MW Yerrick Creek Hydroelectric Project (Project) located on Yerrick Creek. The Project would off-set diesel generation which presently supplies power to the communities of Tetlin, Tanacross, Dot Lake, and Tok. The Project will consist of a small diversion structure, approximately 15,000 feet of penstock, powerhouse with a single generating unit, tailrace, small substation, and transmission line. The Project operation will be run-of-river; annual generation is expected to be approximately 4,900 MWh/yr (approximately 40% of the annual interconnected load). The Project will provide clean, renewable electricity, as well as rate stabilization. The cost to maintain a hydro project is also significantly lower than diesel generation.

AP&T's customers in Tetlin, Tok, Tanacross and Dot Lake presently pay between **$0.47-$0.65** per kWh (excluding PCE; based on the fluctuating rates in 2008). Once the Project interties with the Tok grid, the cost per kWh could be reduced by approximately 20% to about $0.37-$0.52 per kWh (excluding PCE; based on 2008 rates). This hydroelectric project will reduce diesel fuel consumption by approximately 350,000 gallons per year, which at today's prices (2008 average=$3.577/gal.) is equivalent to $1,252,000 annually. The existing diesel plant in Tok, which supplies electricity to all four communities, would use fewer diesel generators to meet the remaining load, reducing labor and maintenance costs and the frequency of generator overhaul and replacement for a potential savings of $50,000 annually. Lower energy costs would help stimulate both residential and commercial development.

The environmental impacts of AP&T's diesel generation, (e.g. air pollution, noise pollution, and potential for spills, etc.) will be significantly reduced by the Project. During part of the year it is expected that the entire load can be carried by the Project, and during the winter the use of diesel generation will supplement the Project.

Studies Conducted:

On June 19, 2008, and then again on July 22, 2008, AP&T submitted draft study plans to the resource agencies to see what studies would be necessary in order to permit this project. SHPO and ADF&G were the primary respondents with ADF&G handling all the environmental issues. Copies of agency/AP&T correspondence are enclosed in the Attachments.

AP&T proposed to conduct the following surveys as part of the assessment of this site as a potential hydroelectric project:

1. Stream gaging
2. Fish & Wildlife surveys
3. Wetland Delineation
4. Threatened, Endangered & Sensitive (TES) plant species
5. Water Quality Testing
6. Archaeological survey
7. Design
8. Topographic mapping
9. Permitting

1. <u>Stream gaging</u>: Gaging began in 2007 by AP&T personnel who installed a gage below the diversion location. Flow has shown that there is sufficient water there to operate a hydro project perhaps all twelve months of the year, depending on the fall rains and coldness of winter.

2. <u>Fish & Wildlife surveys</u>: After providing the resource agencies with the draft study plans, they determined that the available information was adequate regarding wildlife resources in the area. Fish surveys however were required to determine the extent of Dolly Varden and Arctic Grayling habitat because of their known or suspected use of the creek. The fish surveys began in September 2008 and were conducted by consultant Steve Grabacki of Graystar Pacific Seafood, Ltd. out of Anchorage. ADF&G wanted the following evaluated:

    1. Are there any fish in the creek.
    2. Which species are present in the creek.
    3. If indeed Spotted Dolly Varden and Arctic Grayling were in the creek.
    4. If one / both of these species wintered in the creek.
    5. If either / both of these species migrate up in the spring / down in the fall.
    6. If the hydroelectric project would have a significant impact on the fish habitat.

    In two September 2008 surveys a small number of Spotted Dolly Varden (DV) and Artic Grayling were found in Yerrick Creek using various methods of fish entrapment including: rod & reel, electrofishing, nets, and minnow traps. The largest DV was only 176mm (approx. 6.92”), and the Grayling 150mm (5.9”) in length. The DV remained upstream as ice was forming suggesting year round residency while the Grayling found in the creek mouth at the Tanana River suggests seasonal migration. The pools where they found the fish were marked for early spring study to verify this theory.

    In May 2009, a meeting was held between AP&T and ADF&G in Fairbanks to discuss what was known and what if any additional information was needed to get a permit for construction by August 1, 2009. While acknowledging that DV were probably resident in the upper Yerrick Creek and would not be impacted by the project, ADF&G asked for information on whether DV or Arctic Grayling were over-wintering in the bypass reach of the creek, if DV migrated up from the Tanana River each spring, and if the Arctic Grayling were spawning in the creek in the bypass reach.

In response, AP&T went back out to Yerrick Creek before thaw and videoed fish under the ice in the creek, which were identified as DV, no Arctic Grayling. This showed that DV over-wintered in the creek rather than coming up from the Tanana River in the spring. Surveys were also repeated in June to observe any spawning activity, particularly by Arctic Grayling, which were not found in any great numbers and were not observed in spawning activity. This information leads the biologist to believe the DV are resident and primarily use the area above the diversion site. Arctic Grayling are believed to possibly spawn below the projects discharge point in the lower part of the creek near its confluence with the Tanana River and otherwise use the creek opportunistically for feeding. The information that ADF&G provided us on Arctic Grayling use of the Tanana River basin indicates other streams provide better habitat and that Yerrick Creek may only be significantly utilized when there is an abundance of Arctic Grayling and they are looking for additional habitat. Sufficient surface flow was also found during the summer between the creek and the river to indicate that on a yearly basis there is access to the creek by fish, rather than having an isolated population.

In a July 20, 2009, letter to AP&T, ADF&G said there was additional information they were still waiting for before they could issue a permit. AP&T responded on July 24 with the information below that addressed their previous requests:

"ADF&G: Effects on fish habitat, particularly seasonal or over-wintering refugia, in the bypass.
<u>AP&T Response</u>: Studies conducted have shown that the majority of Dolly Varden (DV) year-round habitat is above the diversion structure and it was acknowledged during the May 2009 meeting with you that DV would not be significantly impacted by this project. Also, there are little over-wintering refugia in the bypass portion of the creek so that their loss will have minimal impact to DV."

"Arctic grayling (AG), which became a highlighted issue at the May 2009 meeting, were not found to spawn in Yerrick Creek and appear to only use it opportunistically. Grayling are also limited in getting up to the bypass reach due to the submergence of flow above the highway for significant portions of the year. The bypass reach that will be dewatered by the project diversion may also reduce the extent that AG are able to go up the creek at certain times of the year. However, given the natural barriers created during low flow periods, limited habitat quality in the bypass reach, and small fish numbers found in Yerrick Creek, we believe there will be little, if any, impact to AG. Based on this analysis we've concluded that fish passage is not necessary to protect AG. We do not propose to employ any fish passage in the bypass reach except what nature provides in the way of flow over the diversion spillway when flow exceeds 60 cfs or when demand is less than the naturally occurring flow. For this reason, subsurface flow data is not needed because there is no fish passage issue.

"Information has been provided on fish movement between stream reaches, life stage, and time of year for DV and grayling. Fish survey reports that have previously been supplied are enclosed with this letter.

"ADF&G: Fish passage through the bypass reach and past the diversion structure.
<u>AP&T Response</u>: Because the studies have found limited use by either species of the bypass reach and that DV primarily use the creek above the diversion site and the few grayling that feed in the creek primarily use the lower part of the creek, there is no need to construct fish passage devices.

"ADF&G: Existing surface and subsurface discharge characteristics in the bypass reach.
<u>AP&T Response</u>: As stated above, only surface flow has been gaged because we believe the data on fish use supports the conclusion that little habitat is available in the bypass reach, therefore there is no need to collect additional hydrological information.

"ADF&G: Life history and movements of DV in the project area.
<u>AP&T Response</u>: AP&T's fish studies indicate that most DV reside year-round in upper Yerrick Creek, from near the diversion site to well above the diversion site. DV do not appear to move through the project reach to any appreciable degree.

"ADF&G: Hydrologic information on instream flows necessary to preserve fish habitats and passage.
<u>AP&T Response</u>: Over two years ago a stream gage station was installed near the diversion site to measure surface water flow. The suggestion to install a second stream gage downstream of the bypass reach was rejected because of the absence of surface flow in that reach during much of the year, and the expense of a second gage prior to a better understanding of the area's fish distribution and habitat quality. As stated above, the fish habitat available in the bypass and corresponding low numbers of fish found in this reach does not warrant a more intensive investigation.

"ADF&G: Basic water quality characteristics including water temperatures.
<u>AP&T Response</u>: Basic water quality and hydrology data was collected by Travis/Peterson Environmental Consulting, Inc. in their report dated October 2008. We have enclosed it with this letter. As a result of our May 2009 meeting with you we also collected water temperature data in conjunction with our summer fish distribution and spawning field studies conducted in May, June, and July of this year. Temperature information is included in these fish survey reports.

"We believe you have the information needed to determine that a fishway passage device is not necessary for this project.

"It is our understanding that Alaska's Fishway Act (AS 16.05.841) requires the Department of Fish and Game (ADF&G) to decide if a fishway passage device is necessary to protect the fish resources that may be impacted by the proposed Yerrick Creek Hydroelectric project. State law does not authorize, or require you to make a decision based on an evaluation of "the potential project effects and benefits" as stated in your letter. To date, the information we have presented to ADF&G has been to support a reasoned and balanced evaluation of the proposed project's effects on Yerrick Creek's fish resources. If our reading of the Fishway Passage Act is incorrect, we are prepared to more fully describe the public economic and environmental benefits that can be reasonably expected from the project. We believe these public benefits far outweigh any adverse effects the project may have on Yerrick Creek's fish resource values.

"Studies conducted over a number of years by Alaska Power and Telephone (APT), the ADF&G, and Northwest Alaskan Pipeline have adequately characterized the Yerrick Creek fish resources with respect to their numbers, distribution, and habitat availability. The collected information indicates that Dolly Varden reside throughout the year in the upper part of Yerrick Creek, primarily above the diversion site, and Arctic grayling use the creek in the summer months for opportunistic feeding, from the Tanana River to near the proposed diversion area. There is no evidence of Arctic grayling spawning in Yerrick Creek, or that Yerrick Creek makes any more than a very minor contribution to the Arctic grayling resources in the Upper Tanana River basin.

"The proposed project's diversion of water would reduce flow in 11,000 feet of Yerrick Creek and create a temporary barrier to a few[1] *Arctic grayling when the Creek's natural flow is less than 60 cubic feet per second (cfs). We believe it is reasonable to assume that Arctic grayling would continue to occupy the drainage below the diverted flow's re-entry to Yerrick Creek at the Alaska Highway crossing, and further upstream in the "bypass area" when flows exceed 60 cfs. The insignificant displacement of a few Arctic grayling during low water flow periods (less than 60 cfs) does not appear to justify the construction of a fishway passage. The proposed project will also have little, if any, impact to the Dolly Varden population that resides above the proposed project diversion.*

"Over one year ago we provided ADF&G with our study plan for evaluating the fish resources of Yerrick Creek. Since that time we have adjusted our investigations to address the recommendations of your staff where appropriate and funded field studies to collect data relevant to a reasonable evaluation of the effect of the project on local fish resources. Your July 20, 2009, letter references a number of "information needs" that must be met for you to make a decision. As noted above, we believe we have provided the information and analysis to support a decision at this time.

[1] The largest number of grayling found in the proposed Yerrick Creek diversion bypass area was 18 recorded on July 22 in 1975.

"Three months ago we provided you a draft memorandum of agreement based on our analysis and conclusion that a fishway passage is not necessary for the project to protect resident Dolly Varden or transitory Arctic grayling. We also requested your final decision by August to secure project funding and begin construction this season. At this late date it is unacceptable to put the project on hold to produce information we believe has already been provided or has little bearing on the decision to be made."

(ADF&G subsequently issued a habitat permit for construction of this project on August 5, 2009)

3. Wetland Delineation: A wetland delineation was conducted by HDR Alaska out of Anchorage in August 2008. Their report defined where wetlands were in relation to the project features and will enable us to get a Corp of Engineer permit. Wetlands will be impacted by the Project, but to a lesser degree than thought primarily because of the glacial till providing drainage and the amount of uplands found on site. A copy of the HDR report is enclosed in the Attachments.

4. Threatened, Endangered, and Sensitive Plant Species: A TES plant survey was conducted by HDR Alaska while they were conducting the wetland delineation. No TES plants were encountered or identified in the area surveyed. Most plant species observed in the project area are considered common and widespread in interior Alaska. A copy of the HDR report is enclosed in the Attachments.

5. Water Quality & Baseline Hydrology: Water quality sampling and a baseline hydrology survey were conducted by Travis/Peterson Environmental Consulting out of Fairbanks. Historical hydrologic data for Yerrick Creek indicates that every two years there is a peak flow event of 1102 cfs, and every five years a peak flow event of 1575 cfs. Hundred year events are estimated to be as high as 3093 cfs. These flows are probably related to summer rain events (when statistically the highest flow occurs) and are the reason the creekbed is cobbled with clean boulders throughout its width and most of its length. Water quality sampling found that Yerrick Creek is a clear, oligotrophic (low nutrient levels), and well oxygenated stream. The moderately high pH for surface water suggests contact with some kind of carbonate rock within the drainage. Laboratory results confirm that Yerrick Creek and has minimal levels of most dissolved substances and does not warrant further investigation for water quality. A copy of the Travis/Peterson report is enclosed in the Attachments.

6. Archaeological Survey: An archaeological survey was started in 2008 and will be finished this summer of 2009 by Northern Land Use Research out of Fairbanks. One site was found (TNX-074) that could be eligible for the National Register, but isn't listed at this time. The site can easily be avoided by the Project because of its small size.

7. Design: Project design was slowed in part because of negotiations with Tanacross Inc. who resisted granting access to their land along the highway. AP&T

eventually received approval to access their land which allowed seismic refraction surveys and environmental surveys to take place. We have looked at several different routes for the penstock and access road on both the east and west sides of the creek; examples are enclosed in the Attachments. We want to keep the road and penstock in the same corridor to minimize environmental impacts. The west side offers the most opportunities because of the terrain, but the best route needs further evaluation. Of considerable concern is the location of permafrost, because that would impact the design significantly. During May-July 2009, permitting with the agencies was carried out to drive an excavator up the creek in order to dig test pits in the diversion area in August 2009. This will determine how deep bedrock is and what the substrate is like in general. During August-September a final design is likely to be completed so that permitting can be finalized to start construction either this fall or winter. During permitting it was determined that burying the penstock along the road would be best to allow wildlife and hunters to continue to easily cross this corridor.

8. Topographic Mapping: Topographic mapping was conducted by Aero-Metric, Inc. in 2008. This gave us highly detailed photo images and topographic mapping of the project site with which to design the project. Evidence of this mapping is available in the enclosed project design drawings.

9. Permitting: AP&T started the permitting process when sending out the draft study plans to the resource agencies in June and July 2008. Environmental surveys began in August 2008. A meeting was held with ADF&G in Fairbanks in May 2009 to discuss receiving a habitat permit to begin construction by August 1, 2009, however, additional information was requested in order to get a permit. Also, because we want to drive an excavator up the creek bed in August 2009 to dig test pits near the diversion site during low flows, we applied for and received permits from the Corp of Engineers, ADF&G, DNR, and Tanacross, Inc. In addition, AP&T negotiated with ADF&G a fish habitat permit to start construction, which was issued on August 5, 2009. Additional permits to start construction will be from the COE and DNR. SHPO must also provide clearance to start construction, which won't be able to occur until the archaeological survey is completed in August 2009.

Summary:

In summary, AP&T has been able to complete the following due to the grant funding provided by the AEA:

1. Stream gaging and the historical record from USGS shows sufficient water is there year round to generate electricity.
2. Fish surveys were completed enabling ADF&G to complete their review and issue a habitat permit to begin construction.
3. For the wetland delineation, approximately 21.3% (147.1 acres), a conservative delineation, of the mapped acres were determined to meet the USACOE requirements for being classified as wetlands. Most of the mapped wetland areas

are not within the proposed project construction areas. The remainder of the mapped project area, approximately 78.7% (542.6 acres) of the mapped area, lacks one or more of the required three parameters to support classifying an area as wetland (Table 5), and is not below the plane of Ordinary High Water (OHW) of Yerrick Creek.

4. The TES plant survey found no TES plants in the surveyed area.
5. Water quality was found to be within normal ranges for a stream of its type. No additional water quality surveying was recommended. Hydrologic baseline data indicates that significant flow occurs in this creek. AP&T's hydrologic data indicates hydropower could be generated most or all months of the year.
6. The archaeological survey has yet to be completed, but from what has been surveyed to date, no impacts will occur from the construction and operation of this project to historical or cultural resources. Cost's for this area has exceeded funding sought due to the archaeologist having to go out twice to complete the survey.
7. The final design is still being worked on by the engineering staff of AP&T.
8. The topographic mapping has been very useful not only for the engineering studies and design but also the environmental surveys and archaeological survey.
9. Permitting accomplished during this grant funding period allowed AP&T to narrow down the studies to be conducted after consultation with the resource agencies and to complete most of the studies. The meeting with ADF&G drove costs up above what was anticipated in the Project Management & Permitting category as well as managing other activities associated with this project. We were able to permit driving an excavator up the creek bed for August 2009 to check the substrate out by digging test pits through the COE, DNR, and ADF&G. We also were able to get a permit to go ahead with construction from ADF&G. These were significant inroads into getting this project near the construction phase.

Grant Budget:

As can be seen in the Table below, cost to AP&T far exceeded the 25% that we were responsible for in this matching grant. Beyond the AEA's $100,000 grant and AP&T's matching of $25,000, an additional $240,224.90 was expended.

Period: June 1, 2008 to June 30, 2009

Budget Summary by Task or Milestone

Task or Milestone Number	Total Grant Budget	Total Expenditures	Balance
1. Field Work in AK - Stream Gauging	3,750.00	65,514.51	(61,764.51)
2. Fish & Wildlife Surveys	56,250.00	71,979.32	(15,729.32)
3. Wetland Delineation/TES Survey	26,875.00	43,506.38	(16,631.38)
4. Water Quality Testing	6,250.00	12,478.34	(6,228.34)
5. Archaeological Survey	2,500.00	9,804.78	(7,304.78)
6. Conceptual Design	1,250.00	47,966.75	(46,716.75)
7. Topographic Mapping	18,750.00	67,779.02	(49,029.02)
8. Project Management & Permitting	5,000.00	45,786.60	(40,786.60)
9. Quarterly AEA Report	625.00	409.20	215.80
10. Complete Study and Submit Draft	1,875.00	-	1,875.00
11. Final Report	1,875.00	-	1,875.00
I. TOTAL Project Cost	125,000.00	365,224.90	(240,224.90)

Budget Summary by Fund Sources

Grant Funds	100,000.00	100,000	
Grantee Match - Cash	25,000.00	167,261.03	(240,224.90)
Grantee Match - In-kind			
Grantee Match - Other Funds (Source)			
Grantee - Federal Funds			
TOTAL	125,000.00	365,224.90	(240,224.90)

Project Outcomes:

Project outcomes were positive in that all environmental surveys were completed and some of the engineering design work completed, including determining that the project is feasible. The project is feasible because there is adequate water available most of the year to generate electricity. Also, getting the permits for the excavator to drive up the creekbed and getting ADF&G's habitat permit for construction were significant achievements toward completing this project.

Problems Encountered:

From an engineering standpoint, the difficulty of the substrate and terrain for determining the best route for a road and pipe to come into the project has been challenging. The creek channel itself is very dynamic, obvious by the clean boulders and cobble throughout the creek which indicates high flow. Placing the pipe in the creek bed or having a bridge across the creek that is so dynamic is a challenge. The uplands around the creek also has pockets of permafrost, which we would prefer to avoid incase thaw should occur. There are also wetlands and pockets of gravel and bedrock outcroppings to contend with. These are not unsolvable, but are none the less challenging.

Problems from a permitting standpoint would have to do with the expectation by ADF&G that we would study the project site more than necessary by installing a second stream gage down by the powerhouse site, install a stream gage for subsurface flow, and conduct an analysis and design of a fish passage device/structure to allow fish past the diversion structure, none of which they eventually agreed was needed.

Conclusions and Recommendations:

To reach the level of permitting and study completion we have within a year is pretty efficient. We have no recommendations regarding this phase of the project.

Project Feasibility Assessment Timeline For Grant Funds:

o Browne Research, Inc.: Report that no AHRS sites near proposed project	06/05/08
o AP&T to Agencies: Draft Study Plan for review	06/13/08
o GRAYSTAR: Summary of site visit for fisheries baseline	06/30/08
o ADF&G: Draft Study Plan Comments	07/01/08
o ADF&G: Fish Resource Collection Permit	07/01/08
o AP&T to DNR: Project Information	07/09/08
o AP&T to Agencies: Draft Study Plan – Version 2	07/22/08
o DNR to AP&T: Initiation of Section 106 Consultation	08/15/08
o ADF&G: Comments on Revised Draft Study Plan	09/03/08
o ADF&G: Comments on Draft Study Plan	09/19/08
o GRAYSTAR: Field Report, Baseline Study	10/01/08
o NORTHERN LAND USE RESEARCH: Cultural Resource Survey Report	10/07/08
o GRAYSTAR: Fisheries Baseline Study	10/30/08
o USDA-RUS: Teleconference meeting summary between AP&T, Tanacross, Inc. and RUS	11/13/08
o AEA to AP&T: Grant Agreement	01/13/09
o HDR-Alaska: TES Plant Report	01/27/09
o HDR-Alaska: Preliminary Jurisdictional Determination	01/27//09
o GCI: Summary of meeting with Kerry Howard-ADF&G	04/10/09
o AP&T to ADF&G: Fish Habitat Permit application	05/01/09
o AP&T to DNR: State Land Use Permit application	05/01/09
o AP&T to COE: Dept of Army Permit application	05/01/09
o GCI to ADF&G: Agenda for meeting at ADF&G Fairbanks office	05/17/09
o ADF&G: Scientific Fish Collection Permit expires 12/31/09	05/20/09
o GCI to AP&T: Summary of Meeting with ADF&G in Fairbanks	05/21/09

- COE: Permit issued, valid for two years 05/21/09
- GRAYSTAR: Report on two fish samplings 06/02/09
- GRAYSTAR: Conducted three fish samplings 06/10/09
- AP&T to ADF&G: Request for Fish Habitat Permit for Construction 06/12/09
- ADF&G: More info needed for permitting 07/20/09
- AP&T to ADF&G: Response to additional info request and ultimatum 07/24/09
- ADF&G: Fish Habitat Permit FH09-III-0182 issued for construction 08/05/09

ATTACHMENTS

1. **Correspondence**
2. **Wetland Delineation**
3. **TES Plant Survey**
4. **Water Quality and Hydrology Baseline Study**
5. **Fish Reports**
6. **Design Diagrams**

YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

~CORRESPONDENCE~

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

NOTHERN REGION LANDS OFFICE

SARAH PALIN, GOVERNOR

☐ NORTHERN REGION
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August 12, 2009

Glen D. Martin
Project Manager
Alaska Power & Telephone Company
Corporate Headquarters
P.O. Box 3222
Port Townsend, WA 98368
(360) 385-1733 x122
(360) 385-7538 fax

Mr. Martin,

This letter is to inform you that the Land Use Permit, LAS #27271, for geotechnical exploration in the Yerrick Creek drainagne has been completed and is ready for signature. Please review the attached Memorandum of Decision (MOD) and the permit and listed stipulations. You will need to print out the permit, provide your information and signature where indicated, and then return only the signature page to me via email or by fax. I will then sign where indicated and issue the permit by sending you a scanned copy of the completed signature page. You will need to send me your original signed page by regular mail.

I realize APT wants to send the excavator up Yerrick Creek soon and the only requirement remaining is the Performance Guaranty. The signed permit will be valid as soon as we receive proof of the bond.

If you have questions about any of the enclosed information or stipulations, please feel free to contact me at (907) 451-2710 or at valerie.baxter@alaska.gov. Thank you.

Sincerely,

Valerie Baxter

Valerie Baxter
Natural Resource Specialist

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER
NORTHERN REGION

Memorandum of Decision
LAS 27271 – Yerrick Creek Geotechnical Exploration Access

Proposed Action

Glen Martin, on behalf of Alaska Power and Telephone Company (APT), submitted a land use permit application to drive an excavator through the Yerrick Creek drainage in order to conduct geotechnical exploration at a proposed hydroelectric project site. APT is requesting four days to travel from the Alaska Highway to the project site, conduct testing, and return. The excavator is a Robox 130 LCM-3 and the proposed route across state land would involve travel in the dry creek beds of Yerrick Creek and would require crossing the active channels of Yerrick Creek up to 6 times. The geotechnical exporation would involve the digging of 6 test pits, up to 20ft deep, to characterize the substrate. The test pits would be located a minimum of 50ft from the active channel and would be refilled with the excavated material upon completion.

The Department proposes to issue the permit as requested.

Authority

This permit is being adjudicated pursuant to Alaska Statute 38.05.850 (Permits).

Administrative Record

The administrative record for the proposed action consists of Alaska Administrative Code 11 AAC 96 (Miscellaneous Land Use); Tanana Basin Area Plan (TBAP, 1991 Update); LAS 27271, the current casefile, and this memorandum of decision.

Location

Geographic:	The access point to Yerrick Creek is located at milepost 1333.6 of the Alaska Highway and is 88.4 miles east of Delta Junction. USGS Map Tanancross B-6 63K. See attachment A.
Legal Description:	Copper River Meridian, Township 18 North, Range 9 East, Sections 11 and 14.
Borough:	This area is within the Tanacross Inc., region and 3 sections of corporation land must be crossed before reaching state land. Permission to access and cross Tanacross Inc., lands was obtained on June 10, 2009, and permits from ADF&G Habitat division (FH09-III-0128) and the US Army Corps of Engineers (POA-2009-445) have also been received. The project is within an unorganized Borough, though it is not within a coastal zone.

Title

The State received tentative approval for Sections 11 and 14 under General Grant GS895 on 12/20/1963.

Classification

This site is within the Tanana Basin Area Plan (TBAP, 1991 Update), Subregion 6, Upper Tanana, Management Unit 6C3, Buck Creek, and is classified wildlife habitat. This management unit has critical rated habitat for grizzly bear, moose, and sheep. The Tok River area of 6C3 has been identified in the TBAP as meriting legislative designation as a State Game Refuge because of outstanding wildlife and public values.

Forestry and recreation are listed as secondary surface uses within this unit and the unit is closed to land disposals and remote cabins. 6C3 is open to mineral entry. There is nothing in the TBAP which prohibits the proposed use.

Eligibility

Alaska Power and Telephone Company is in good standing with the state of Alaska.

Courtesy Agency Notice

Courtesy agency notice was sent via electronic mail to the following agencies:

Meg Hayes and Associates, Land Management Consultant for Tanancross, Inc.

Jim Vohden, Hydrologist, Water Section, DMLW, DNR

Robert McLean, Regional Manager, Division of Habitat, AK Department of Fish & Game

Alan Skinner, Regulatory Specialist, US Army Corp of Engineers, Anchorage, AK

Three agency comments were received: one from ADF&G acknowledging that a fish habitat permit had been issued; one from the USACE, acknowledging that a Nationwide Permit 6 authorization had been granted for this project; one from Tanacross, Inc., stating that they have granted permission to AP&T to access Tanacross lands for this project. No comments were received that objected to ADNR issuing this land use permit.

A Public Notice was issued on 07/15/2009 and the comment deadline was 07/31/2009. No public comments were received.

Background

APT is pursuing a run-of-river hydroelectric project on Yerrick Creek and in 2007 they applied for a state land lease, ADL 418154. They are currently applying for a temporary land use permit to conduct substrate testing to determine permeability and the location of bedrock in order to choose the best placement of the hydroelectric diversion structure.

The first sections of the proposed route cross Tanacross, Inc, land and APT has acquired their permission for access. A wetlands delineation and jurisdictional determination were conducted and APT was authorized to conduct testing under a US Army Corps of Engineers Nationwide Permit No. 6 (POA-2009-445). Fish surveys in Yerrick Creek were also performed and APT has received authorization for instream equipment crossing and geotechnical exploration from ADF&G Habitat Division (FH09-III-0128).

No roads exist into the proposed testing area. Yerrick Creek is a cobble, gravel, and sand substrate creek which crosses the Alaska Highway at approximately milepost 1339. The project area is mostly undeveloped, with an open gravel waterway, old gravel side channels in various stages of succession, and forested banks. There is an existing ANCSA 17(b) easement trail that runs roughly parallel to the creek, through the forest, on the west side. This trail's permitted uses, when adjacent to Tanacross lands, include only travel by foot, dogsleds, animals, snowmobiles, two- and three-wheeled vehicles, and small all-terrain vehicles. The trail is currently approximately 6 ft wide and is typically used by hunters to access the foothills to the south. Accessing the project site via this trail would involve vegetation clearing and disturbance of the vegetative mat and is not the least environmentally damaging alternative.

Discussion

According to LAS and the APMA waypoint file there are no other land authorizations in this area.

In adjudicating a LUP permit, DNR seeks to facilitate development, conservation, and enhancement of state lands for present and future Alaskans, while minimizing disturbance to vegetative, hydrologic, and topographic characteristics of the area that may impair water quality and soil stability. This use will not adversely affect the State of Alaska's goals of conserving and enhancing natural resources for use by present and future Alaskans.

Environmental Risk

Equipment storage and fueling operations would not occur within 50' of Yerrick Creek, a drainage or wetland. In order to minimize potential impacts to resident fish, the proposed timing of travel for the excavator is during the low water period of August/September 2009.

Performance Guarantee and Insurance

As directed in 11 AAC 96.060 (Performance guaranty) the applicant shall furnish security acceptable to the department. Using the performance guarantee matrix, the recommended performance guaranty is $4500.

Permit Fees

As directed in 11 AAC 05.010(c)(5) there is no annual use fee for a land use permit that does not hinder other public use.

Recommendation

Based upon the information provided by the applicant, as well as review of relevant planning documents, statutes, and regulations related to this application, it is the decision of the Alaska Department of Natural Resources, Division of Mining, Land and Water, to issue this land use permit on condition that all permit stipulations are followed as described in attached permit. The term of this permit is for the months of **August 13, 2009 through September 30, 2009**. During the period of the permit periodic inspections may be conducted at the discretion of DNR to ensure permit compliance.

Valerie Abbott
Adjudicator

8-12-2009
Date

Review by Manager

8/12/09
Date

Appeals

A person affected by this decision may appeal it, in accordance with 11 AAC 02. Any appeal must be received by 09/15/2009, as defined in 11 AAC 02.040(c) and (d) and may be mailed or delivered to Tom Irwin, Commissioner, Department of Natural Resources, 550 W. 7th Avenue, Suite 1400, Anchorage, Alaska 99501; faxed to 1-907-269-8918, or sent by electronic mail to dnr.appeals@alaska.gov. This decision takes effect immediately. If no appeal is filed by the appeal deadline, this decision becomes a final administrative order and decision of the department on 09/30/2009. An eligible person must first appeal this decision in accordance with 11 AAC 02 before appealing this decision to Superior Court. A copy of 11 AAC 02 may be obtained from any regional information office of the Department of Natural Resources.

STATE OF ALASKA
Department of Natural Resources
Division of Mining, Land & Water

LAND USE PERMIT
Under AS 38.05.850

PERMIT # LAS 27271

Alaska Power and Telephone Company, herein known as the permittee, is issued this permit authorizing the use of state land located within:

Copper River Meridian, Township 18 North, Range 9 East, Sections 11 and 14, as shown in Attachment A.

This permit is **effective beginning August 13th, 2009 and ending September 30th, 2009** unless sooner terminated at the State's discretion. This permit does not convey an interest in state land and as such is revocable with or without cause.

This permit is issued for the purpose of authorizing:

Travel of a Robox 130 LCM-3 excavator through the Yerrick Creek drainage. The proposed route across state land would involve travel in the dry creek beds of Yerrick Creek and would require crossing the active channels of Yerrick Creek up to 6 times. The geotechnical exploration would involve the digging of 6 test pits, up to 20ft deep, to characterize the substrate.

All activities shall be conducted in accordance with the following Permit Stipulations.

Permit Stipulations

1. **Authorized Officer.** The Authorized Officer for the Department of Natural Resources is the Regional Land Manager or his designee. The Authorized Officer may be contacted at 3700 Airport Way, Fairbanks, Alaska 99709 or (907) 451-2740. The Authorized Officer reserves the right to modify these stipulations or use additional stipulations as deemed necessary.

2. **Compliance with Governmental Requirements and Recovery of Costs.** Permittee shall, at its expense, comply with all applicable laws, regulations, rules and orders, and the requirements and stipulations included in this authorization. Permittee shall ensure compliance by its employees, agents, contractors, subcontractors, licensees, or invitees. This authorization is revocable immediately upon violation of any of its terms, conditions, and stipulations or upon failure to comply with any applicable laws, statutes and regulations (state and federal).

3. **Performance Guaranty.** The permittee shall provide a surety bond or other form of security acceptable to the Division in the amount of $ 4500.00 payable to the State of Alaska. Such performance guaranty shall remain in effect for the term of this authorization and shall secure performance of the permittee's obligations hereunder. The amount of the performance guaranty may be adjusted by the Authorized Officer upon approval of amendments to this authorization, changes in the development plan, upon any change in the activities conducted, or performance of operations conducted on the premises. If Permittee fails to perform the obligations under this permit within a reasonable amount of time, the State may perform Permittee's obligations at Permittee's expense. Permittee agrees to pay within 20 days following demand, all costs and expenses reasonably incurred by the State of Alaska as a result of the failure of the permittee to comply with the terms of this permit. The provisions of this permit shall not prejudice the State's right to obtain a remedy under any law or regulation. If the Authorized Officer determines that the permittee has satisfied the terms and conditions of this authorization the performance guaranty may be released. The performance guaranty may only be released in a writing signed by the Authorized Officer.

4. **Other Authorizations.** The issuance of this authorization does not alleviate the necessity of the permittee to obtain authorizations required by other agencies for this activity.

5. **Termination.** This permit does not convey an interest in state land and as such is revocable immediately, with or without cause.

6. **Public Access.** The permittee shall not close landing areas or trails. The ability of all users to use or access state land or public water must not be restricted in any manner.

7. **Public Trust Doctrine.** The Public Trust Doctrine guarantees public access to, and the public right to use navigable and public waters and the land beneath them for navigation, commerce, fishing and other purposes. This authorization is issued subject to the principles of the Public Trust Doctrine regarding navigable or public waters. The Division of Mining, Land and Water (Division) reserves the right to grant other interests consistent with the Public Trust Doctrine.

8. **Valid Existing Rights.** This authorization is subject to all valid existing rights in and to the land covered under this authorization. The State of Alaska makes no representations or warranties, whatsoever, either expressed or implied, as to the existence, number or nature of such valid existing rights.

9. **Reservation of Rights.** The Division reserves the right to grant additional authorizations to third parties for compatible uses on or adjacent to the land covered under this authorization. Authorized concurrent users of state land, their agents, employees, contractors, subcontractors and licensees shall not interfere with the operation or maintenance activities of authorized users.

10. **Preference Right.** No preference right for long term use or conveyance of the land is granted or implied by the issuance of this authorization.

11. **Assignment.** This permit may not be transferred or assigned to another individual or corporation.

12. **Site Maintenance**. The area subject to this authorization shall be maintained in a neat, clean, and safe condition, free of any solid waste, debris, or litter.

13. **Site Disturbance.**

    (a) Site disturbance shall be kept to a minimum to protect local habitats. All activities at the site shall be conducted in a manner that will minimize the disturbance of soil and vegetation and changes in the character of natural drainage systems.

14. **Site Restoration.**

    (a) Upon expiration, completion, or termination of this authorization, the site shall be vacated and all improvements, personal property, and other chattels shall be removed or they will become the property of the state.

    (b) The site shall be left in a clean, safe condition acceptable to the Authorized Officer. All solid waste debris and any hazardous wastes that are used and stored on the site shall be removed and backhauled to an ADEC approved solid waste facility.

15. **Fire Prevention, Protection and Liability.** The permittee shall take all reasonable precautions to prevent and suppress forest, brush and grass fires, and shall assume full liability for any damage to state land resulting from negligent use of fire. The State of Alaska is not liable for damage to the permittee's personal property and is not responsible for forest fire protection of the permittee's activity.

16. **Holes and Excavations.** All holes shall be backfilled with sand, gravel, or native materials.

17. **Destruction of Markers.** All survey monuments, witness corners, reference monuments, mining claim posts, bearing trees, and unsurveyed lease corner posts shall be protected against damage, destruction, or obliteration. The permittee shall notify the Authorized Officer of any damaged, destroyed, or obliterated

markers and shall reestablish the markers at the permittee's expense in accordance with accepted survey practices of the Division of Land.

18. **Hazardous Substances.** The use and/or storage of hazardous substances by the permittee must be done in accordance with existing federal, state and local laws, regulations and ordinances. Debris (such as soil) contaminated with used motor oil, solvents, or other chemicals may be classified as a hazardous substance and must be removed and disposed of in accordance with existing federal, state and local laws, regulations and ordinances.

19. **Spill Notification.** The permittee shall immediately notify the Alaska Department of Environmental Conservation (ADEC) by telephone, and immediately afterwards send ADEC a written notice by facsimile, hand delivery, or first class mail, informing ADEC of: any unauthorized discharges of oil to water, any discharge of hazardous substances other than oil; and any discharge or cumulative discharge of oil greater than 55 gallons solely to land and outside an impermeable containment area. If a discharge, including a cumulative discharge, of oil is greater than 10 gallons but less than 55 gallons, or a discharge of oil greater than 55 gallons is made to an impermeable secondary containment area, the permittee shall report the discharge within 48 hours, and immediately afterwards send ADEC a written notice by facsimile, hand delivery, or first class mail. Any discharge of oil, including a cumulative discharge, solely to land greater than one gallon up to 10 gallons must be reported in writing on a monthly basis. The posting of information requirements of 18 AAC75.305 shall be met. Scope and Duration of Initial Response Actions (18 AAC 75.310) and reporting requirements of 18 AAC 75, Article 3 also apply.

    The permittee shall supply ADEC with all follow-up incident reports. Notification of a discharge must be made to the nearest DEC Area Response Team during working hours: Anchorage (907) 269-7500, fax (907) 269-7648; Fairbanks (907) 451-2121, fax (907) 451-2362; Juneau (907) 465-5340, fax (907) 465-2237. The DEC oil spill report number outside normal business hours is (800) 478-9300.

20. **Operation of Vehicles.**

    (a) Crossing waterway courses will be made using an existing low angle approach in order to not disrupt the naturally occurring stream or lake banks.

    (b) There shall be no bank modification.

    (c) Wherever possible, watercourses shall be crossed at shallow riffle areas from point bar to point bar.

    (d) During equipment maintenance operations and overnight storage, the site shall be protected from leaking or dripping hazardous substances or fuel. The permittee shall place drip pans or other surface liners designed to catch and hold fluids under the equipment or develop a maintenance area by using an impermeable liner or other suitable containment mechanism.

21. **Alaska Historic Preservation Act.** The Alaska Historic Preservation Act (AS 41.35.200) prohibits the appropriation, excavation, removal, injury, or destruction of any state-owned historic, prehistoric (paleontological) or archaeological site without a permit from the commissioner. Should any sites be discovered during the course of field operations, activities that may damage the site will cease and the Office of History and Archaeology, Division of Parks and Outdoor Recreation, (907) 269-8721, shall be notified immediately.

22. **Inspections.** Authorized representatives of the State of Alaska shall have reasonable access to the subject parcel for purposes of inspection. The permittee may be charged fees under 11 AAC 05.010(a)(7)(M) for routine inspections of the subject parcel, inspections concerning non-compliance, and a final closeout inspection.

23. **Indemnification.** Permittee assumes all responsibility, risk, and liability for its activities and those of its employees, agents, contractors, subcontractors, licensees, or invitees, directly or indirectly related to this permit, including environmental and hazardous substance risk and liability, whether accruing during or after the term of this permit. Permittee shall defend, indemnify, and hold harmless the State of Alaska, its agents and employees, from and against any and all suits, claims, actions, losses, costs, penalties, and damages of whatever kind or nature, including all attorney's fees and litigation costs, arising out of, in connection with, or incident to any act or omission by Permittee, its employees, agents, contractors, subcontractors,

licensees, or invitees, unless the proximate cause of the injury of damage is the sole negligence or willful misconduct of the State or a person acting on the State's behalf. Within 15 days, Permittee shall accept any such cause, action or proceeding upon tender by the State. This indemnification shall survive the termination of the permit.

24. **Violations.** This authorization is revocable immediately upon violation of any of its terms, conditions, stipulations, nonpayment of fees, or upon failure to comply with any other applicable laws, statutes and regulations (federal and state). Should any unlawful discharge, leakage, spillage, emission, or pollution of any type occur due to permittee's, or its employees', agents', contractors', subcontractors', licensees', or invitees' act or omission, permittee, at its expense shall be obligated to clean the area to the reasonable satisfaction of the State of Alaska.

25. **Change of Address.** Any change of address must be submitted in writing to the office of responsibility.

26. **Permit Amendments.** Permittee proposals requiring the amendment of this permit must be in submitted in writing.

27. **Completion Report.** A completion report shall be submitted within 30 days of the termination of the authorized activities. The report shall contain the following information:

    (a) A statement of restoration activities and methods of debris disposal.

    (b) Photographs of the permitted site taken before, during, and after the proposed activity to document permit compliance. Photos must consist of a series of aerial or ground level view photos that clearly depict compliance with site cleanup and restoration guidelines.

Advisory Regarding Violations of the Permit Guidelines. Pursuant to 11 AAC 96.145, a person who violates a provision of a permit issued under this chapter (11 AAC 96) is subject to any action available to the department for enforcement and remedies, including revocation of the permit, civil action for forcible entry and detainer, ejectment, trespass, damages, and associated costs, or arrest and prosecution for criminal trespass in the second degree. The department may seek damages available under a civil action, including restoration damages, compensatory damages, and treble damages under AS 09.45.730 or 09.45.735 for violations involving injuring or removing trees or shrubs, gathering geotechnical data, or taking mineral resources.

If a person responsible for an unremedied violation of 11 AAC 96 or a provision of a permit issued under this chapter (11 AAC 96) applies for a new authorization from the department under AS 38.05.035 or 38.05.850, the department may require the applicant to remedy the violation as a condition of the new authorization, or to begin remediation and provide security under 11 AAC 96.060 to complete the remediation before receiving the new authorization. If a person who applies for a new authorization under AS 38.05.035 or 38.05.850 has previously been responsible for a violation of this chapter or a provision of a permit issued under this chapter, whether remedied or unremedied, that resulted in substantial damage to the environment or to the public, the department will consider that violation in determining the amount of the security to be furnished under 11 AAC 96.060 and may require the applicant to furnish three times the security that would otherwise be required.

The Authorized Officer reserves the right to modify these stipulations or use additional stipulations as deemed necessary. The permittee will be advised before any such modifications or additions are finalized. Any correspondence on this permit may be directed to the Department of Natural Resources, Division of Mining, Land and Water, Northern Region Office, 3700 Airport Way, Fairbanks, Alaska 99709-4699 telephone (907) 451-2740.

I have read and understand all of the foregoing and attached stipulations. By signing this permit, I agree to conduct the authorized activity in accordance with the terms and conditions of this permit.

Glen D. Martin   Project Manager   8-12-09

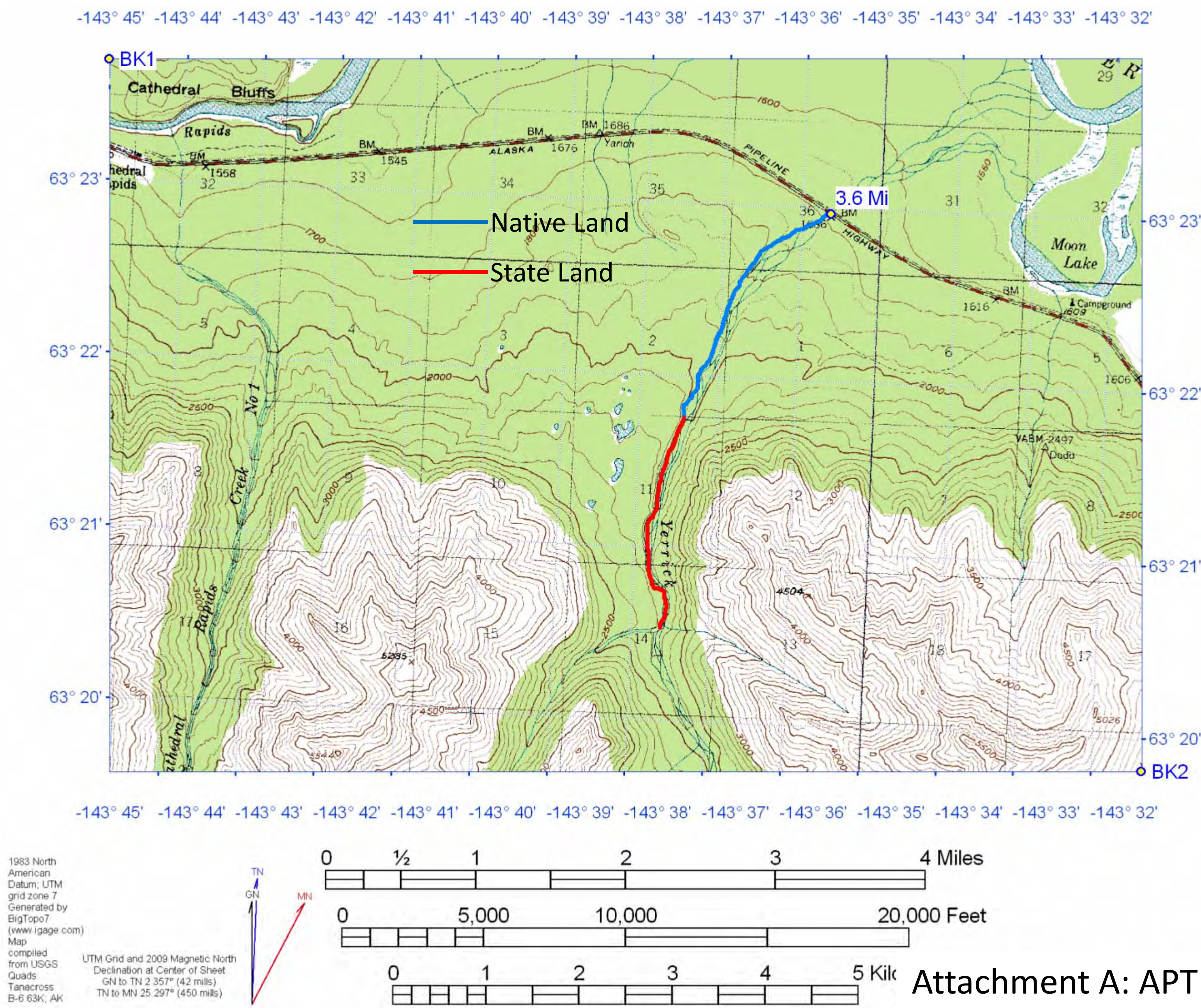
Permittee   Title   Date

PO Box 3222, Port Townsend, WA 98368   360-385-1733 x122   Glen

Address   Phone   Contact Name

Valerie Barton   NRS II   8-12-2009

Signature of Authorized State Representative   Title   Date



Attachment A: APT Yerrick Creek Access Map

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

DIVISION OF HABITAT

SEAN PARNELL, GOVERNOR

1300 COLLEGE ROAD
FAIRBANKS, AK 99701-1551
PHONE: (907) 459-7289
FAX: (907) 459-7303

FISH HABITAT PERMIT
FH09-III-0182

ISSUED: August 5, 2009
EXPIRES: December 31, 2012

Mr. Glen Martin
Project Manager
Alaska Power and Telephone Company
P.O. Box 3222
Port Townsend, WA 98368

RE: Yerrick Creek Hydroelectric Stream Diversion and Water Impoundment

Pursuant to AS 16.05.841, the Alaska Department of Fish and Game (ADF&G), Division of Habitat has reviewed your proposal to construct an impoundment dam and bypass up to 60 cfs of water through a 48-inch diameter, 15,000 feet long penstock, with bypassed flows reentering Yerrick Creek after passing through a hydro power house located near the Alaska Highway. Civil design for construction of the diversion or bypass of excess water around the diversion were not provided.

Yerrik Creek support resident fish species (e.g., Arctic grayling, Dolly Varden) in the area of your proposed activity. The resident Dolly Varden population is located in the headwaters and middle bypass reach. Arctic grayling are predominately in the lower reach below the diversion reentry point, but also have been documented in the middle bypassed reach.

Based upon our review of your plans, your proposed project may obstruct the efficient passage and movement of fish. In accordance with AS 16.05.841, project approval is hereby given subject to the following stipulations:

1. Prior to construction, civil plans for construction of the impoundment dam and excess flow bypass shall be submitted to ADF&G for review and approval.

2. The excess flow bypass shall be constructed as a roughened channel (see enclosed example) that permits all flow in excess of 60 cfs to remain in the middle bypass reach and that provides fish passage, both upstream and downstream.

3. Prior to construction, plans shall be submitted to provide for fish exclusion at the penstock intake. These plans must provide for an effective screen opening that does not exceed ¼ inch.

The permittee is responsible for the actions of contractors, agents, or other persons who perform work to accomplish the approved plan. For any activity that significantly deviates from the approved plan, the permittee shall notify the Division of Habitat and obtain written approval in the form of a permit amendment before beginning the activity. Any action taken by the permittee, or an agent of the permittee, that increases the project's overall scope or that negates, alters, or minimizes the intent or effectiveness of any stipulation contained in this permit will be deemed a significant deviation from the approved plan. The final determination as to the significance of any deviation and the need for a permit amendment is the responsibility of the Division of Habitat. Therefore, it is recommended that the Division of Habitat be consulted immediately when a deviation from the approved plan is being considered.

This letter constitutes a permit issued under the authority of AS 16.05.841 and must be retained on site during the permitted activity. Please be advised that this approval does not relieve you of the responsibility of securing other permits, state, federal or local.

This permit provides reasonable notice from the Commissioner that failure to meet its terms and conditions constitutes violation of AS 16.05.861; no separate notice under AS 16.05.861 is required before citation for violation of AS 16.05.841 can occur. In addition to the penalties provided by law, this permit may be terminated or revoked for failure to comply with its provisions or failure to comply with applicable statutes and regulations. The Division of Habitat reserves the right to require mitigation measures to correct disruption to fish and game created by the project and which was a direct result of the failure to comply with this permit or any applicable law.

The recipient of this permit (permittee) shall indemnify, save harmless, and defend the Division of Habitat, its agents and its employees from any and all claims, actions or liabilities for injuries or damages sustained by any person or property arising directly or indirectly from permitted activities or the permittee's performance under this permit. However, this provision has no effect, if, and only if, the sole proximate cause of the injury is the Division of Habitat negligence.

Please be advised that this determination applies only to activities regulated by the Division of Habitat; other departments and agencies also may have jurisdiction under their respective authorities. This determination does not relieve you of the responsibility for securing other permits, state, federal, or local. You are still required to comply with all other applicable laws.

Sincerely,

Denby S. Lloyd, Commissioner

BY: Robert F. "Mac" McLean, Regional Supervisor
Division of Habitat

ecc: Chris Milles, ADNR, Fairbanks
Larry Bright, USFWS, Fairbanks
NOAA Fisheries, Anchorage
Al Ott, ADF&G, Fairbanks
Fronty Parker, ADF&G, Delta
Tom Taube, ADF&G, Fairbanks
Jeff Gross, ADF&G, Tok

RFM/mac

Roughened-Channel Design

The most important aspects to consider in the design of roughened channels are:

- bed stability,
- average velocity at flows up to the fish-passage design flow,
- turbulence, and
- bed porosity.

Maximum average velocity and turbulence are the basic criteria of the Hydraulic Design Option. The bed materials inside the culvert create resistance to flow. Their stability is fundamental to the permanence of that structure. The effect of turbulence on fish passage can be approximated by limiting the energy-dissipation factor (EDF). In order for low flows to remain on the surface of the culvert bed and not percolate through a course, permeable substrate, bed porosity must be minimized. (Each of these considerations are discussed in subsequent sections of this chapter.)

The following is an outline of a suggested procedure for designing roughened channels. These steps are iterative; several trials may have to be calculated to determine a final acceptable design. (Additional details of these steps are provided in subsequent sections.)

1. Assume a culvert span. Begin with a culvert bed width equal to the stream width. Habitat considerations should be included at this phase in the design process. In particular, debris and sediment transport and the passage of nontarget fish and wildlife should be considered, all of which benefit from increased structure width.

2. Size the bed material for stability on the basis of unit discharge for the 100-year event (Q_{100}), as outlined in Step 3.

3. Check to see that the largest bed-particle size, as determined by stability, is less than one quarter the culvert span. If not, increase the culvert width, which decreases the unit discharge and, in turn, the particle size.

4. Create a bed-material gradation to control porosity (see Chapter 6).

5. Calculate the average velocity and EDF at the fish-passage design flow on the basis of culvert width and the bed D_{84} from gradation in Step 4 above. If the velocity or EDF exceed the criteria, increase the culvert span.

6. Check the culvert capacity for extreme flood events. This step is not detailed here, but it is required, just as it is for any new culvert or retrofit culvert design that affects the culvert's capacity.

The width of the culvert bed should be at least the width of the natural stream channel as defined in this guideline. When the width of the bed in roughened channel culverts is less than the bed width of the stream, hydraulic conditions are more extreme and the channel inside the culvert is more likely to scour. As gradient and unit discharge increase, the best way to achieve stability and passability is to increase the culvert width.

Bed Stability

In order for the roughened channel to be reliable as a fish-passage facility, it is essential that the bed material remain in the channel more or less as placed. It is expected that the bed material will shift slightly but not move any appreciable distance or leave the culvert. Bed stability is essential because these channels are not alluvial. Since they are often steeper and more confined than the natural, upstream channel, recruitment of larger material cannot be expected. Any channel-bed elements lost will not be replaced, and the entire channel will degrade. The 100-year flood is suggested as a high structural-design flow.

Bed-stability considerations, rather than fish-passage velocities, usually dominate the design of the bed-material composition. It is, therefore, recommended that bed-stability analysis be performed before calculating the fish-passage velocity.

At this time, there are no procedures that can determine the specific size of bed material needed to meet the angle of slope and volume of discharge for steep, roughened channels. In the case of the stream-simulation design option we can use natural analogs or models of natural systems to reliably estimate bed-material size (see Chapter 6). Roughened channels, on the other hand, increase hydraulic forces due to constriction and increased slope. Unfortunately we do not have a factor to relate the two and must resort to other methods. Four general methods are reviewed here:

- the U.S. Army Corps of Engineers steep slope riprap design,
- the critical-shear-stress method,
- the U.S. Army Corps of Engineers flood-control-channel method, and
- empirical methods.

U.S. Army Corps of Engineers Riprap Design

U.S. Army Corps of Engineers reference, EM 1110-2-1601, Section e., steep slope riprap design, gives this equation (Equation 1) for cases where slopes range from two to 20 percent, and unit discharge is low.

$$D_{30} = \frac{1.95S^{0.555}(1.25q)^{2/3}}{g^{1/3}}$$

Equation 1

Where:
- D_{30} = the dimension of the intermediate axis of the 30th percentile particle
- S = the bed slope
- q = the unit discharge
- g = acceleration due to gravity.

The recommended value of 1.25 as a safety factor may be increased. The study from which this equation was derived cautions against using it for rock sizes greater that 6 inches.[1] The equation predicts sizes reasonably in hypothetical situations above this, but it has not been tested in real applications.

The U.S. Army Corps of Engineers recommends angular rock with a uniform gradation (D_{85}/D_{15} = 2). This material is not preferred for use in a fish-passage structure (see the section on bed porosity, below). An approximate factor to scale D_{30} of a uniform riprap gradation for one that is appropriate for stream channels is 1.5, so that,

$$D_{84} = 1.5D_{30}$$

Equation 2

Where:
- D_{84} = the dimension of the intermediate axis of the 84th percentile particle.

Critical-Shear-Stress Method

Critical shear stress is a time-honored method to estimate the initial movement of particles. J. C. Bathurst[2] and D. S. Olsen, et. al.,[3] among others, have said that critical shear stress should not be applied to steep channel, although R. A. Mussetter,[4] and R. Wittler and S. Abt[5] and others have used it. The Federal Highway Administration, developed a channel-lining design method based on critical shear stress, with data from flume and field studies.[6] The data is largely from low-gradient situations, but the design charts show slopes up to 10 percent and particle sizes up to 1.9 feet, which places it in the range of designed roughened channels.

The condition of stability is defined as the point at which the critical shear stress, τ_c, equals the maximum shear stress, τ_{0max}, experienced by the channel.

The critical shear stress is the shear stress required to cause the movement of a particle of a given size and is equal to four times D_{50}, where D_{50} is the 50^{th} percentile particle, in feet. This relationship implies a critical, dimensionless shear stress of about 0.039. Mussetter[4] and Wittler and Abt[5] used 0.047. J. M Buffington and D. R. Montgomery[7] discuss the range of τ_c. The maximum shear stress is 1.5 times γRS, where γ is the unit weight of water, R the hydraulic radius and S the slope.

U.S. Army Corps of Engineers Flood-Control-Channel Method

U.S. Army Corps of Engineers EM 1110-2-1601 hydraulic design of flood-control channels manual uses a modified shear-stress approach to riprap design. This method should not be applied to channels greater than two-percent gradient. S. T. Maynord[8] modified this method for steep slopes:

$$D_{30} = C' \, (q^{2/3}S^{0.432})/(g^{1/3}\,K1)$$

Equation 3

$$C' = 5.3(S_f C_v C_t C_s)^{0.785}\left(\frac{\gamma_w}{\gamma_s - \gamma_3}\right)$$

Equation 4

$$K1 = \cos\alpha\,(1-(\gamma_w/(\gamma_s-\gamma_w))\tan\alpha/\tan\phi)$$

Equation 5

Where:
- α = the angle of the channel bottom from horizontal
- ϕ is the angle of repose of the riprap.

Other constants as described in the Corps manual. Note the similarity to Equation 1 above. This method should only be applied by those familiar with EM 1110-2-1601.

Empirical Methods

There are a number of velocity methods based on empirical studies: U.S. Bureau of Reclamation (USBR EM-25),[9] U.S. Geological Survey,[10] S. V. Isbash[11] and the American Society of Civil Engineers.[12] They have in common this basic equation (Equation 6), with some modifications, where a and K are constants derived from field studies.

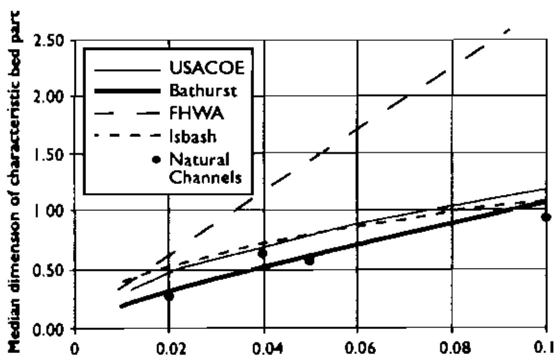
$$D_{30} = V^a/(K(\gamma_s - \gamma))$$

Equation 6

These methods are questionable for the design of roughened channel beds. Theoretically, the problem is that stream slope is not explicitly a factor in the analysis, and the velocity distribution is quite different at high bed slopes than it is in the low-gradient channels for which these methods were developed. Gravitational forces increase with slope, decreasing stability of a given rock size. Roughness increases with slope,[13] which reduces velocity, and, in turn the recommended rock size.

Figure E-1 compares various predictions of bed-material size as a function of slope. The sediment size is D_{84} for all the methods (except the Federal Highway Administration method[6] and the Isbash method,[11] which are riprap sizing techniques giving D_{50} of a uniform riprap gradation). The other significant variable – discharge – is held constant at 10 cfs/ft. This is a typical, bed-forming flow intensity for high-gradient channels. With increasing unit discharge, Isbash predicts smaller particle sizes at higher slopes relative to the other methods, and the Federal Highway Administration predicts much larger sizes.

Figure E-1. Relative performance of various sediment stability equations (Unit discharge = 10cfs/ft)



Various predictions of bed-material size as a function of slope.

Four natural streams are also shown in **Figure E-1** for reference. These streams' bed-changing discharge is estimated to be, on average, 9.4 cfs/ft. D_{84} from the actual bed-material distribution is shown here.

Shear stress is directly proportional to slope so the Federal Highway Administration method (critical shear stress) shows a linear relationship with slope. This is a trend not reflected in the other methods or the natural beds. Although, what is not accounted for in this simple analysis is that only a portion of the total boundary shear stress is responsible for sediment transport. Momentum losses due to hydraulic roughness other than bed friction account for the rest.[14] In addition, velocity profiles of steep, rough channels are not the same as hydraulically smooth, lower-gradient channels where shear-stress analysis was developed.[15] High-gradient channels have velocity profiles that are nonlogarithmic, unlike low-gradient channels.

The Isbash method is based solely on velocity, which is relatively insensitive to slope. Velocity, in this case, was developed from the J. T. Limerinos[16] roughness equation averaged with J. Costa's[17] power law for velocity, using the Bathurst[2] estimate of bed material size.

It is interesting to note that all the riprap-sizing techniques converge when slope is roughly one percent, which is the slope considered the upper limit of shear stress and velocity-based analysis.

Bathurst is consistent with natural streambed material that is expected to move at this flow intensity and is recommended for the design of stream simulation culverts. This should be the lower limit of particle sizes for designing roughened channels. The safety factor, which separates Bathurst from the actual design requirement, should be based on the various design factors.

As the width of the roughened channel culvert decreases relative to the width of the channel, flow intensity increases, and inlet contraction plays a role in stability. The bed-material design techniques account for increases in intensity, but they do not include inlet contraction as a factor. Small increases in head loss at the inlet can result in changes in velocity large enough to significantly change bed-material size estimates. Head loss of 0.1 foot represents an approximate 1.8 feet/sec velocity increase ($h = KV^2/2g$, $K = 0.5$) at the inlet, possibly forcing supercritical flow (see next paragraph). If Isbash is used, a 50-percent increase in rock size may be required. Equivalent flow intensity (the increase in unit discharge required to represent the head loss) increases dramatically as inlet losses occur.

The movement of bed material in natural, steep channels is thought to coincide with supercritical flow.[18] If, by decreasing the width of a culvert, the Froude number is caused to approach 1.0 at flows below those used to size the particles, then it is likely that the bed may fail prematurely. Unfortunately, most of the roughness-factor models were specifically developed for subcritical flow; it is, as a result, difficult to determine how flow velocity approaches supercritical flow. K. J. Tinkler[19] used an approach that calculates a specific Manning's *n* for the critical case, as a function of slope and depth. The Limerinos equation[16] (shown below in the section on velocity) follows this closely when it is determined that the bed roughness approximates a natural channel.

In cases where inlet contraction is minimal and flow inside the culvert is not expected to go supercritical prematurely, it is recommended that the U.S. Army Corps of Engineers' equation for steep channels be used to size bed material for roughened channels. This recommendation is made even though the equation was not considered applicable for particles over six inches in diameter. It still gives results in line with what we might expect to find in steep channels.

In addition to the methods mentioned here, theoretical work has been done by a number of researchers on the initial movement and general bedload discharge in steep, rough natural channels. Citations are shown in the references section at the end of this appendix.[1,2,18,21,22,23]

It is not recommended that culverts with bed material inside be designed to operate in a pressurized condition under any predicted flow. The riprap design methods suggested here assume open channel flow. They were not developed for high velocity and turbulence under pressure. Under most scenarios, it is assumed that minimum width requirements and fish-passage velocity criteria will be the limiting factors in design, not high flow capacity. But there may be cases where an unusual combination of events creates a situation where headwater depth exceeds the crown of the culvert. In such a case a conservative stability analysis would model the culvert using a complete culvert analysis program and/or a backwater model. The hydraulic results could then used to estimate shear stress conditions and determine a stable rock size.

Fish-Passage Velocity

The point of roughening the channel is to create an average cross-sectional velocity within the limits of the fish-passage criteria and the Hydraulic Design Option. The average velocity of a roughened channel culvert is essentially a function of

- stream flow,
- culvert bed width, and
- bed roughness.

The flow used to determine the fish-passage velocity is the fish-passage design flow as described in the section, Hydrology in Chapter 5, *Hydraulic Design Option*. As a design starting point, the width of the culvert bed should be at least the width of the natural stream-channel bed.

Steep and rough conditions present a unique challenge for hydraulic modeling. Traditional approaches to modeling open-channel flow assume normal flow over a bed having low relative roughness. In roughened channels, the height of the larger bed materials are comparable with the flow depth and complex turbulence dominates the flow.[21] A number of equations are available for an analysis of these conditions, but they are crude and generate widely varying results. Research to date has centered on estimating flow in natural, cobble/boulder streams and is not intended for use in engineering artificial channels.

Three researchers have used bed-material characterization and/or channel geometry to create empirical equations predicting roughness: Jarrett,[13] Limerinos[16] and Mussetter.[4] Generally, the conclusion one can draw from these studies is that friction factors in steep, rough channels are much larger than those found in lower-gradient streams. This conclusion is not surprising but it is notable just how high the roughness factors are. For instance, in Mussetter's field data on steep channels, 75 percent of the Manning's *n* values exceed 0.075, the highest *n* featured in H. H. Barnes' *Roughness Characteristics of Natural Channels*,[24] which covers larger, lower-gradient streams. It remains unclear as to how natural channels compare to constructed, roughened channels.

AOP Case Studies

Janes Creek
Roughened Channel over Small Dam

Case Study Contributors
- Antonio Llanos, Michael Love & Associates
- Michael Love, Michael Love & Associates

Location
South Fork Janes Creek, Humboldt Bay Watershed, Northern California, USA. MAP

Project Type
- Roughened Channel over Dam
- Prefabricated Bridge

Pre-project Conditions
- 4 ft (1.2 m) tall dam, historically used for water supply
- Concrete box spillway with access road across dam crest
- Stored sediment created marshy wetland habitat ideal for rearing coho salmon

Pre-project Barrier
- 4 ft (1.2 m) drop over spillway plunging into shallow pool
- Barrier to all coho salmon, steelhead and cutthroat trout

Watershed Characteristics
- Drainage Area: 0.74 mi^2 (1.9 km^2)
- Peak Design Flow (100-yr): 290 cfs (8.2 cms)
- Bankfull Flow (1.5-yr): 65 cfs (1.8 cms)
- High Passage Flow for:
  - Salmon and steelhead (1% exceedance flow): 15.9 cfs (0.45 cms)
  - Cutthroat trout (5% exceedance flow): 6.3 cfs (0.18 cms)
  - Juvenile salmonids (10% exceedance flow): 3.7 cfs (0.10 cms)

Ecological Value
Provide upstream and downstream passage for all native aquatic organisms. Open access to 5,000 ft (1,524 m) of salmonid spawning and rearing habitat upstream of dam, including 2,360 ft (719 m) of low gradient marshy habitat for rearing coho salmon.

Project Design

- Roughened channel: 100 ft (30.5 m) at 5% slope with 10 ft (3.0 m) long horizontal

  transition aprons at each end
- Roughened channel bed material designed to be stable up to 100-year flow
- Active channel base-width = 7 ft (2.1 m)
- Bankfull width = 12 ft (3.7 m)
- 9 channel spanning rock structures placed flush with finished grade
- Installation of prefabricated bridge with 40 ft (12.2 m) span over roughened channel

Challenges and Lessons Learned
- Project to provide fish passage while preserving wetland formed by stored sediments behind dam
- Lack of construction oversight resulted in a wider and steeper channel than designed
- Donated rock too large for constructed channel banks, leading to excessive voids

Project Contributors
- Humboldt Fish Action Council
- Michael Love and Associates
- Winzler & Kelly Consulting Engineers
- Kernen Construction
- Green Diamond Resource Company

Project Funding
California Dept. of Fish and Game

Completion Date
October 2005

Total Project Cost
$77,442

Project Summary

The 4 ft (1.2 m) high water diversion dam built in the 1950's blocked upstream movement for all fish. Over time, the reservoir filled with fine sediment, forming an impounded high-value wetland. The stream flowed over the dam's spillway, which consisted of a concrete box culvert. The spillway created a 4 ft (1.2 m) drop into a shallow plunge pool.

The project objective was to preserve the upstream impounded wetland for juvenile rearing habitat while providing fish passage over the dam. The preferred alternative involved removal of the concrete spillway and construction of a roughened rock channel designed to (1) maintain the existing upstream grade, (2) avoid release of stored sediments, and (3) provide upstream and downstream passage for all native fish and other aquatic organisms.

The roughened channel is 100 ft (30.5 m) long, with an average slope of 5%. The shape and features of the roughened channel are intended to create a hydraulic environment similar to a natural channel of similar slope. Since the upstream channel material is mostly fine grain sands and silts, the larger rock in a roughened channel will not be replenished if it is transported downstream. Therefore, the D84 sized rock used in the roughened channel was designed to be stable up to the 100-year design flow. Because the dam crest also serves as an access road, a 40 ft (12.1 m) long prefabricated steel bridge was placed over the roughened channel at the location of the removed spillway.

Channel Design

Design of the roughened channel involved a bed stability analysis to determine the minimum rock size necessary to maintain a stable channel bed during the 100-year peak flow of 290 cfs (8.2 cms). The fish passage analysis examined water depth, velocity and turbulence during fish migration flows. By design, a roughened channel provides a wide distribution of water velocities, with many areas of slower water.

This analysis required an iterative process involving the interdependent variables of particle size, particle stability, channel roughness, and channel geometry. Two methods were used: the Unit-Discharge Bed Equation as defined by Bathurst (1978) for incipient motion of the D_{84} particle, (84% of the particles have a smaller diameter than the D_{84}) and the US Army Corps of Engineers Steep Slope Riprap Design for the D_{30} particle (ACOE, 1994 in WDFW, 2003). A particle distribution was then developed following methods outlined in (WDFW, 2003) for the *Engineered Streambed Material* within the channel.

Rock Size	730 mm	290 mm	120 mm	36 mm	< 2 mm
Percent Finer	100	84	50	16	7

Using a maximum roughened channel slope of 5% as a "rule-of-thumb", the final design converged on an active channel base width of 7 ft (2.1 m), bankfull width of 12 ft (3.7 m), and bankfull depth of about 2 ft (0.6 m). To concentrate low flows, ensure adequate water depth for adult fish, and provide slower edge-water for smaller fish, the channel bottom includes a side slope of 10% towards the center. The banks were constructed of large rock to create a rigid and confined channel, characteristic of steep stream channels.

A series of rock structures constructed of 2 layers of 1 ton rock were built across the channel and backfilled with the Engineered Streambed Material. Rock structures were designed as rigid bed controls and to create small drops and complex flow patterns. The top of the rock structures were placed flush with the finished channel grade and maximum spacing between structures was limited to 20 ft (6 m). By design, higher streamflows were expected to move and sort the smaller rock, exposing the larger rock and create an intricate series of small steps, pools, and flow constrictions. This complex hydraulic environment creates suitable migration pathways for fish over a wide flow range, similar to those found in a naturally steep channel reach.

Lessons Learned

In general, construction of a roughened channel requires skilled equipment operators, a large quantity of imported rock and aggregate, and on-site construction guidance from persons familiar with this type of design. Due to a lack of thorough construction oversight, the upper section of the channel was built with a width far wider than designed. Additionally, the slope of the upper channel section was less than designed, requiring steepening the channel slope under the bridge to approximately 8%. These deviations from the design have the potential to create insufficient depth at lower migration flows, possibly hindering fish passage.

The rock used to construct the channel banks was donated to the project, and larger than called for in the design. This resulted in large voids within the bank rock that should have been chinked with smaller material to prevent water from flowing behind the rocks and scouring the native material.

The horizontal transition apron constructed at the downstream end appears to be functioning well. The transition effectively dissipates energy and has prevented scour of the downstream natural channel.

Two years after construction the channel appears to be stable and functioning properly.

References

Bathurst, J.C. 1978. *Flow Resistance of Large-Scale Roughness.* Journal of the Hydraulics Division, AM. Soc. Civil Engr., Vol. 104, No. HY12, pp. 1587-1603.

Washington Department of Fish and Wildlife Environmental Engineering Division. 2003. *Fish passage design at road culverts: a design manual for fish passage at road crossings.* May 2003. http://www.wdfw.wa.gov/hab/engineer/cm/.

Published 04/04/07

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July 24, 2009

Robert F. "Mac" McLean
Regional Supervisor
Division of Habitat
Alaska Department of Fish & Game
1300 College Road
Fairbanks, AK 99701-1551

Re: Yerrick Creek Hydroelectric Project
Response to July 20 Information Needs

Dear Mr. McLean:

In response to your July 20, 2009, below is a point by point explanation of how your information requests have been addressed:

ADF&G: Effects on fish habitat, particularly seasonal or over-wintering refugia, in the bypass.
AP&T Response: Studies conducted have shown that the majority of Dolly Varden (DV) year-round habitat is above the diversion structure and it was acknowledged during the May 2009 meeting with you that DV would not be significantly impacted by this project. Also, there are little over-wintering refugia in the bypass portion of the creek so that their loss will have minimal impact to DV.

Arctic grayling (AG), which became a highlighted issue at the May 2009 meeting, were not found to spawn in Yerrick Creek and appear to only use it opportunistically. Grayling are also limited in getting up to the bypass reach due to the submergence of flow above the highway for significant portions of the year. The bypass reach that will be dewatered by the project diversion may reduce the extent that AG are able to go up the creek at certain times of the year. However, given the natural barriers created during low flow periods, limited habitat quality in the bypass reach, and small fish numbers found in Yerrick Creek, we believe there will be little, if any, impact to AG. Based on this analysis we've concluded that fish passage is not necessary to protect AG. We do not propose to employ any fish passage in the bypass reach except what nature provides in the way of flow over the diversion spillway when flow exceeds 60 cfs or when demand is less than the naturally occurring flow. For this reason, subsurface flow data is not needed because there is no fish passage issue.

Information has been provided on fish movement between stream reaches, life stage, and time of year for DV and grayling. Fish survey reports that have previously been supplied are enclosed with this letter.

ADF&G: Fish passage through the bypass reach and past the diversion structure.
AP&T Response: Because the studies have found limited use by either species of the bypass reach and that DV primarily use the creek above the diversion site and the few grayling that feed in the creek primarily use the lower part of the creek, there is no need to construct fish passage devices.

ADF&G: Existing surface and subsurface discharge characteristics in the bypass reach.
AP&T Response: As stated above, only surface flow has been gaged because we believe the data on fish use supports the conclusion that little habitat is available in the bypass reach, therefore there is no need to collect additional hydrological information.

ADF&G: Life history and movements of DV in the project area.
AP&T Response: AP&T's fish studies indicate that most DV reside year-round in upper Yerrick Creek, from near the diversion site to well above the diversion site. DV do not appear to move through the project reach to any appreciable degree.

ADF&G: Hydrologic information on instream flows necessary to preserve fish habitats and passage.
AP&T Response: Over two years ago a stream gage station was installed near the diversion site to measure surface water flow. The suggestion to install a second stream gage downstream of the bypass reach was rejected because of the absence of surface flow in that reach during much of the year, and the expensive of a second gage prior to a better understanding of the area's fish distribution and habitat quality. As stated above, the fish habitat available in the bypass and corresponding low numbers of fish found in this reach does not warrant a more intensive investigation.

ADF&G: Basic water quality characteristics including water temperatures.
AP&T Response: Basic water quality and hydrology data was collected by Travis/Peterson Environmental Consulting, Inc. in their report dated October 2008. We have enclosed it with this letter. As a result of our May 2009 meeting with you we also collected water temperature data in conjunction with our summer fish distribution and spawning field studies conducted in May, June, and July of this year. Temperature information is included in these fish survey reports.

We believe you have the information needed to determine that a fishway passage device is not necessary for this project.

It is our understanding that Alaska's Fishway Act (AS 16.05.841) requires the Department of Fish and Game (ADF&G) to decide if a fishway passage device is necessary to protect the fish resources that may be impacted by the proposed Yerrick Creek Hydroelectric project. State law does not authorize, or require you to make a decision based on an evaluation of “the potential project effects and benefits” as stated in your letter. To date, the information we have presented to ADF&G has been to support a reasoned and balanced evaluation of the proposed project’s effects on Yerrick Creek’s fish resources. If our reading of the Fishway Passage Act is incorrect, we are prepared to more fully describe the public economic and environmental benefits that can be reasonably expected from the project. We believe these public benefits far outweigh any adverse effects the project may have on Yerrick Creek’s fish resource values.

Studies conducted over a number of years by Alaska Power and Telephone (APT), the ADF&G, and Northwest Alaskan Pipeline have adequately characterized the Yerrick Creek fish resources with respect to their numbers, distribution, and habitat availability. The collected information indicates that Dolly Varden reside throughout the year in the upper part of Yerrick Creek, primarily above the diversion site, and Arctic grayling use the creek in the summer months for opportunistic feeding, from the Tanana River to near the proposed diversion area. There is no evidence of Arctic grayling spawning in Yerrick Creek, or that Yerrick Creek makes any more than a very minor contribution to the Arctic grayling resources in the Upper Tanana River basin.

The proposed project’s diversion of water would reduce flow in 11,000 feet of Yerrick Creek and create a temporary barrier to a few[1] Arctic grayling when the Creek’s natural flow is less than 60 cubic feet per second (cfs). We believe it is reasonable to assume that Arctic grayling would continue to occupy the drainage below the diverted flow’s re-entry to Yerrick Creek at the Alaska Highway crossing, and further upstream in the “bypass area” when flows exceed 60 cfs. The insignificant displacement of a few Arctic grayling during low water flow periods (less than 60 cfs) does not appear to justify the construction of a fishway passage. The proposed project will also have little, if any, impact to the Dolly Varden population that resides above the proposed project diversion.

Over one year ago we provided ADF&G with our study plan for evaluating the fish resources of Yerrick Creek. Since that time we have adjusted our investigations to address the recommendations of your staff where appropriate and funded field studies to collect data relevant to a reasonable evaluation of the effect of the project on local fish resources. Your July 20, 2009, letter references a number of “information needs” that must be met for you to make a decision. As noted above, we believe we have provided the information and analysis to support a decision at this time.

Three months ago we provided you a draft memorandum of agreement based on our analysis and conclusion that that a fishway passage is not necessary for the project to protect resident Dolly Varden or transitory Arctic grayling. We also requested your final decision by August to secure project funding and begin construction this season. At this late date it is unacceptable to put the project on hold to produce information we believe has already been provided or has little bearing on the decision to be made.

---

[1] The largest number of grayling found in the proposed Yerrick Creek diversion bypass area was 18 recorded on July 22 in 1975.

If we do not have a decision by you before July 31, 2009, we will request a meeting with you and the appropriate Department Division Directors to clarify what AP&T must do to ensure the Yerrick Creek Hydroelectric project complies with Alaska’s Fishway Act.

Sincerely,

Glen D. Martin
Project Manager
(360) 385-1733 x122
glen.m@aptalaska.com

ENCLOSURES

A. *Fisheries Baseline Study for a Proposed Hydroelectric Development on Yerrick Creek*, October 2008.

B. *Fisheries Study for Spawning AG and DV and their movement throughout the Creek during May and June 2009*, June 2009.

C. *AP&T Temperature and Fish Presence Survey,* (e-mail) June 24, 2009.

D. *Literature Review and Field Report: Hydrology Baseline Study* (Including Water Quality Testing), October 2008.

A. *Fisheries Baseline Study for a Proposed Hydroelectric Development on Yerrick Creek*, October 2008.

GRAYSTAR

REPORT

FISHERIES BASELINE STUDY

for a

PROPOSED HYDROELECTRIC DEVELOPMENT

on

YERRICK CREEK

near

TOK, ALASKA

prepared for –

ALASKA POWER & TELEPHONE Company
Port Townsend, Washington

by –

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October 2008

1 -- INTRODUCTION

ALASKA POWER AND TELEPHONE COMPANY (AP&T) has proposed to install a hydroelectric project on Yerrick Creek, near Tok, Alaska. This document is the report of the first year of a fisheries baseline study, in support of that project.

The study area included Yerrick Creek (YER) and Cathedral Rapids Creek #1 (CR1). These streams are small tributaries of the upper Tanana River, in eastern interior Alaska. The fish and fisheries of the upper Tanana River drainage are studied and managed by the Alaska Department of Fish & Game (ADFG, or "the department"). Neither YER nor CR1 are listed in ADFG's Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated Atlas -- http://www.sf.adfg.state.ak.us/SARR/awc/ -- although the Tanana River itself is listed.

YER and CR1 lie within ADFG's Upper Tanana Management Area (UTMA), which is within ADFG's fishery management region III, also known as the Arctic-Yukon-Kuskokwim (AYK) region (Figure 1). The UTMA encompasses Delta Junction, Tok, and several smaller communities (Figure 2).

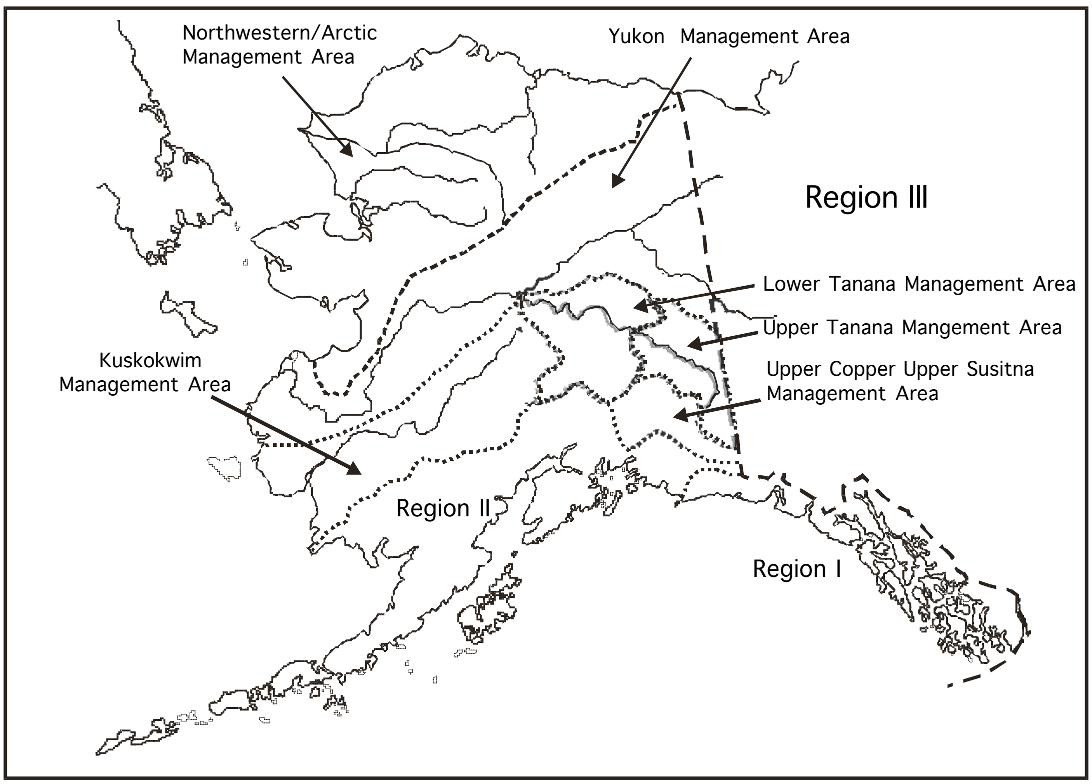

Figure 1 -- Map of ADFG's Sport Fish Regions, and the Six Region III Management Areas
source: Parker 2006

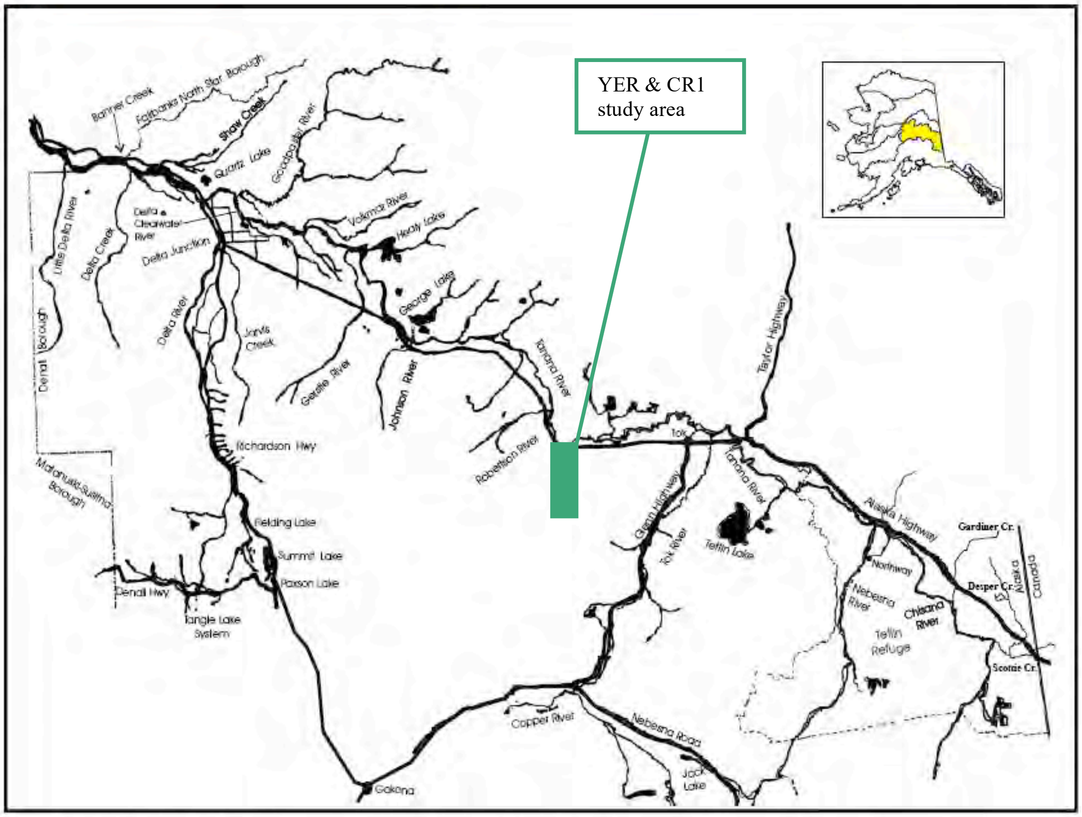

Figure 2 -- Map of the Upper Tanana Management Area within the Tanana River Drainage
source: Parker 2006

Several fish species are found in the UTMA –

Common Name	*Scientific Name*
chinook (king) salmon	*Oncorhynchus tshawytscha*
coho (silver) salmon	*Oncorhynchus kisutch*
chum (keta) salmon	*Oncorhynchus keta*
Arctic grayling	*Thymallus arcticus*
burbot	*Lota lota*
lake trout	*Salvelinus namaycush*
Dolly Varden	*Salvelinus malma*
round whitefish	*Coregonus cylindraceum*
least cisco	*Coregonus sardinella*
humpback whitefish	*Coregonus pidschian*
northern pike	*Esox lucius*

ADFG's Division of Sport Fish publishes an annual Fishery Management Report for Sport Fisheries in the Upper Tanana River Drainage. These reports focus on the more abundant sport-caught fishes: coho salmon, Arctic grayling, northern pike, lake trout, and burbot. Dolly Varden char are not explicitly studied. The most recent available such report (as of October 2008) is Parker 2006.

ADFG has stocked rainbow trout (*Oncorhynchus mykiss*), Arctic char (*Salvelinus alpinus*), coho salmon, Arctic grayling, and lake trout in selected waters of the Upper Tanana area (Parker 2006).

In general, there is less sport fishing effort in the UTMA, as compared to the Lower Tanana Management Area (Parker 2006); for example, in 2005 --

* 33% of anglers in the Tanana River drainage fished in UTMA
* 30% of fishing trips in the Tanana River drainage were in UTMA
* 28% of fishing effort in the Tanana River drainage was in UTMA
* 39% of fish harvest in the Tanana River drainage was in UTMA

In 2005, Arctic grayling comprised over half of the sport fish catch, but less than one-third of the sport fish harvest (fish caught and retained) in UTMA (Parker 2006) –

Species	Catch	% of Catch[d]	Harvest	% of Harvest[e]	% Harvested
Salmon					
* chinook	25	0.03	25	0.15	100.0
* coho[a]	2,830	2.97	267	1.61	9.4
* coho[b]	2,973	3.12	1,002	6.02	33.7
* chum	686	0.72	0	0.0	0.0
Non-Salmon					
* rainbow trout	17,355	18.20	6,336	38.10	36.5
* lake trout	3,651	3.83	569	3.42	15.6
* char[c]	1,453	1.52	463	2.78	31.8
* Arctic grayling	55,943	58.66	5,242	31.52	9.4
* northern pike	8,299	8.70	1,646	9.90	19.8
* whitefish	455	0.48	60	0.36	30.5
* burbot	1,370	1.44	1,021	6.14	74.8
* sheefish	0	0.0	0	0.0	0.0
* other fishes	321	0.34	0	0.0	0.0
TOTAL	95,361		16,631		17.4

[a] – anadromous salmon
[b] – landlocked coho & Chinook salmon
[c] – includes Arctic char & Dolly Varden
[d] – the species' percent of UTMA total catch, calculated from Table 7 in Parker 2006
[e] – the species' percent of UTMA total harvest, calculated from Table 7 in Parker 2006

The preceding table shows that 1.52% of the catch, and 2.78% of the harvest, were composed of "char", which includes both wild Dolly Varden and stocked Arctic char.

Because of their wide distribution and comparatively high abundance, Arctic grayling are important to both sport and subsistence harvesters. As such, they have been extensively studied by ADFG scientists for decades. In the Tanana River drainage, grayling exhibit a wide range of age and size at maturity (Clark 1992). Similar studies have not been conducted for Dolly Varden in the upper Tanana drainage, but anecdotal observations indicate that Dolly Varden in that area may reach maturity and spawn at small sizes (< 200 mm fork length) (J.F. Parker, ADFG, personal communication, 2008), and even while exhibiting so-called "juvenile" characteristics such as parr marks (A.E. Rosenberger, University of Alaska Fairbanks, School of Fisheries & Ocean Sciences, personal communication, 2008).

ADFG has conducted comprehensive fish surveys of the streams of the middle and lower Tanana River drainage, including clear, clear/glacial, glacial, humic/glacial, and humic creeks and rivers, and found no Dolly Varden in any of those habitats (Durst 2001, Hemming & Morris 1999).

Arctic grayling conduct seasonal migrations among overwintering, spawning, and summer feeding habitats, and seasonal changes in water temperature are generally considered to be the triggers for those movements (Ridder 1995, Ridder 1994, and several previous studies cited in those reports. Similar studies have not been conducted for Dolly Varden in the upper Tanana drainage, but anecdotal reports indicate that there may be year-round resident populations of Dolly Varden in the upper reaches of Yerrick Creek (J.F. Parker, ADFG, personal communication, 2008).

In 1988, 367 Tok households were surveyed to determine their subsistence use of fish, game, and plant resources. Most households used subsistence-caught salmon (79.4%) and freshwater fish (71.4%). In the freshwater fish category, the predominant subsistence species were grayling (55.7%), burbot (40.2%), rainbow trout (35.0%), large pike (27.2%), whitefish (25.9%), and lake trout (22.9%). Only 0.9% of Tok households reported using subsistence-caught Dolly Varden. The report does not identify where these various fish species were harvested, but because the Tok data set includes marine fish (27.5%), such as halibut, it appears that Tok residents harvest subsistence fisheries resources far from home, and not only in the local Tok area (McMillan & Cuccarese 1988).

In conclusion, Arctic grayling are the most commonly sport-caught fish in the UTMA, and the second-most common sport-harvested species. Grayling are also taken by subsistence harvesters. Dolly Varden are comparatively uncommon in the UTMA, in both the sport and subsistence harvests, and were not reported by either of two ADFG scientific investigations.

Finally, in the late 1970s and early 1980s, the Alaska Department of Fish & Game's Division of Fisheries Rehabilitation, Enhancement, & Development (FRED) investigated possible sites for salmon hatcheries throughout Alaska. In a survey of Yerrick Creek in February 1980, Raymond (1980) reported –

* the Upper Tanana River Valley has many ingredients for a good hatchery site: year-round highway access, high-gradient streams, and hardly any salmon
* most of the creeks in this area dry up in winter
* there was no evidence of running water at the highway bridge
* there was evidence of running water at two sites: 1 mile and 2 miles upstream of the highway
* water temperature was too low for a flow-through hatchery
* there was plenty of hydropower available

2 -- METHODS

YER is characterized by steep gradient, cascading flows, and large boulder substrate. The channels appear to be dynamic, as judged by cleanliness of the substrate in and near the water: very little periphyton and almost no terrestrial vegetation. There are few pools in YER that appear capable of providing habitat for fishes. Those pools are small, in the range of 10-20 ft long.

CR1 is much smaller and steeper than YER. It is essentially one long, cascading run, with strong current and large boulder substrate. Small pools are apparent only at very low flows. For example, in June (lower flow than in September), a pool of roughly 10 ft wide x 20 ft long x 2 ft deep was observed at WP 037: 63°21.595'N 143°43.005'W elevation: 2,239 ft but this pool could not be located in early September, when flow was greater. Similarly, a few smaller pools were observed in June, but by early September, the dynamic channel appeared to have shifted so that they were no longer apparent.

During sampling visits in summer 2008, the wetted perimeters of both streams were much smaller (narrower) than their respective dynamic channels (area of clean boulders).

The fish sampling stations on YER and CR1 were selected to bracket the area of interest to AP&T's proposed project (Figure 3) –

* Station UYC: upper Yerrick Creek, well above the hydropower impoundment site
* Station UMY: middle/upper Yerrick Creek, above the impoundment site
* Station YCI: Yerrick Creek, in the general vicinity of the proposed impoundment
* Station MYC: middle Yerrick Creek, between the impoundment and the powerhouse
* Station LYC: lower Yerrick Creek, downstream of the proposed powerhouse
* Station CRI: Cathedral Rapids Creek #1, in the vicinity of the proposed impoundment

The purpose of this study was to characterize the seasonal presence and distribution of fishes in the two streams.

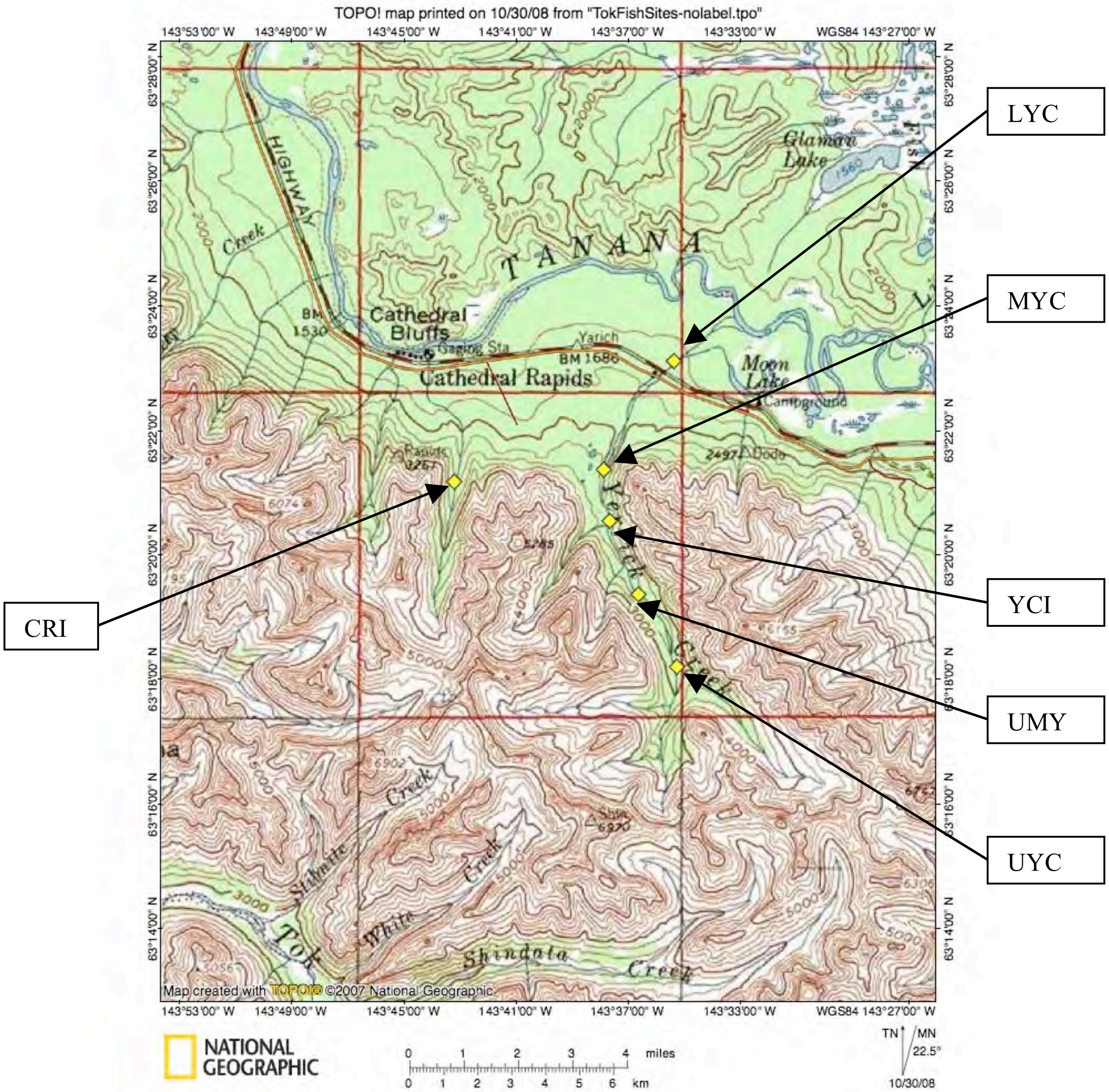

Figure 3 -- Sampling Sites for the 2008 Fisheries Baseline Study

The two creeks were visited on foot and examined, but not sampled, 6-7 June 2008. Fish habitat was generally characterized, and the locations of possible fish-bearing pools were recorded.

Sampling, supported by helicopter, was conducted –

* 3-4 September 2008 (YER and CR1); this sampling was originally scheduled for early August, in order to sample fish in their summer habitats, but because of unusually heavy and prolonged rains and flooding in the Tok area, the trip was postponed twice until early September; nevertheless, the weather and water were warm and summer-like, but the water flow was still noticeably higher than in June

* 29-30 September 2008 (YER only); this sampling was intended to sample fish immediately before freeze-up, in order to understand the species winter habitats; the water flows were lower than in early September

Sampling methods included --

* electrofisher + bag seine (the electrofisher was used to herd the fish into the bag seine, rather than stunning them); it was difficult to maintain the seine in the current at some sites, and impossible at other sites; also, this was more effective in late September, because flow was less than in early September; where it was not possible to maintain the bag seine in strong current, electrofishing was performed as best as possible along the sides of the stream and in small backwater areas; in most cases, electrofishing was performed by two people: one bearing the backpack unit, and the other using a dipnet

* minnow traps baited with commercially cured salmon eggs and left to soak overnight in pools, where pools could be found; fewer pools were visible during early September (higher flow) vs. in late September (lower flow), so that traps were not set at all sites in early September

GPS coordinates, as displayed on a brand new Garmin GPS unit, do not appear to match the apparent location as displayed in Figure 3, which is drawn from a brand new version of the TOPO! mapping software. It is not clear if the error is within the GPS unit, the software, or in the interaction between the two. In this report, the GPS readings are listed in Appendix A, and the apparent location is shown in Figure 3.

3 -- RESULTS

Fish sampling was conducted under ADFG Fish Resource Permit SF2008-172. A report of those activities was submitted to ADFG on 27 October 2008, and is attached to this report as Appendix A. Two species of fish were captured: Dolly Varden (DV) and Arctic grayling (AG). All fishes were measured and released alive, in apparent good condition. The results of the 2008 fish sampling were –

YERRICK CREEK – 3-4 September 2008

Station UYC

** 1 minnow trap + electrofish ~40 yds of stream

DV (5): 127, 122, 120, 127, 117 mm fork length (FL)

Station YCI
** 2 minnow traps + electrofish ~160 yds of stream
DV (4): 135, 110, 102, 115 mm FL
AG (3 possible males): 220, 235, 190 mm FL
AG (1 possible female): 207 mm FL
AG (7 undetermined sex): 165, 150, 148, 190, 148, 162, 148 mm FL

Station MYC
* not possible to set bag seine: current too strong, too wide in run, too deep & fast
* not possible to set minnow trap: current too strong, no slow water
* water still high & fast >10 days after latest rain; thalweg depth 3.5-4.0 ft
* attempted electrofishing along ~50 yards of shoreline: sighted 1 fish ~150mm, species unknown

Station LYC
* set of seine not very good; current very strong
* electrofish ~35 yards downstream to seine: no fish observed
* no other fish-able sites nearby or anywhere below old pipeline corridor
* no minnow trap set here

YERRICK CREEK – 29-30 September 2008

Station UYC
** 1 minnow trap
DV (3): 175, 126, 145 mm FL

Station UMY
** 1 minnow trap + electrofish ~ 25 yds of stream
DV (4): 125, 147, 159, 142 mm FL
+ 1 DV sighted

Station YCI
** 2 minnow traps + electrofish ~40 yds of stream
DV (14): 124, 131, 167, 133, 131, 137, 136, 128, 125, 123, 141, 105, 130, 80 mm FL
DV (1 possible gravid female?): 149 mm FL

Station MYC
* 1 minnow trap + electrofish ~100 yds of stream

DV (2): 122, 98 mm FL

DV (1 w/ white-edged fins, possible spawning male?): 164 mm FL

AG (1): 162 mmFL

+ sighted 3 small fish, each <100 m FL

Station LYC
* 1 minnow trap + electrofish ~100 yds of stream

AG (1): 79 mm FL

CATHEDRAL RAPIDS CREEK #1 – 3-4 September 2008

Station CRI
* electrofished ~0.1 mile of CR1, roughly near the approximate impound site

no fish sighted or captured
* no minnow trap set (no pools)

4 – CONCLUSIONS

Yerrick Creek is used by Dolly Varden and Arctic grayling, in occasional small pools separated by long sections of cascading runs.

Dolly Varden were captured in the middle and upper reaches of the creek (including the proposed impoundment area), while Arctic grayling were captured in the middle and lower sections. In this sampling, Arctic grayling were captured less often than were Dolly Varden.

Dolly Varden were commonly encountered in both late summer and late fall (immediately before freeze-up), which suggests that they are year-round residents, including over winter. [Inferring the over-winter habitat of Dolly Varden based on pre-freeze-up surveys and sampling is used by ADFG biologists in other Alaska streams (Scanlon 2008).]

The capture of a possibly gravid female and possibly spawning male suggests that Dolly Varden might spawn in the middle reaches of this stream.

This apparent distribution is consistent with general anecdotal observations of these species in UTMA –

* dwarf Dolly Varden are thought to be year-round residents of upper Yerrick Creek

* Arctic grayling migrate seasonally into and out of lower Yerrick Creek

No fish were captured or sighted in Cathedral Rapids Creek #1, and fish habitat appears to be very scarce. It is not clear to what extent, if any, this cascading stream is used by either fish species.

5 -- RECOMMENDATIONS

The 2008 fisheries sampling has provided useful characterizations of fish presence and distribution in Yerrick Creek and Cathedral Rapids Creek #1, in late summer, late fall, and by inference, over-winter. These data, when supplemented by a sampling in late spring or early summer of 2009, will yield a picture of yearly habitat use of these two streams. This future sampling should be performed at a very low water stage, to allow for thorough electrofishing at all stations.

6 – LITERATURE CITED

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APPENDIX A

Report for FRP SF2008-172

Report of Activities and Collections

27 October 2008

Fish Resource Permit SF2008-172

Stephen T. Grabacki, FP-C; 907-272-5600; graystar@alaska.net

Location: Yerrick Creek (YER) and Cathedral Rapids Creek #1 (CR1)

The two creeks were examined but not sampled 6-7 June 2008. Fish habitat was generally characterized, and the GPS locations of possible fish-bearing pools were recorded.

Sampling was conducted 3-4 September 2008 (YER and CR1), and 29-30 September 2008 (YER only), with electrofisher + bag seine (the electrofisher was used to herd the fish into the bag seine, rather than stunning them), and minnow traps baited with commercially cured salmon eggs and left to soak overnight.

GPS coordinates, as displayed on Grabacki's brand new Garmin GPS unit, do not appear to match the apparent location as displayed on the attached map. In this report, the GPS readings are listed in the text, and the apparent location is shown on the map.

<u>(1) RESULTS FROM 3-4 SEPTEMBER 2008</u>

<u>YERRICK CREEK (YER)</u>

Upper YER, above fork, western channel, well above impoundment, 04SEP08
63°18.204'N 143°35.387'W elevation: 2,830 ft
Minnow trap set 03SEP08@1915, retrieved 04SEP08@1030 –
    DV (1): 127 mmFL
Electrofished 2 channels –
* single channel, ~40 yards
* Y-shaped channel, ~80 yards
    DV (4): 122, 120, 127, 117 mmFL
All fish in apparent good condition, released alive

Pool at/near impoundment site (above Mike's camp), 03SEP08
Waypoint 009, elevation: 2,284 ft
63°20.435'N   143°37.852'W
Electrofished pool & run, ~30 yards –
    DV (1): 115 mmFL
    AG (3 possible males): 220, 235, 190 mmFL
    AG (1 possible female): 207 mmFL
    AG (5 undetermined sex): 150, 148, 190, 148, 162, 148 mmFL
All fishes in apparent good condition, and released alive
Minnow trap set 1430, retrieved 0955 (04SEP08) –
    DV (2): 110, 102 mmFL
    Fish in apparent good condition, released alive

Pool below impoundment site, 03SEP08
Waypoint 008, elevation: 2,263 ft
63°20.589'N   143°37.684'W
Electrofished 2 channels –
* main channel, ~80 yards: no fish captured or sighted
* side channel, ~50 yards: 1 fish sighted + 2 fish captured –
    Arctic grayling (AG) 165mm fork length (FL), apparent good condition, released alive
    Dolly Varden (DV) 135 mmFL, apparent good condition, released alive
    (DV bore parr marks)
Minnow trap set 1300, retrieved 0930 (04SEP08): no catch

Middle YER, near big cut in hill on west bank
Waypoint 024 on Mike Warner's GPS: 63°21.411'N   143°37.852'W   elevation: 2,100 ft
Not possible to set bag seine: current too strong, too wide in run, too deep & fast below pool
Water still high >10 days after latest rain; thalweg depth 3.5-4.0 ft
Attempted electrofishing along ~50 yards of shoreline: sighted 1 fish ~150mm, species unknown
Same conditions downstream ~0.5 mile
Might be able to work this site in lower flow

Lower YER, below highway bridge
63°23.062'N   143°35.538'W   elevation: 1,971 ft
Set bag seine below a slight pool
Set of seine not very good; current very strong; lead line not on bottom in some places
My assistant was the anchor for one end of the seine
Electrofished ~35 yards downstream to seine: no fish observed
No other fish-able sites nearby or anywhere below old pipeline corridor

Observation: In June, flow at upper YER was greater than at lower YER. In September, there was stronger flow at mid- and lower YER sites. Judging by wet marks on the rocks, the water level was dropping.

Yerrick Creek is characterized by steep gradient, cascading flows, and large boulder substrate. The channels appear to be dynamic, as judged by cleanliness of the substrate in and near the water: very little periphyton and almost no terrestrial vegetation. There are few pools in YER that appear capable of providing habitat for fishes. Those pools are small, in the range of 10 ft long. Besides the pools that we sampled, other small pools were observed (in June) at –

* 63°22.308'N 143°37.007'W elevation: 1,847 ft
* 63°22.123'N 143°37.104'W elevation: not recorded
* 63°21.572'N 143°37.608'W elevation: 2,050 ft (pool near spur of hill)
* 63°21.582'N 143°37.638'W elevation: 1,930 ft
* 63°21.257'N 143°37.913'W elevation: 2,220 ft (pool near scree slope; 1 AG seen in June)

CATHEDRAL RAPIDS CREEK #1 (CR1)

Station CRI

Electrofished ~0.1 mile of CR1, roughly near the approximate impound site

* from WP 012: 63°21.086'N 143°43.153'W elevation: 2,495 ft
* to WP 011: 63°21.175'N 143°43.163'W elevation: 2,442 ft

No fish sighted or captured

No minnow trap set (no pools)

Note: this site was not really a pool or pools; it was a reach of the stream near the impound site, where we could reasonably set the bag seine and conduct electrofishing.

CR1 is much smaller and steeper than YER. It is essentially one long, cascading run, with strong current and large boulder substrate. In June (lower flow than in September), a pool of roughly 10 ft wide x 20 ft long x 2 ft deep was observed at WP 037: 63°21.595'N 143°43.005'W elevation: 2,239 ft but this pool could not be located in early September. Similarly, a few smaller pools were observed in June, but by early September, the dynamic channel appeared to have shifted so that they were no longer apparent.

(2) RESULTS FROM 29-30 SEPTEMBER 2008

YERRICK CREEK (YER)

Station UYC
Upper YER
Waypoint 026, elevation: 2,811 ft
63° 18.193'N 143°35.406'W
Minnow trap set 29SEP08@1415; retrieved 30SEP08@1320 --
DV (3): 175, 126, 145 mmFL
All fish in apparent good condition, released alive

Station UMY
Upper YER, below WP 026
Waypoint 029, elevation: 2,548 ft
63° 19.371'N 143°36.591'W
Nice pool at big dead spruce and snag
Minnow trap set 29SEP08@1440; retrieved 30SEP08@ 1235 –
DV (3): 147, 159, 142 mm FL
All fish in apparent good condition, released alive.
Electrofished 2 pools, ~25 linear yards of stream –
DV (1): 125 mm FL
+ 1 DV sighted
Fish in apparent good condition, released alive

Station YCI
Pools near impoundment site
Waypoint 030, elevation: 2,242 ft
63° 20.606'N 143°37.686'W
2 minnow traps set 29SEP08@1500, retrieved 30SEP08@1115 –
DV (12): 149*, 133, 131, 137, 136, 128, 125, 123, 141, 105, 130, 80 mm FL
* possible gravid female?
All fish in apparent good condition, released alive.
Electrofished pools near impoundment site, ~25 linear yards of stream –
no fish sighted or captured
Electrofished pool at fork of 3 channels ~100 yards above impoundment site
Waypoint 032, elevation: 2,204 ft
63° 20.521'N 143° 37.773'W
DV (3): 124, 131, 167 mm FL
All fish in apparent good condition, released alive

Station MYC
Middle YER, near big spur of hill (“razorback”) on west bank
Waypoint 031, elevation: 2,026 ft
63° 21.623’N   143° 37.565’W
Minnow trap set 29SEP08@1550, retrieved 30SEP08@1400 –
    DV (3): 164*, 122, 98 mmFL
    * white-edged fins, possible spawning male?
Electrofished ~100 linear yards of stream, in various small pools –
AG (1): 162 mmFL
    + sighted 3 small fish, each <100 m FL
Fish in apparent good condition, released alive

Station LYC
Lower YER, below highway bridge
Waypoint 025, elevation: 1,717 ft
63° 22.878’N   143°36.438’W
Minnow trap set 29SEP08@1350, retrieved 30SEP08@1000 –
    * no catch
Electrofished ~100yards of stream –
    AG (1): 79 mm FL

B. *Fisheries Study for Spawning AG and DV and their movement throughout the Creek during May and June 2009*, June 2009.

10 June 2009

To: APT – Glen Martin

From: GRAYSTAR – Steve Grabacki

Subject: Report of Fisheries Fieldwork, Yerrick Creek, May-June 2009

I conducted three sampling sessions on Yerrick Creek -- 19-20 May 2009, 27-29 May 2009, and 7 June 2009.

For the first two sessions, the study area included lower Yerrick Creek, from roughly ½-mile above the proposed powerhouse site downstream to the Tanana River. The main purpose of the sampling was to compare spawning aggregations of Arctic grayling above vs. below the proposed powerhouse site. Sampling methods included visual observation with polarized lenses, angling with spin and fly terminal tackle, underwater video, and 3 styles of fish traps (small wire-mesh minnow traps, medium collapsible minnow traps with larger throat, and larger collapsible traps) baited with commercially cured salmon roe.

On the third sampling session, we focused on the creek downstream of the highway. The purpose of this sampling was to observe and capture Arctic grayling in lower Yerrick Creek, and to compare grayling's use of the creek for spring spawning by adults vs. summer feeding by juveniles. Sampling methods included visual observation with polarized lenses, angling with spin and fly terminal tackle, and herding fish through pools into a bag seine.

General Habitat Description

For most of its length, Yerrick Creek is a cascading stream with fast flow and boulder substrate. The stream generally comprises 1-3 channels, within a wide dynamic (scoured) perimeter. Apparent fish habitat consists of widely spaced, very small (~10-foot long) pools behind large boulders or logjams.

Roughly 1 mile before the creek joins the Tanana River, the habitat is significantly different. Flow is much slower, and the habitat is composed mostly of sand. In this “delta” area, there are 3 main channels, several smaller channels which leave and rejoin the larger channels, and at least one large area (“city block” in size) through which the creek flows more-or-less overland, in very shallow channels among dense spruce trees.

In between these two reaches is a transition zone, where flow is intermediate in strength and substrate is small rocks & large gravel. This transition zone is only a few hundred yards long.

Complicating this situation is the fact that the water flowing in the creek is not always continuous with the river. Because of the porous substrate, the water sometimes disappears from the surface, and flows underground.

First Sampling Session

During the field trip of 19-20 May 2009, Yerrick Creek did not flow into (connect to) the Tanana River. Water flow appeared strongest at the uppermost sampling station (above the powerhouse site), and water was flowing in only 1 channel under the highway bridge.

On 19 May, the water disappeared approximately ¾-mile downstream of the bridge, within the rocky streambed. On 20 May, the water had reached about 0.9 miles farther downstream, but disappeared in the sandy substrate. In the sandy delta area, there were a few very small pools with very little flow, and mostly dry substrate.
At the bridge, water temperature was –

10.8°C at about 1630 on 18 May

5.1°C at 1030 on 19 May

1.7°C at 0915 on 20 May

-- this range of daily temperature variation was observed on both sampling trips. (Arctic grayling are thought to spawn at 4°C).

The 3 channels of Yerrick Creek drain into a backwater slough of the Tanana River. Although there was no surface water flow from the creek to the river, there was water in that slough. Water temperature was 10.5°C. We observed approximately 12 grayling in a tight school. The fish appeared to be roughly 250-300 mm in length. They were easily spooked, and did not respond to spinners or flies. We also observed 1 round whitefish, of approximately 300 mm in length, dozens of small (~20 mm) grayling, and hundreds of tiny (<10 mm) fish (species unknown). We captured no fish in the fish traps.

Above the powerhouse site on 19-20 May, we captured 1 Dolly Varden (225 mm FL) in a trap, but observed no other fishes in this area.

Second Sampling Session

During the field trip of 27-29 May 2009, the flow in the creek was much greater, and the water appeared to be more turbid, than it had been a week earlier. At the bridge, the water was flowing in 2 channels (vs. one 1 channel, a week before), and was –

5.1°C at 1010 on 27 May

4.1°C at 0600 on 28 May, after a cool night

7.1°C at 1240 on 28 May

2.8°C at 0610 on 29 May, after a rainy night

3.5°C at 0925 on 29 May

5.3°C at 1455 on 29 May

Yerrick Creek was flowing into the Tanana River (the slough where we had earlier sampled) through its 3 main channels. Just above those confluences, the creek was braided through the forest, with several small channels and overland flows (among the trees). In these small channels, we observed 2 individual grayling (the fish were widely separated, not aggregated).

We observed no fish in the lower creek (below the bridge), on either the rocky or sandy substrates, but we did capture 2 slimy sculpin in a trap. Water temperature in the lower creek was –

6.8°C at 1145 on 28 May

4.5°C at 1135 on 29 May

Above the powerhouse site, we captured 7 Dolly Varden in traps, but observed no other fishes, with any sampling method. Water temperature in this area was –

7.5°C at 1325 on 28 May

3.7°C at 1330 on 29 May

During this second field trip, we found some of the fish traps in different positions from where we had set them. They appeared to have been moved to the shore or (in one case) out of the water by an overnight flood event.

To summarize the first two samplings -- For grayling to spawn in Yerrick Creek, 2 factors are necessary – water temperature of 4-5°C, and continuity of water flow from the creek to the river. As expected, we observed a school of grayling in the Tanana River very near the mouth of Yerrick Creek, before the creek had reached the river. Those fish were apparently waiting to enter the creek. After the creek had reached the river, we observed grayling in the sandy-bottom, slower-flowing "delta" channels of the creek, but no grayling in the rocky-bottom, faster-flowing cascading parts of the creek. Also, we did not observe aggregations of grayling anywhere in Yerrick Creek.

<u>Third Sampling Session</u>

We sampled Yerrick Creek on 7 June 2009. The weather was cool and rainy in the morning, but turned mostly sunny and warm in the afternoon. Water was clear, and 5.4C at 1100.

The purpose of this sampling was to observe and capture Arctic grayling in lower Yerrick Creek, and to compare grayling's use of the creek for spring spawning by adults vs. summer feeding by juveniles. Sampling methods included: visual observation with polarized lenses, angling with spin and fly gear, and herding fish downstream through pools into a bag seine, which was stretched across the creek.

We observed no fishes in the fast flow / boulder substrate zone, or in the slow flow / sand substrate zone. In the transition zone, we captured 1 grayling, and observed 4 individual (not aggregated) grayling: 2 of these were roughly 200 mm long, and 2 fish were approximately 100 mm long. The captured grayling was 208 mm fork length, and did not appear to be in either a pre-spawning or post-spawning condition.

I took scale samples from the captured grayling, and released it in apparent good condition. I drove to Delta, and met with ADFG's Fronty Parker. We discussed my findings, and we pressed and read the sample of scales that I took from the fish I caught on Sunday (6/7). That grayling was 2 or 3 years old, definitely juvenile, not a spawning adult.

Based on my sampling in early September 2008, and on these three sampling sessions in May-June 2009, a picture of grayling use of Yerrick Creek seems to have emerged. Grayling appear to use parts of Yerrick Creek (below and within the bypass reach) for summer feeding, on an opportunistic basis. While I cannot prove that grayling do not spawn in Yerrick Creek, I have found no evidence to support it --

* The creek did not connect to the river at the expected time of grayling spawning.

* I observed no aggregations of grayling anywhere in Yerrick Creek; all grayling observed in the creek in May-June 2009 appeared to be individual fish.

* I observed no adult-size grayling, and the largest grayling observed in June 2009 (the 2- or 3-year-old) did not appear to be in either a pre-spawning or post-spawning condition.

C. *AP&T Temperature and Fish Presence Survey,* (e-mail) June 24, 2009.

From: Dolly Henton
To: "Eric Hannan (EricHannan)"; graystar@alaska.net
Cc: "Glen Martin"
Subject: Yerrick Creek Fishing Results
Date: Wednesday, June 24, 2009 6:35:50 PM
Attachments: mike 012_800x600.jpg
mike 013_800x600.jpg
mike 014_800x600.jpg
mike 015_800x600.jpg
mike 016_800x600.jpg
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mike 020_800x600.jpg
mike 021_800x600.jpg
mike 022_800x600.jpg
Photo Key.doc

All,
Mike Warner arrived at Yerrick Creek today at 7:30 am. Water temp was 4.8 C.

He did catch fish as follows:

1st Fish: 5 3/4" long 2nd Fish: 6 1/4" long 3rd Fish: 4" long 4th Fish: 6 1/8" long	All four fish were grayling & caught on a tan colored fly north of the bridge
1st Fish: 4 3/4" long 2nd Fish: 5 1/2" long 3rd Fish: 6 1/4" long	All three fish were grayling & caught on a tan colored fly near the power plant sight

Photos he took are attached.

Thanks,

Dolly Henton
Admin Assist / G.I.S.

Alaska Power & Telephone (AP&T)
P.O. Box 207
Tok, AK 99780

(907)883-5208 - direct
(907) 883-5101 - general
(907) 883-5815 - fax
dolly.h@aptalaska.com

Yerrick Creek Photo Key

28 May 09 - Steve, Ace, & Mike went to Yerrick Creek – These photos taken by Mike

1. Steve Grabacki – pulling fish traps – about ½ mile from Tanana River – in the sand bottom area
2. Steve pulling the trap out of the water
3. Skulpin (sp?)
4. Two skulpins
5. Steve documentation – sand bottom hole in the boulder field. Caught fish on line here first.
6. Steve & Eric "Ace" Hannan
7. Water flow – same place as above photos – about 1 mile north of the bridge
8. Yerrick Creek – about ½ mile north of the bridge; pulling traps
9. Water flow - approx ¼ mile from the bridge 5-29-09
10. Same photo as #9
11. blurry photo – deleted

Photos #12 – 22 Taken 24 June 09 – Mike went to the creek by himself

12. Biggest grayling caught: 6 1/8" long (on Mike's hand)
13. Same grayling as photo #12
14. Same grayling – note dorsal fine
15. Location of his catch. Note water level has dropped off dramatically
16. Same area – note water flow dropped off. Approx ½ mile north of the bridge
17. Same location as #16 – looking downstream towards the Tanana
18. Downstream of the bridge
19. Approx ¼ mile of the bridge. Photo to show depth, clarity of the water
20. Approximately 1 mile above bridge / at about the power plant site (above the pipeline corridor)
21. Water flow at about the pipeline corridor. Mike caught his 2nd grayling here.
22. Fishable pool – caught 3rd fish here. The fish are caught in the calm areas by the big rocks – let fly drift over the top of calm water.

Mike's Photo 12

Mike's Photo 13

Mike's Photo 14

Mike's Photo 15

Mike's Photo 16

Mike's Photo 17

Mike's Photo 18

Mike's Photo 19

Mike's Photo 20

Mike's Photo 21

Mike's Photo 22

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STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF FISH AND GAME

DIVISION OF HABITAT

1300 COLLEGE ROAD
FAIRBANKS, AK 99701-1551
PHONE: (907) 459-7289
FAX: (907) 459-7303

July 20, 2009

Mr. Glen D. Martin, Project Manager
Alaska Power and Telephone Company
P.O. Box 3222
Port Townsend, WA 98368-0922

Dear Mr. Martin:

RE: Information Needs for Proposed Yerrick Creek Hydroelectric Project Permitting

As noted in your letter of June 12, 2009, I met with representatives of Alaska Power and Telephone Company (AP&T) on May 18, 2009 regarding information needs to move forward with permit evaluation for the proposed Yerrick Creek Hydroelectric Project. As currently proposed, AP&T would construct a diversion structure across Yerrick Creek and divert up to 60 cfs through a penstock to a powerhouse near the Alaska Highway, after which the water would be returned to Yerrick Creek.

At that meeting, I noted that the Alaska Department of Fish and Game (ADF&G) would need full and complete information on what resources were potentially affected by the proposed activity so a reasoned and balanced evaluation could be made of the potential project effects and benefits. At this time, AP&T has not fully met the information needs identified in my letters of April 7, July 1, and September 30, 2008. ADF&G continues to wait for the requested information on fish distribution and habitat availability including stream flow data from above and below the proposed bypass reach. ADF&G staff also brought up the possibility of incorporating a natural bed bypass ramp into the diversion structure design as Jim Durst of my staff discussed with you some time ago. To date, we have not seen this being evaluated by AP&T.

ADF&G will be unable to evaluate this permit application until all requested information is provided.

If you have questions or need additional information, contact me or Jim Durst (459-7254).

Sincerely,

Robert F. McLean

Robert F. "Mac" McLean, Regional Supervisor
Division of Habitat

ecc: Fred Bue, ADF&G CF, Fairbanks
Al Ott, ADF&G HAB, Fairbanks
Fronty Parker, ADF&G SF, Delta Junction
Jim Ferguson, ADF&G SF, Anchorage
Scott Maclean, ADF&G, Anchorage
Jim Simon, ADF&G SUBS, Fairbanks
Jeff Gross, ADF&G WC, Tok
Torsten Bentzen, ADF&G WC, Tok
Chris Milles, ADNR Lands, Fairbanks
Gary Prokosch, ADNR Water, Anchorage

RFM/jdd

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
REGULATORY DIVISION
P.O. BOX 6998
ELMENDORF AFB, ALASKA 99506-0898

REPLY TO
ATTENTION OF:

MAY 21 2009

Regulatory Division
POA-2009-445

Mr. Glen D. Martin
Alaska Power and Telephone Company
193 Otto Street
Post Office Box 3222
Port Townsend, Washington 98368

Dear Sir:

This is in response to your May 1, 2009, application for a Department of the Army (DA) permit, to conduct sample test pits. It has been assigned file number POA-2009-445, Yerrick Creek, which should be referred to in all future correspondence with this office. The project site is located within Sections 1, 2, 11, & 14, T. 18 N., and Section 36, T. 19 N., Range 9 E, Cooper River Meridian; USGS Quad Map Tanacross B-6; Latitude 63.3826° N., Longitude 143.5989° W.; approximately 20 miles west of Tok, Alaska.

DA permit authorization is necessary because your project may involve work in or placement of structures and dredged or fill material into waters of the U.S. under our regulatory jurisdiction.

Based upon the information and plans you provided, we hereby verify that the work described above, which would be performed in accordance with the enclosed plan (sheets 1-5), dated May 2009, is authorized by Nationwide Permit (NWP) No. 6, Survey Activities. NWP No. 6 and its associated Regional and General Conditions can be accessed at our website at www.poa.usace.army.mil/reg. You must comply with all terms and conditions associated with NWP No. 6.

Further, please note General Condition 26 requires that you submit a signed certification to us once any work and required mitigation are completed. Enclosed is the form for you to complete and return to us.

This verification will be valid for two years from the date of this letter, unless the NWP authorization is modified, suspended, or revoked.

Nothing in this letter excuses you from compliance with other Federal, State, or local statutes, ordinances, or regulations.

You may contact me via email at allan.g.skinner@usace.army.mil, by mail at the address above, by phone at (907) 753-2797, or toll free from within Alaska at (800) 478-2712, if you have questions or to request paper copies of the jurisdictional determination, regional and/or general conditions. For additional information about our Regulatory Program, visit our web site at www.poa.usace.army.mil/reg.

Sincerely,

Allan G. Skinner

Allan G. Skinner
Regulatory Specialist

Enclosures

Enclosure

US Army Corps of Engineers
Alaska District

Permit Number: POA-2009-445

Name of Permittee: Alaska Power and Telephone Company

Date of Issuance: May 22, 2009

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to Mr. Allan G, Skinner at the following address:

U.S. Army Corps of Engineers
Alaska District
Regulatory Division
Post Office Box 6898
Elmendorf AFB, Alaska 99506-0898

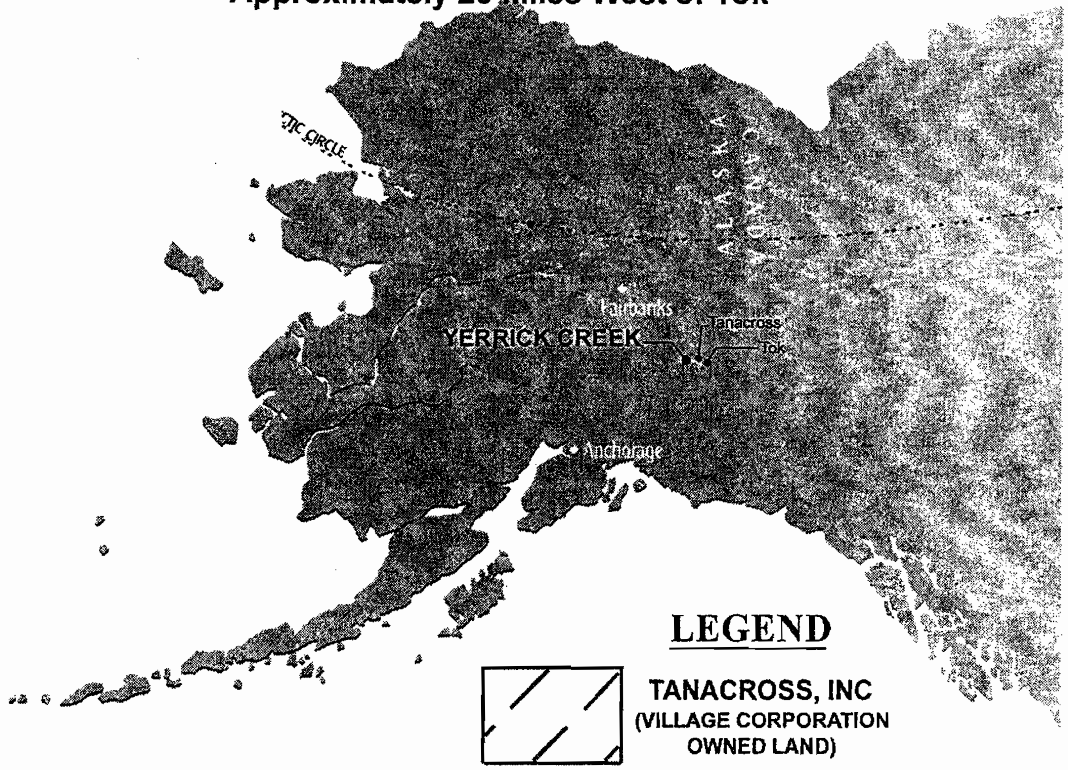
Please note that your permitted activity is subject to a compliance inspection by an U.S. Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification, or revocation.

I hereby certify that the work authorized by the above-referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

Signature of Permittee   Date

PROJECT LOCATION

T18N, R9E, Section 1, 2, 11, 14
T19N, R9E, Section 36, CRM
USGS Tanacross (B-6)
Mile Post 1333.5 Alaska Hwy
Approximately 20 Miles West of Tok



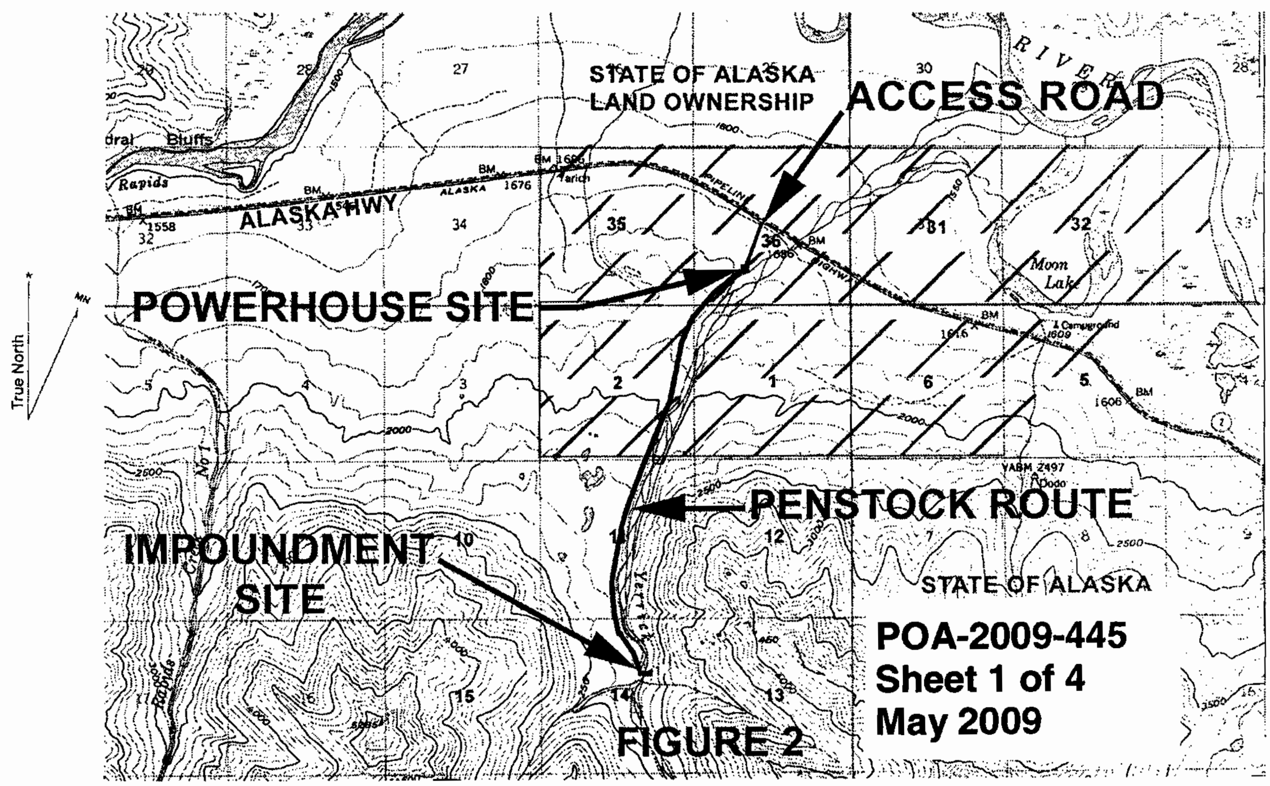
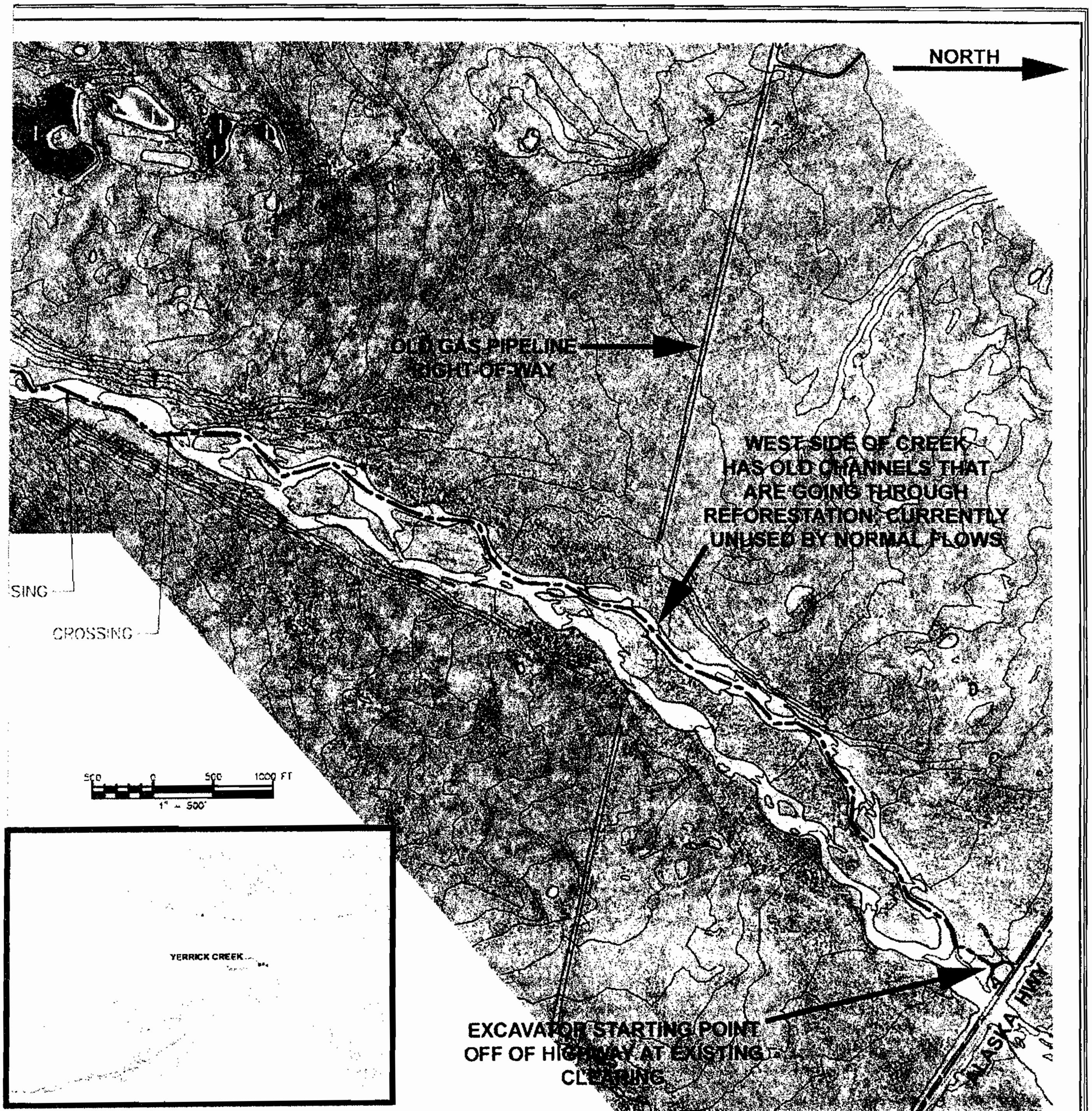


FIGURE 2

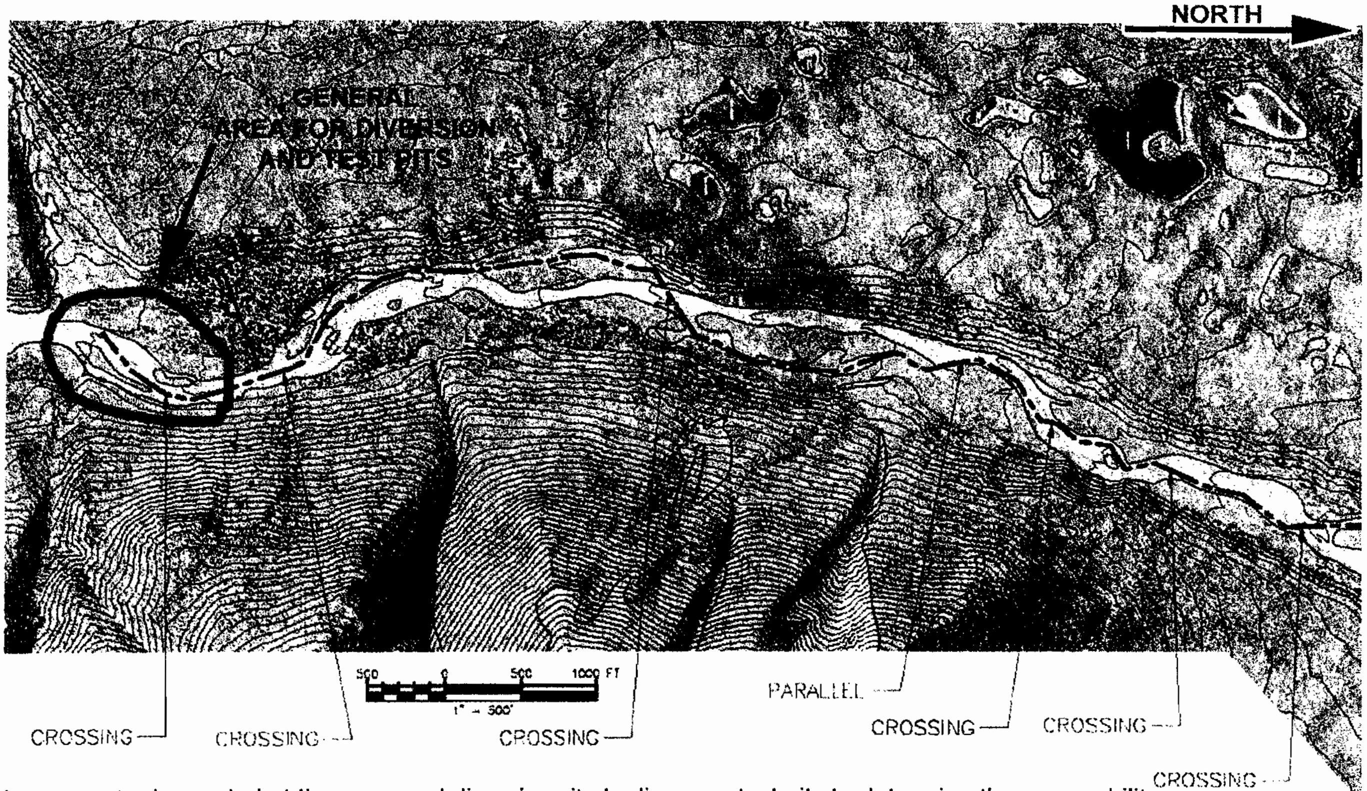
Site Development Diagram



T18N, R9E, SEC. 1, 2, 11, 14, CRM
T19N, R9E, SEC. 36, CRM

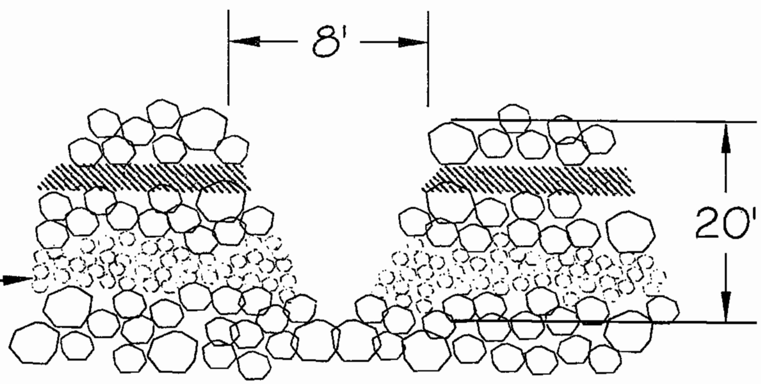
AP&T ALASKA POWER & TELEPHONE COMPANY	EXCAVATOR ACCESS PATH YERRICK CREEK HYDROELECTRIC PROJECT	U.S. ARMY CORPS OF ENGINE PERMIT APPLICATION PLAN VIEW	**POA-2009-445** **Sheet 2 of 4** **May 2009**

Site Development Diagram

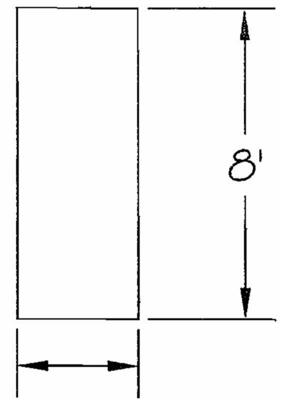


An excavator is needed at the proposed diversion site to dig some test pits to determine the permeability of the area for placing the diversion structure. No road exist into this site, so this route would have the least environmental impacts due to it occurring at seasonal low flow and half the route is in old, unused channels on the west side of the creek. Activity: an excavator would be driven up the west creek channel that is dry and unused and going through reforestation. This activity would also occur when flows are typically the lowest, during August and/or September 2009. The excavator would follow the easiest route up the old creek bed until it needs to cross the creek, as indicated on the map. The creek is composed of cobble, gravel and sand. The wetland JD that HDR conducted describes Yerrick Creek as follows: "*The project area is located along Yerrick Creek, a cobble-, gravel-, sand-substrate creek which crosses the Alaska Highway at approximately milepost 1339. Most of the project area is undeveloped, with an open gravel waterway, adjacent forests, abandoned gravel side channels in various states of revegetation, and heavily forested banks.*" Each crossing would not require any preparation, as is illustrated by the enclosed photographs the creek is mostly large cobble. The excavator would drive acrossed the narrowest, shallowest portions of the active east channel, using operator judgement for the best location, crossing the active creek 6 times to access the diversion site. It is proposed that it will take one day to drive in, two days will be spent on site, and one day to drive back out. Once the excavator crosses the creek at the upper most point, near the diversion site, 6 test pits would be dug within 300-500 feet upstream and/or downstream of the last crossing. No excavation would occur closer than 50 feet to the active flow. Test pits would be refilled with the excavated material. Though the upper part of the creek is used by Dolly Varden and the lower part is used by Arctic Grayling, the habitat in this part of the creek is marginal, being heavily cobbled with only a few small pools (a copy of the 2008 survey results is included). The impact to fish habitat would be negligable and because activity would occur at the lowest flows, fish from below would not be able to access this portion of the creek because flows go subterrainian down near the highway. A wetland survey by HDR is also enclosed.

LAS #	AP&T ALASKA POWER & TELEPHONE COMPANY	EXCAVATOR ACCESS PATH YERRICK CREEK HYDROELECTRIC PROJECT	U.S. ARMY CORPS OF ENGINEERS PERMIT APPLICATION PLAN VIEW	**POA-2009-445** **Sheet 3 of 4** **May 2009**



TYPICAL EXCAVATION CROSS-SECTION
(Not To Scale)



TYPICAL EXCAVATION PLAN VIEW
(Not To Scale)

Excavation will be approximately 8' x 3' to a maximum depth of approximately 20', or until impermeable substrate is encountered, whichever happens first.

POA-2009-445
Sheet 4 of 4
May 2009

2	ORIGINAL ISSUE	GM		04/21/03
REV	DESCRIPTION	AUTH	REV BY	DATE

AP&T ALASKA POWER & TELEPHONE COMPANY

ENGINEER	PB	DESCRIPTION: TEST PIT EXCAVATION CROSS SECTION & PLAN VIEW	JOB DWG. NO. AA
DRAWN	GM		SH 03
CHECKED		PROJECT: YERRICK CREEK HYDRO PROJECT	FILE NO. 11586
APPROVED	04/21/03		
SCALE	AS NOTED		

6. **Survey Activities**. Survey activities, such as core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory-type bore holes, exploratory trenching, soil surveys, sampling, and historic resources surveys. For the purposes of this NWP, the term "exploratory trenching" means mechanical land clearing of the upper soil profile to expose bedrock or substrate, for the purpose of mapping or sampling the exposed material. The area in which the exploratory trench is dug must be restored to its pre-construction elevation upon completion of the work. In wetlands, the top 6 to 12 inches of the trench should normally be backfilled with topsoil from the trench. This NWP authorizes the construction of temporary pads, provided the discharge does not exceed 25 cubic yards. Discharges and structures associated with the recovery of historic resources are not authorized by this NWP. Drilling and the discharge of excavated material from test wells for oil and gas exploration are not authorized by this NWP; the plugging of such wells is authorized. Fill placed for roads and other similar activities is not authorized by this NWP. The NWP does not authorize any permanent structures. The discharge of drilling mud and cuttings may require a permit under Section 402 of the Clean Water Act. (Sections 10 and 404)

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STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF FISH AND GAME

DIVISION OF HABITAT

1300 COLLEGE ROAD
FAIRBANKS, AK 99701-1551
PHONE: (907) 459-7289
FAX: (907) 459-7303

FISH HABITAT PERMIT
FH09-III-0128

ISSUED: May 20, 2009
EXPIRES: December 31, 2009

Mr. Glen D. Martin, Project Manager
Alaska Power and Telephone Company
P.O. Box 3222
Port Townsend, AK 98368

Dear Mr. Martin:

RE: Proposed Instream Equipment Crossings and Geotechnical Exploration
Yerrick Creek
Sec 1, 2, 11, & 14, T18N, R9E, and Sec 36, T19N, R9E, CRM; Tanacross B-6 Quad

Pursuant to AS 16.05.841 (Fishway Act), the Alaska Department of Fish and Game (ADF&G), Division of Habitat has reviewed your proposal to cross Yerrick Creek with a tracked excavator at the referenced locations, and to conduct geotechnical exploration within the limits of ordinary high water. Your application dated May 1, 2009 was supplemented with information provided at a meeting between ADF&G and company representatives on May 18 and by email from you on May 20, 2009.

Your proposed operation includes walking a ROBEX 130 LCM-3 or similar tracked excavator from the Alaska Highway approximately 3¼ miles up the floodplain of Yerrick Creek to the proposed Yerrick Creek Hydro Project diversion site to perform exploratory trenching, and return. The work would be accomplished during the late summer or fall low water period, and would make use of dry channels whenever possible. Six crossings of the active channel of Yerrick Creek are proposed, as is travel within the floodplain. Approximately six geotechnical test pits would be dug to a depth of 20 feet. The pits would be located at least 50 feet from any active channels of Yerrick Creek and would be refilled after excavation. Some or all of the excavation areas would be within the limits of ordinary high water of Yerrick Creek.

Yerrick Creek supports resident fish species (including Arctic grayling and Dolly Varden) in the area of your proposed activities. Based upon our review of your plans, your proposed project has the potential to obstruct the efficient passage and movement of fish.

ADF&G recommends that disturbance to vegetation within 50 feet of, but outside the limits of, ordinary high water be avoided to the extent practicable, particularly adjacent to sheer or cut banks. Note that this is not intended to preclude travel across gravel bars vegetated with willow or alder.

In accordance with AS 16.05.841, project approval is hereby given subject to your proposed scope of work and the following stipulations:

(1) Stream crossings shall be made from bank to bank in a direction substantially perpendicular to the direction of stream flow.

(2) Stream crossings shall be made only at locations with gradually sloping banks. There shall be no crossings at locations with sheer or cut banks.

(3) Stream banks and stream beds shall not be altered or disturbed in any way to facilitate crossings. If stream banks are inadvertently disturbed, they shall be immediately stabilized to prevent erosion.

(4) Log jams and embedded large woody debris within the limits of ordinary high water shall not be moved or removed without specific authorization from ADF&G.

(5) Any excavation within the limits of ordinary high water shall be reclaimed and stabilized in a manner that is not conducive to erosion and that cannot trap fish under fluctuating water levels. Photo documentation of each reclaimed pit within the limits of ordinary high water shall be forwarded to this office within 30 days of the activity.

The permittee is responsible for the actions of contractors, agents, or other persons who perform work to accomplish the approved plan. For any activity that significantly deviates from the approved plan, the permittee shall notify the ADF&G and obtain written approval in the form of a permit amendment before beginning the activity. Any action taken by the permittee, or an agent of the permittee, that increases the project's overall scope or that negates, alters, or minimizes the intent or effectiveness of any stipulation contained in this permit will be deemed a significant deviation from the approved plan. The final determination as to the significance of any deviation and the need for a permit amendment is the responsibility of the ADF&G. Therefore, it is recommended that the ADF&G be consulted immediately when a deviation from the approved plan is being considered.

This letter constitutes a permit issued under the authority of AS 16.05.841 and must be retained on site during the permitted activity. Please be advised that this approval does not relieve you of the responsibility of securing other permits, state, federal or local.

This permit provides reasonable notice from the Commissioner that failure to meet its terms and conditions constitutes violation of AS 16.05.861; no separate notice under AS 16.05.861 is required before citation for violation of AS 16.05.841 can occur.

In addition to the penalties provided by law, this permit may be terminated or revoked for failure to comply with its provisions or failure to comply with applicable statutes and regulations. The ADF&G reserves the right to require mitigation measures to correct disruption to fish and game created by the project and which was a direct result of the failure to comply with this permit or any applicable law.

The recipient of this permit (permittee) shall indemnify, save harmless, and defend the ADF&G, its agents and its employees from any and all claims, actions or liabilities for injuries or damages sustained by any person or property arising directly or indirectly from permitted activities or the permittee's performance under this permit. However, this provision has no effect, if, and only if, the sole proximate cause of the injury is the ADF&G's negligence.

Please be advised that this determination applies only to activities regulated by the ADF&G; other departments and agencies also may have jurisdiction under their respective authorities. This determination does not relieve you of the responsibility for securing other permits, state, federal, or local. You are still required to comply with all other applicable laws.

Sincerely,

Denby S. Lloyd, Commissioner

BY: Robert F. "Mac" McLean, Regional Supervisor
Division of Habitat

ecc: Tim Pilon, ADEC, Fairbanks
Bonnie Borba, ADF&G CF, Fairbanks
Al Ott, ADF&G HAB, Fairbanks
Fronty Parker, ADF&G SF, Delta Junction
Jim Simon, ADF&G SUBS, Fairbanks
Jeff Gross, ADF&G WC, Tok
Chris Milles, ADNR DMLW, Fairbanks
NOAA Fisheries, Anchorage
Allan Skinner, USACE, Anchorage POA-2009-445
Larry Bright, USFWS, Fairbanks
Meg Hayes, Tanacross Inc.
Eric Hannan, AP&T, Tok

RFM/jdd

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STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF FISH AND GAME

DIVISION OF HABITAT

1300 COLLEGE ROAD
FAIRBANKS, AK 99701-1551
PHONE: (907) 459-7289
FAX: (907) 459-7303

September 3, 2008

Mr. Glen D. Martin, Project Manager
Alaska Power and Telephone Company
P.O. Box 3222
Port Townsend, WA 98368-0922

Dear Mr. Martin:

RE: Comments on Yerrick Creek Hydroelectric Project Revised Draft Study Plan

The Alaska Department of Fish and Game (ADF&G), Division of Habitat has reviewed your July 22, 2008 Revised Draft Study Plan for the proposed Yerrick Creek Hydroelectric Project. During this review, we consulted with appropriate ADF&G biologists and have incorporated their comments into this document.

The current comments are intended to augment, and be taken in context with, my letters of April 7 and July 1, 2008, regarding the Yerrick Creek Hydro Project. In addition, we recommend that Alaska Power and Telephone Company contact other appropriate state and federal agencies for any information needs they may have regarding this proposed project; in particular, contact the Land Section and Water Section of the Alaska Department of Natural Resources, Division of Mining, Land and Water.

PROPOSED PROJECT

From this revised draft, we understand that the proposed project capacity is 2-3 MW, although the maximum proposed water usage is not given. The penstock would be at least mostly buried, and it and the access road would be sited at least 66 feet from Yerrick Creek except at the impoundment structure and powerhouse. The impoundment structure would likely be made of sheet pile, and designed to feed flow into the penstock rather than store water. Operations would be year-round run-of-river.

FISH AND WILDLIFE RESOURCES

We noted and acknowledge the significant update you made to the Existing Resources portion of the document, and have no further comments on that portion at this time.

PERMITTING INFORMATION NEEDS

The table of stream gage data from near the impoundment site is helpful. Please indicate its location on Figure 1 for reference, and provide latitude and longitude coordinates. It appears that the temperature data presented are air temperature; water temperatures would be very useful for helping refine timing of Dolly Varden spawning and other life history events. We continue to note that a second gage downstream of the bypass reach will be needed to adequately characterize surface flows in that reach and to provide a basis for development of appropriate instream flow requirements for project operations. It is our position that surface flows through the bypass reach can be documented and examined independent of fish surveys. Rather, knowledge of hydrologic characteristics, and whether it is a gaining or losing reach, is expected to add to the ability to delineate and evaluate fish habitat and passage in the area.

We are concerned that it appears the summer residency fish sampling field work did not happen this year. At the present time, overnight temperatures in the project area are near or below freezing, so water temperatures may have dropped enough that fish have begun to move from their summer habitats to ones more suited to lower temperatures and lower flows. As such, fish distribution data for the summer residency period are still needed.

We did not see methods described in the Study Plan that will provide data on the seasonal movement of fish between stream reaches and habitats as we have previously requested. Information on the life history of Dolly Varden in the project area is also needed.

Based on our current understanding of wildlife resources and uses in the project area, we concur that most project effects on wildlife are likely to be indirect, associated primarily with changes to access, and relatively minor. Mitigation measures to minimize effects to the extent practicable will be developed as the project is refined.

If you have questions or need additional information, contact me or Jim Durst (459-7254).

Sincerely,

Robert F. "Mac" McLean, Regional Supervisor
Division of Habitat

ecc: Fred Bue, ADF&G CF, Fairbanks
Fronty Parker, ADF&G SF, Delta Junction
Jim Ferguson, ADF&G SF, Anchorage
Caroline Brown, ADF&G SUBS, Fairbanks
Jeff Gross, ADF&G WC, Tok
Torsten Bentzen, ADF&G WC, Tok
Chris Milles, ADNR Lands, Fairbanks
Jim Vohden, ADNR Water, Fairbanks

RFM/jdd

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ALASKA POWER & TELEPHONE COMPANY
P.O. BOX 3222 • 193 OTTO STREET
PORT TOWNSEND, WA 98368
(360) 385-1733 • (800) 982-0136
FAX (360) 385-5177

July 22, 2008

To: All Agencies

Regarding: Yerrick Creek Hydro Draft Study Plan – Version 2

Dear Agency Representatives:

Enclosed is a revised draft study plan for your review for the Yerrick Creek Hydroelectric Project, located approximately 20 miles west of Tok on the Alaska Highway. A project description and map are included in the draft study plan. This plan incorporates ADF&G's comments and provides more detail on what studies are being conducted.

Please provide your comments by August 29, 2008. Thank you for your time.

Sincerely,

Glen D. Martin

Glen D. Martin
Project Manager
glen.m@aptalaska.com
(360) 385-1733 x122

Enc. (as stated)

Cc: Deborah Rocque, USF&WS
Victor Ross, COE
Krissy Plett, DNR-Water
Jim Vohden, ADNR Water
Chris Milles, DNR-Land
Tim Wingerter, DEC
Jim Ferguson, ADF&G
Fronty Parker, ADF&G
Jeff Gross, ADF&G
Todd Nichols, ADF&G
Mac McLean, ADF&G
Jim Durst, ADF&G
Caroline Brown, ADF&G
Judith Bittner, SHPO

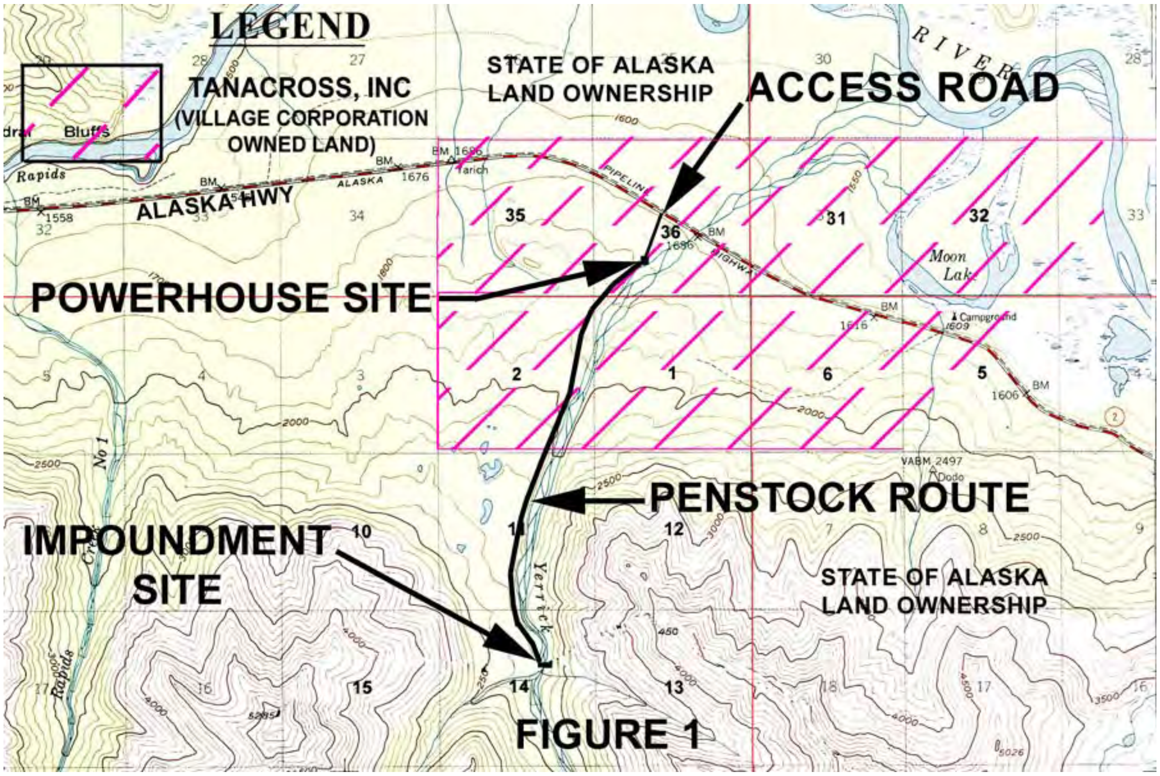
YERRICK CREEK HYDROELECTRIC PROJECT

(REVISED) DRAFT STUDY PLAN

1.0 PROJECT DESCRIPTION

APC proposes to construct a run-of-river hydroelectric project that will interconnect with the grid supplying electricity to the communities of Tetlin, Tok, Dot Lake, and Tanacross. This grid is presently wholly reliant upon diesel generation. APC is the certified utility for this area along the Alaska Highway and is within the boundaries of APC's certificate from the Regulatory Commission of Alaska. This project is called the **Yerrick Creek Hydroelectric Project**. The project is located approximately 20 miles west of Tok on the Alaska Highway at Milepost 1339. Although APC's existing transmission infrastructure follows the highway right-of-way past the project site, this infrastructure (conductor) will need to be upgraded to handle the load from the project. Project capacity is expected to be 2-3 megawatts (MW). Project features would include a small diversion structure, an approximately 11,000 foot long penstock, powerhouse with a single impulse turbine (Pelton or Turgo) and generator, tailrace, small substation, and transmission line to and along the Alaska Highway, as shown in Figure 1. The building season is short at this north latitude, so it will take two years to complete this project. This project not only will provide clean, renewable energy that will stabilize rates, but will provide a stable source of energy that can quickly come on line after power outages, which makes it one of the best renewable resources. The cost to maintain a hydro project is also significantly lower than diesel generation. The existing diesel generation plant in Tok will continue to supplement the grid as the hydro project is only expected to provide electricity for 100% of the load part of the year and down to approximately 10% of the load during low flow periods of the year, such as during the winter.

This project will reduce the cost of electricity to the residents of Tetlin, Tok, Tanacross and Dot Lake who presently pay **$0.36** per kWh. Once the hydroelectric project interties with the Tok grid, the cost per kWh will be reduced by approximately 20%. The environmental impacts, i.e. air pollution, noise pollution, spills, etc., of any self-generation will be significantly reduced by this intertie, as well as from generation at APC's powerplant in Tok. During part of the year it is estimated the entire load can be carried by the hydroelectric project, and during the winter the use of diesel generation will supplement the hydroelectric project.



This hydroelectric project will reduce fossil fuel consumption by approximately 509,800 gallons per year, which at 2007 prices is equivalent to $1,157,246 annually. The existing diesel plant in Tok, which supplies electricity to all four communities, would use fewer diesel generators to meet the remaining load, reducing labor and maintenance costs and the frequency of generator overhaul and replacement for a potential savings of $1,153,200 annually. At present usage levels, this hydroelectric project would save the residents of all four communities approximately $693,043 per year (2007). Lower energy costs would help stimulate development, both economically and home building.

2.0 Project Components

The project facilities described herein are based on a preliminary evaluation of the site, and represent the maximum degree of resource development. The proposed project features are described in more detail below:

Impoundment

The project design for this run-of-river hydroelectric project include construction of either a concrete, steel, or other material impoundment structure. The impoundment structure is likely to be made of sheet piling to create a barrier that will impound enough water for an intake to remove it and generate electricity at the powerhouse. Due to the depth of the cobble expected in Yerrick Creek, it is not expected that the sheet pile will reach bedrock, and therefore it is expected that some water will go subterranean under the impoundment structure and surface further down the creek.

Penstock

The penstock is estimated to be approximately 11,000 feet in length and would probably consist of a combination of HDPE and steel or iron pipe. The penstock is proposed to be buried along most if not all its length. The diameter of the penstock may be approximately 36-inches. The penstock would parallel the creek down to the powerhouse requiring some clearing along its right-of-way.

Powerhouse

The powerhouse would be a metal structure of approximately 30 x 40 feet with a height of approximately 25 feet. The powerhouse would contain the controls for the operation of the project, including switchgear, Pelton or Turgo impulse turbine, a generator rated at 2-3 MW, and controls for valves at the impoundment structure. After the water passes through the turbine it will fall into a tailrace that will discharge back into Yerrick Creek above the highway bridge that spans the creek.

Access Road

An access road would be constructed to the powerhouse from off the Alaska Highway. The road is expected to be less than a mile in length. Another access road would come down the west side of Yerrick Creek from the impoundment structure, due to its more moderate elevation changes, to the powerhouse site. The one lane access road width would be approximately 14-feet wide with frequent pullouts.

Substation

A small pad-mount step-up transformer will be adjacent to the powerhouse to adjust the voltage for the transmission line to Tok.

Transmission Line

The transmission line will go from the powerhouse step-up transformer to intertie with the Tok grid along the Alaska Highway, approximately one mile away. This would require approximately 20 vertical wood pole structures set about 300 feet apart.

Land Ownership

The enclosed Figure 1 is a project map showing property boundaries in relation to the project features. The project will be located on land managed by the State of Alaska and Tanacross, Inc., a Village Corporation.

Environmental Impacts

Previous man-made land disturbance (old gas pipeline corridor paralleling the highway, which was once cleared of vegetation) has left a footprint on the environment that will reduce this projects impact by utilizing the corridor for part of the access road and powerhouse site. Impacts to wetlands will occur as areas along the access route are in muskeg. The access route will parallel the creek on its west side. It is estimated that approximately 5-6 acres of land would be disturbed, with possibly ¾'s being in muskeg and the creek. To minimize impacts, an erosion and sedimentation control plan will be implemented to confine impacts during construction, of which silt fencing and straw or hay bales would play a significant part, and repair after construction where possible. Construction methods, i.e. minimize the construction footprint, will also keep impacts to a minimum.

Threatened, Endangered, or Under Consideration Species

No species listed on the ADF&G or USF&WS websites as Threatened or Endangered or under consideration (http://www.adfg.state.ak.us/special/esa/esa_home.php) will be impacted by this project as they either reside or prefer habitat outside of the project area.

DRAFT STUDY PLAN

Existing Resources

Part of the information presented here is from the Tetlin National Wildlife Refuge (east of the project) website, and hence the mention of Refuge throughout this description. The Refuge's data is used because of its proximity to the project area and wealth of information available on indigenous species of the area, however, the Refuge's geography is different then that of Yerrick Creek which is primarily a mountainous drainage whereas the Refuge is more lowlands. There was also a significant amount of information on the ADF&G website regarding hunting and trapping in Unit 12, which Yerrick Creek is within. Information from the ADF&G website is also incorporated into the description of resources in the Yerrick Creek area found below.

Botanical Resources

Boreal forest (taiga) and upland tundra are the dominant vegetation types in all of interior Alaska. In the alpine areas, dry, broad ridge tops are dominated by dryas dwarf scrub and ericaceous dwarf scrub tundra vegetation. Mesic to moist saddles, slopes, and snow-melt meadows support mesic graminoid herbaceous and open, low scrub vegetation. Rock-dominated sites support alpine herbs.

Aquatic Resources

The Department of Natural Resources, Habitat Management Division, provided the following information in an April 7, 2008, letter to AP&T regarding the Yerrick Creek drainage.

"Yerrick Creek provides habitat for a variety of non-anadromous fish species, including Arctic grayling, Dolly Varden, round whitefish, and slimy sculpin. Arctic grayling and round whitefish are fairly ubiquitous in Tanana River basin stream systems, but the presence of Dolly Varden in Yerrick Creek makes this stream somewhat unusual.

"Fish presence and habitat near the mouth and in the lower reaches of Yerrick Creek (well downstream of the Alaska Highway) are poorly documented, although habitat for a variety of species including Arctic grayling, northern pike, burbot, round whitefish, lake chub, longnose sucker, and slimy sculpin occurs here. Stream flow in portions of Yerrick Creek in this reach are completely subsurface at times. If operated as run-of-river, the Yerrick Creek Hydropower project is unlikely to affect these downstream fish resources and habitats.

"That portion of Yerrick Creek from downstream of the Alaska Highway to upstream of the Haines-Fairbanks Pipeline crossing has been the most surveyed for fish presence and use. Arctic grayling and Dolly Varden have been found present from the beginning of June through late August, and Arctic grayling through late November (under ice cover). Round whitefish were present in late summer. Even when this reach appears frozen, high quality water is typically flowing in at least one channel below the ice; adult aquatic invertebrates were hatching from a small channel under ice in the third week of March one year. Although Yerrick Creek flow apparently goes subsurface in various locations between the Alaska Highway and the Tanana River for much of most summers, the portion of the stream between the mountains and the subsurface flow appears to provide connected surface flow and habitat.

"Adult and juvenile Arctic grayling and Dolly Varden have been captured upstream of the proposed diversion structure location up to where Yerrick Creek forks more than 6 miles above the Alaska Highway crossing. A small falls downstream of the fork is apparently not a fish barrier. Biologists suggested that this reach between the ridges may be used for grayling spawning and for grayling and Dolly Varden over-wintering habitats. Sheep hunters have reported seeing fish in stream portions in the upper part of the drainage that appeared to provide good habitat."

Wildlife Resources

The Department of Natural Resources, Habitat Management Division, provided the following information in an April 7, 2008, letter to AP&T regarding the Yerrick Creek drainage.

"*The Yerrick Creek drainage is used by a variety of big game species including moose, caribou, and Dall sheep, and is part of the Tok Management Area for Dall sheep. A significant amount of sheep hunting occurs in this drainage. Some sheep hunters have reported being able to walk up the Yerrick Creek streambed to access sheep country since the stream in portions was mostly gravel and rocks with a relatively small channel of water meandering through*."

Yerrick Creek is located in Game Management Unit 12 (GMU-12). Information on the harvesting of these species was found on the ADF&G website. All these species benefit from a diverse plant community commonly created by forest fires. Wildlife agencies are now trying controlled burns and clear-cuts to improve habitat that not only benefits herbivores but also predators who feed on them.

Dall Sheep (*Ovis dalli*)

The Dall sheep is a stocky sheep that utilize nearly inaccessible, steep mountain slopes, ridges and meadows for feeding and resting. They are generally high country animals but sometimes occur in rocky gorges below timberline in Alaska.

They are mostly white and weigh between 125 and 200 pounds. Male Dall sheep are called rams and are distinguished by massive curling, yellowish horns. The females, ewes, have shorter, more slender, slightly curved horns. Dall sheep are sometimes mistaken for mountain goats, however, the mountain goat has long fur and a beard, and small, slender, black horns that curve slightly backward.

The management goals for the harvest of Dall sheep is being met, but will continue to be watched to make sure they are not over grazed.[1] In RY02-RY03 the number of permits issued was reduced because hunters complained of overcrowding. Since then there have been fewer complaints.

Yerrick Creek is one of the few drainages on the north side of the range that has provided historical access to Dall sheep hunting grounds (Cathedral Rapids Creeks and Sheep Creek being the others). For this reason, maintaining access to these hunting grounds without providing 'improved' access that could further stress the population would be the goal of project design. Gating any access road to the project would be the preferred method of maintaining access for hunters as exists today, although they would be able to hike up the road on foot to the projects impoundment site, but would not be able to drive up the drainage beyond what they presently can. This could be viewed as an impact by providing an easier hike into part of the drainage.

Moose (*Alces alces*)

Moose are the world's largest members of the deer family and are most abundant in recently burned areas that contain willow and birch shrubs, on timberline plateaus, and

[1] Dall Sheep Management Report, 2005, ADF&G; www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

along the major rivers of Southcentral and Interior Alaska. During fall and winter, moose consume large quantities of willow, birch, and aspen twigs. In the spring, moose eat a variety of foods, particularly sedges, equisetum (horsetail), pond weeds, and grasses. During summer, moose feed on vegetation in shallow ponds, forbs, and the leaves of birch, willow, and aspen.

Moose are long-legged and heavy bodied with a "bell" or dewlap under the chin; only the bulls have antlers. Their color ranges from golden brown to almost black, depending upon the season and the age of the animal. The hair of newborn calves is generally red-brown fading to a lighter rust color within a few weeks.

Moose are common in this area and are also hunted in this and the adjoining drainages. Moose in this GMU have had lower harvest levels than desired by ADF&G so that wolf and bear harvesting quotas may be increased to reduce the moose's major predators. Yerrick Creek is brushy habitat, providing food for Moose including the few small lakes and marshes approximately 0.5 miles west of the creek. Moose may be temporarily impacted by this project from construction activity, but should otherwise not be impacted. The penstock (pipe) will be primarily buried along its route and will not be a barrier to the moose's movement through the area.

Caribou (*Rangifer tarandus*)

All caribou and reindeer throughout the world are considered to be the same species, but there are 7 subspecies, two of which occur in Alaska: barren ground and woodland.

Caribou have special adaptations that allow them to survive their harsh arctic environment. Long legs and broad, flat hooves allow them walk on snow, and a dense woolly undercoat overlain by stiff, hollow guard hairs helps keep them warm. Caribou are also the only member of the deer family in which both sexes grow antlers. Antlers of adult bulls are large and massive; those of adult cows are much shorter and are usually more slender. In late fall, caribou are clove-brown with a white neck, rump, and feet and often have a white flank stripe. Weights of adult bulls average 350 to 400 pounds and females average 175 to 225 pounds.

The caribou present in the Yerrick Creek area, which is in GMU 12, are the Macomb caribou herd (MCH). Harvest of the MCH has remained below the harvest objective due to the small size of the herd and the slow increase in herd size with the present management plan. An increase in wolf take was approved in 1995 in an effort to reduce the MCH's main predatory species. The MCH also uses the lowlands of the Tanana River valley as winter range.[2]

According to ADF&G, Caribou are known to pass through the Yerrick Creek drainage.[3] Project construction should be the only factor to impact Caribou and this should be a temporary impact from noise and activity.

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[2] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

[3] Personal communication between AP&T and Jeff Gross, Tok ADF&G Office, May 2008.

Gray (Timber) Wolf (*Canis lupus*)

Wolves are described as having the greatest natural range of any terrestrial mammal, excluding humans. Most wolves in Alaska weigh between 85 and 115 pounds with most females rarely reaching more than 110 pounds. Color varies greatly from pure black to almost white. Wolves in southern Alaska tend to be darker and slightly smaller than those in the Arctic.

Wolves are skilled hunters and prey on a variety of species including moose, caribou, hares, beaver, fish, mice and other small mammals. Most wolves hunt and live in packs that range from two to thirty wolves; six or seven is the average.

"Historically, the Unit 12 wolf population fluctuated dramatically in response to federal and state predator control programs, ungulate prey abundance, and harvest. The current wolf control program in Unit 12, projected to last 5 years, began in January 2005 in an 1190-mi² area north of the Alaska Highway and west of the Taylor Highway. The area was expanded in 2006 to include all portions of Unit 12 north of the Alaska Highway."

"The Unit 12 wolf population increased by an estimated 22% from RY93-RY95 to RY96-RY98. A comparable estimate was not obtained for RY02-RY04, but results of surveys conducted in portions of Unit 12 and adjacent Unit 20E indicate wolf numbers increased during RY99-RY04, likely as a result of increased survival and productivity associated with an increased prey base and harvest below sustainable rates. Harvest rates averaged 22% during RY96-RY98 and the same prey base, wolf numbers likely continued to increase during RY02-RY04. Annual harvest rates of >30% would likely be required to preclude wolf population growth in Unit 12.

"Prior to 1998 and the arrival of wintering Nelchina and Mentasta caribou herds and the increase in the Unit 12 wolf population, the moose population in Unit 12 increased about 5% annually (Gardner 2002a). The Unit 12 moose population in Unit 12 stopped growing during the period of wolf population growth. Moose are the only ungulate prey available to much of the Unit 12 wolf population between April and mid October. Since 1998 however, northern Unit 12 packs have had access to large numbers of caribou during the winter. Packs in central Unit 12 can also access large numbers of caribou in October, March, and April, but since 1997 only a few caribou winter in the central portion of the unit. The southern unit packs rely primarily on moose year-round.

"*During the 1980's the Unit 12 wolf population was lightly harvested. During the 1990's the annual wolf harvest in Unit 12 varied and in some years was the primary limiting factor to the wolf population. During RY99-RY01, harvest was light but caused area-specific declines in wolf numbers. During RY02-RY04 harvest was light and did not limit the wolf population. Harvest rates in the remote areas are dependent on fur price and weather conditions. Along the road system, trapping pressure is high especially around communities and wolves are regulated at lower numbers.*

"Most area residents desire some type of intensive management to benefit Unit 12 moose. Area residents support management that incorporates a combination of area-specific wolf reduction programs conducted by the public and habitat enhancement programs conducted by agencies. Modeling predicts this management regime could cause a low to moderate increase in the moose population. However, this level of management is not expected to attain a high-density moose population. This management is feasible because the areas most trapped for wolves are also the areas most hunted for moose. The primary challenge will be to design a habitat enhancement program that is economically feasible, and is supported by the department and the public."[4]

According to ADF&G, wolves are trapped in the Yerrick Creek basin. This project should only have a temporary impact related to the noise and activity of construction.

Black Bear (*Ursus americanus*)

The term "black" used to describe this species is not entirely accurate. Black bears come in a variety of colors from brown to gray and the occasional cream, although black with a brown muzzle is the most common. Brown colored black bears are often confused with brown bears but normally Brown bears are much larger. Black bears also have a smaller, more pointed head with a straight profile. Brown bears have a more rounded head and dished-shaped face along with a distinctive hump on their shoulders that is lacking in the black bear. Average male black bears weigh between 180 to 200 pounds depending on the season and stand over two feet tall at the shoulder. Females are usually around 120 to 150 pounds also depending upon the season.

Black bears are omnivorous (eat both meat and plants), although vegetation makes up a substantial portion of their diet. Their diet varies from vegetation in the spring to fish in some areas during the summer. Otherwise, their diet consists mostly of berries and insects.

"*Historically, human use of black bears in Unit 12 was relatively low despite liberal hunting regulations and moderate bear population levels. Most black bear hunting occurred along the highway system and the Tanana River. There was no closed season for black bears in Unit 12, and the bag limit was 3 bears.* "

"*In 1992 interest in black bear hunting increased, particularly at bait stations, and has remained relatively high. Most bears are taken by local residents in the spring and are an important meat source. Even before regulations were implemented requiring the salvage of black bear meat from 1 January to 31 May, meat was salvaged from over 90% of all black bears harvested by local residents. In the fall most black bears were harvested incidentally during hunts for other species*."

Black bear have been observed in and around the Yerrick Creek drainage.

[4] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

Brown Bear (*Ursus arctos*)

Brown bears tend to be larger than black bears. Brown bears are considered the largest living land carnivore. Though polar bears can be larger, they are not considered to be land dwelling. Brown bear sizes vary depending on location, time of year, age and gender. Most male brown bears range from 500 to 900 pounds. Color varies greatly from black with silver tipped hair to blonde. Males tend to be darker than females and cubs often sport a white collar during their first summer. Although the same species, Alaskans typically refer to coastal bears as "browns" and interior bears as "grizzlies". The grizzlies of the Tetlin Refuge are smaller and lighter in weight than those in southern and western Alaska. Grizzlies occur throughout the entire Refuge at a low density, but are more abundant along the foothills and mountains.

Brown bears have a varied diet ranging from grasses in the spring, berries in the summer, and fish during the fall. Meat is not usually a major component of the bears' diet but they will eat whatever they can catch which includes marmots, porcupines, squirrels, mice, moose, and caribou.

Brown bears are distributed throughout most of Unit 12. As with the black bear population, brown bears have liberal hunting management objectives to maintain or reduce their numbers in order to improve moose survival, the preferred game meat by residents. Hunting for brown bears has increased with the liberalization of the hunting season. Brown bears most likely utilize the Yerrick Creek area.

Small Furbearers

Small furbearers present in the Yerrick Creek basin and historically or currently trapped include lynx, wolverine, marten, mink, coyote, and red fox.[5] "*Marten and lynx are the most economically important furbearers in Units 12 and 20E. During population highs, muskrats are also economically and culturally important in Unit 12. Beavers are an important subsistence resource to Northway residents but are lightly trapped in most of the area. Little trapping effort is spent on coyotes, red foxes, mink, river otters, ermine, red squirrels, and wolverines because of low pelt values, low abundance, or difficulty and expense of trapping*."[6] Current management plans for Unit 12 to improve furbearer habitat is to conduct burns and clear-cuts to increase the diversity of habitat.

Lynx (*Lynx canadensis*)

The lynx is the only cat native to Alaska and is known to be in Unit 12. Lynx occur over most of northern North America (though their numbers in the northern continental United States have been greatly reduced) and throughout Alaska except the Aleutian islands, Kodiak archipelago, the islands of the Bering Sea and some islands of Prince William Sound and Southeast Alaska. Because they are shy and unobtrusive animals, people think

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[5] July 1, 2008, letter from ADF&G.
[6] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

that lynx are scarce. In Alaska, however, they are commonly seen during long periods of summer daylight, especially during years that they are abundant. “Link” is a common local name for lynx in Alaska and the Yukon.

Lynx inhabit much of Alaska's forested terrain and use a variety of habitats, including spruce and hardwood forests, and both subalpine and successional communities.

The primary prey of lynx in most areas is the snowshoe hare, which undergoes an 8-11 year cycle of abundance. This cycle appears to be caused by the interaction of hares with their food and predators. Lynx numbers fluctuate with those of hares and other small game, but lag one or two years behind. Although snowshoe hares are an important prey for lynx, when they are scarce lynx use other food sources more extensively during these periods. Other small prey such as grouse, ptarmigan, squirrels, and microtine rodents are regularly taken. Lynx are also known to prey on caribou, Dall sheep, and foxes, especially during periods of scarcity.

Since the early 1970s, lynx pelts have increased in value and may bring from $200 to $500. Their high value has led to increased trapping pressure and concern among trappers that lynx harvest should be regulated more closely. However, lynx numbers and harvest began to increase in Unit 12 following the cyclic low in RY03. Lynx pelt prices increased and were adequate for most trappers. In combination with the upswing of the lynx cycle, increased lynx pelt prices could begin to influence trapper effort. Harvest of lynx is currently more relaxed in the management plan.[7]

Marten (*Martes americana*)

The long, beautiful, chocolate brown coat of marten lead to its nickname: American Sable. A streak of lighter fur usually runs from the throat onto the chest. They have a fox-like face with broad rounded ears and unlike other members of the weasel family, a long bushy tail. Male marten grow 10 to 25 inches long plus an 8-inch tail and weigh up to 3 pounds. Females are substantially smaller.

Marten are mostly nocturnal and spend a great deal of their time in trees. They inhabit mature conifer forests and prey on red squirrels and other small mammals but will vary their diet with snowshoe hares, insects, birds, eggs, fruit and nuts.

Historically in Unit 12 marten trapping contributed most of the income for area trappers and is considered the most sought after furbearer due to the increase in fur value. Trapper information indicates that marten declined to moderate-to-low numbers during RY03-RY05. However, no regulatory changes are planned for marten harvesting.[8]

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[7] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt
[8] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

Wolverine (*Gulo gulo*)

Wolverines are among the least understood large carnivores in North America and the largest land-dwelling member of the weasel family. Most wolverines weigh 15 to 45 pounds and stand 15 to 18 inches at the shoulder. Females are smaller than males. Their coats are glossy dark brown with two pale lateral stripes converging at the base of the tail. Wolverine heads are gray with black muzzles, short ears, and dark eyes. They are described as having a low-slung body with powerful legs and large, curved claws.

Wolverines are omnivorous (eat both meat and plants) and will eat anything from berries to moose. They also feed on small mammals such as voles, squirrels, and hares.

Wolverines appear to occur at low density levels in the Upper Tanana Valley. They are primarily found in the foothills and mountainous areas where access is limited. Wolverine harvest was low in Unit 12, with the majority harvested by a few area trappers who selected for wolverine due to their high market value relative to other furbearer species. No change was recommended in their management plan.[9]

River (Land) Otter (*Lontra canadensis*)

River otters have a powerful, low-slung, slender body and flattened heads. They have a tapered tail, short legs, and webbed feet. Large males can grow to almost five feet long and stand 9 to 10 inches high at the shoulder. Most river otters weigh between 15 and 35 pounds with females being about a quarter smaller than males. The fur is very dense and with shades of brown that are distinctively lighter on the underparts, chin, and throat.

River otters eat mainly fish but also consume a variety of foods including shellfish, insects, frogs, birds, eggs, small mammals, and vegetation. They are mostly aquatic but will travel distances over land to reach another stream or lake. River otters are also social and tend to travel in pairs or larger groups.

River otter populations in Unit 12 were low due to a lack of suitable habitat. Trappers seldom selected for river otters due to low fur prices and the difficulty of catching them.[10]

Fox (*Vulpes vulpes*)

Red fox usually weigh between six and fifteen pounds, standing 16 to 18 inches high at the shoulder. The most common color is a rich red-gold, with black legs and feet. The chest and underparts are usually white with a long bushy tail also tipped in white. Other color variations include pure black and silver.

Red fox are omnivorous. They appear to prefer mice and hares, but also feed upon birds, eggs, plants, berries, and insects. Red fox populations in Unit 12 show indications of

[9] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt
[10] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

being stable at moderate-to-high levels. Little trapping effort is spent on red foxes most likely due to low pelt prices and expense to trap.[11]

Snowshoe Hare (*Lepus americanus*)

Snowshoe hares average 18 to 20 inches in length and weigh three to four pounds. Their summer coats are yellowish to grayish brown with white underparts, and the tail is brown on top. During the winter, their coat is replaced by white fur, but the hair is dusky at the base with a gray underfur. Snowshoes' ears are dark at the tip.

Hares are found in mixed spruce forests, wooded swamps, and brushy areas. They feed on a variety of vegetation including grasses, buds, twigs, leaves, needles, and bark. Snowshoe hares travel on well-established trails or runways at all times of the year.

Hare populations in Unit 12 cycle every 8 to 11 years. Hare population fluctuations are closely related to predator populations.

Avian Species

The Refuge provides habitat for 143 breeding and 47 migrating bird species (Bird Checklist - pdf) and serves as a major migration corridor for many of the bird species that are entering or leaving interior Alaska. Compared to the rest of Alaska, the diversity of landbirds is high because the Refuge is located within a major migration corridor and a number of species reach their northern range limit here. However, extreme winter weather sends most birds traveling south, leaving only about 25 resident species year round.

The Refuge was set aside primarily for its unique waterfowl values. It has one of Alaska's highest densities of nesting waterfowl and annually produces an estimated 35,000 to 65,000 ducklings. Spectacular migrations of lesser sandhill cranes, tundra and trumpeter swans occur each spring and fall. Up to 200,000 cranes, representing about one half of the world population, migrate through this corridor. The Refuge also provides habitat for an expanding population of trumpeter swans and for the largest concentration of nesting osprey in Alaska. Raptors such as bald eagles are common nesters along the major rivers and shorelines of larger lakes and nesting pairs have been observed along the Tanana River. Peregrine falcons can be seen once again as new pairs find local cliffs for nesting. Nine species of marsh and waterbirds, and 26 species of shorebirds occur on the refuge.

Terrestrial Avian Species

Tetlin Refuge has a comprehensive landbird monitoring program that is consistent with the International Partners in Flight Initiative. This includes maintaining migratory bird arrival dates, participating in the North American Migration Count, Breeding Bird

[11] www.wildlife.alaska.gov/index.cfm?adfg=pubs.mgt

Surveys, off-road point counts, and fall migration banding. In addition, a Christmas Bird Count is conducted each winter and an Upper Tanana Bird Festival is hosted by the Refuge in mid-May.

Four Breeding Bird Surveys (BBS) routes in eastern interior Alaska are annually completed. Off-road point counts were established on the Refuge in 1994 as part of a pilot project for Boreal Partners in Flight. Seven routes are monitored each year.

A fall migration banding station was established in 1993 seven miles east of Tok and has been operated daily in August and September each year. This long-term banding effort is part of a regional landbird monitoring program and helps to monitor landbird populations not adequately monitored by the Breeding Bird Survey. The most common species captured are: slate-colored junco, swainson's thrush, Wilson's warbler, ruby-crowned kinglet, myrtle (yellow-rumped) warbler, and orange-crowned warbler.

Relatively few species of birds are residents on the Refuge. Gray jay, black-billed magpie, common raven, black-capped chickadee, boreal chickadee, and redpolls are the most common species with lesser numbers of the non-migratory owls and woodpeckers. White-winged crossbills are abundant during productive cone crop years.

Spruce grouse, ruffed grouse, sharp-tailed grouse, and willow ptarmigan are uncommon breeders on the Refuge. Rock ptarmigan are rarely seen but may breed in the upper Cheslina River drainage. Sharp-tailed grouse have increased, especially in the Tok and Tetlin Village areas following the Tok River Fire in 1990.

Raptors

Thirteen species of hawks are known to occur on Tetlin Refuge. Usually present in small numbers, bald eagle, osprey, northern harrier, sharp-shinned hawk, red-tailed hawk, and American kestrel are confirmed breeders. Less frequently observed northern goshawk, golden eagle, merlin, peregrine falcon, and gyrfalcon are rare breeders on the Refuge. Rough-legged hawks are uncommon migrants. Turkey vultures and Swainson's hawks are casual visitors.

Six species of owls occur on the Refuge, the most common being the great horned owl. Northern hawk owls, great gray owls, and boreal owls can be fairly common some years. The short-eared owl is a migrant and casual summer breeder, while the snowy owl is a casual visitor in fall and winter.

The American peregrine falcon is the only previously endangered species found on the Refuge. The population of this species/race has been increasing nation-wide and was de-listed in 1999. The first peregrine falcon nest on Tetlin Refuge was discovered in June 1994 along the Nabesna River nearly 100 river miles upstream from the closest known nest site. Recovering peregrine populations have increased their density within their nesting range in the Upper Tanana Valley in the last decade, doubling the number of territories in the last 4 years to 16 presently known above the Robertson River.

Extensive raptor surveys have been completed annually since 1991. Most raptor nests are located along the rivers and wetlands.

Waterfowl
Green-winged teal, mallard, American wigeon, ring-necked duck, scaup (primarily lesser) and bufflehead are the most abundant ducks breeding on the Refuge. Smaller numbers of northern pintail, northern shoveler, Barrow's goldeneye, common goldeneye, white-winged scoter, surf scoter, canvasback and blue-winged teal are known to breed here as well. Rarely sightings are made of common mergansers, redheads, ruddy ducks, gadwall and harlequin ducks which also breed in the area, or of long-tailed ducks which do not. An estimated 35,000 to 65,000 ducklings are produced on Tetlin Refuge each year.

The Refuge lies along an important migration route for both Canada and greater white-fronted geese that migrate to and from the state. Occasionally snow geese and brant are seen during migration. Canada geese breed on the refuge in small numbers.

The Refuge provides important habitat for migrating tundra and trumpeter swans during spring and fall. Over 200 trumpeter swans were banded and neck collared from 1983 to 1984 and from 1989 to 1995. Recoveries and sightings of banded trumpeter swans help identify their wintering habitat as being coastal wetlands and fields from the central coast of British Columbia to northern Puget Sound.

Waterbirds
Nine species of marsh and water birds occur on the Refuge with horned grebe, pacific loon, and red-necked grebe being the most common breeders. Common loons are rare breeders and red-throated loons are considered casual. A small number of sandhill cranes nest on the muskeg flats in the northern third of the refuge. During spring and fall migration, up to 200,000 sandhill cranes (one half of the entire world population) can pass through the Tanana River Valley. The numbers seen from year to year vary depending on weather conditions which affect their flight paths. The Upper Tanana Valley is one of the few places in Alaska where sora and American coot are found regularly.

While some 26 species of shorebirds occur on the Refuge, most are migrants passing between wintering and breeding grounds. The most abundant breeding shorebird is the ubiquitous lesser yellowlegs. Common snipe are less abundant but widely distributed, while spotted sandpipers are common along watercourses. Red-necked phalaropes are often seen during fall migration. Mew and Bonaparte's gulls are common breeders. The American golden plover, upland sandpiper, and whimbrel breed in the alpine areas.

Avian species of all types may pass through the Yerrick Creek drainage because of its proximity to the Tanana River. There are also a few wetlands within or adjacent to the drainage that may attract waterfowl and predators alike during the summer months.

Cultural - Historical Resources

A review of the Alaska Heritage Resource Survey (AHRS) documents and related data sources at the Alaska Office of History and Archaeology (OHA) for records of known AHRS sites and previous cultural resource investigations in or near the Areas of Potential Effect (APE) was conducted by a certified archaeologist. One site was found on the west side of Yerrick Creek (TNX-074) that will be along the access road and penstock route. This site can be avoided by project alignment. SHPO is being consulted for clearance.

STUDY PLAN

Water Resources

Water quality sampling by Travis/Peterson Environmental Consulting-Anchorage is occurring over one year on a more or less quarterly basis.

A stream gage was installed in Yerrick Creek in May 2007. A table showing the flow data over one year is enclosed. The gage will remain in place. An analysis of what the flow regime might be in the bypass reach during project operations has yet to be done.

Botanical Resources

A wetland delineation and threatened, endangered, and sensitive (TES) plant species survey of the project will be conducted in August 2008 by HDR out of Anchorage.

Aquatic Resources

Fish surveys by Steve Grabacki are being conducted this summer, fall, and next spring. Surveys are focused on Dolly Varden, Arctic grayling, and round whitefish. This will be a multiyear baseline fisheries survey going from the summer 2008 to late winter of 2008-2009. Gear to be used are angling, electrofishing, minnow traps, hoop traps, fyke nets, gillnets, and dip nets, as appropriate to local conditions. All specimens will be released alive. Studies will occur above, at, and downstream of the possible impoundment site to the powerhouse site. The objective in this first year of surveying is to examine the habitat for use by all life stages of fishes, including – summer residency, migratory pathway, over-wintering, spawning, rearing, etc. Four or five sampling trips are planned – a reconnaissance level survey in early summer (angling only) was already accomplished, a full-scope sampling in late summer, another sampling shortly before freeze-up, and a spring sampling shortly after break-up. If appropriate, a late-winter examination of over-wintering habitat (in 2009) might be conducted. The first report will be submitted by the end of December 2008.

Until fish habitat has been described in the bypass reach, an analysis of instream flows needed in the bypass reach cannot be conducted.

Both Yerrick Creek and the drainage just west of Yerrick Creek, Cathedral Rapids Creek #1 will be surveyed. Cathedral Rapids Creek #1 will be surveyed for potential future consideration if more water is needed for electricity. This survey will give us a baseline on Cathedral Rapids Creek #1 so we will have advanced knowledge to make any future determination of its use. However, at this point in time we propose to only develop Yerrick Creek.

Wildlife Resources

Wildlife is not expected to be significantly impacted by this project, either by construction or operation. Species that use the Yerrick Creek area are not considered threatened, endangered, or listed species of concern. A literature search conducted does not point to any TES using this basin, although some may occasionally pass through during migration. Of the many species that do use the Yerrick Creek area, some are hunted for their meat (moose, caribou, Dall sheep, black and brown bear), and trapped for their pelts (lynx and marten). There will be a minimal loss of habitat types from project features such as the access road/penstock route, powerhouse site with staging area for materials, and the impoundment site. The staging area for materials at the powerhouse will be in or near the gas pipeline clearing near the highway, which should minimize vegetative clearing.

The project will remain in close proximity to the west side of Yerrick Creek as it parallels the creek between the impoundment and powerhouse. As desired in the ADF&G July 1, 2008, letter, the penstock and access road will remain a minimum of 66 feet from the creek accept when intersecting with the impoundment structure or powerhouse. The penstock (pipe) will be passable because it will be buried along most or all of its length, allowing mammals, including hunters, access to and through the project site, eliminating wildlife passage as an issue. We view this project as having limited impacts to wildlife in the area. The main concern would be whether this project will provide easier vehicular access into this basin for hunters and trappers, which could place more pressure on wildlife. We are interested in discussing methods to minimize this potential impact.

Birdlife is not expected to be significantly impacted due to the limited nature of the clearing needed (15 feet wide access road / penstock route) although there could be some loss of habitat.

Cultural – Historical Resources

A review by an archaeologist has already been completed for the project site and the report was submitted to SHPO for their review and comments.

RESOURCES

ADF&G, *Biological Information Needs*, Letter, Robert F. McLean, April 7, 2008.

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Gross, Jeff, ADF&G, Personal communication in which wildlife species were discussed for the project area, and in particular info on Dall Sheep hunting in area. May 2008.

http://alaska.fws.gov/fisheries/endangered/listing.htm

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http://tetlin.fws.gov/wildlife/brown_bear.htm

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http://tetlin.fws.gov/wildlife/dall_sheep.htm

http://tetlin.fws.gov/wildlife/fox.htm

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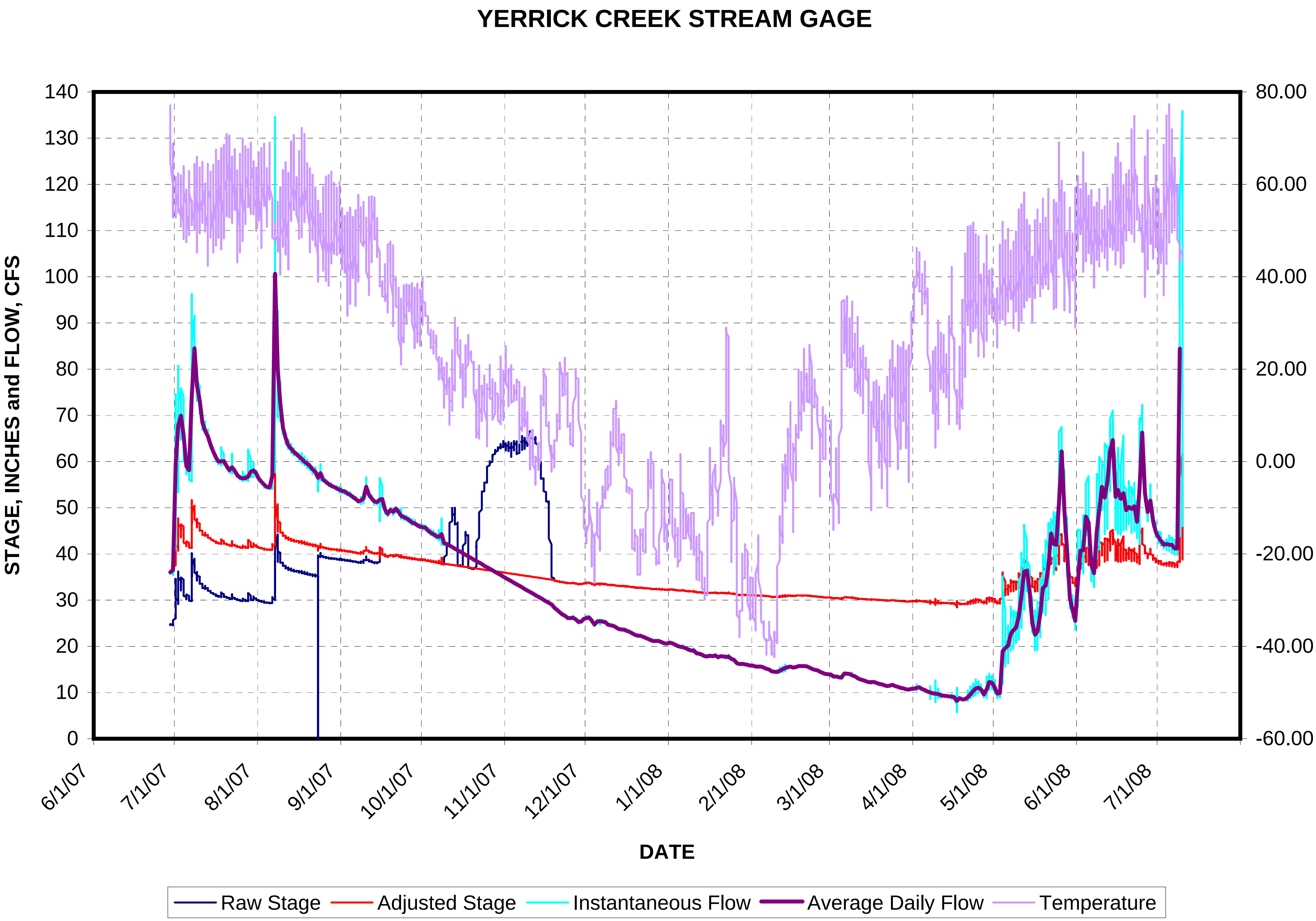

YERRICK CREEK STREAM GAGE
STAGE, INCHES and FLOW, CFS
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
TEMPERATURE, °F
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
6/1/07
7/1/07
8/1/07
9/1/07
10/1/07
11/1/07
12/1/07
1/1/08
2/1/08
3/1/08
4/1/08
5/1/08
6/1/08
7/1/08
DATE
Raw Stage
Adjusted Stage
Instantaneous Flow
Average Daily Flow
Temperature

Above Photo: Looking up Yerrick Creek from Alaska Highway bridge.

Above Photo: Alaska Highway crossing over Yerrick Creek

Above Photo: Yerrick Creek just above impoundment site

Above Photo: Yerrick Creek at gaging site.

Above Photo: Yerrick Creek near impoundment site

Above Photo: Yerrick Creek below impoundment site

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STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF FISH AND GAME

DIVISION OF HABITAT

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July 1, 2008

Mr. Glen D. Martin, Project Manager
Alaska Power and Telephone Company
P.O. Box 3222
Port Townsend, WA 98368-0922

Dear Mr. Martin:

RE: Yerrick Creek Hydroelectric Project Draft Study Plan Comments

The Alaska Department of Fish and Game (ADF&G), Division of Habitat has reviewed your June 13, 2008 Draft Study Plan for the proposed Yerrick Creek Hydroelectric Project between the communities of Tok and Dot Lake. During this review, we also consulted with appropriate ADF&G biologists, and have incorporated their comments into this document. We found the document to be primarily a description of the proposed project and potentially affected environment, with very little detail on current or proposed studies.

On April 7, 2008, I sent you a letter (under our previous letterhead as the Alaska Department of Natural Resources, Office of Habitat Management and Permitting) reviewing what is known about the fish and wildlife resources of the project area, what additional information would be needed for project permitting, and how the needed information might be acquired. We noted that you incorporated much of the information we provided on existing fish and wildlife resources in the project area, but the draft study plan does not address many of the information needs we identified. Note that neither the April 7 letter nor this review are intended to provide formal project scoping, and that ADF&G reserves the right to revise the identified concerns as project planning moves forward.

PROPOSED PROJECT

Several aspects of the project are unclear to us. Project capacity was given as 1.5 MW is the January 2007 FERC filing, but is listed as 2-3 MW in the current Project Description. Which is correct? How would this change the anticipated maximum water usage?

Would the penstock be within the access road clearing? How wide would the access road clearing be, and would all such clearing be at least 66 feet from the ordinary high water of all channels of Yerrick Creek?

Would the penstock be on the surface as presented in the draft study plan's Project Components section, or buried as presented in the plan's Wildlife Resources section?

FISH AND WILDLIFE RESOURCES

It is unclear to us how a sediment and erosion control plan would qualify as mitigation.

Gating the access road would likely have minimal effect on restricting use of the route for hunters or anglers, since off-road vehicles can typically navigate around such devices. The road would be expected to increase hunter access to Dall sheep, moose, and bear populations in the Yerrick Creek basin, and potentially also to caribou when they migrate through the area.

The Yerrick Creek area (not necessarily the basin) is currently used by four trappers based on furbearer harvest reports. Furbearers present in the Yerrick Creek basin and historically or currently trapped include lynx, wolverine, marten, mink, wolf, coyote, and red fox. Red squirrels and snowshoe hare are present in the basin, as are both black and brown bears. Based on reports and observations from biologists and trappers, the Yerrick Creek basin upstream of the Alaska Highway supports few if any beaver or river otter.

We recommend that AP&T augment the information in the Wildlife Resources portion of the plan with the publicly-available hunting and trapping information for the basin.

The penstock should be designed and constructed to avoid significant alteration of moose and other wildlife movement and migration patterns, or restrict or endanger human travel through the area. An 11,000 foot long, 36-inch diameter penstock elevated by 12-inch saddles has the potential to create a significant barrier to movement by wildlife and public users of the area. It would be preferable to bury the penstock in or beside the access road. If burial for the entire length is not practicable, then the penstock would need to have buried and/or elevated sections at regular intervals to allow for wildlife and human movements. At a minimum, above ground pipelines need to be elevated a minimum of 10 feet, as measured from the ground to the bottom of the pipe, except where the pipeline intercepts a road, pad, or ramp installed to facilitate wildlife passage. Increased snow depth in the area should be considered in relation to pipe elevation to ensure adequate clearance for wildlife and mechanized travel.

PERMITTING INFORMATION NEEDS

Since Mr. Grabacki's referenced study plan for sampling Yerrick Creek is not included, we are unable to provide comments directly on it. Based on the summary provided in the Aquatic Resources portion of the draft study plan, the baseline fish work appears to examine a 9-month period rather than the stated multi-year effort. In particular, no effort appears planned during the likely window for spring migrations. As noted in our letter of April 7, 2008, studies for at least a full year are necessary to fully describe fish use of the project area. The sampling area is also unclear in the review document, but needs to include the bypass reach as well as relevant portions of the stream upstream and downstream of the bypass reach. The goal is to fully describe the life histories and use patterns for all fishes using these stream reaches.

The draft study plan does not mention any hydrologic or water quality studies. As our April 7, 2008 letter noted, a full understanding of surface and subsurface hydrology in the project area will be necessary for permitting of the Yerrick Creek Hydro Project.

We suggest that AP&T check proposed field activities against guidance in our April 7 letter to be sure that adequate information is being collected so project design and permitting can proceed smoothly. In summary, the major areas of concern for fish are (1) effects on fish habitat, particularly seasonal or overwintering refugia, in the bypass reach and (2) fish passage through the bypass reach and past the diversion structure. Information needed for permitting includes:

- Existing surface and subsurface discharge characteristics in the bypass reach
- Fish movements between stream reaches by species, life stage, and time of year
- Life history and movements of Dolly Varden in the project area
- Hydrologic information on instream flows necessary to preserve fish habitats and passage

Methods of obtaining this information include:

- Minnow trapping, electrofishing, or other effective survey methods from the Alaska Highway to upstream of the diversion site on a regular basis for at least a year may be effective (seining difficult because of substrate).
- Determining fish movement between stream reaches through such techniques as plastic or radio tags, dyes, or a weir with video camera.
- USGS (or equivalent) gages at the diversion and tailrace entrance sites to document existing surface flows; a water budget and assessment of subsurface flow may also be needed.
- Mapping of available habitat by season, type, and flow, and measuring basic water quality characterizations over the seasons.

If you have questions or need additional information, contact me or Jim Durst (459-7254).

Sincerely,

Robert F. "Mac" McLean

Robert F. "Mac" McLean, Regional Supervisor
Division of Habitat

ecc: Fred Bue, ADF&G CF, Fairbanks
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RFM/jdd

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June 13, 2008

To: All Agencies

Regarding: Yerrick Creek Hydro Draft Study Plan

Dear Agency Representatives:

Enclosed is a draft study plan for your review for the Yerrick Creek Hydroelectric Project, located approximately 20 miles west of Tok on the Alaska Highway. A project description and map are included in the draft study plan.

Please provide your comments by July 14, 2008.

Sincerely,

Glen D Martin

Glen D. Martin
Project Manager
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(360) 385-1733 x122

Enc. (as stated)

Cc: Deborah Rocque, USF&WS
Dave Meyer, USGS
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Denby Lloyd, ADF&G
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YERRICK CREEK HYDROELECTRIC PROJECT

DRAFT STUDY PLAN

1.0 PROJECT DESCRIPTION

APC proposes to construct a run-of-river hydroelectric project that will interconnect with the grid supplying electricity to the communities of Tetlin, Tok, Dot Lake, and Tanacross. This grid is presently wholly reliant upon diesel generation. APC is the certified utility for this area along the Alaska Highway and is within the boundaries of APC's certificate from the Regulatory Commission of Alaska. This project is called the **Yerrick Creek Hydroelectric Project**. The project is located approximately 20 miles west of Tok on the Alaska Highway at Milepost 1339. Although APC's existing transmission infrastructure follows the highway right-of-way past the project site, this infrastructure (conductor) will need to be upgraded to handle the load from the project. Project capacity is expected to be 2-3 megawatts (MW). Project features would include a small diversion structure, an approximately 11,000 foot long penstock, powerhouse with a single impulse turbine (Pelton or Turgo) and generator, tailrace, small substation, and transmission line to and along the Alaska Highway, as shown in Figure 1. The building season is short at this north latitude, so it will take two years to complete this project. This project not only will provide clean, renewable energy that will stabilize rates, but will provide a stable source of energy that can quickly come on line after power outages, which makes it one of the best renewable resources. The cost to maintain a hydro project is also significantly lower than diesel generation. The existing diesel generation plant in Tok will continue to supplement the grid as the hydro project is only expected to provide electricity for 100% of the load part of the year and down to approximately 10% of the load during low flow periods of the year, such as during the winter.

This project will reduce the cost of electricity to the residents of Tetlin, Tok, Tanacross and Dot Lake who presently pay **$0.36** per kWh. Once the hydroelectric project interties with the Tok grid, the cost per kWh will be reduced by approximately 20%. The environmental impacts, i.e. air pollution, noise pollution, spills, etc., of any self-generation will be significantly reduced by this intertie, as well as from generation at APC's powerplant in Tok. During part of the year it is estimated the entire load can be carried by the hydroelectric project, and during the winter the use of diesel generation will supplement the hydroelectric project.

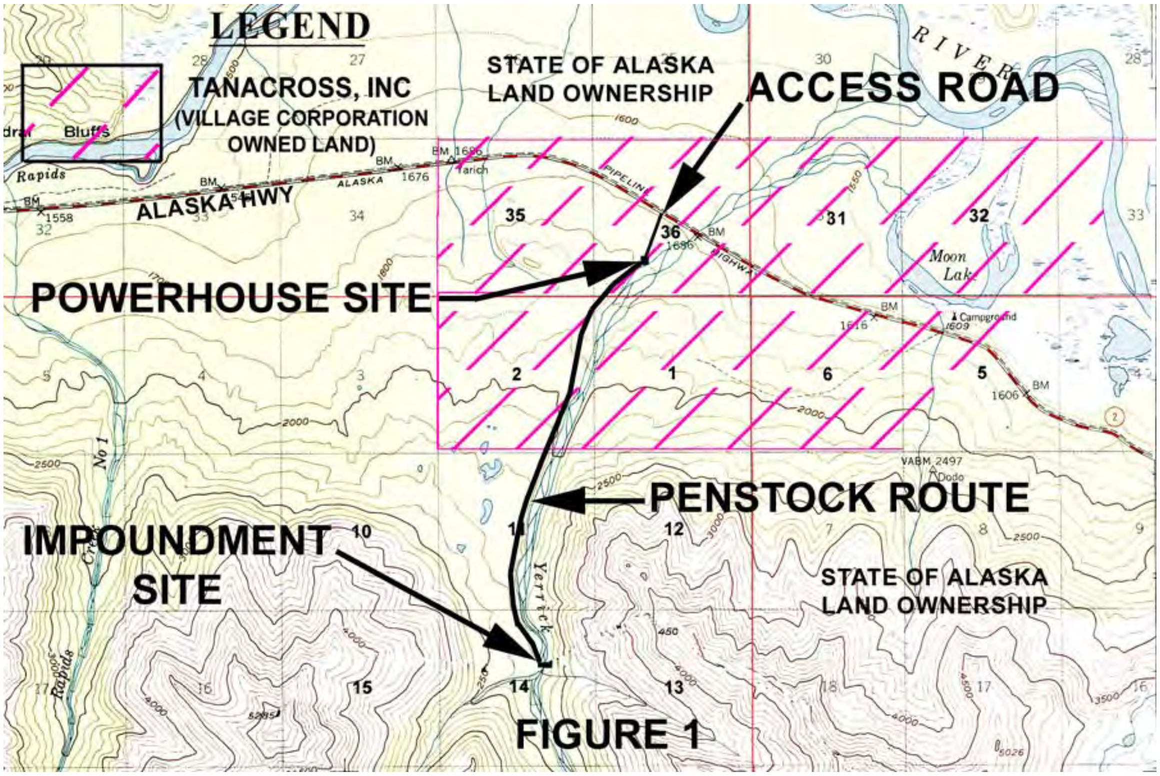

FIGURE 1

This hydroelectric project will reduce fossil fuel consumption by approximately 509,800 gallons per year, which at 2007 prices is equivalent to $1,157,246 annually. The existing diesel plant in Tok, which supplies electricity to all four communities, would use fewer diesel generators to meet the remaining load, reducing labor and maintenance costs and the frequency of generator overhaul and replacement for a potential savings of $1,153,200 annually. At present usage levels, this hydroelectric project would save the residents of all four communities approximately $693,043 per year (2007). Lower energy costs would help stimulate development, both economically and home building.

2.0 Project Components

The project facilities described herein are based on a preliminary evaluation of the site, and represent the maximum degree of resource development. The proposed project features are described in more detail below:

Impoundment

The project design for this run-of-river hydroelectric project include construction of either a concrete, steel, or other material impoundment structure. The impoundment structure is likely to be made of sheet piling to create a barrier that will impound enough water for an intake to remove it and generate electricity at the powerhouse. Due to the depth of the cobble expected in Yerrick Creek, it is not expected that the sheet pile will reach bedrock, and therefore it is expected that some water will go subterranean under the impoundment structure and surface further down the creek.

Penstock

The penstock is estimated to be approximately 11,000 feet in length and would probably consist of a combination of HDPE and steel or iron pipe. The penstock is proposed to be on the surface rather than buried to keep costs down. The diameter of the penstock may be approximately 36-inches. The penstock would parallel the creek down to the powerhouse requiring some clearing along its right-of-way.

Powerhouse

The powerhouse would be a metal structure of approximately 30 x 40 feet with a height of approximately 25 feet. The powerhouse would contain the controls for the operation of the project, including switchgear, Pelton or Turgo impulse turbine, a generator rated at 2-3 MW, and controls for valves at the impoundment structure. After the water passes through the turbine it will fall into a tailrace that will discharge back into Yerrick Creek above the highway bridge that spans the creek.

Access Road

An access road would be constructed to the powerhouse from off the Alaska Highway. The road is expected to be less than a mile in length. Another access road would come down the west side of Yerrick Creek from the impoundment structure, due to its more moderate elevation changes, to the powerhouse site. The one lane access road width would be approximately 14-feet wide with frequent pullouts.

Substation

A small pad-mount step-up transformer will be adjacent to the powerhouse to adjust the voltage for the transmission line to Tok.

Transmission Line

The transmission line will go from the powerhouse step-up transformer to intertie with the Tok grid along the Alaska Highway, approximately one mile away. This would require approximately 20 vertical wood pole structures set about 300 feet apart.

Land Ownership

The enclosed Figure 2 is a project map showing property boundaries in relation to the project features. The project will be located on land managed by the State of Alaska and Tanacross, Inc., a Village Corporation.

Environmental Impacts

Previous man-made land disturbance (old gas pipeline corridor paralleling the highway, which was once cleared of vegetation) has left a footprint on the environment that will reduce this projects impacts by utilizing the corridor for part of the access road and powerhouse site. Impacts to wetlands will occur as areas along the access route are in muskeg. The access route will parallel the creek on its west side. It is estimated that approximately 5-6 acres of land would be disturbed, with possibly ¾'s being in muskeg and the creek. To mitigate this, an erosion and sedimentation control plan will be implemented to confine impacts during construction, of which silt fencing and straw or hay bales would play a significant part, and repair after construction where possible. Construction methods, i.e. minimize the construction footprint, will also keep impacts to a minimum.

DRAFT STUDY PLAN

Existing Resources

Much of the information presented here is from the Tetlin National Wildlife Refuge (east of the project) website, and hence the mention of Refuge throughout this description. The Refuge's data is used because of its proximity to the project area and wealth of information available on indigenous species of the area, however, the Refuge's geography is different then that of Yerrick Creek which is primarily a mountainous drainage whereas the Refuge is more lowlands. With that caveat in mind, here is information on species that may be present.

Botanical Resources

Boreal forest (taiga) and upland tundra are the dominant vegetation types in all of interior Alaska. In the alpine areas, dry, broad ridge tops are dominated by dryas dwarf scrub and ericaceous dwarf scrub tundra vegetation. Mesic to moist saddles, slopes, and snow-melt meadows support mesic graminoid herbaceous and open, low scrub vegetation. Rock-dominated sites support alpine herbs.

Aquatic Resources

The Department of Natural Resources, Habitat Management Division, provided the following information in an April 7, 2008, letter to AP&T regarding the Yerrick Creek drainage.

"Yerrick Creek provides habitat for a variety of non-anadromous fish species, including Arctic grayling, Dolly Varden, round whitefish, and slimy sculpin. Arctic grayling and round whitefish are fairly ubiquitous in Tanana River basin stream systems, but the presence of Dolly Varden in Yerrick Creek makes this stream somewhat unusual.

"Fish presence and habitat near the mouth and in the lower reaches of Yerrick Creek (well downstream of the Alaska Highway) are poorly documented, although habitat for a variety of species including Arctic grayling, northern pike, burbot, round whitefish, lake chub, longnose sucker, and slimy sculpin occurs here. Stream flow in portions of Yerrick Creek in this reach are completely subsurface at times. If operated as run-of-river, the Yerrick Creek Hydropower project is unlikely to affect these downstream fish resources and habitats.

"That portion of Yerrick Creek from downstream of the Alaska Highway to upstream of the Haines-Fairbanks Pipeline crossing has been the most surveyed for fish presence and use. Arctic grayling and Dolly Varden have been found present from the beginning of June through late August, and Arctic grayling through late November (under ice cover). Round whitefish were present in late summer. Even when this reach appears frozen, high quality water is typically flowing in at least one channel below the ice; adult aquatic invertebrates were hatching from a small channel under ice in the third week of March one year. Although Yerrick Creek flow apparently goes subsurface in various locations between the Alaska Highway and the Tanana River for much of most summers, the portion of the stream between the mountains and the subsurface flow appears to provide connected surface flow and habitat.

"Adult and juvenile Arctic grayling and Dolly Varden have been captured upstream of the proposed diversion structure location up to where Yerrick Creek forks more than 6 miles above the Alaska Highway crossing. A small falls downstream of the fork is apparently not a fish barrier. Biologists suggested that this reach between the ridges may be used for grayling spawning and for grayling and Dolly Varden over-wintering habitats. Sheep hunters have reported seeing fish in stream portions in the upper part of the drainage that appeared to provide good habitat."

Wildlife Resources

The Department of Natural Resources, Habitat Management Division, provided the following information in an April 7, 2008, letter to AP&T regarding the Yerrick Creek drainage.

"*The Yerrick Creek drainage is used by a variety of big game species including moose, caribou, and Dall sheep, and is part of the Tok Management Area for Dall sheep. A significant amount of sheep hunting occurs in this drainage. Some sheep hunters have reported being able to walk up the Yerrick Creek streambed to access sheep country since the stream in portions was mostly gravel and rocks with a relatively small channel of water meandering through*."

Dall Sheep (*Ovis dalli*)

The Dall sheep is a stocky sheep that utilize nearly inaccessible, steep mountain slopes, ridges and meadows for feeding and resting. They are generally high country animals but sometimes occur in rocky gorges below timberline in Alaska.

They are mostly white and weigh between 125 and 200 pounds. Male Dall sheep are called rams and are distinguished by massive curling, yellowish horns. The females, ewes, have shorter, more slender, slightly curved horns. Dall sheep are sometimes mistaken for mountain goats, however, the mountain goat has long fur and a beard, and small, slender, black horns that curve slightly backward.

A single young lamb is born in late May or early June. Lambs begin feeding on vegetation within a week after birth and are usually weaned by October. Sheep have well-developed social systems. Adult rams live in bands which seldom associate with female groups except during the mating season in late November and early December.

Yerrick Creek is one of the few drainages on the north side of the range that has provided historical access to Dall sheep hunting grounds (Cathedral Rapids Creeks and Sheep Creek being the others). For this reason, maintaining access to these hunting grounds without providing 'improved' access that could further stress the population would be the goal of project design. Gating any access road to the project would be the preferred method of maintaining access for hunters as exists today, although they would be able to hike up the road on foot to the projects impoundment site, but would not be able to drive up the drainage beyond what they presently can. This could be viewed as an impact by providing an easier hike into part of the drainage.

Moose (*Alces alces*)

Moose are the world's largest members of the deer family and are most abundant in recently burned areas that contain willow and birch shrubs, on timberline plateaus, and along the major rivers of Southcentral and Interior Alaska. During fall and winter, moose consume large quantities of willow, birch, and aspen twigs. In the spring, moose eat a variety of foods, particularly sedges, equisetum (horsetail), pond weeds, and grasses. During summer, moose feed on vegetation in shallow ponds, forbs, and the leaves of birch, willow, and aspen.

Moose are long-legged and heavy bodied with a "bell" or dewlap under the chin; only the bulls have antlers. Their color ranges from golden brown to almost black, depending upon the season and the age of the animal. The hair of newborn calves is generally red-brown fading to a lighter rust color within a few weeks.

Calves are born any time from mid-May to early June after a gestation period of about 230 days; newborns weigh 28 to 35 pounds and within five months grow to over 300 pounds. Males can weigh from 1,200 to 1,600 pounds and females weigh 800 to 1,300 pounds.

Moose are common in this area and are also hunted in this and the adjoining drainages. Yerrick Creek is brushy habitat, providing food for Moose including the few small lakes and marshes approximately 0.5 miles west of the creek. Moose may be temporarily impacted by this project from construction activity, but should otherwise not be impacted. If the penstock (pipe) is kept on the surface (least expensive method of construction) and placed on saddles that elevate the penstock from 6-12 inches (and assuming the penstock will have a diameter of 36-inches), it could be a barrier to young moose, but adults should be able to get over. The alternatives would be to partially bury, or place berms approximately every 300 feet on either side to allow mammals to get past the penstock. Due to variances in the terrain, if the penstock is on the surface it may be suspended over ravines or be partially buried through a rise, or be 6-12 inches above flat terrain.

Caribou (*Rangifer tarandus*)

All caribou and reindeer throughout the world are considered to be the same species, but there are 7 subspecies, two of which occur in Alaska: barren ground and woodland.

Caribou have special adaptations that allow them to survive their harsh arctic environment. Long legs and broad, flat hooves allow them walk on snow, and a dense woolly undercoat overlain by stiff, hollow guard hairs helps keep them warm. Caribou are also the only member of the deer family in which both sexes grow antlers. Antlers of adult bulls are large and massive; those of adult cows are much shorter and are usually more slender. In late fall, caribou are clove-brown with a white neck, rump, and feet and often have a white flank stripe. Weights of adult bulls average 350 to 400 pounds and females average 175 to 225 pounds.

<u>Barren Ground Caribou (Rangifer tarandus granti)</u>
In the United States, Alaska is the only state that supports a healthy barren ground caribou population. Barren ground caribou are found in the arctic tundra, mountain tundra, and northern forests of North America, Russia, and Scandinavia.

Calving occurs in late May to early June. After calving, barren ground caribou collect in large “postcalving aggregations”. Migration then begins in the fall, where large herds often travel long distances (up to 400 miles) between summer and winter ranges. During the summer, barren ground caribou feed on the leaves of willows, sedges, flowering tundra plants, and mushrooms. They switch to lichens, dried sedges, and small shrubs during the fall.

Portions of four different barren caribou herds winter on or near Tetlin National Wildlife Refuge. The Nelchina Herd (> 30,000 animals), makes up the majority of caribou that pass through or winter on the Refuge. The Fortymile Herd (> 40,000 animals) is generally found north of the Refuge during the winter, although occasional individuals are also on Refuge lands. The remaining two herds are much smaller (< 1,000 animals). The Mentasta Herd calves on the slopes of Mt. Sanford in the Wrangell Mountains with a few individuals lingering some years in the southwest portion of the Refuge. The

Macomb Herd calves northwest of the Refuge on the Macomb Plateau, and rarely moves onto Refuge lands.

According to ADF&G, Caribou are known to pass through the Yerrick Creek drainage.[1]

Gray (Timber) Wolf (*Canis lupus*)

Wolves are described as having the greatest natural range of any terrestrial mammal, excluding humans. Most wolves in Alaska weigh between 85 and 115 pounds with most females rarely reaching more than 110 pounds. Color varies greatly from pure black to almost white. Wolves in southern Alaska tend to be darker and slightly smaller than those in the Arctic.

Wolves are skilled hunters and prey on a variety of species including moose, caribou, hares, beaver, fish, mice and other small mammals. Most wolves hunt and live in packs that range from two to thirty wolves; six or seven is the average.

Breeding occurs January through March and the pups are born in late May to early June. Litter size varies from two to thirteen but averages four to seven pups. Females usually will produce a litter every year. The packs usually include the parents and the current year's pups. The young are usually not able to kill large game for themselves until late winter when they have reached adult size.

Wolves may pass through the Yerrick Creek drainage in pursuit of game.

Snowshoe Hare (Lepus americanus)

Snowshoe hares average 18 to 20 inches in length and weigh three to four pounds. Their summer coats are yellowish to grayish brown with white underparts, and the tail is brown on top. During the winter, their coat is replaced by white fur, but the hair is dusky at the base with a gray underfur. Snowshoes' ears are dark at the tip.

Hares are found in mixed spruce forests, wooded swamps, and brushy areas. They feed on a variety of vegetation including grasses, buds, twigs, leaves, needles, and bark. Snowshoe hares travel on well-established trails or runways at all times of the year.

Young are born April thru August with two to three litters per year. Litters average two to four leverets (young hares) and can range from one to seven. Leverets weigh about two ounces at birth and can walk as soon as their fur is dry. They are weaned after about a month, but will eat green vegetation at only two weeks old.

Refuge staff monitor relative snowshoe hare population abundance with permanent mile-long transects. Hare populations on the Tetlin National Wildlife Refuge (east of the

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[1] Personal communication between AP&T and Jeff Gross, Tok ADF&G Office, May 2008.

project) cycle every 8 to 11 years and appear to follow those in central Yukon by about a year.

Snowshoe hares could use the Yerrick Creek drainage.

Wolverine (*Gulo gulo*)

Wolverines are among the least understood large carnivores in North America and the largest land-dwelling member of the weasel family. Most wolverines weigh 15 to 45 pounds and stand 15 to 18 inches at the shoulder. Females are smaller than males. Their coats are glossy dark brown with two pale lateral stripes converging at the base of the tail. Wolverine heads are gray with black muzzles, short ears, and dark eyes. They are described as having a low-slung body with powerful legs and large, curved claws.

Wolverines are omnivorous (eat both meat and plants) and will eat anything from berries to moose. They also feed on small mammals such as voles, squirrels, and hares. Although they are very strong for their size, their reputation for ferocious attacks on large carnivores has been exaggerated. They will vigorously defend their food, but do tend to avoid bears, wolves, and other large predators. Wolverines are solitary hunters and roam large areas in search of food.

Breeding occurs May through July and the kits are born in January through April. Kits emerge from their dens, usually in snow caves, hollow stumps, or under rock piles, in early summer and remain with their mother until fall.

Wolverines appear to occur at low density levels in the Upper Tanana Valley. They are primarily found in the foothills and mountainous areas where access is limited. It is possible that wolverines may use or pass through the Yerrick Creek drainage.

River (Land) Otter (*Lontra canadensis*)

River otters have a powerful, low-slung, slender body and flattened heads. They have a tapered tail, short legs, and webbed feet. Large males can grow to almost five feet long and stand 9 to 10 inches high at the shoulder. Most river otters weigh between 15 and 35 pounds with females being about a quarter smaller than males. The fur is very dense and with shades of brown that are distinctively lighter on the underparts, chin, and throat.

River otters eat mainly fish but also consume a variety of foods including shellfish, insects, frogs, birds, eggs, small mammals, and vegetation. They are mostly aquatic but will travel distances over land to reach another stream or lake. River otters are also social and tend to travel in pairs or larger groups.

Breeding usually occurs May to July with young born in April or May. Litters average two pups and can range from one to five.

Although not common, characteristic signs of this wetland furbearer can be found throughout the Refuge wherever there are beaver ponds or open water in winter. In summer, they are occasionally seen along fishing streams.

River otters may also use or pass through the Yerrick Creek drainage, though they may more likely be below the highway toward the Tanana River. There are no beaver dams on Yerrick Creek within the range of the projects impacts.

Marten (*Martes americana*)

The long, beautiful, chocolate brown coat of marten lead to its nickname: American Sable. A streak of lighter fur usually runs from the throat onto the chest. They have a fox-like face with broad rounded ears and unlike other members of the weasel family, a long bushy tail. Male marten grow 10 to 25 inches long plus an 8-inch tail and weigh up to 3 pounds. Females are substantially smaller.

Marten are mostly nocturnal and spend a great deal of their time in trees. They inhabit mature conifer forests and prey on red squirrels and other small mammals but will vary their diet with snowshoe hares, insects, birds, eggs, fruit and nuts.

Breeding usually occurs July to August with young born in April. Litters average two to four and the newborns are six inches long, weighing only one ounce. They develop slowly and are about half of adult size by mid-July. By fall the young are independent and leave their mother to become solitary hunters.

Marten could be present in the Yerrick Creek drainage.

Fox (*Vulpes vulpes*)

Red fox usually weigh between six and fifteen pounds, standing 16 to 18 inches high at the shoulder. The most common color is a rich red-gold, with black legs and feet. The chest and underparts are usually white with a long bushy tail also tipped in white. Other color variations include pure black and silver.

Red fox are omnivorous. They appear to prefer mice and hares, but also feed upon birds, eggs, plants, berries, and insects.

Breeding occurs February thru March and the pups are born in April to May. Litter size averages four pups. Females usually will produce a litter every year. The pups remain in the den for the first three or four weeks and continue to hunt from it for the next three months. The family will break up in the fall and each individual will goes its own way.

Foxes may use the Yerrick Creek drainage.

Black Bear (*Ursus americanus*)

The term “black” used to describe this species is not entirely accurate. Black bears come in a variety of colors from brown to gray and the occasional cream, although black with a brown muzzle is the most common. Brown colored black bears are often confused with brown bears but normally Brown bears are much larger. Black bears also have a smaller, more pointed head with a straight profile. Brown bears have a more rounded head and dished-shaped face along with a distinctive hump on their shoulders that is lacking in the black bear. Average male black bears weigh between 180 to 200 pounds depending on the season and stand over two feet tall at the shoulder. Females are usually around 120 to 150 pounds also depending upon the season.

Black bears are omnivorous (eat both meat and plants), although vegetation makes up a substantial portion of their diet. Their diet varies from vegetation in the spring to fish in some areas during the summer. Otherwise, their diet consists mostly of berries and insects.

Breeding occurs June through July and the cubs are born in January or February, weighing only 8 to 10 ounces. Litter size varies from one to four, with twins being the most common. The cubs are weaned by September but will den with their mothers their second winter, after which they will be on their own. Females typically breed every year in good habitat.

Black bears are typically dormant during the winter months. Denning times can vary depending on location, snow levels, and temperature. Like brown bears, their metabolism and temperature are lowered and their need for food and water are eliminated. Bears in colder climates will remain in their dens longer and males typically emerge before females.

Black bear have been observed in and around the Yerrick Creek drainage.

Brown Bear (*Ursus arctos*)

Brown bears tend to be larger than black bears. Brown bears are considered the largest living land carnivore. Though polar bears can be larger, they are not considered to be land dwelling. Brown bear sizes vary depending on location, time of year, age and gender. Most male brown bears range from 500 to 900 pounds. Color varies greatly from black with silver tipped hair to blonde. Males tend to be darker than females and cubs often sport a white collar during their first summer. Although the same species, Alaskans typically refer to coastal bears as “browns” and interior bears as “grizzlies”. The grizzlies of the Tetlin Refuge are smaller and lighter in weight than those in southern and western Alaska. Grizzlies occur throughout the entire Refuge at a low density, but are more abundant along the foothills and mountains.

Brown bears have a varied diet ranging from grasses in the spring, berries in the summer, and fish during the fall. Meat is not usually a major component of the bears’ diet but they will eat whatever they can catch which includes marmots, porcupines, squirrels, mice, moose, and caribou.

Breeding occurs May thru July and the cubs are born in January / February, weighing only 8 to 10 ounces. Litter size varies from one to four, with twins being the most common. Most females nurse their young for two summers, and then wean the cubs during the third.

Brown bears typically "hibernate" in dens during the winter months. Denning times can vary depending on location, snow levels, and temperature. While denning, the bears' metabolism and temperature are lowered and their need for food and water are eliminated. Bears in colder climates remain in their dens longer and males typically emerge before females.

It is possible Brown bears, or grizzlies, pass through Yerrick Creek in pursuit of forbs and game.

Birds

The Refuge provides habitat for 143 breeding and 47 migrating bird species (Bird Checklist - pdf) and serves as a major migration corridor for many of the bird species that are entering or leaving interior Alaska. Compared to the rest of Alaska, the diversity of landbirds is high because the Refuge is located within a major migration corridor and a number of species reach their northern range limit here. However, extreme winter weather sends most birds traveling south, leaving only about 25 resident species year round.

The Refuge was set aside primarily for its unique waterfowl values. It has one of Alaska's highest densities of nesting waterfowl and annually produces an estimated 35,000 to 65,000 ducklings. Spectacular migrations of lesser sandhill cranes, tundra and trumpeter swans occur each spring and fall. Up to 200,000 cranes, representing about one half of the world population, migrate through this corridor. The Refuge also provides habitat for an expanding population of trumpeter swans and for the largest concentration of nesting osprey in Alaska. Raptors such as bald eagles are common nesters along the major rivers and shorelines of larger lakes. Peregrine falcons can be seen once again as new pairs find local cliffs for nesting. Nine species of marsh and waterbirds, and 26 species of shorebirds occur on the refuge.

Landbirds

Tetlin Refuge has a comprehensive landbird monitoring program that is consistent with the International Partners in Flight Initiative. This includes maintaining migratory bird arrival dates, participating in the North American Migration Count, Breeding Bird Surveys, off-road point counts, and fall migration banding. In addition, a Christmas Bird Count is conducted each winter and an Upper Tanana Bird Festival is hosted by the Refuge in mid-May.

Four Breeding Bird Surveys (BBS) routes in eastern interior Alaska are annually completed. Off-road point counts were established on the Refuge in 1994 as part of a pilot project for Boreal Partners in Flight. Seven routes are monitored each year.

A fall migration banding station was established in 1993 seven miles east of Tok and has been operated daily in August and September each year. This long-term banding effort is part of a regional landbird monitoring program and helps to monitor landbird populations not adequately monitored by the Breeding Bird Survey. The most common species captured are: slate-colored junco, swainson's thrush, Wilson's warbler, ruby-crowned kinglet, myrtle (yellow-rumped) warbler, and orange-crowned warbler.

Relatively few species of birds are residents on the Refuge. Gray jay, black-billed magpie, common raven, black-capped chickadee, boreal chickadee, and redpolls are the most common species with lesser numbers of the non-migratory owls and woodpeckers. White-winged crossbills are abundant during productive cone crop years.

Spruce grouse, ruffed grouse, sharp-tailed grouse, and willow ptarmigan are uncommon breeders on the Refuge. Rock ptarmigan are rarely seen but may breed in the upper Cheslina River drainage. Sharp-tailed grouse have increased, especially in the Tok and Tetlin Village areas following the Tok River Fire in 1990.

Raptors
Thirteen species of hawks are known to occur on Tetlin Refuge. Usually present in small numbers, bald eagle, osprey, northern harrier, sharp-shinned hawk, red-tailed hawk, and American kestrel are confirmed breeders. Less frequently observed northern goshawk, golden eagle, merlin, peregrine falcon, and gyrfalcon are rare breeders on the Refuge. Rough-legged hawks are uncommon migrants. Turkey vultures and Swainson's hawks are casual visitors.

Six species of owls occur on the Refuge, the most common being the great horned owl. Northern hawk owls, great gray owls, and boreal owls can be fairly common some years. The short-eared owl is a migrant and casual summer breeder, while the snowy owl is a casual visitor in fall and winter.

The American peregrine falcon is the only previously endangered species found on the Refuge. The population of this species/race has been increasing nation-wide and was de-listed in 1999. The first peregrine falcon nest on Tetlin Refuge was discovered in June 1994 along the Nabesna River nearly 100 river miles upstream from the closest known nest site. Recovering peregrine populations have increased their density within their nesting range in the Upper Tanana Valley in the last decade, doubling the number of territories in the last 4 years to 16 presently known above the Robertson River. Extensive raptor surveys have been completed annually since 1991. Most raptor nests are located along the rivers and wetlands.

Waterfowl
Green-winged teal, mallard, American wigeon, ring-necked duck, scaup (primarily lesser) and bufflehead are the most abundant ducks breeding on the Refuge. Smaller numbers of northern pintail, northern shoveler, Barrow's goldeneye, common goldeneye, white-winged scoter, surf scoter, canvasback and blue-winged teal are known to breed here as well. Rarely sightings are made of common mergansers, redheads, ruddy ducks,

gadwall and harlequin ducks which also breed in the area, or of long-tailed ducks which do not. An estimated 35,000 to 65,000 ducklings are produced on Tetlin Refuge each year.

The Refuge lies along an important migration route for both Canada and greater white-fronted geese that migrate to and from the state. Occasionally snow geese and brant are seen during migration. Canada geese breed on the refuge in small numbers.

The Refuge provides important habitat for migrating tundra and trumpeter swans during spring and fall. Over 200 trumpeter swans were banded and neck collared from 1983 to 1984 and from 1989 to 1995. Recoveries and sightings of banded trumpeter swans help identify their wintering habitat as being coastal wetlands and fields from the central coast of British Columbia to northern Puget Sound.

Waterbirds

Nine species of marsh and water birds occur on the Refuge with horned grebe, pacific loon, and red-necked grebe being the most common breeders. Common loons are rare breeders and red-throated loons are considered casual. A small number of sandhill cranes nest on the muskeg flats in the northern third of the refuge. During spring and fall migration, up to 200,000 sandhill cranes (one half of the entire world population) can pass through the Tanana River Valley. The numbers seen from year to year vary depending on weather conditions which affect their flight paths. The Upper Tanana Valley is one of the few places in Alaska where sora and American coot are found regularly.

While some 26 species of shorebirds occur on the Refuge, most are migrants passing between wintering and breeding grounds. The most abundant breeding shorebird is the ubiquitous lesser yellowlegs. Common snipe are less abundant but widely distributed, while spotted sandpipers are common along watercourses. Red-necked phalaropes are often seen during fall migration. Mew and Bonaparte's gulls are common breeders. The American golden plover, upland sandpiper, and whimbrel breed in the alpine areas.

Avian species of all types may pass through the Yerrick Creek drainage because of its proximity to the Tanana River. There are also a few wetlands within or adjacent to the drainage that may attract waterfowl and predators alike during the summer months.

Cultural - Historical Resources

A review of the Alaska Heritage Resource Survey (AHRS) documents and related data sources at the Alaska Office of History and Archaeology (OHA) for records of known AHRS sites and previous cultural resource investigations in or near the Areas of Potential Effect (APE) was conducted by a certified archaeologist. One site was found on the west side of Yerrick Creek (TNX-074) that will be along the access road and penstock route. This site can be avoided by project alignment.

Study Plan

Botanical Resources

A wetland delineation of the project will be conducted.

Aquatic Resources

Fish surveys by Steve Grabacki are being conducted this summer and fall. Surveys are focused on Arctic Grayling, Dolly Varden, and Round Whitefish. This will be a multiyear baseline fisheries survey going from the summer 2008 to late winter of 2008-2009. Gear to be used are minnow traps, hoop traps, fyke nets, gillnets, dip nets, spat collectors, etc. All specimens will be released alive. Studies will occur above, at, and downstream of the possible impoundment site. The objective in this first year of surveying is to examine for use by all life stages of fishes, including – summer residency, migratory pathway, over-wintering, spawning, rearing, etc. Three sampling trips are planned – a reconnaissance level survey in early summer (angling only), a full-scope sampling in late summer, and a late-winter examination of over-wintering habitat (in 2009). The first report will be submitted by the end of December 2008.

Both Yerrick Creek and the drainage just west of Yerrick Creek, Cathedral Rapids Creek #1 will be surveyed. Cathedral Rapids Creek #1 will be surveyed for potential future consideration if more water is needed for electricity. This survey will give us a baseline on Cathedral Rapids Creek #1 so we will have advanced knowledge to make any future determination of its use. However, at this point in time we propose to only develop Yerrick Creek.

Wildlife Resources

We request input and guidance from the resource agencies, however, it is expected that certain species of mammal may utilize the project corridor and therefore attempt to cross project features. The project will remain in close proximity to the west side of Yerrick Creek as it parallels the creek between the impoundment and powerhouse. The penstock (pipe) will be passable because it will be buried along most or all of its length, allowing mammals, including hunters, access to and through the project site. Therefore, wildlife passage should not be an issue. In addition, this project is in the lower part of this drainage (but above the highway) and for that reason is less likely to be in important habitat as may be the case for further up the valley. We view this project as having limited impacts to wildlife in the area.

Cultural – Historical Resources

A review by an archaeologist has already been completed and the report will be submitted to SHPO for their review and comments.

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Gross, Jeff, ADF&G, Personal communication in which wildlife species were discussed for the project area, and in particular info on Dall Sheep hunting in area. May 2008.

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http://alaska.fws.gov/fisheries/endangered/listing.htm

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YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

~WETLAND DELINEATION REPORT~

Yerrick Creek Hydroelectric Project
Tok, Alaska

Preliminary Jurisdictional Determination

February 2009

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Yerrick Creek Hydroelectric Project
Preliminary Jurisdictional Determination

1. Introduction and Purpose

The purpose of this report is to identify and describe wetlands and other waters within an approximately 700-acre area along Yerrick Creek near Tok, Alaska (Figure 1). The area contains land owned by the State of Alaska and by Tanacross, Inc.

This report describes locations within the project area that are subject to the jurisdiction of the US Army Corps of Engineers (USACOE) under authority of Section 404 of the Clean Water Act. By federal law (Clean Water Act) and associated policy, it is necessary to avoid project impacts to wetlands wherever practicable, minimize impact where impact is not avoidable, and in some cases compensate for the impact. The focus of this document is on delineation of wetlands. Wetlands, waters of the U.S., and uplands (non-wetlands), as referenced in this report, are defined as:

Wetlands. "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 Code of Federal Regulations [CFR] Part 328.3(b)). Wetlands are a subset of "waters of the U.S." Note that the "wetlands" definition does not include unvegetated areas such as streams and ponds.

Waters of the U.S. Waters of the U.S. include other waterbodies regulated by the USACOE, such as lakes, ponds, and streams, in addition to wetlands. The ponds and streams mapped in the project area are "waters of the U.S." but not "wetlands".

Uplands. Non-water and non-wetland areas are called uplands.

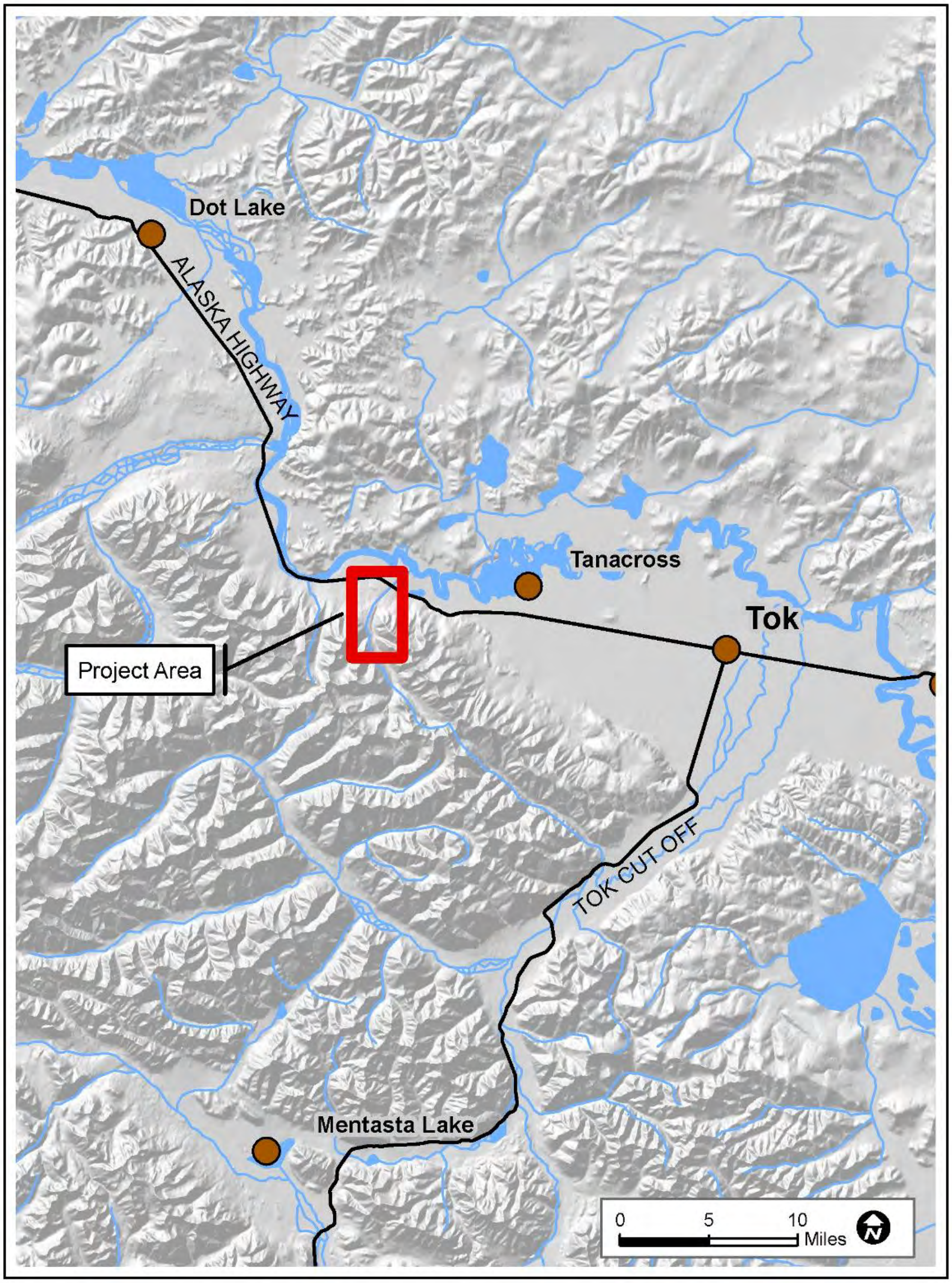
As described in the 1987 U.S. Army Corps of Engineers wetlands delineation manual, wetlands must possess the following three characteristics:

1. Hydrophytic Vegetation: Vegetation community dominated by plant species that are typically adapted for life in saturated soils.

2. Wetland Hydrology: Inundation or saturation of the soil during the growing season.

3. Hydric Soils: Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions.

Figure 1: Project Vicinity Map



Project Location and Environment

The project area is located along Yerrick Creek, a cobble-, gravel- and sand-substrate creek which crosses the Alaska Highway at approximately milepost 1339 (Figure 2). Most of the project area is undeveloped, with an open gravel waterway, adjacent forests, abandoned gravel side channels in various states of revegetation, and heavily forested banks (see images below). Specific legal and geographic descriptions for the property required for Preliminary Jurisdictional Determinations are included in Table 1.

Figure 2: Yerrick Creek Photos

Table 1: Project Area Information

1. APPLICANT: Alaska Power and Telephone Company (AP&T)
2. WATERWAY: Yerrick Creek
3. LOCATION:

A. Narrative: The project area is along Yerrick Creek near Tok, Alaska, approximately 20 miles west of Tok at milepost 1339 of the Alaska Highway.

B. Legal Description:
Sections: 36 and 1, 2, 11, and 14 Township: 19N and 18N Range: 9E Meridian: Copper River
Latitude/Longitude (WGS84 Datum): N55.0667159 / W132.1461172

4. SOURCE(S):

USGS Maps: Tanacross B-6
NWI Maps: Tanacross B-6, digital interpretation
Soil Maps: None
Corps Wetland Maps: None
Aerial Photographs: True Color Aerial Photography, 2008, provided by AP&T. Color Infrared High Altitude Aerial Photography, 1978, from the Alaska GeoData Center archives.
Other: Reconnaissance-level field survey with wetland data forms, written site observations, and photographs from HDR Alaska, Inc. site visit dated August 21-25, 2008.

2. Methods

Two steps were used to inventory wetlands and waterbodies in the project area. These two steps include:

Field Investigation

A five-day site visit was completed between August 21 and 25, 2008, to identify any wetlands and other waters potentially under the jurisdiction of the USACOE. USACOE guidance on Alaska's growing season references the end of the growing season to generally follow several continuous days below 28°F. Temperature and precipitation data for the three-month period prior to the field investigation (June 2008 through August 2008) was reviewed to determine the degree to which any recent climatic events may have influenced field hydrology and vegetation indicators. Weather and climate data are given in Appendix A, including monthly summaries of temperature and precipitation, recording period average, and stream gage output for part of 2008 for Yerrick Creek.

The general trend in the summer of 2008 was a colder, wetter season than normal. Over the three-month period preceding the field visit, the average maximum temperature in °F (64.87 for June, 63.9 for July, and 61.52 for August) was lower than the average maximum temperature for the recording period of 1954 to 2005 (71 for June, 73 for July, and 68 for August) (NOAA 2008). The average minimum temperature (48.39 for June, 48.55 for July, and 42.9 for August) was higher than the average minimum temperature for the recording period (40 for June, 43 for July, and 39 for August). Precipitation for June 2008 was 2.12 inches compared to an average of 1.82 inches. July precipitation average for the period 1946 to 2008 is 2 inches, compared to the single year (2008) measurement of 6.68 inches. August average is 1.2 inches, compared to the 2008 measurement of 0.79 inches. The much higher than average precipitation in July led to higher than normal water levels in the creek, and unusual conditions at the study site during the field survey. Side channels that normally lack water experienced flow during July, according to AP&T personnel familiar with the project area. Observations of side channels by AP&T personnel and HDR scientists suggested that such channels had not experienced any flow in over 20 years. A stream gage on the main channel of Yerrick Creek was knocked out during an especially high storm at the end of July.

Scientists collected detailed information on soil conditions, hydrology, and plant community composition. A summary table listing plot number, wetland status, wetland mapping code from the U.S. Fish and Wildlife's National Wetland Inventory (NWI) mapping program (USFWS 2006), and photo numbers is found in Appendix B. Photographs taken at each of the data collection locations are included in Appendix C. Locations were studied using the U.S. Corps of Engineers 1987 wetland delineation manual's (USACOE 1987) and 2007 Alaska Regional Supplement's (USACOE 2007) three-parameter method of determining an area's wetland status. Standard 2007 Alaska Regional Supplement Corps of Engineers data sheets were completed at these sites and are included in Appendix D. Each location visited during the field visit was logged into a handheld global positioning system (GPS) Archer Field PC unit. Representative photographs and observational data were collected at each plot.

While in the field, wetland/upland boundaries were determined by completing standard wetland data forms near observable transition zones between wetter and drier areas. A wetland determination is completed in the area with questionable wetland status, then the boundary identified in the appropriate direction between that point and obvious wetlands or uplands. The wetland/upland boundary between the two data plots is then notated on paper aerial photography maps of the area for later guidance in Geographic Information System (GIS) mapping of wetland/upland boundaries. In addition, photo points were taken at more sites to document conditions at a wider range of locations. For these points, a data sheet was not completed, but photos were taken and conditions were notated in a field notebook.

Mapping

Scientists analyzed aerial photography and NWI wetland mapping in a GIS map environment. GPS locations of field-visited sites and wetland/upland boundaries were overlaid on aerial photography and notes and photographs completed at each site were reviewed to identify any wetlands or waterbodies present within the project area. The process of delineating wetlands from aerial photography included using the following methods:

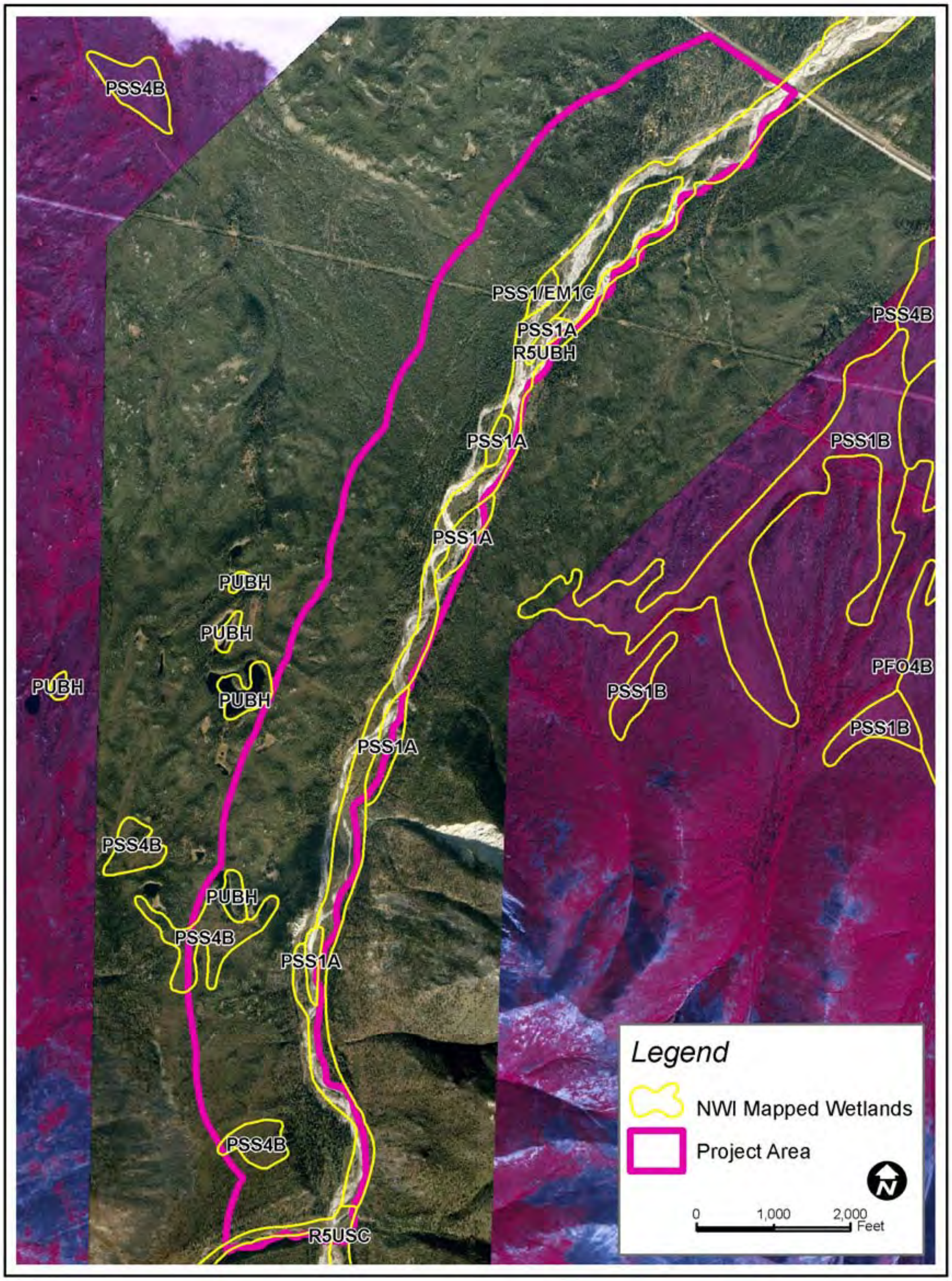
Vegetation clues: On aerial photography, scientists looked for saturation-adapted vegetation communities, indicative canopy structure and height, and presence of hydrophytic plant species. A common example is dwarf spruce trees, which are indicative of a limitation to growth such as excessively wet soils.

Evidence of soil saturation: Visible evidence of wetland hydrology was sought, including surface water and darker areas of photos indicating surface saturation. A site's proximity to streams, open water habitat, and marshes may be indicative of shallow subsurface water.

Existing mapping: Wetland mapping from the U.S. Fish and Wildlife's National Wetland Inventory mapping program is available for the project area (USFWS 2006). This mapping is generally an effective tool for large-scale planning and analysis of wetlands but not suitable for smaller site-specific projects such as needed for this study. NWI mapping is primarily based on aerial photographic interpretation with limited ground truthing, and therefore wetland boundaries tend to be oversimplified with many smaller wetland complexes not included in the mapping. According to available NWI mapping for USGS quadrangle Tanacross B-6, wetlands occur in the project area (Figure 3). Four pond polygons and two evergreen shrub polygons were mapped at the fringe of the project area, in mostly forested areas to the west of the creek channel. The main creek channel is mapped as riverine waters, with seven shrub polygons mapped on channel islands or on the edge of the main channel.

Areas with marginal evidence of wetland characteristics were mapped conservatively as wetlands. Preliminary JDs do not make legally binding determinations, therefore individual sites can be assessed at a later date if necessary (USACOE, June 2008).

Figure 3: NWI Mapping of Project Area



3. Results

No detailed vegetation or soil mapping was available for the project area prior to the field study. Information presented below is summarized from data collected at 28 wetland data form locations over the five-day field investigation (Appendix D). Locations of each data collection location are displayed on Figure 4. Of the 28 wetland data form locations, 6 were determined to occur in wetlands and 3 in other waters of the U.S.

Vegetation

At wetland data form locations, 15 out of the 28 sites had hydrophytic vegetation (Table 2). Dominant plant species are shown by stratum for each plot. The most common trees in the project area include white spruce (*Picea glauca*), balsam poplar (*Populus balsamifera*), and some paper birch (*Betula papyrifera*). The most common shrub is alder (*Alnus crispa*). Saplings of white spruce and cottonwood are also common in the shrub layer. Common graminoids include bluejoint reedgrass (*Calamagrostis canadensis*) and a variety of sedges (*Carex* spp.). Common forbs include timberberry (*Geocaulon lividum*) and dwarf fireweed (*Chamerion latifolium*). Mosses and lichens were found primarily in forested plots.

Table 2: Vegetation at Wetland Data Form Sites – Dominant Species per Plot

	Tree Stratum					Shrub Stratum							
	black spruce	felt-leaved willow	balsam poplar	paper birch	white spruce	bog kalmia	Labrador tea	black spruce	diamond willow	alder	dwarf birch	crowberry	red currant
	Picea mariana	*Salix alexensis*	*Populus balsamifera*	*Betula papyrifera*	*Picea glauca*	*Andromeda polifolia*	*Ledum groenlandicum*	*Picea mariana*	*Salix pulchra*	*Alnus crispa*	*Betula glandulifera*	*Empetrum nigrum*	*Ribes triste*
Plot Number	**FACW**	**FAC**	**FACU**	**FACU**	**FACU**	**OBL**	**FACW**	**FACW**	**FACW**	**FAC**	**FAC**	**FAC**	**FAC**
101	1						1				1		
103					1		1						
104										1			
105										1			
106										1			
107			1		1					1			1
108										1			
109			1							1			
110		1								1			
116			1		1					1			
118									1				
119													
120													
121				1	1					1			
122				1	1					1			
124										1			
125			1		1					1			
126								1				1	
128						1							
130	1						1						
132				1	1					1			
133										1			
134			1		1					1			
135										1			
136										1			
137			1							1			
138					1					1			
139					1								

Table 3, continued

	Shrub Stratum						Herbaceous Stratum					
	bog blueberry	lingonberry	bunchberry dogwood	white spruce	balsam poplar	prickly rose	boreal bog sedge	NT sedge	water sedge	marsh five-finger	marsh horsetail	Biglow's sedge
	Vaccinium uliginosum	*Vaccinium vitis-idaea*	*Cornus canadensis*	*Picea glauca*	*Populus balsamifera*	*Rosa acicularis*	*Carex magellanica*	*Carex utriculata*	*Carex aquatilis*	*Comarium palustris*	*Equisetum pratense*	*Carex biglowii*
Plot Number	**FAC**	**FAC**	**FACU**	**FACU**	**FACU**	**FACU**	**OBL**	**OBL**	**OBL**	**OBL**	**FACW**	**FAC**
101	1											1
103	1	1										
104												
105												
106												
107												
108												
109					1							
110												
116				1								
118								1		1		
119			1			1						
120								1	1			
121												
122					1							
124					1							
125												
126												
128							1		1			
130									1			
132					1							
133												
134												
135					1							
136					1							
137												
138											1	
139				1								

Table 4, continued

	Herbaceous Stratum										
	bluejoint reedgrass	fireweed	dwarf fireweed	Menzies' campion	common horsetail	timberberry	bluebells	boreal sagebrush	glaucous bluegrass	field locoweed	purple reedgrass
	Calamagrostis canadensis	*Chamerion angustifolium*	*Chamerion latifolium*	*Silene menziesii* ssp. *williamsii*	*Equisetum arvense*	*Geocaulon lividum*	*Mertensia paniculata*	*Artemisia arctica*	*Poa glauca*	*Oxytropis campestris*	*Calamagrostis purpurascens*
Plot Number	**FAC**	**FAC**	**FAC**	**FAC**	**FACU**	**FACU**	**FACU**	**NI**	**NI**	**NI**	**NI**
101											
103						1					
104			1					1			
105	1										
106	1										
107	1							1			
108			1								
109	1		1								
110	1										
116	1										
118	1										
119	1										
120											
121						1	1				
122						1					
124	1										
125						1					
126	1				1						
128											
130						1					
132		1									
133	1		1								
134	1					1					
135			1	1							1
136	1								1	1	1
137	1										
138	1					1	1				
139						1					

Hydrology

The project area is situated along the valley bottom and slopes of the Yerrick Creek drainage. Yerrick Creek experiences a declining flow along the surveyed length due to subterranean flow. The unusually high precipitation and storm events in July filled channels that normally do not experience flow, and in some cases, likely did not experience any flow for over 20 years, according to observations of persons familiar with the study area. Hydrological indicators were carefully examined at plot data collection locations that occurred in side channels to ensure that data collected was not influenced by conditions deviating from normal. All efforts were made by wetland scientists to consider normal conditions despite the unusual weather conditions preceding the field data collection time.

At wetland data form locations, 13 out of the 28 sites had wetland hydrology (Table 3). Commonly seen primary indicators included surface water, saturation, high water table, and drift deposits. Common secondary indicators included drainage patterns, geomorphic position, stunted or stressed plants, and FAC-neutral test.

Table 5: Indicators at Wetland Data Form Sites with Wetland Hydrology

	Field Observations			Primary Wetland Hydrology Indicators							Secondary Wetland Hydrology Indicators							
Plot Number	Surface Water Depth (inches)	Water Table Depth (inches)	Saturation Depth (inches)	Surface Water (A1)	High Water Table (A2)	Saturation (A3)	Water Marks (B1)	Sediment Deposits (B2)	Drift Deposits (B3)	Inundation Visible on Aerial Image (B7)	Water Stained Leaves (B9)	Drainage Patterns (B10)	Presence of Reduced Iron (C4)	Stunted or Stressed Plants (D1)	Geomorphic Position (D2)	Shallow Aquitard (D3)	Microtopographic relief (D4)	FAC Neutral Test (D5)
101	0-10	11	5	X	X	X	X									X	X	X
104	0-24	0	0	X	X	X			X	X		X		X	X			
105								X	X		X	X			X			
108	0-24	0	0	X	X	X		X	X	X		X		X	X			
109								X	X			X						
118	12	0	0	X														
119									X									
120	2	0	0	X	X	X					X		X					X
126		11	6		X	X								X	X			X
128	4	0	0	X	X	X				X				X	X			X
129	0	8	4	X		X												X
133								X	X			X						
136									X									

Soils

Both hydric and non-hydric soil conditions were observed in soil pits examined during the field visit. Soils were carefully assessed by wetland scientists to consider soils under normal conditions, despite the unusual rainfall of the season. Hydric soils were encountered at 6 of the 28 wetland data form sites (Table 4). Indicators of hydric soil included histosol, histic epipedons, and several other indicators that fell under problematic soil conditions. Analysis of conditions at all sites with problematic hydric soils that are listed in Table 4 concluded that the site did contain a hydric soil as per USACE direction (USACE 1987, 2007). Specific characteristics of the sampled mineral soils, including color and texture, are included on the wetland data forms (Appendix D).

Table 6: Soils at Wetland Data Form Sites Found to Have Hydric Soils

	Hydric Soil Indicators				
Plot Number	Histosol or Histel (A1)	Histic Epipedon (A2)	Restrictive Layer Type	Restrictive Layer Depth (inches)	Other Indicator of Hydric Soils or "Waters" Status
101	X		Permafrost	16	
104					Outwash, Entisol (Substrate too young and coarse to show redox features and with too little organic carbon to promote reduction)
108					Outwash, Entisol (Substrate too young and coarse to show redox features and with too little organic carbon to promote reduction)
118					No pit, emergent vegetation and 12" standing water present
120					Hydrophytic vegetation, primary hydrology indicator, concave landscape, positive alpha-alpha dipyridyl
126	X				
128	X				
130		X			

4. Conclusion

Wetland locations are based upon the dominance of hydrophytic vegetation, hydrologic indicators, and hydric soil indicators. Other waters of the U.S. are based on the investigators' judgement about the location of the ordinary high water mark of Yerrick Creek. Based on the findings above, it has been determined that areas displayed as wetlands or waters on Figure 4 meet the USACOE criteria for being classified as wetland or fall below the plane of Ordinary High Water (OHW) of Yerrick Creek. Approximately 21.3% (147.1 acres), a conservative delineation, of the mapped acres were determined to meet the USACOE requirements for being classified as wetlands or other waters, and are listed and described in Table 5. The areas shown as wetlands and other waters on Figure 4 may be subject to jurisdiction under Section 404. For the purpose of this PJD, it is assumed that Yerrick Creek is a Relatively Permanent Tributary to Traditional Navigable Waters, and that the mapped wetlands are "adjacent" to Yerrick Creek. Most of the mapped wetland areas are not within the proposed project construction areas.

The remainder of the mapped project area, approximately 78.7% (542.6 acres) of the mapped area, lacks one or more of the required three parameters to support classifying an area as wetland (Table 5), and is not below the plane of OHW of Yerrick Creek. The areas would not be subject to jurisdiction under Section 404. As project plans are developed, if construction would affect wetlands or other waters, AP&T may wish to refine wetland boundaries by further field investigation and consideration of the jurisdictional status of any affected wetlands.

Yerrick Creek and its adjacent active bars are waters of the US below the creek's OHW mark. OHW is particularly difficult to define for a braided channel such as this one. There may be some areas within the river bars shown on Figure 4 that are not actually below OHW.

Table 7: Mapped Area Summary

Wetland Type	NWI Mapping Code	Approximate Area (Acres)
Seasonally flooded emergent persistent herbaceous wetland	PEM1C	0.51
Semipermanently flooded emergent persistent herbaceous wetland	PEM1F	3.89
Saturated needle-leafed evergreen forest/broad-leafed scrub-shrub wetland	PF04/SS3B	5.07
Saturated needle-leafed evergreen forest wetland	PFO4B	0.68
Seasonally flooded broad-leafed scrub-shrub wetland	PSS1C	0.10
Saturated broad-leafed evergreen/needle-leaved scrub-shrub wetland	PSS3/4B	42.24
Seasonally flooded broad-leafed evergreen scrub-shrub/persistent herbaceous wetland	PSS3/EM1B	0.64
Seasonally flooded broad-leafed evergreen scrub-shrub wetland	PSS3B	0.37
Seasonally flooded broad-leafed evergreen/broad-leafed evergreen scrub-shrub wetland	PSS4/3B	5.92
Saturated needle-leafed evergreen scrub-shrub wetland	PSS4B	14.33
Permanently flooded unconsolidated bottom palustrine wetland	PUBH	3.35
Temporarily flooded upper perennial unconsolidated floor/permanently flooded unconsolidated bottom wetland	R3USA/UBH	69.96
Upland (non-wetland)	U	542.56
	Total Mapped Area	**689.63**
	Total Wetlands and Other Waters	**147.1 acres (21.3%)**
	Total Upland (non-wetland)	**542.6 acres (78.7%)**

Determination Made By

Elizabeth Bella, Chris Wrobel, and Irina Lapina
Wetland Scientists
HDR Alaska, Inc.
Date: February 2008

Attachments

Figure 4: Yerrick Creek Wetlands Map Book

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Appendices

Appendix A: Weather and Climate Data

http://www.arh.noaa.gov/climate.php

NOAA National Weather Service Alaska Regional Headquarters Data

Period of Record:1946 to 2008

Day 2008	Observed (°F)		Observed	Extreme Temperature (°F)							
	Max Temp:	Min Temp:	Precipitation (inches):	Highest Max:		Lowest Max:		Highest Min:		Lowest Min:	
1-Jun	63	47	0	87	1958	44	1947	57	1990	31	1969
2-Jun	69	47	0	80	1958	44	1947	57	1979	32	1947
3-Jun	67	49	T	85	1958	44	1974	57	1957	32	1974
4-Jun	61	49	T	84	1957	40	2006	56	1985	27	1961
5-Jun	61	49	0	85	1957	44	1963	60	1958	26	2006
6-Jun	64	44	T	84	1951	49	1985	60	1986	31	1963
7-Jun	66	49	0.01	84	1958	52	1983	57	1965	36	1991
8-Jun	67	48	T	84	1946	51	1970	55	1969	30	1992
9-Jun	56	45	0.09	83	1947	50	1983	56	2006	32	1961
10-Jun	62	47	0.02	79	1971	52	1959	60	2006	34	1991
11-Jun	63	44	T	80	1972	52	1955	56	2005	35	1987
12-Jun	61	48	0.32	81	1992	52	1979	56	2005	36	1960
13-Jun	68	44	0	85	1972	48	1952	59	1969	36	1955
14-Jun	69	47	0	91	1969	45	1954	58	1972	37	1971
15-Jun	71	48	0.36	91	1969	50	1985	60	1950	32	1960
16-Jun	64	48	0.08	81	1948	52	1985	58	1968	36	1960
17-Jun	59	50	T	88	1948	56	1982	58	1946	40	1987
18-Jun	67	52	0.01	86	1967	52	1980	62	1948	36	1982
19-Jun	69	55	0.09	82	1958	51	1949	58	1967	35	1960
20-Jun	75	50	0	88	1958	53	2005	58	1958	41	1951
21-Jun	M	M	M	90	1991	47	1956	58	1969	33	1968
22-Jun	72	55	T	82	1987	50	2006	60	1969	38	1993
23-Jun	61	50	0.56	85	1971	50	1963	57	1983	33	1949
24-Jun	57	48	0.28	90	1991	50	1964	58	1971	39	1961
25-Jun	M	M	M	86	1983	44	1949	60	1980	35	1949
26-Jun	M	M	M	83	1991	50	1949	63	1983	34	1949
27-Jun	M	M	M	85	1957	49	1949	65	1969	36	1960
28-Jun	M	M	M	81	1986	8	1971	68	1968	-11	1971
29-Jun	M	M	M	85	1992	48	1949	70	1968	34	1949
30-Jun	M	M	M	87	1992	47	1971	64	1987	35	1971
JUNE 2008 AVERAGE	**64.87**	**48.39**	**Total: 1.82**								
JUNE NORMAL	**71**	**40**	**2.12**								
1-Jul	M	M	M	83	1991	47	1945	58	1985	32	1971
2-Jul	M	M	M	82	1990	55	1981	60	1958	34	1960
3-Jul	80	48	T	85	1958	57	1969	62	1955	36	1961
4-Jul	82	53	T	91	1958	57	1959	62	1990	37	1961

5-Jul	79	53	T	86	1990	55	1949	62	1968	44	1960
6-Jul	72	58	0.07	84	1986	57	1981	63	1980	41	1963
7-Jul	70	53	0.01	82	1982	54	1981	60	1986	42	1993
8-Jul	55	49	0.23	85	1951	54	1981	62	1968	43	1992
9-Jul	68	50	0.01	82	1946	54	1957	60	1968	38	1991
10-Jul	69	52	0.08	88	1975	54	1964	59	1989	36	1960
11-Jul	68	53	0.15	85	1975	48	1954	60	1980	35	1960
12-Jul	73	52	0.01	89	1960	55	1962	59	1980	38	1990
13-Jul	68	52	0.04	85	1960	55	1959	60	1975	36	1961
14-Jul	58	51	0.13	85	1967	53	1971	64	1989	38	1961
15-Jul	71	46	0.01	85	1993	57	1960	62	1954	42	1991
16-Jul	72	52	0	88	1951	53	1955	60	1993	38	1960
17-Jul	63	49	0.27	83	1993	47	2003	62	1947	38	2003
18-Jul	51	46	0.53	79	1993	51	2008	57	1988	39	1961
19-Jul	58	45	T	84	1990	52	1965	59	1978	41	1966
20-Jul	56	47	0.1	85	1990	51	1973	59	1990	38	1968
21-Jul	64	45	0.27	81	1976	51	1956	60	2006	42	1959
22-Jul	55	42	0.16	83	1955	54	1959	61	1952	40	1968
23-Jul	58	44	T	86	1990	58	2008	60	1961	42	1971
24-Jul	67	43	T	86	1990	52	1965	62	1990	38	1988
25-Jul	62	49	T	90	1955	49	1969	60	1947	40	1991
26-Jul	68	50	0.54	85	1955	48	1957	59	1978	40	1961
27-Jul	55	49	0.41	86	1953	53	1963	63	1977	39	1957
28-Jul	51	44	2.27	83	1953	8	1971	62	1958	-11	1971
29-Jul	59	43	0.36	85	1977	59	2008	60	1962	38	1975
30-Jul	53	46	0.28	88	1977	53	2008	62	1947	42	1971
31-Jul	48	44	0.75	85	1978	48	2008	58	1965	35	1968
JULY 2008 AVERAGE	**63.9**	**48.55**	**Total: 6.68**								
JULY NORMAL	**73**	**43**	**2**								
1-Aug	60	45	0.1	87	1976	56	1982	64	1993	34	1968
2-Aug	70	44	0.3	79	1962	56	1971	64	1953	35	1948
3-Aug	54	44	0.13	82	1977	50	2003	59	1986	40	1964
4-Aug	M	M	M	88	1977	49	1947	60	1986	36	1968
5-Aug	M	M	M	80	1968	56	1962	62	1977	34	1946
6-Aug	M	M	M	86	1968	54	1949	60	1981	33	1946
7-Aug	M	M	M	85	1968	45	1969	58	1981	33	1969
8-Aug	49	41	0.03	79	1977	42	1969	61	1981	33	1969
9-Aug	53	37	0.01	82	1957	53	2008	62	1977	34	1969
10-Aug	M	M	M	85	2005	43	1969	63	1979	29	1969
11-Aug	61	44	0.05	86	1980	50	1965	59	1945	33	1969
12-Aug	68	35	0	84	1980	46	1969	59	1958	33	1969
13-Aug	66	49	0	85	1990	48	1973	66	1975	29	1969
14-Aug	71	45	T	86	1990	45	1946	57	1991	26	1969
15-Aug	67	50	T	85	1990	50	1983	64	1979	27	1969
16-Aug	67	46	0.04	84	1957	42	1981	64	1979	36	1981
17-Aug	59	49	0.11	80	2007	48	1946	63	1990	28	1981

18-Aug	M	M	M	81	1977	53	1992	56	1977	32	1947
19-Aug	60	45	T	81	1950	51	1987	57	2007	35	2005
20-Aug	59	42	0	81	1973	49	1981	55	1950	33	1946
21-Aug	62	37	T	86	1977	42	1946	56	1972	31	1974
22-Aug	64	49	0.02	84	1977	41	1948	56	1963	30	1989
23-Aug	M	M	M	79	1979	44	1948	57	1989	25	1986
24-Aug	58	39	T	82	1979	45	1983	55	1963	22	1948
25-Aug	60	43	0	80	1981	45	1983	57	1989	31	1993
26-Aug	62	38	0	78	1981	38	1984	57	1989	27	1991
27-Aug	M	M	M	80	1981	40	1984	61	1957	29	1991
28-Aug	62	41	T	82	1949	8	1971	63	1989	-11	1971
29-Aug	M	M	M	82	1949	40	1984	51	1951	28	1991
30-Aug	60	38	0	85	1974	40	1948	56	1949	25	1955
31-Aug	M	M	M	77	1974	42	1962	49	1993	23	1987
AUGUST 2008 AVERAGE	**61.52**	**42.9**	**Total = 0.79**								
AUGUST NORMAL	**68**	**39**	**1.2**								

http://www.wrcc.dri.edu/summary/Climsmak.html
Western Regional Climate Center, wrcc@dri.edu

Monthly Climate Summary for Tok, AK

Period of Record : 6/11/1954 to 12/31/2005

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (°F)	-6.6	7.7	25	44	60.4	71	73	68	54	32	8.9	-3.5	36.2
Average Min. Temperature (°F)	-25	-16	-6	16	29.5	40	43	39	29	13	-9.9	-22	10.8
Average Total Precipitation (inches)	0.35	0.3	0.2	0.2	0.7	2.1	2	1.2	0.8	0.6	0.5	0.43	9.22

Appendix B: Summary Table

Plot Number	Plot Type	JD Status	NWI Code	Photo Numbers
101	JD	W	PSS3/4C	124-pit, 125-surface, 126-W, 127-E, 128-S
102	PP-RW*	W	R4SBH	129-W, 130-E
103	JD	U	U	131-pit, 132-surface, 133-E, 134-W, 135-S
104	JD	W	R3UB1/2H	136-N, 137-E, 138-S, 139-W
105	JD	U	U	144-N, 145-S, 146-pit, 147-surface
106	JD	U	U	148-pit, 149-surface, 150-E, 151-SW, 152-N
107	JD	U	U	153-pit, 154-surface, 155-N, 156-S
108	JD	W	R3US1/2C	157-W, 158-N, 159-E, 160-S, 161-SW
109	JD	U	U	162-N, 163-SE, 164-SW, 165-NW, 166-pit, 167-surface
110	JD	U	U	168-pit, 169-surface, 170-SE, 171-S, 172-N
111	PP-RU	U	U	173-SW, 174-NW, 175-NE
112	PP-RW	W	R3UB2H	180-channel, 181-channel
113	PP-RU	U	U	182-NW, 183-SE, 184-SE-channel, 185-N
114	PP-RU	W	R3UBH	186-NW, 187-SE
115	PP-RW	W	R4SB2C	188-N, 189-S
116	JD	U	U	190-pit, 191-surface, 192-N, 193-S
117	PP-RW	W	R4UBF	194-NW, 195-SE
118	JD	W	PEM1F (Center of polygon is PUBH)	196-water, 197-E, 198-W, 199-pond
119	JD	U	U	200-pit, 201-surface, 202-NE, 203-N, 204-hydro
120	JD	W	PEM1F	205-pit, 206-redox, 207-alpha-alpha, 208-E, 209-W
121	JD	U	U	210-N, 211-S, 212-pit, 213-surface
122	JD	U	U	216-N, 217-S, 218-pit, 219-surface
123	PP-RW	W	R3UB1/2H (Gravel Bar is R3US1/2C or A)	220-NE, 221-SW, 222-S
124	JD	U	U	226-NE, 227-SW, 228-SE, 229-pit, 230-surface
125	JD	U	U	233-N, 234-S, 235-windthrow, 236-pit, 237-surface
126	JD	W	PSS4B	238-N, 239-N, 241-pit, 242-surface
127	PP-RW	U	U	243-N, 244-S, 245-pit
128	JD	W	PEM1/SS3C (PEM1C adjacent)	246-N, 247-S, 248-water
129	PP-RW	W	PUBH (PEM1C on fringe)	249-NE, 250-W, 251-W
130	JD	W	PF04/SS3B	252-NE, 253-SW, 254-pit, 255-surface
131	PP-RW	W	PF04/SS3B	256-N, 257-S, 260-pit, 261-surface
132	JD	U	U	262-NE, 263-SE, 264-S, 267-pit, 268-surface
133	JD	U	U	269-NE, 270-SE, 271-SW
134	JD	U	U	272-NE, 273-SW, 274-pit, 275-surface
135	JD	U	U	277-NE, 278-SE, 279-SW
136	JD	U	U	280-N, 281-SW (cliff), 282-SW, 283-pit, 284-surface
137	JD	U	U	292-NE, 293-SW, 294-pit, 295-surface
138	JD	U	U	297-N, 298-S, 299-pit, 300-surface
139	JD	U	U	305-N, 306-W, 307-S, 310-pit, 311-surface
140	PP-RU	U	U	312-NE, 313-SW

*PP-RW or PP-RU: Photopoint Plot at a Representative Wetland or Waters (RW) or a Representative Upland (RU) site, where photos and basic information are recorded instead of the entire field form, due to similarity in site conditions with previously surveyed plots.

Appendix C: Photographs

Included as a Word document:
AppendixC_photos_yerrick.doc

Appendix D: Field Data Forms

Included as an Adobe document:
AppendixD_plotfieldforms_yerrick.pdf

YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

~TES PLANT SURVEY REPORT~

Yerrick Creek Hydroelectric Project
Tok, Alaska

Threatened, Endangered, and Sensitive (TES) Plant Report

February 2009

Prepared for:
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Figures

Tables

Yerrick Creek Hydroelectric Project

Threatened, Endangered, and Sensitive (TES) Plant Report

Key Findings:

No threatened, endangered, or sensitive plants were located within areas likely to be affected by project activities.

The project, as described, is not expected to adversely affect any sensitive plants.

Study Purpose and Location

A threatened, endangered, and sensitive (TES) plant survey was conducted within the Yerrick Creek Hydroelectric project area. The purpose of the study was to determine if there were any individuals or populations of plant species of interest that may be affected by project activities. The survey was conducted at Level 5 intensity (Appendix A).

The project area is located near along Yerrick Creek, a cobble, gravel and sand substrate creek which crosses the Alaska Highway at approximately milepost 1339 (see Figure 1 in the Yerrick Creek Preliminary Jurisdictional Determination Report for wetlands). Most of the project area is undeveloped with an open gravel waterway, islands of mixed hardwood and softwood trees, abandoned gravel side channels in various states of revegetation, and heavily forested banks. Specific legal and geographic descriptions for the property required for Preliminary Jurisdictional Determinations are included in the Preliminary Jurisdiction report for wetlands in Table 1.

The main vegetation of Yerrick Creek study area is typically open paper birch – white spruce forest. Open balsam poplar–white spruce forest and open white spruce forest inhabit drier sites. Open black spruce forest and open dwarf black spruce forest occupy areas with poorly drained soils. Closed tall alder or willow scrub occupies the transitional areas between forested areas and creek channel. Narrow areas of gravel floodplain areas along Yerrick Creek are inhabited by early seral graminoids and forbs. Bluejoint meadows and lowland sedge wet meadows occupy wet areas adjacent to ponds.

Methods

A five-day site visit was completed between August 21st and 25th, 2008, to identify any threatened, endangered, and sensitive plant species in the proposed project area.

To target rare plants within the Yerrick Creek project area, we composed a list of rare plant species likely to be encountered. The target species list was compiled based on the Alaska Natural Heritage Program's (AKNHP) Biotics database. The AKNHP database query did not show the occurrence of rare plants within the project area. This area has not been previously surveyed for rare plants. Rare plants known in the general vicinity of Tanacross B5 and B6 USGS Quad maps were located from two queries on 7/21/2008. One query was the AKNHP Biotics Database query, and the other was from the Arctos Database at the University of Alaska-Fairbanks (UAF), which lists all known herbarium records stored at the UAF Herbarium (code letters ALA). The compiled list was reviewed and edited by local botanist Rob Lipkin (pers. com.) Rarity was determined by the AKNHP's 2006 Vascular Plant Tracking list (Lipkin, 2008).

Table 1: Preliminary list of potential rare plants (for explanation of Rarity Rank, see Appendix A).

Scientific Name	Common Name	Family	Global Rarity Rank	State Rarity Rank	Possible Habitat
Agrostis clavata	clavate bentgrass	Poaceae	G4G5	S1S2	Open balsam poplar-white spruce forest. Bare soils, wet meadows
Carex heleonastes	Hudson Bay sedge	Cyperaceae	G4G5	S2S3	Peat bogs, swamps
Castilleja annua		Scrophulariaceae	G3G4Q	S3S4	Waste places
Ceratophyllum demersum	coon's tail	Ceratophyllaceae	G5	S1	Ponds, lakes, and slow moving streams and rivers. Either anchored in the mud or floating freely near the surface.
Draba paysonii	Payson's draba	Brassicaceae	G5	S1S2	Gravel cutbank in glacial cirque
Lupinus kuschei	Yukon lupine	Fabaceae	G3	S2	roadsides
Montia bostockii	Bostock's minerslettuce	Portulacaceae	G3	S3	Wet places in the mountains
Phacelia mollis	soft phacelia	Hydrophyllaceae	G2G3	S2S3	Tall white spruce-aspen forest, coarse sand, dry sand beach, dry alpine tundra meadows.
Poa secunda	curly bluegrass	Poaceae	G5	SNA	Meadows, open woods
Taraxacum carneocoloratum	fleshy dandelion	Asteraceae	G3Q	S3	high alpine scree slopes, extremely rare

Sampling Design

The goal was to visit all vegetation types in the study area and identify all plant species encountered during field work that was focused on wetland mapping. All species were identified in the field or collected for further identification.

We reviewed aerial photography to identify vegetation types most likely to contain the taxa of interest. Habitats of greatest interest included the following:

- Openings in mixed birch – spruce forest,
- Edges of ponds and meadows,
- Seeps and small creeks,
- Gravel river banks along Yerrick Creek.

Daily work was planned to visit as many different habitat types as possible, including those most likely to include rare plants.

Field Methods

Teams traveled by foot while conducting the survey. As new vegetation communities were encountered, sampling points were established and the following data were collected:

- Each plot was georeferenced using a Garmin GPS unit. Survey routes were also mapped.
- Representative photos of the vegetation community were taken at each plot.
- Vegetation type and dominant species by growth form (trees, shrubs, forbs, ferns/ non-vascular plants) were recorded at each site, using the vegetation classification system by Viereck (1992).
- Additional data were gathered specific to the location, habitat, landform, notable plants, bare ground, or other parameters of interest.
- Unidentified plants were collected for lab identification and noted on the field form.
- A complete list of plant species encountered was compiled as the survey progressed.

Collection and Vouchers

Collections were made only if the population was large enough to support removal of individuals. The following data were recorded with each voucher specimen: date, latitude and longitude (Datum: NAD_1983_StatePlane_Alaska_2_FIPS_5002_Feet, in decimal degrees, taken from the Garmin GPS unit), associated species, vegetation type, substrate, notes on characteristics that may not preserve well (e.g., flower color), associated photo number, and other ecological observations. Each voucher specimen was referenced to a specific geographic locality.

Results and Discussion

The HDR project botanist surveyed most of the major vegetation types, and covered much of the geographic extent of the Yerrick Creek project area. The majority of collection locations were concentrated on gravel river bars and shrub areas adjacent to the Yerrick Creek.

More than 100 vouchers were collected. Specimens were given provisional names in the field and later sorted, examined and identified by the HDR botanist. Specimens of notable taxa will be sent to the UAF Herbarium (ALA) for review by the museum staff. Most of these species are widespread in interior Alaska. No non-native species were observed in the Yerrick Creek study area.

In total, 145 species from 40 families were recorded at the area. The complete list of species encountered in Yerrick Creek study area is found in Appendix C.

Two lakes were visited. Aquatic plants were observed and recorded from the shore. The study area was not surveyed for aquatic plants specifically.

Notable Plants

Four notable plants were found in the project area. The AKNHP tracks populations of plants of interest. Notable plants are not considered rare, sensitive, or endangered but are considered to be of ecological interest by the AKNHP.

Phlox sibirica (Siberian phlox) was not previously reported from the area. The closest records of this plant are approximately (UAF 2008):

1. 30 miles NW of Yerrick Creek in Fort Greely Military Reservation in 2004 (63.78°, -145.79°)
2. 45 miles SE of Yerrick Creek at Wrangell-St. Elias National Park and Preserve (62.20266°, -142.123273°)

Figure 2: *Phlox sibirica,* Siberian phlox.

Other notable plants, for which there are no nearby records, include:

1. *Botrychium lunaria* (common moonwort)
2. *Platanthera obtusata* (blunt-leaved orchid)
3. *Astragalus robbinsii* ssp. *harringtonii* (Harold's milkvetch)

Conclusion

No globally or state ranked Rare or Sensitive species were encountered or identified during the survey.

No Endangered species were encountered or identified during the survey. The only plant federally listed or proposed by the U.S. Fish and Wildlife Service in Alaska is *Polystichum aleuticum* C. Christensen, which is endangered. It is only known from Adak Island and is not expected to occur in the project area.

Most plant species observed in the Yerrick Creek project area are considered common and widespread in interior Alaska.

This TES plant survey is significant as a first floristic study in Yerrick Creek area.

Determination of TES Species Made By

Irina Lapina
Vegetation Ecologist
HDR Alaska, Inc.
Date: February 2008

Attachments

Figure 1: TES Survey Map

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Appendices

Appendix A: Survey Intensity and Rarity Rank for Species

Survey intensity level for plants:
LEVEL 1 = "FIELD CHECK"
The surveyor gives the area a quick "once-over" but does not walk completely through the project area. The entire project area has not been examined.
LEVEL 2 = "CURSORY"
The surveyor gives the area a "once-over" by walking through the project area. The entire project area has not been examined.
LEVEL 3 = "LIMITED FOCUS"
The surveyor closely examines one or more habitat-specific locations within the project area, but does not look at the rest of the area.
LEVEL 4 = "GENERAL"
The surveyor gives the area a closer look by walking through the project area and walking around the perimeter of the area or by walking more than once through the area. Most of the project area is examined.
LEVEL 5 = "INTUITIVE CONTROLLED"
The surveyor has closer look by conducting a complete examination of specific areas of the project after walking through the project area and perimeter or by walking more than once through the area.
LEVEL 6 = "COMPLETE"
The surveyor has walked throughout the survey area until nearly all of the area has been examined.

Rarity Rank for Species:

The rarity rank is a value that best characterizes the relative rarity or endangerment of a native taxon within the specified geographic boundaries (i.e., range-wide for global, or within-state or province for subnational).

In general, NatureServe Central Science staff assign global, U.S., and Canadian national Element ranks with guidance from local Heritage Programs/Conservation Data Centres, especially for endemic Elements, and from experts on particular taxonomic groups. Local installations assign subnational ranks for Elements in their respective jurisdictions.
Only the following rank components should be entered in this Rank field:

The appropriate geopolitical-level prefixes currently in use are:
G = global
S = subnational

Allowable values are:
1 = critically imperiled
2 = imperiled
3 = vulnerable

4 = apparently secure
5 = secure
H = possibly extinct
X = presumed extinct
U = unrankable
NR = not ranked
NA = not applicable (Element is not a suitable target for conservation)

If applicable, an indicator of uncertainty about the rank, either in the form of a range rank or a "?" qualifier following a numeric basic rank.

For national and subnational ranks, a suffix that describes the population of a migratory species, as follows:
B = breeding population
N = nonbreeding population
M = transient population

Ranks for one, two, or all three population segments can be entered, separated by commas (e.g., S1B,S2N,S3M).

For global ranks, if applicable, an appended T-rank for an infraspecies.
For global ranks, if applicable, a qualifier after the basic rank in the form of a Q indicating questionable taxonomy, or a C indicating captive or cultivated

Species Ranks used by the Alaska Natural Heritage Program
Species Global Rankings

G1:	Critically imperiled globally (5 or fewer occurrences)
G2:	Imperiled globally (6-20 occurrences)
G3:	Rare or Uncommon globally (20-100 occurrences)
G4:	Apparently secure globally, but cause for long-term concern (>100 occurrences)
G5:	Demonstrably secure globally
G#G#	Rank of species uncertain, best described as a range between two ranks
G#Q	Taxonomically questionable
G#T#	Global rank of species and global rank of the described variety or subspecies

Species State Rankings

S1:	Critically imperiled in state (5 or fewer occurrences)
S2:	Imperiled in state (6-20 occurrences)
S3:	Rare or Uncommon in state (20-100 occurrences)
S4:	Apparently secure in state, but cause for long-term concern (>100 occurrences)
S5:	Demonstrably secure in state
S#S#	Rank of species uncertain, best described as a range between two ranks

For further information concerning rare plant species for this area, please contact the Alaska Natural Heritage Program Botanist (907) 257-2785.

Appendix B: Plants Recorded at Sample Plots

Scientific Name	Plot Number	Latitude	Longitude	Elevation (ft)	Habitat
Betula papyrifera	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Picea glauca	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Alnus viridis ssp. crispa	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Betula glandulosa	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Ledum groenlandicum	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Vaccinium vitis-idaea	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Vaccinium uliginosum	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Salix scouleriana	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Geocaulon lividum	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Salix alaxensis	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Calamagrostis canadensis	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Lycopodium annotinum	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Polygonum alaskanum	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Cornus canadensis	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Carex sp.	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
feather moss	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
lichens	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Polytrichum sp.	1	63.34361	-143.63515	2479	open paper birch-white spruce forest
Picea mariana	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Ledum groenlandicum	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Salix pulchra	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Betula glandulosa	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Vaccinium vitis-idaea	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Empetrum nigrum	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Alnus viridis ssp. crispa	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Andromeda polifolia	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Lycopodium annotinum	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Equisetum arvense	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Equisetum sylvaticum	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Vaccinium oxycoccus	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Geocaulon lividum	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Carex sp.	2	63.34405	-143.63589	2407	dwarf open black spruce forest
feather mosses	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Sphagnum russowii	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Sphagnum sp.	2	63.34405	-143.63589	2407	dwarf open black spruce forest
lichen	2	63.34405	-143.63589	2407	dwarf open black spruce forest
Betula glandulosa	3	63.34571	-143.63655	2378	open black spruce forest
Ledum groenlandicum	3	63.34571	-143.63655	2378	open black spruce forest
Vaccinium vitis-idaea	3	63.34571	-143.63655	2378	open black spruce forest
Empetrum nigrum	3	63.34571	-143.63655	2378	open black spruce forest
Vaccinium uliginosum	3	63.34571	-143.63655	2378	open black spruce forest
Salix glauca	3	63.34571	-143.63655	2378	open black spruce forest
Carex sp.	3	63.34571	-143.63655	2378	open black spruce forest
Rubus chamaemorus	3	63.34571	-143.63655	2378	open black spruce forest
Trientalis europaea	3	63.34571	-143.63655	2378	open black spruce forest

Scientific Name	Plot Number	Latitude	Longitude	Elevation (ft)	Habitat
Geocaulon lividum	3	63.34571	-143.63655	2378	open black spruce forest
Petasites frigidus x hyperboreoides	3	63.34571	-143.63655	2378	open black spruce forest
Vaccinium oxycoccus	3	63.34571	-143.63655	2378	open black spruce forest
Polytrichum sp.	3	63.34571	-143.63655	2378	open black spruce forest
Sphagnum sp.	3	63.34571	-143.63655	2378	open black spruce forest
Agrostis sp.	4	63.34128	-143.63066	2285	active channel, partially vegetated
Arabis lyrata	4	63.34128	-143.63066	2285	active channel, partially vegetated
Artemisia tilesii	4	63.34128	-143.63066	2285	active channel, partially vegetated
Calamagrostis inexpansa	4	63.34128	-143.63066	2285	active channel, partially vegetated
Epilobium latifolium	4	63.34128	-143.63066	2285	active channel, partially vegetated
Festuca rubra	4	63.34128	-143.63066	2285	active channel, partially vegetated
Poa alpina	4	63.34128	-143.63066	2285	active channel, partially vegetated
Poa arctica	4	63.34128	-143.63066	2285	active channel, partially vegetated
Poa arctica ssp. lanata	4	63.34128	-143.63066	2285	active channel, partially vegetated
Poa palustris	4	63.34128	-143.63066	2285	active channel, partially vegetated
Poa pratensis	4	63.34128	-143.63066	2285	active channel, partially vegetated
Salix alaxensis	4	63.34128	-143.63066	2285	active channel, partially vegetated
Trisetum spicatum	4	63.34128	-143.63066	2285	active channel, partially vegetated
Picea glauca - sapling	5	63.34141	-143.63107	2288	closed tall alder scrub
Alnus viridis ssp. crispa	5	63.34141	-143.63107	2288	closed tall alder scrub
Salix alaxensis	5	63.34141	-143.63107	2288	closed tall alder scrub
Populus balsamifera - sapling	5	63.34141	-143.63107	2288	closed tall alder scrub
Dryopteris fragrans	5	63.34141	-143.63107	2288	closed tall alder scrub
Calamagrostis canadensis	5	63.34141	-143.63107	2288	closed tall alder scrub
Artemisia tilesii	5	63.34141	-143.63107	2288	closed tall alder scrub
Poa glauca	5	63.34141	-143.63107	2288	closed tall alder scrub
Silene menziesii ssp. williamsii	5	63.34141	-143.63107	2288	closed tall alder scrub
Populus balsamifera	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Picea glauca	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Alnus viridis ssp. crispa	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Salix alaxensis	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Ribes triste	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Rosa acicularis	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Spiraea beauverdiana	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Calamagrostis canadensis	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Artemisia tilesii	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Stellaria sp. - no flowers	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Boschniakia rossica	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Pyrola sp.	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Poa glauca	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Aster sibiricus	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Angelica lucida	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Aconitum delphinifolium	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Geocaulon lividum	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Mertensia paniculata	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Taraxacum sp.	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest
Anemone richardsonii	6	63.34259	-143.63077	2287	open balsam poplar-white spruce forest

Scientific Name	Plot Number	Latitude	Longitude	Elevation (ft)	Habitat
Betula papyrifera	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Picea glauca	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Populus balsamifera	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Geocaulon lividum	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Alnus viridis ssp. crispa	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Rosa acicularis	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Salix barclayi	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Ribes triste	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Rubus idaeus	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Ledum groenlandicum	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Calamagrostis canadensis	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Equisetum pratense	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Cornus canadensis	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Vaccinium vitis-idaea	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Epilobium angustifolium	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Linnaea borealis	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Polygonum alaskanum	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Geocaulon lividum	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Pyrola secunda	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Aconitum delphiniifolium	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Equisetum sp.	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Hylocomium splendens	7	63.34992	-143.63422	2274	open paper birch-white spruce forest
Salix barclayi	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Chamaedaphne calyculata	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Carex aquatilis	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Eriophorum sp.	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Calamagrostis canadensis	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Potentilla palustris	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Equisetum fluviatile	8	63.35283	-143.63574	2257	fresh sedge marsh and open water
Populus tremuloides	9	63.35394	-143.63544	2289	bluejoint herb meadow
Iris setosa	9	63.35394	-143.63544	2289	bluejoint herb meadow
Calamagrostis canadensis	9	63.35394	-143.63544	2289	bluejoint herb meadow
Carex lyngbyei	9	63.35394	-143.63544	2289	bluejoint herb meadow
Carex spp.	9	63.35394	-143.63544	2289	bluejoint herb meadow
Callitriche verna	9	63.35394	-143.63544	2289	bluejoint herb meadow
Alopecurus aequalis	9	63.35394	-143.63544	2289	bluejoint herb meadow
Juncus filiformis	9	63.35394	-143.63544	2289	bluejoint herb meadow
Rorippa palustris	9	63.35394	-143.63544	2289	bluejoint herb meadow
Ranunculus filiformis	9	63.35394	-143.63544	2289	bluejoint herb meadow
Agropyron sp.	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Alnus viridis ssp. crispa	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Artemisia tilesii	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Aster sibiricus	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Boschniakia rossica	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand

Scientific Name	Plot Number	Latitude	Longitude	Elevation (ft)	Habitat
Calamagrostis canadensis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Calamagrostis purpurascens	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Dryopteris fragrans	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Epilobium angustifolium	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Geocaulon lividum	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Hylocomium splendens	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Leymus mollis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Linnaea borealis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Lupinus nootkatensis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Mertensia paniculata	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Moehringia lateriflora	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Picea glauca	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Goodyera repens	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Lupinus nootkatensis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Poa glauca	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Poa pratensis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Ribes triste	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Rosa acicularis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Saxifraga cespitosa	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Shepherdia canadensis	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Silene menziesii ssp. williamsii	14	63.37882	-143.60716	1806	open black spruce forest, with bare ground channel - sand
Alnus viridis ssp. crispa	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Vaccinium uliginosum	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Betula glandulosa	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Empetrum nigrum	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Ledum groenlandicum	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Chamaedaphne calyculata	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Carex aquatilis	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Andromeda polifolia	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Lycopodium annotinum	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Carex sp. - peat forming	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Rubus chamaemorus	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow

Scientific Name	Plot Number	Latitude	Longitude	Elevation (ft)	Habitat
Geocaulon lividum	15	63.36281	-143.63779	2190	subarctic lowland sedge wet meadow
Carex aquatilis	16	63.36144	-143.63693	2229	pond
Nuphar lutea	16	63.36144	-143.63693	2229	pond
Carex lyngbyei	16	63.36144	-143.63693	2229	pond
Iris setosa	16	63.36144	-143.63693	2229	pond
Potamogeton zosteriformis	16	63.36144	-143.63693	2229	pond
Populus balsamifera	18	63.37563	-143.61504	1843	open alder tall shrub
Picea glauca	18	63.37563	-143.61504	1843	open alder tall shrub
Alnus viridis ssp. crispa	18	63.37563	-143.61504	1843	open alder tall shrub
Rubus idaeus	18	63.37563	-143.61504	1843	open alder tall shrub
Populus balsamifera - sapling	18	63.37563	-143.61504	1843	open alder tall shrub
Shepherdia canadensis	18	63.37563	-143.61504	1843	open alder tall shrub
Pyrola secunda	18	63.37563	-143.61504	1843	open alder tall shrub
Calamagrostis canadensis	18	63.37563	-143.61504	1843	open alder tall shrub
Calamagrostis purpurascens	18	63.37563	-143.61504	1843	open alder tall shrub
Artemisia tilesii	18	63.37563	-143.61504	1843	open alder tall shrub
Silene menziesii ssp. williamsii	18	63.37563	-143.61504	1843	open alder tall shrub
Aconitum delphiniifolium	18	63.37563	-143.61504	1843	open alder tall shrub
Poa glauca	18	63.37563	-143.61504	1843	open alder tall shrub
Mertensia paniculata	18	63.37563	-143.61504	1843	open alder tall shrub
Angelica lucida	18	63.37563	-143.61504	1843	open alder tall shrub
Agropyron subsecundum	18	63.37563	-143.61504	1843	open alder tall shrub
lichen	18	63.37563	-143.61504	1843	open alder tall shrub
feather moss	18	63.37563	-143.61504	1843	open alder tall shrub
Hylocomium splendens	18	63.37563	-143.61504	1843	open alder tall shrub
Picea glauca	19	63.37489	-143.61653	1894	open white spruce forest
Rosa acicularis	19	63.37489	-143.61653	1894	open white spruce forest
Geocaulon lividum	19	63.37489	-143.61653	1894	open white spruce forest
Vaccinium vitis-idaea	19	63.37489	-143.61653	1894	open white spruce forest
Shepherdia canadensis	19	63.37489	-143.61653	1894	open white spruce forest
Alnus viridis ssp. crispa	19	63.37489	-143.61653	1894	open white spruce forest
Equisetum pratense	19	63.37489	-143.61653	1894	open white spruce forest
Mertensia paniculata	19	63.37489	-143.61653	1894	open white spruce forest
Astragalus americanus	19	63.37489	-143.61653	1894	open white spruce forest
Calamagrostis canadensis	19	63.37489	-143.61653	1894	open white spruce forest
Boschniakia rossica	19	63.37489	-143.61653	1894	open white spruce forest
Coptis trifolia	19	63.37489	-143.61653	1894	open white spruce forest
Goodyera repens	19	63.37489	-143.61653	1894	open white spruce forest
Erigeron acris	19	63.37489	-143.61653	1894	open white spruce forest
Epilobium angustifolium	19	63.37489	-143.61653	1894	open white spruce forest
Aster sibiricus	19	63.37489	-143.61653	1894	open white spruce forest
Pyrola secunda	19	63.37489	-143.61653	1894	open white spruce forest
Hylocomium splendens	19	63.37489	-143.61653	1894	open white spruce forest
Silene menziesii ssp. williamzii	19	63.37489	-143.61653	1894	open white spruce forest

Appendix C: Project Area Plant Species List

#	Scientific Name	Family
1	Achillea millefolium	Asteraceae
2	Aconitum delphiniifolium	Ranunculaceae
3	Agropyron sp.	Poaceae
4	Agropyron subsecundum	Poaceae
5	Agrostis scabra	Poaceae
6	Agrostis sp.	Poaceae
7	Alnus viridis ssp. crispa	Betulaceae
8	Alopecurus aequalis	Poaceae
9	Andromeda polifolia	Ericaceae
10	Anemone parviflora	Ranunculaceae
11	Anemone richardsonii	Ranunculaceae
12	Angelica lucida	Apiaceae
13	Antennaria sp.	Asteraceae
14	Arabis lyrata	Brassicaceae
15	Arctagrostis latifolia	Poaceae
16	Arctostaphylos uva-ursi	Ericaceae
17	Artemisia alaskana	Asteraceae
18	Artemisia arctica	Asteraceae
19	Artemisia tilesii	Asteraceae
20	Aster sibiricus	Asteraceae
21	Astragalus alpinus	Fabaceae
22	Astragalus americanus	Fabaceae
23	Astragalus robbinsii ssp. harringtonii	Fabaceae
24	Betula glandulosa	Betulaceae
25	Betula papyrifera	Betulaceae
26	Boschniakia rossica	Orobanchaceae
27	Botrychium lunaria	Ophioglossaceae
28	Calamagrostis canadensis	Poaceae
29	Calamagrostis inexpansa	Poaceae
30	Calamagrostis lapponica	Poaceae
31	Calamagrostis purpurascens	Poaceae
32	Calamagrostis purpurascens ssp. purpurascens	Poaceae
33	Callitriche verna	Callitrichaceae
34	Campanula lasiocarpa	Campanulaceae
35	Carex aquatilis	Cyperaceae
36	Carex brunnescens	Cyperaceae
37	Carex canescens	Cyperaceae
38	Carex loliacea	Cyperaceae
39	Carex magellanica	Cyperaceae
40	Carex saxatilis	Cyperaceae
41	Carex scirpoidea	Cyperaceae
42	Carex tenuiflora	Cyperaceae
43	Carex utriculata	Cyperaceae
44	Cerastium sp.	Caryophyllaceae
45	Chamaedaphne calyculata	Ericaceae
46	Coptis trifolia	Ranunculaceae
47	Cornus canadensis	Cornaceae
48	Crepis elegans	Asteraceae

#	Scientific Name	Family
49	Dasiphora fruticosa ssp. floribunda	Rosaceae
50	Dryopteris fragrans	Dryopteridaceae
51	Empetrum nigrum	Ericaceae
52	Epilobium angustifolium	Onagraceae
53	Epilobium latifolium	Onagraceae
54	Equisetum arvense	Equisetaceae
55	Equisetum fluviatile	Equisetaceae
56	Equisetum pratense	Equisetaceae
57	Equisetum scirpoides	Equisetaceae
58	Equisetum sylvaticum	Equisetaceae
59	Erigeron acris	Asteraceae
60	Erigeron acris ssp. polatus	Asteraceae
61	Eriophorum brachyantherum	Cyperaceae
62	Eriophorum vaginatum	Cyperaceae
63	Festuca brachyanterum	Poaceae
64	Festuca brachyphylla	Poaceae
65	Festuca rubra	Poaceae
66	Geocaulon lividum	Santalaceae
67	Goodyera repens	Orchidaceae
68	Hedysarum mackenzii	Fabaceae
69	Hierochloe alpina	Poaceae
70	Hierochloe odorata	Poaceae
71	Iris setosa	Iridaceae
72	Juncus castaneus	Juncaceae
73	Juncus filiformis	Juncaceae
74	Ledum groenlandicum	Ericaceae
75	Leymus innovatus	Poaceae
76	Linnaea borealis	Caprifoliaceae
77	Lupinus arctica	Fabaceae
78	Lupinus nootkatensis	Fabaceae
79	Luzula parviflora	Juncaceae
80	Lycopodium annotinum	Lycopodiaceae
81	Lycopodium clavatum	Lycopodiaceae
82	Lycopodium complanatum	Lycopodiaceae
83	Mertensia paniculata	Boraginaceae
84	Mertensia paniculata ssp. paniculata	Boraginaceae
85	Minuartia stricta	Caryophyllaceae
86	Moehringia lateriflora	Caryophyllaceae
87	Moneses uniflora	Pyrolaceae
88	Nuphar lutea	Nymphaeaceae
89	Oxyria digyna	Polygonaceae
90	Oxytropis campestris	Fabaceae
91	Oxytropis campestris ssp. gracilis	Fabaceae
92	Oxytropis nigrescens	Fabaceae
93	Pedicularis labradorica	Scrophulariaceae
94	Petasites frigidus	Asteraceae
95	Petasites frigidus x hyperboreoides	Asteraceae
96	Petasites hyperboreus	Asteraceae
97	Phlox sibirica	Polemoniaceae

#	Scientific Name	Family
98	Picea glauca	Pinaceae
99	Picea mariana	Pinaceae
100	Platanthera obtusata	Orchidaceae
101	Poa alpina	Poaceae
102	Poa arctica ssp. lanata	Poaceae
103	Poa glauca	Poaceae
104	Poa palustris	Poaceae
105	Poa pratensis	Poaceae
106	Polemonium acutiflorum	Polemoniaceae
107	Polygonum alaskanum	Polygonaceae
108	Polygonum bistorta	Polygonaceae
109	Populus balsamifera	Salicaceae
110	Populus tremuloides	Salicaceae
111	Potamogeton zosteriformis	Potamogetonaceae
112	Potentilla palustris	Rosaceae
113	Pyrola asarifolia	Pyrolaceae
114	Pyrola secunda	Pyrolaceae
115	Ranunculus filiformis	Ranunculaceae
116	Ranunculus lapponicus	Ranunculaceae
117	Ribes triste	Grossulariaceae
118	Rorippa palustris	Brassicaceae
119	Rosa acicularis	Rosaceae
120	Rubus chamaemorus	Rosaceae
121	Rubus idaeus	Rosaceae
122	Salix alaxensis	Salicaceae
123	Salix alaxensis var. alaxensis	Salicaceae
124	Salix arbusculoides	Salicaceae
125	Salix barclayi	Salicaceae
126	Salix bebbiana	Salicaceae
127	Salix glauca	Salicaceae
128	Salix pulchra	Salicaceae
129	Salix scouleriana	Salicaceae
130	Saxifraga cespitosa	Saxifragaceae
131	Saxifraga tricuspidata	Saxifragaceae
132	Sedum rosea	Crassulaceae
133	Shepherdia canadensis	Eleagnaceae
134	Silene menziesii ssp. williamsii	Caryophyllaceae
135	Spiraea beauverdiana	Rosaceae
136	Stellaria crassifolia	Caryophyllaceae
137	Taraxacum sp.	Asteraceae
138	Trientalis europaea	Primulaceae
139	Trisetum spicatum	Poaceae
140	Trisetum spicatum ssp. spicatum	Poaceae
141	Vaccinium oxycoccus	Ericaceae
142	Vaccinium uliginosum	Ericaceae
143	Vaccinium vitis-idaea	Ericaceae
144	Viburnum edule	Caprifoliaceae

Appendix D: Photographs

Included as a Word file:
AppendixD_plantphotos_yerrick.doc

Appendix E: Field Data Forms

Included as an Adobe file:
AppendixE_plantfieldforms_yerrick.pdf

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YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

~WATER QUALITY & HYDROLOGY BASELINE REPORT~

LITERATURE REVIEW AND FIELD REPORT: HYDROLOGY BASELINE STUDY
YERRICK CREEK HYDROELECTRIC PROJECT, TOK, ALASKA

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October 2008

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1.0 INTRODUCTION

The hydroelectric project proposed by Alaska Power and Telephone (AP&T) will include an impoundment in Yerrick Creek just below the confluence of two tributaries with Yerrick Creek (Yerrick Creek Diversion Sample Site, Figure 1.1). A penstock will be constructed to carry water to a powerhouse to be constructed near the old pipeline corridor (Yerrick Creek Discharge Sample Site). A separate diversion and powerhouse system may be constructed on Cathedral Rapids Creek No. 1 as well. The impoundment would be in the approximate location of Cathedral Rapids No. 1 Diversion Sample Site (Figure 1.1). Power generated from the hydroelectric project would power Tok and surrounding communities during summer months and possibly supply some portion of the power supply for a larger portion of the year.

Figure 1.1. Sample locations on Yerrick Creek and Cathedral Rapids Creek No. 1 (Google Earth, 2008).

The purpose of the hydrology and water quality studies presented herein is to establish a preliminary baseline necessary for the permitting process. Additional baseline studies may be required (see Section 4.0 for recommended further action). Additional flow studies are being conducted by AP&T to determine the potential power output and feasibility of the hydroelectric project.

2.0 HYDROLOGY AND WATER QUALITY MONITORING

2.1 BACKGROUND

Hydroelectric project background

The Yerrick Creek hydroelectric project, as described by AP&T is to include: (1) a small diversion structure with intake; (2) a 48-inch diameter, 15,000-foot long penstock; (3) a powerhouse with the capacity of 2 to 3 MW; (4) a 0.5-mile long buried and 22-mile overhead transmission line to connect an existing power grid; and (5) appurtenant facilities.

Hydrology background from nearby USGS stations

Water quality data were collected from Yerrick Creek at USGS station 632257143353500, which is located in Yerrick Creek at the highway crossing (63°22'57" N; 143°35'35" W; NAD27). Data were collected between 1949 and 1956. No flow data are available, but a total of 28 physical and chemical parameters were recorded, most of which are summarized in tables below (Table 2.1, 2.2, 2.3, and 2.4; USGS, 2008).

Table 2.1. Yerrick Creek USGS water quality measurements (USGS, 2008).

	Temperature	**Specific Conductance**	**pH**	**Carbon Dioxide**	**Color**
	°C	µS/cm	pH units	mg/L	PtCo units, filtered
7/21/1949	7	95	6.6	14	--
6/22/1951	--	164	7	8.2	10
6/4/1952	--	109	6.8	9.6	25
2/17/1953	0	254	7.5	4.5	5
5/13/1953	0	130	7.1	5.6	25
5/18/1955	--	107	7	6.1	50
9/20/1955	--	161	7.8	1.5	5
5/11/1956	--	105	7	6.4	--

Table 2.2. Yerrick Creek USGS water quality sampling – alkalinity and hardness (USGS, 2008).

	Acid neutralizing capacity	**bicarbonate**	**hardness**	**non-carbonate hardness**
	mg/L as CaCO3	mg/L	mg/L as $CaCO_3$	mg/L as $CaCO_3$
7/21/1949	29	35	39	10
6/22/1951	42	51	65	23
6/4/1952	31	38	50	19
2/17/1953	72	88	120	49
5/13/1953	36	44	60	24
5/18/1955	31	38	46	15
9/20/1955	50	61	68	18
5/11/1956	33	40	45	12

Table 2.3. Yerrick Creek USGS water quality sampling – metals, filtered (USGS, 2008).

	Calcium	Magnesium	Sodium	Potassium	Iron
	mg/L, filtered	mg/L, filtered	mg/L, filtered	mg/L, filtered	µg/L, unfiltered
7/21/1949					
6/22/1951	21	3.1			20
6/4/1952	15	3.1	1.8	2.1	70
2/17/1953	39	5.6	2.8	4.3	10
5/13/1953	19	3.1	1.2	2.3	40
5/18/1955	15	2.2	1.2	2.4	170
9/20/1955	22	3.2	2.3	2.8	0
5/11/1956	14	2.5	1.6	2	

Table 2.4. Yerrick Creek USGS water quality sampling – nutrients, ions, and residuals (USGS, 2008).

	Nitrate	**Sulfate**	**Chloride**	**Fluoride**	**Silica**	**Residue, sum of constituents**	**Residue**
	mg/L as N, filtered	mg/L, filtered	mg/L, filtered	mg/L, filtered	mg/L filtered	mg/L, filtered	tons/acre-foot, filtered
7/21/1949	0.2	15	0.5		4.3		
6/22/1951	0.2	27	0.5	0.2	7.3	88	0.12
6/4/1952	0.38	20	1	0.1	5.7	69	0.09
2/17/1953	0.34	58	0.5	0.1	8.4	164	0.22
5/13/1953	0.25	25	0.5	0.2	3.9	78	0.11
5/18/1955	0.47	20	0.5	0	4.4	66	0.09
9/20/1955	0.16	26	0	0	11	98	0.13
5/11/1956		17	1			58	0.08

Data are also available from USGS station 15476000 on the Tanana River just downstream of the confluence of Cathedral Rapids Creek #1 with the Tanana River. The drainage area sampled by this station is 8,550 square miles. Data were collected at this site from 1953 through 1990, including discharge, peak stream-flow, and water quality information. The record of daily mean discharge is shown in Figure 2.1. Peak flows are shown in Figure 2.2 and the distribution of peak flows among the summer months is shown in Figure 2.3 (USGS, 2008).

Nine of the ten highest daily discharge measurements for USGS 154760000 occurred between July 19th and 27th in 1988. Of the 50 highest daily discharge measurements, 27 occurred in July, 18 occurred in August, and 5 occurred in June, suggesting that summer rains cause the highest flows rather than snowmelt and breakup. If, however, the month of July 1988 is removed from the record, four of the top ten daily discharges occurred in August and three occurred in each June and July. Likewise, excepting July 1988, 29 of the 50 highest daily discharges occurred in August, 14 occurred in July, and 7 occurred in June.

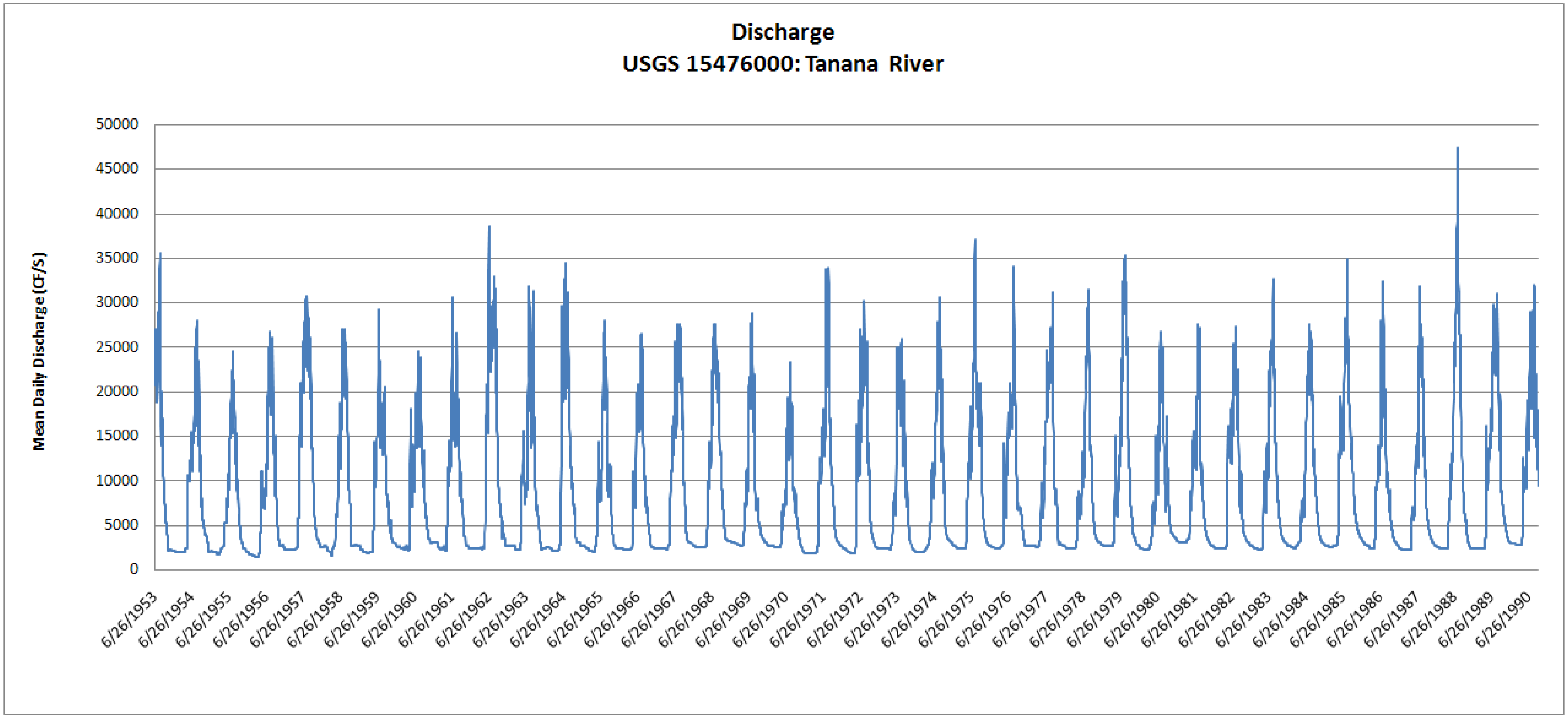

Figure 2.1. Tanana River mean daily discharge, 1953 through 1990 (USGS, 2008).

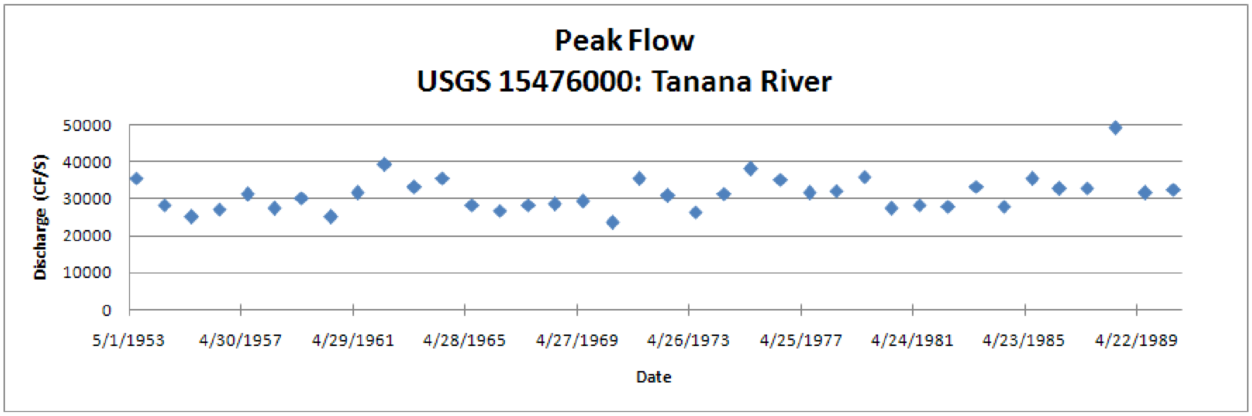

Figure 2.2. Tanana River peak flow (USGS, 2008).

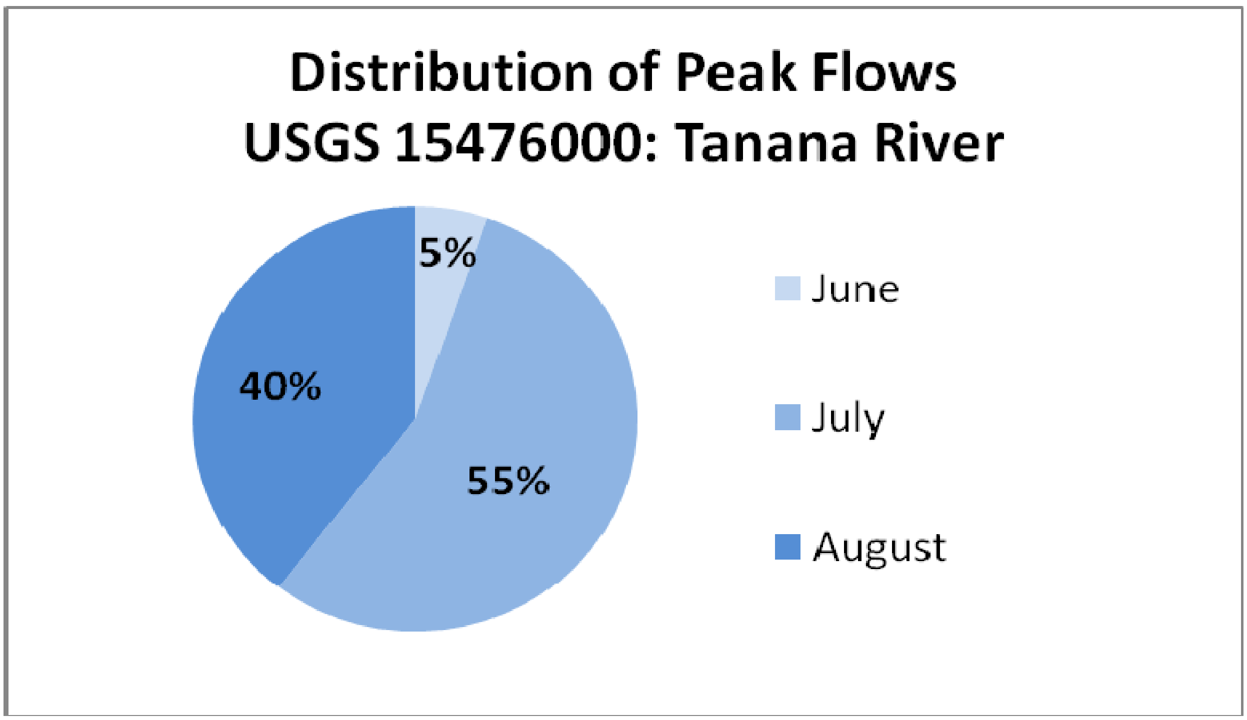

Figure 2.3. Tanana River peak flow distribution (USGS, 2008).

Water quality data for USGS 15476000 on the Tanana River include 101 parameters. A portion of the data is presented below and the remainder is available from the USGS at http://alaska.usgs.gov/science/water/index.php. Data collected only once or several times were not included in the table below.

Table 2.5. Summary of water quality data from USGS 15476000 on the Tanana River (USGS, 2008).

Parameter, units	Maximum	Minimum	Count	Mean	Median
Temperature, °C	16.5	0	105	6.3	6.5
Color, filtered, PtCo units	60	0	203	10.4	5
Specific Conductance, µS/cm	448	160	222	233.0	220
pH	8.4	6.6	212	7.7	7.7
Carbon Dioxide, mg/L	68	0.7	212	5.4	3.7
Acid neutralizing capacity, mg/L as CaCO3	203	61	212	98.3	92
Bicarbonate, mg/L	247	74	212	119.7	112
Nitrate, mg/L as Nitrogen	0.77	0	206	0.17	0.14
Phosphate, mg/L	0.16	0	52	0.019	0.01
Hardness, mg/L as CaCO3	230	72	207	110.4	100
Non-carbonate Hardness, mg/L as CaCO3	30	0	207	12.2	12
Calcium, filtered, mg/L	62	20	207	32.8	31
Magnesium, filtered, mg/L	19	2.9	207	6.97	6.2
Sodium, filtered, mg/L	11	3.3	208	5.84	5.65
Potassium, filtered, mg/L	3.1	0.1	208	1.48	1.5
Chloride, filtered, mg/L	7	0.4	208	3.05	3
Sulfate, filtered, mg/L	45	11	208	21.2	20
Fluoride, filtered, mg/L	1.2	0	205	0.148	0.1
Silica, filtered, mg/L	44	7.2	208	11.8	11
Residue on evaporation, filtered, mg/L	205	108	28	132.6	128
Residue, sum of constituents, filtered, mg/L	310	95	207	143.1	136
Residue, dissolved, tons per day	10500	666	206	4769.2	4680
Residue, filtered, tons per acre foot	0.42	0.13	207	0.196	0.19
Orthophosphate, unfiltered, mg/L as phosphorous	0.05	0	52	0.006	0
Nitrate, filtered, mg/L	3.4	0	206	0.76	0.6
Manganese, unfiltered, µg/L	100	0	140	1.86	0
Iron, unfiltered, µg/L	620	0	192	64.9	30
Suspended sediment, mg/L	3460	15	106	976.9	908
Suspended sediment, tons/day	326000	81	104	52024	28300

USGS station 15475997 is located on Cathedral Rapids Creek No. 1, but no data are available from this station. This station is located on Cathedral Rapids Creek No. 1 approximately 0.4 miles above (south of) the highway crossing (63°22’45”N; 143°44’00”W; NAD27) and has a drainage area of 8.83 square miles (USGS, 2008).

Detectable levels of antimony, arsenic, nitrates/nitrites, barium, chromium, and fluoride have been found in public drinking water systems in the Tok basin (ADEC, 2008). The only inorganic contaminant exceedance of maximum contaminant levels for drinking water has been for nitrates (ADEC, 2008).

Peak Flow Estimates

Yerrick Creek and Cathedral Rapids Creek No. 1 are within region 6 as described by USGS Water-Resources Investigations Report 03-4188 (Curran et al., 2003). As such, the equations for peak stream-flow presented by Curran et al. (2003) include drainage area, area of lakes and ponds (storage), and area of forest. Drainage areas are shown in Figure 2.4. Model input parameters for each stream are shown in Table 2.6. Peak flows are calculated for the proposed diversion points in each drainage. Peak flows for each recurrence interval are presented in Table 2.7.

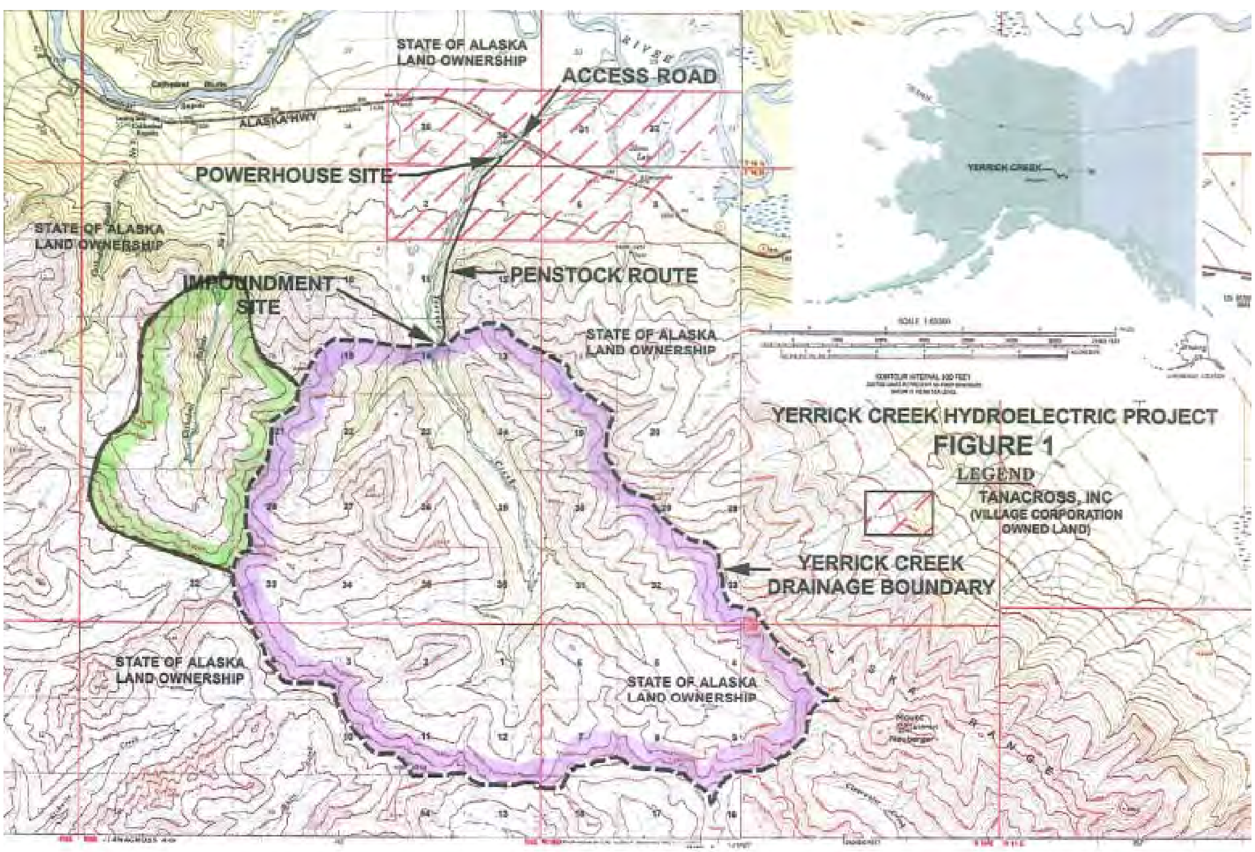

Figure 2.4. Drainage areas for proposed impoundment sites.

Table 2.6. Model input parameters

	Yerrick Creek	Cathedral Rapids Creek No. 1
Drainage Area (square miles)	30	6
Area of lakes and ponds (percent)	0	0
Area of forest (percent)	0	0

Table 2.7. Peak flows and recurrence intervals for Yerrick Creek and Cathedral Rapids Creek #1.

Recurrence Interval (yr)	Yerrick Creek Peak Streamflow (CF/S)	Cathedral Rapids Creek #1 Peak Streamflow (CF/S)
2	1102	262
5	1575	402
10	1916	508
25	2373	652
50	2728	767
100	3093	887
200	3468	1012
500	3985	1186

The model of Curran et al. (2003) was used to estimate peak flows in the upper and lower gage sites of Mack (1987, 1988) at Rhoads-Granite Creek, which is approximately 7 miles east of Donnelly Dome. Input values were a basin area of 32.2 square miles, zero percent storage (lakes and ponds), and 0.5 percent forest for the upper gage site and 81.2 square miles of drainage basin, 5.5 percent storage, and 42 percent forest for the gaging site at the road. Drainage area and percentage forested were extracted from Mack (1987, 1988) and percentage lakes and ponds was selected so as to minimize the difference from Mack's output (loss to groundwater and distributaries are complexities not accounted for in the model of Curran et al. 2003). Output was compared to the model output produced by Mack (1987, 1988) and the average absolute value of the percentage errors (assuming Mack's model output is the best estimate of actual) was approximately 25 percent for each gaging site.

The data from Mack (1987, 1988) was not used to refine or calibrate the model of Curran et al. (2003) for the Yerrick Creek or Cathedral Rapids Creek No. 1 because Mack's output was model output based on limited data and a complex watershed. Since region 6, the region for which the model equations were designed, is quite large, more local data for refinement of the model to a smaller region would be desirable and the Mack studies may provide some significant considerations which may be applicable at Yerrick and Cathedral Rapids Creeks. Some conditions from Rhoads-Granite Creek which may be found at Yerrick Creek and Cathedral Rapids Creek No. 1 are: (1) significant loss to groundwater due to permeable glacial deposits; (2) abandoned channels which may serve as distributaries at high water; and (3) seasonal modeling complexity based on snowmelt and frost conditions.

Local geology

According to Carrara (2004), the map units that occur in the Yerrick Creek drainage include Qac, Qco, Ata, Qfa, Qty, Qto, Qrg, and Qls (Figures 2.5, 2.6). Cathedral Rapids Creek #1 drains an area that includes map units Qac, Qfc, Qto, Qfa, Qrg, and Qta. These map units include alluvial, colluvial, glacial, and periglacial deposits. Biotite gneiss and schist are among the rock types found in the surface geology of the area.

Carrara (2004) notes that areas underlain by the Qac unit are subject to floods and debris flows. The Yerrick Creek bridge abutment was damaged by flooding in August 1997 (Carrara, 2004; Figure 2.6). With regards to map unit Qto, Carrara (2004) notes that in the Yerrick Creek and Cathedral Rapids Creek No. 1 areas the unit forms hummocky end moraines extending out from the base of the Alaska Range.

Bedrock and surficial geology units mapped by Holmes (1965) within the Yerrick Creek and Cathedral Rapids Creek No. 1 drainages (Figure 2.7) include Qc (colluvium – mixtures of rubble, talus, alluvium, and loess), Qag (flood-plain gravelly alluvium), Qt (talus – angular boulders), Qdgl (moraine deposits from Donnelly glaciations), Qdm (moraine deposits from Delta glaciations), Qg (fan-apron and alluvial-fan deposits – mostly gravel; gravel from local sources), pCb (Birch Creek Schist – schist, gneiss, quartzite, and amphibolites), Qdf (glacio-fluvial deposits), and Qts (stream-terrace deposits – mostly silt and sand).

The Birch Creek Schist is the predominant bedrock geologic form in the study area as mapped by Holmes (1965). The Precambrian or early Precambrian Birch Creek Schist is a thick group extensive in area resulting from one or more periods of high grade regional metamorphism (Holmes, 1965). Schist (gray quartz-mica; chloritic; and graphitic), gneiss (gray or light brown biotite; gray hornblende; and hornblende-biotite), quartzite (white to light brown or gray or greenish gray), and amphibolites (black) are the main rock types in the mapped area (Holmes, 1965).

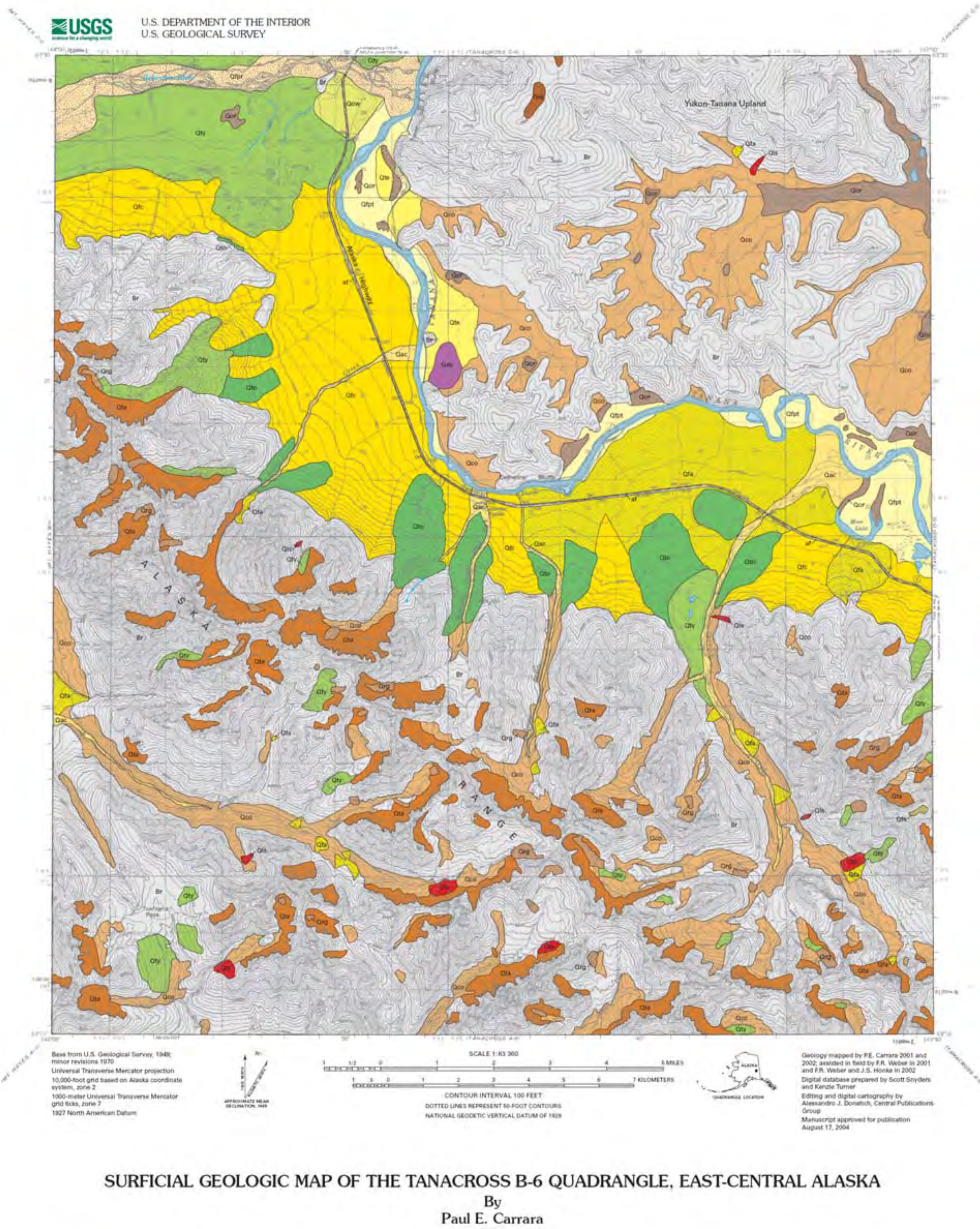

Figure 2.5. Surficial geologic map of the Yerrick Creek Hydroelectric Project area (Carrara, 2004)

Alluvial and colluvial deposits

Qac **Active channels and alluvium and debris flow deposits of streams from Alaska Range (late Holocene)**—Active channels and alluvium and debris flow deposits of streams emerging from Alaska Range (Sheep, Yerrick, and Cathedral Rapids Creeks Nos. 1 and 2). Contains point bar deposits 50–100 cm in height consisting of subrounded cobbles and boulders and containing lenses of sandy pebble gravel 10–50 cm thick. Clasts are mainly biotite gneiss and schist derived from the various drainages and deposited in part by flash floods and debris flows; the largest are about 1 m in diameter. Matrix is light-yellowish-brown (10YR 6/4) sand. Unit commonly forms a zone of unvegetated, cobbly boulder gravel as much as 100 m wide. Relief across unit about 2 m. Areas underlain by unit are subject to floods and (or) debris flows. In August 1997, heavy rains in Alaska Range caused flooding along these stream channels, damaged the bridge abutment over Yerrick Creek, and closed the Alaska Highway. Exposed thickness about 2 m; base not exposed, estimated maximum thickness 10 m

Qfa **Fan deposits of Alaska Range (Holocene and late Pleistocene)**—Fans deposited mainly by flowing water and debris flows along front and within valleys of Alaska Range. Unit consists mainly of an unstratified to poorly stratified, poorly sorted to well-sorted, clast-supported, cobbly pebble and pebbly cobble gravel with a pale-brown (10YR 6/3), silty sand matrix. Clasts are mainly biotite gneiss and schist. Also includes lenses of medium sand to coarse sand about 5 cm thick. Along front of Alaska Range, clasts are mainly subrounded to rounded pebbles and cobbles with a minor amount of boulders. Largest clasts are about 1 m in diameter. Within Alaska Range, clasts consist of angular to subangular cobbles and boulders. In places unit contains bouldery debris flow levees about 1 m high. Locally includes colluvium (Qco) and sheetwash alluvium. Unit is subject to both floods and debris flows. Exposed thickness about 10 m; estimated maximum thickness along front of Alaska Range 30 m

Qfc **Coalescing fan deposits along front of Alaska Range (Holocene and late Pleistocene)**—Large coalescing fans deposited mainly by flowing water and debris flows along front of Alaska Range. Unit consists of mainly unstratified to poorly stratified, poorly sorted to well-sorted, clast-supported, cobbly pebble and pebbly cobble gravel with a light-olive-brown (2.5Y 5/4) to pale-brown (10YR 6/3), silty sand and sand matrix. Clasts are mainly biotite gneiss and schist and consist of mainly subrounded to rounded pebbles and cobbles with a minor amount of boulders; the largest are about 1 m in diameter. In places unit contains bouldery debris flow levees about 1 m high. Locally overlain by as much as 50 cm of massive, light-yellowish-brown (10YR 6/4) silt (loess?). Unit may locally include colluvium (Qco) and sheetwash alluvium. Unit is subject to both floods and debris flows. Exposed thickness about 6 m; estimated maximum thickness 30 m

Colluvial deposits

Qco **Colluvium, undivided (Holocene and late Pleistocene)**—On valley walls and slopes within Alaska Range unit mainly consists of poorly stratified, poorly sorted, clast-supported, cobbly boulder gravel deposited mainly by mass-wasting processes. Clasts are angular to subrounded and generally consist of biotite gneiss and schist; the largest are about 1 m in intermediate diameter. Matrix is mainly a pale-brown (10YR 6/3) sand. In places unit contains bouldery debris flow levees about 1 m high. Unit includes undifferentiated rock avalanche, debris flow, and solifluction deposits as well as fan (Qfa), talus (Qta), younger glacial (Qty), and rock-glacier (Qrg) deposits too small to show at map scale. Hence, this unit is subject to a wide range of geologic hazards. May contain permafrost at shallow depths. Exposed thickness about 5 m; estimated maximum thickness 20 m. In the Yukon-Tanana Upland, unit is poorly exposed but appears to primarily consist of poorly sorted and poorly stratified, locally organic-rich silt, silty sand, sand, and pebbly sand. Permafrost is common at depths below 50 cm. Maximum thickness of unit in northern map area estimated to be 10 m

Qta **Talus deposits (Holocene and late Pleistocene)**—Poorly stratified, poorly sorted, angular rock fragments ranging in size from pebbles to large boulders deposited at base of steep slopes and cliffs in Alaska Range mainly by rockfall. Largest clasts are about 2 m in intermediate diameter. Limited exposures suggest unit may grade into finer material at depth. Locally contains bouldery debris flow levees. In some instances, toe of deposit is lobate indicating rock glacier-like flowage. Many boulders on surface of unit support an extensive lichen cover indicating they have been stable for at least the last several centuries. Upper reaches of unit rest at angle of repose and therefore are potentially unstable. Unit may locally include some alluvium and colluvium (Qco). Unit is prone to rockfall hazards from above slopes. Locally, unit may exceed 20 m in thickness

Landslide deposits (Holocene and late Pleistocene)—Mainly translational and flow types of movement have resulted in an array of landslide deposits including rock slides, rock avalanches, debris slides, and debris avalanches (Varnes, 1978). Unit consists of unconsolidated, heterogeneous mixture of surficial material and bedrock fragments in a wide range of sizes. In some deposits in Alaska Range boulders exceed 2 m in intermediate diameter. Size and lithology of clasts and matrix depend on the various bedrock and surficial deposits involved in landslide. Locally includes small alluvial and talus (Qta) deposits. Many of these landslide deposits may have been induced by seismic events. The magnitude 7.9 earthquake of November 3, 2002, is known to have triggered thousands of landslides in Alaska Range and surrounding areas (Harp and others, 2003) and may have triggered a small recent landslide near confluence of Tanana River and Porcupine Creek, about 52 km east of central map area, on Tanacross B-4 quadrangle. Maximum thickness estimated to be about 30 m

Glacial deposits

Qty **Younger till of Alaska Range glaciers (late Pleistocene; Donnelly glaciation)**—Mainly an unstratified, unsorted, clast-supported, pebbly cobble gravel, with a pale-yellow (5Y 7/3) sandy silt and sand matrix deposited by glaciers heading in valleys in Alaska Range during Donnelly glaciation. Clasts consist of mainly subangular to subrounded granitic biotite gneiss and schist, and quartzite pebbles and cobbles and occasional boulders. Largest clast is about 1 m in diameter. Unit locally overlain by 10–20 cm of loess consisting of light-yellowish-brown (10YR 6/4) silt and sandy silt. In Robertson River area, unit forms broad, hummocky end moraines, as high as 25 m, containing pond and bogs. In Yerrick Creek area, south of Alaska Highway, unit also forms hummocky end moraines, also containing ponds and bogs, with about 20 m of local relief. Other glaciers in Alaska Range in map area during Donnelly glaciation were not extensive enough to extend beyond the range into upper Tanana valley. Deposits from this glaciation are found throughout Alaska Range and generally consist of scattered deposits of ground moraine. Unit locally includes some colluvium (Qco), talus (Qta), and rock glacier (Qrg) deposits and small areas of bedrock (Br). Age of Donnelly glaciation is probably equivalent in part to oxygen isotope stage 2, which occurred about 12–24 k.y. ago (Martinson and others, 1987). Thickness probably greater than 30 m in places

Qdo **Older till of Alaska Range glaciers (middle Pleistocene; Delta glaciation)**—Mainly an unstratified, unsorted, clast-supported, pebbly cobble gravel with a pale-yellow (5Y 7/3) to light-yellowish-brown (10YR 6/4) sandy silt and sand matrix deposited along southern margin of upper Tanana valley by glaciers that emerged from valleys in Alaska Range during Delta glaciation. Clasts consist of subangular and subrounded granite, biotite gneiss and schist, and quartzite pebbles and cobbles and occasional boulders; the largest is about 1 m in diameter. Locally overlain by as much as 1 m of loess consisting of light-yellowish-brown (10YR 6/4) silt and sandy silt. North of Robertson River (immediately north of map area), unit forms broad, subdued, hummocky moraines. In northwestern map area, Robertson Glacier deposited a small lateral moraine trending southeast to northwest about 30 m above general land surface. In areas adjacent to Sheep Creek, Cathedral Rapid Creeks Nos. 1 and 2, and Yerrick Creek, unit forms hummocky end moraines extending out from base of Alaska Range. Locally includes alluvium and colluvium (Qco), and small areas of bedrock (Br). This unit is probably equivalent in age to marine oxygen isotope stage 6, based on correlation with similar deposits in Delta River valley (Begét and Keskinen, 2003) thought to have occurred between about 130 and 188 k.y. ago (Martinson and others, 1987). Thickness probably greater than 30 m in places

Periglacial deposits

Qrg **Rock glacier deposits (Holocene and late Pleistocene)**—Poorly stratified, poorly sorted, large, angular rock fragments formed by periglacial processes and deposited on slopes mainly at head of cirques in Alaska Range. Surface is mostly covered with angular cobbles and boulders. Although larger surface clasts may be 2–3 m in intermediate diameter, clasts grade into finer material at depth. Presently active rock glaciers have steep frontal slopes, as much as 30 m high, which are commonly at angle of repose. These frontal slopes are lobate, indicating flowage induced by either interstitial ice or an ice core at depth. Upper reaches of unit commonly grade into steep talus (Qta) deposits. Unit may locally include talus (Qta) deposits. Some of these deposits are presently downwasting in that they contain collapse pits as much as several tens of meters in diameter and 5 m deep probably caused by melting of underlying ice. In August 2002, a collapse pit in a rock glacier near head of Yerrick Creek was 4–7 m in diameter and contained a small pond several meters below surface of rock glacier. The pit was surrounded by circular cracks at least 10 m beyond the pit itself that indicated a much larger area of subsidence. An exposure along one side of the pit consisted of 2–3 m of poorly stratified, poorly sorted, angular, pebbly cobble gravel overlying an ice core that disappeared at depth into the pond. Some deposits exceed 30 m in thickness

Figure 2.6. Key to geologic map (Figure 2.5).

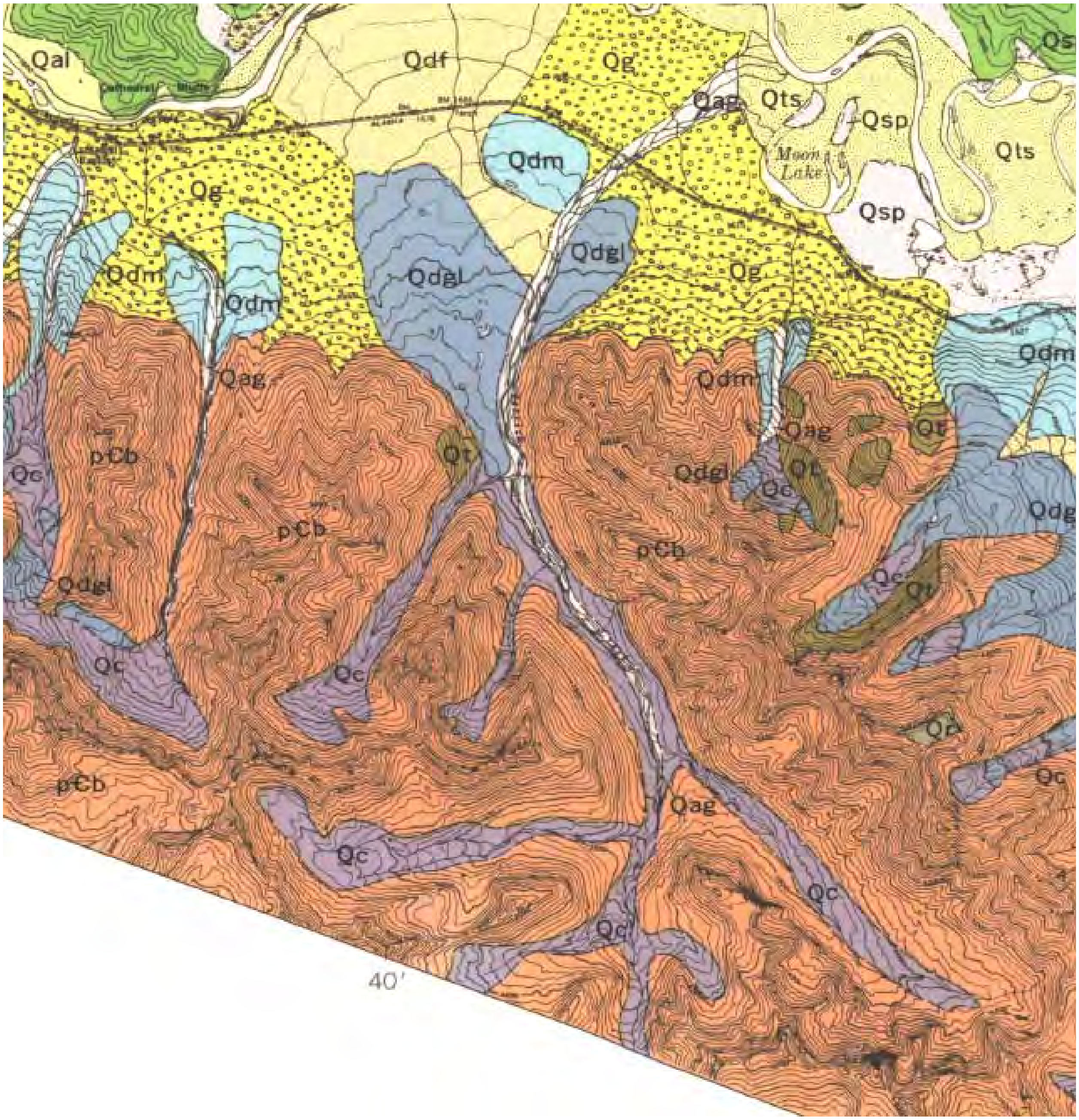

Figure 2.7. Bedrock and surficial geology (Holmes, 1965).

2.2 SAMPLE LOCATIONS

The two streams directly impacted by the Yerrick Creek Hydroelectric Project are Yerrick Creek and Cathedral Rapids Creek No. 1. Yerrick Creek has the larger drainage basin, which includes approximately eight tributaries identifiable on the 1:63,360 scale USGS map. Two small streams merge to form the headwaters of Cathedral Rapids Creek No. 1. Both Cathedral Rapids Creek

No. 1 and Yerrick Creek drain to the north into the Tanana River. The proposed diversions, as of September 2008, would discharge into Yerrick Creek downstream (north) of the old pipeline corridor) and at a separate downstream location on Cathedral Rapids Creek No. 1.

2.3 WATER QUALITY PARAMETERS

The water quality parameters measured are listed in Table 2.8. The physical and chemical parameters include alkalinity, conductivity, dissolved oxygen, hardness (calculated), pH, settleable solids, total dissolved solids, total suspended solids, temperature, and turbidity. Two other general parameters commonly measured are chloride and fluoride. Chloride is necessary for performing an ion balance. Fluoride is included because it is required by the ADEC. The nutrient parameters include nitrate, phosphate, and sulfate. The remaining parameters in Table 2.8 are metals and trace elements. Hardness is calculated from measured parameters. Analysis of all parameters will be on unfiltered samples, so the results are total, not dissolved concentrations

Table 2.8. Surface water quality parameters.

Laboratory				
Antimony	Chloride	Magnesium	Sodium	Total Dissolved Solids
Arsenic	Chromium	Manganese	Sulfate	Total Suspended Solids
Barium	Copper	Mercury	Zinc	Weak Acid Dissociable Cyanide
Beryllium	Fluoride	Potassium		
Cadmium	Iron	Selenium		Total Cyanide
Calcium	Lead	Silver		
Field				
Flow	pH	Conductivity	Temperature	Turbidity
Alkalinity	Nitrate	Color	Settleable Solids	Dissolved Oxygen
Orthophosphate	Nitrite			

2.4 METHODOLOGY

Field and laboratory water quality parameters were measured in accordance with the U.S. Environmental Protection Agency manual Methods for Chemical Analysis of Water and Wastes or Standard Methods for the Examination of Water and Wastewater. Open channel flow was measured using Model 1205 Price type “mini” current meter. In-situ measurements of conductivity, temperature, pH and dissolved oxygen were accomplished with YSI 63 and YSI 95 meters. Color, turbidity, and alkalinity were measured in the field within 24 hours of sample collection using the Hach DR890 Colorimeter, Hach 2100P Turbidimeter, and Hach digital titrator. A table showing analytes and methods is included in Appendix B.

SGS Environmental Services, Inc. was the analytical laboratory selected for the monitoring program. SGS Environmental Services, Inc. is an ADEC Certified Chemistry Lab. Duplicate samples were not collected as part of this sampling effort. Laboratory quality assurance and quality control measures and results are shown in the laboratory data report in Appendix B.

3.0 RESULTS

Measurements and samples were taken at 3 locations. The sample sites, shown in Figure 3.1, are located at:

- The approximate diversion site for Yerrick Creek, which is also the transducer location as of September 2008;
- The approximate diversion site for Cathedral Rapids Creek No. 1; and
- A downstream site near the old pipeline corridor's intersection with Yerrick Creek, which was intended to be at the discharge or re-entry site for water diverted from Yerrick Creek. The discharge point will actually be downstream of the sample site.

The Yerrick Creek diversion site is also the location where AP&T personnel have conducted flow studies and are presently recording stage data on a continuous basis with a permanently installed pressure transducer. The data collected by AP&T is not included in this report, but should be comparable based on location.

The Yerrick Creek downstream site is also in immediate vicinity of field work conducted by Denali-The Alaska Gas Pipeline personnel. Data from their efforts, if made available, should be comparable based on location.

Physical and chemical measurements made in the field are presented in Table 3.1. Laboratory analysis results are shown in Table 3.2. Hardness (Table 3.2) was calculated from the calcium and magnesium concentrations. Iron, zinc, and manganese could have been included, but were all either not detected, or detected at levels below the practical quantitation limit and are therefore minor contributors to total hardness.

Yerrick Creek and Cathedral Rapids Creek No. 1 are clear, oligotrophic (low nutrient levels), and well oxygenated. The moderately high pH for surface water suggests contact with some kind of carbonate rock within the drainage.

Laboratory results confirm that Yerrick Creek and Cathedral Rapids Creek No. 1 have minimal levels of most dissolved substances.

Laboratory quality assurance and quality control information were reviewed. No problems were identified that would affect data quality. For additional details, see the case narrative on page 2 of the laboratory data report in Appendix B.

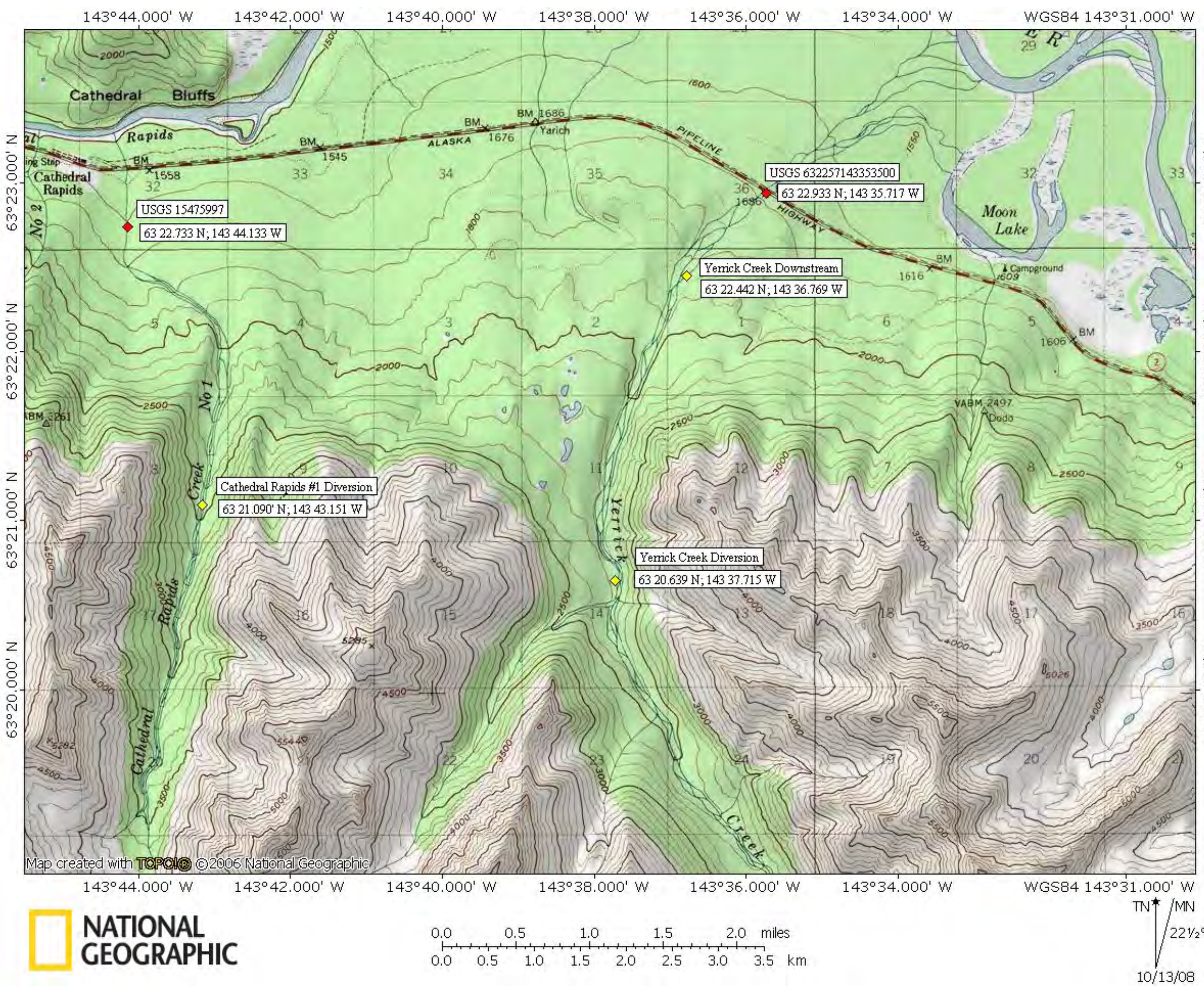

Figure 3.1. Sample site locations.

Table 3.1. Field measurements.

Parameter	Yerrick Creek Diversion	Yerrick Creek Downstream Site	Cathedral Rapids Creek Diversion
Latitude	63° 20.639' N	63° 22.442'	63° 21.090' N
Longitude	143° 37.715' W	143° 36.769	143° 43.151' W
Elevation (feet)	2272	1856	2455
Width (feet)	44	51.5	18.5
Discharge (CF/S)	110	99	27
Temperature (°C)	4.5	6.2	5.0
pH	8.01	8.14	8.18
Specific Conductance (µS)	260	277	384
Dissolved Oxygen (mg/L)	16.02	18.51[1]	12.39
Settleable Solids (mL/L)	< 0.1	< 0.1	< 0.1
Alkalinity (mg/L as $CaCO_3$)	57.6	64.0	80.4
Color (PtCo units)	4	6	0
Turbidity (NTU)	0.91	0.89	0.70
Nitrate-N (mg/L)	0.01	0.03	0.01
Nitrite-N (mg/L)	0.002	0.002	0.002
Orthophosphate (mg/L)	0.18	0.19	0.21

[1]Whitewater – supersaturated.

Table 3.2. Laboratory analyses.

Parameter	Units	Yerrick Creek Diversion	Yerrick Creek Downstream Site	Cathedral Rapids Creek Diversion
Sample ID		AP&T 01	AP&T 03	AP&T 02
Sample Date/Time		9/03/08 12:27	9/03/08 17:50	9/03/08 15:05
Antimony	ug/L	0.621 J	0.454 J	< 0.310
Arsenic	ug/L	< 1.50	< 1.50	< 1.50
Barium	ug/L	32.2	31.8	44.1
Beryllium	ug/L	< 0.500	< 0.500	< 0.500
Cadmium	ug/L	< 0.600	< 0.600	< 0.600
Calcium	ug/L	43500	42700	57600
Chromium	ug/L	< 1.20	< 1.20	< 1.20
Copper	ug/L	< 1.80	< 1.80	< 1.80
Iron	ug/L	< 310	< 310	< 310
Lead	ug/L	< 0.310	< 0.310	< 0.310
Magnesium	ug/L	7880	7790	12900
Manganese	ug/L	0.859 J	0.907 J	1.08 J
Mercury	ug/L	< 0.0620	< 0.0620	< 0.0620
Potassium	ug/L	3290	3330	3660
Selenium	ug/L	< 0.620	< 0.620	< 0.620
Silver	ug/L	< 0.620	< 0.620	< 0.620
Sodium	ug/L	2400	2460	3250
Zinc	ug/L	< 7.80	< 7.80	< 7.80
Chloride	mg/L	0.0880 J	< 0.0310	0.0800 J
Fluoride	mg/L	0.0750 J	0.0870 J	0.049 J
Sulfate	mg/L	81.8	81.0	119
Total Cyanide	mg/L	0.0022 J	< 0.0015	0.0017 J
Weak Acid Dissociable Cyanide	mg/L	< 0.0015	< 0.0015	< 0.0015
Total Dissolved Solids	mg/L	183	176	253
Total Suspended Solids	mg/L	1.00	0.400 J	0.700
Hardness (calc.: Ca, Mg)	mg/L*	141	139	197

*as $CaCO_3$
J = analyte was detected below the practical quantitation limit
Analytes that were not detected are reported as < the minimum detection limit.

4.0 RECOMMENDATIONS

As there are no chemical abnormalities that would warrant further investigation of the streams to be impacted by the hydroelectric project and flow data has been collected regularly by AP&T personnel, no additional hydrology field work should be required before permitting or construction.

5.0 CLOSURE

TPECI holds all information acquired during this investigation in the strictest confidence with AP&T. We will not release any information to any party other than Graystar Pacific Seafoods unless AP&T has notified us of their approval to do so.

6.0 LITERATURE CITED

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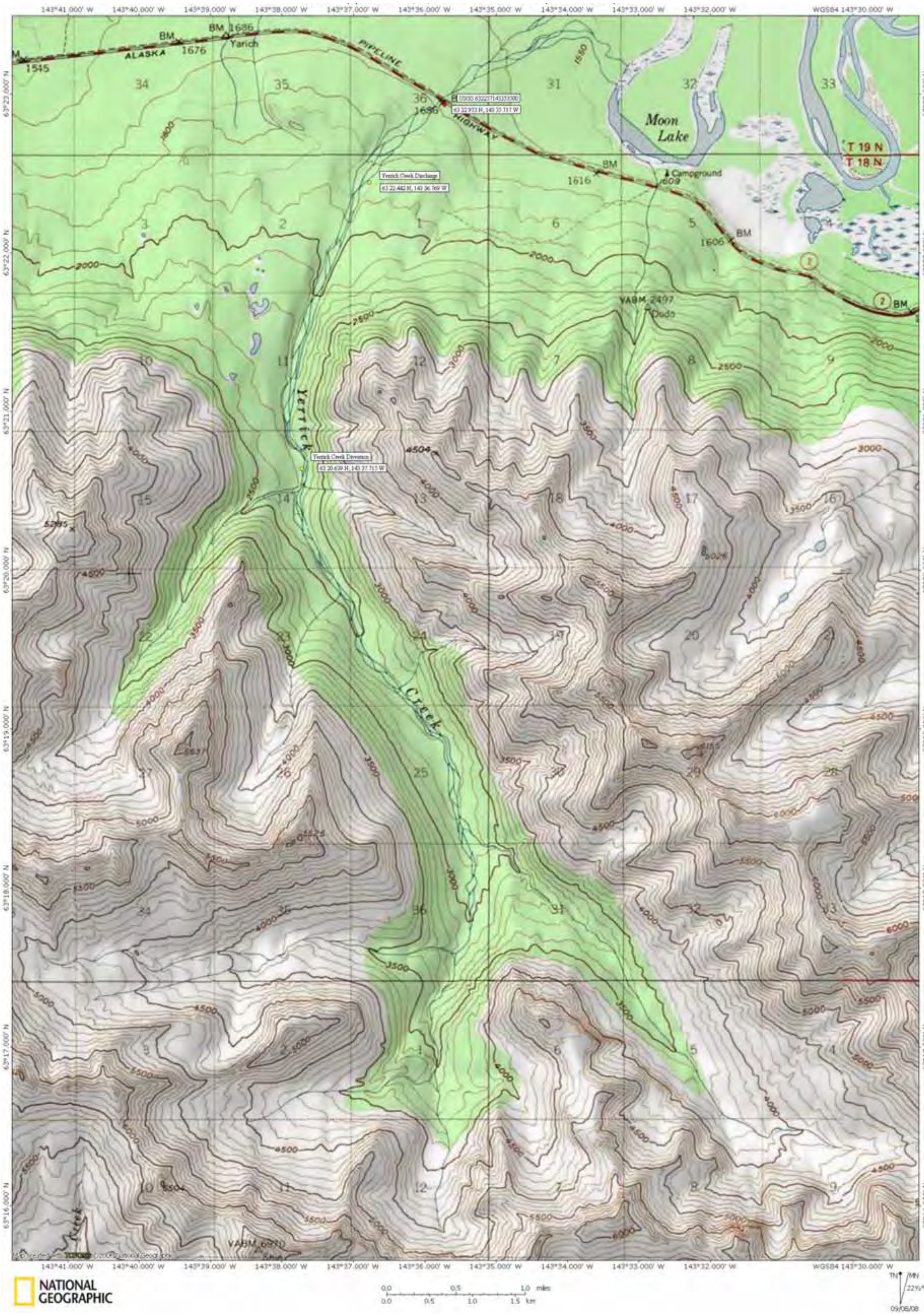
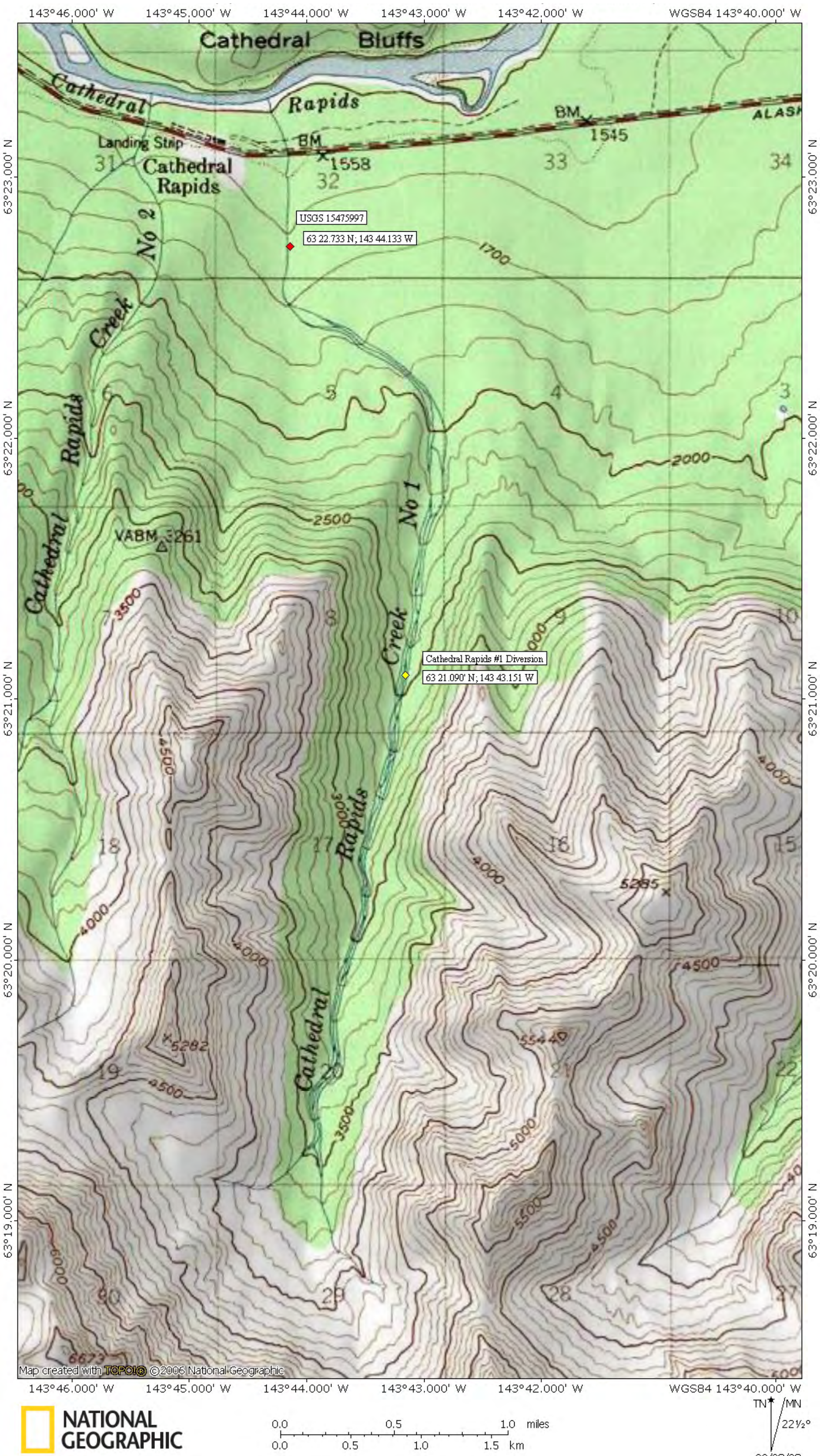
APPENDIX A

SAMPLE SITE MAPS
SITE PHOTOGRAPHS

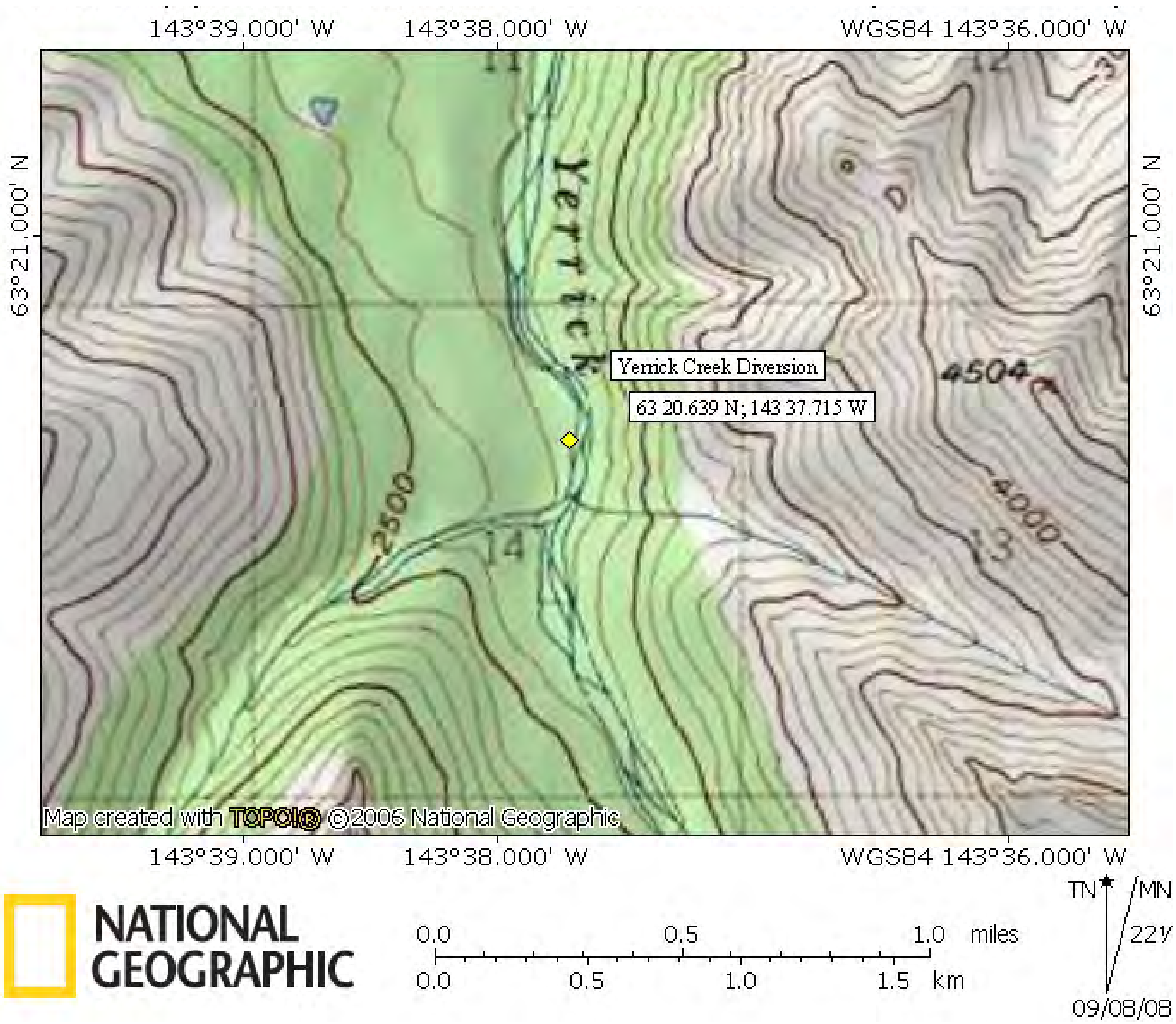
Yerrick Creek Map



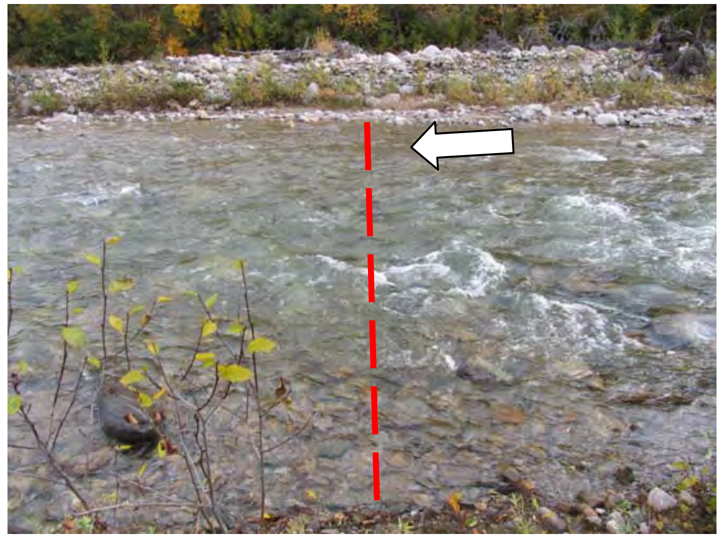
Cathedral Rapids Creek No. 1 Map



Yerrick Creek Diversion Site Map

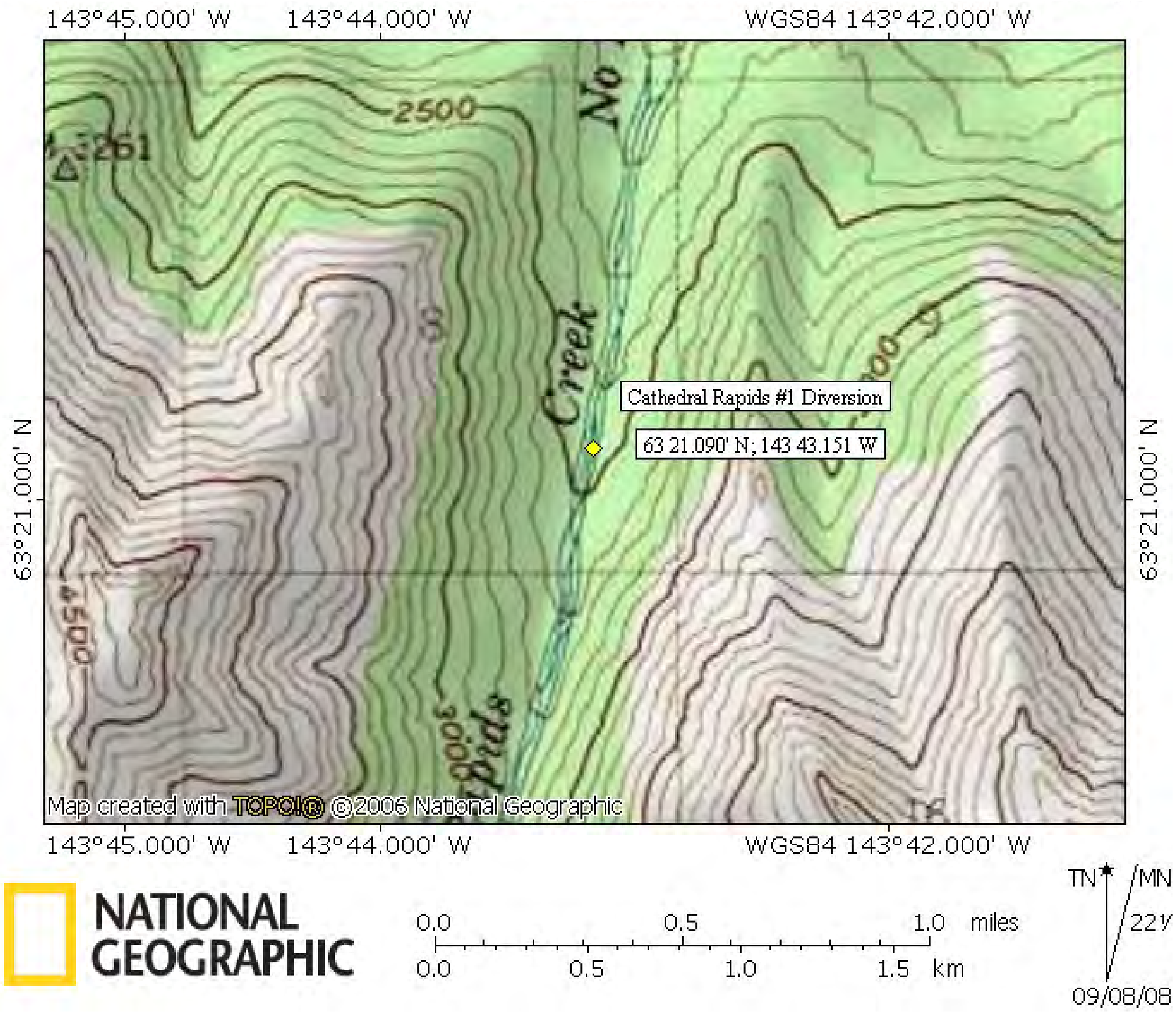


Yerrick Creek Diversion Site Photos

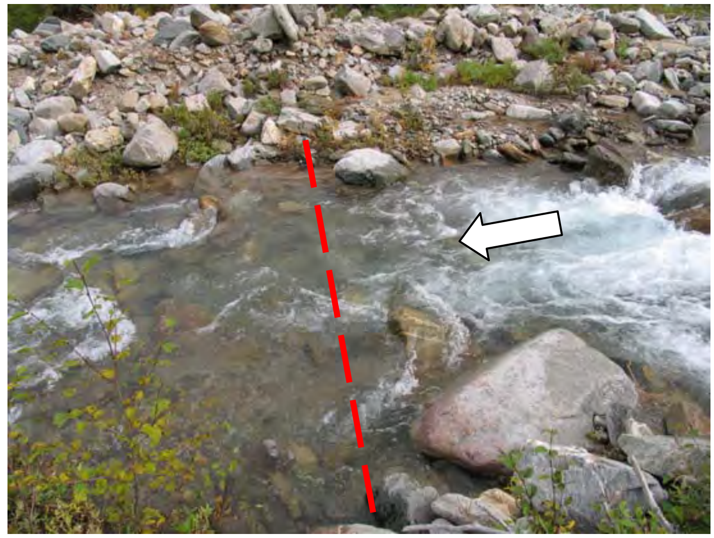


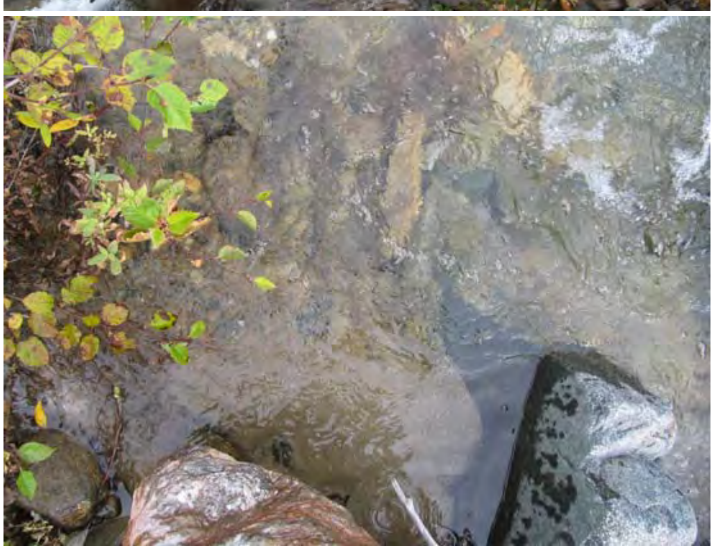
Upper Left: aerial view
Upper Right: site view
Middle Left: upstream view
Middle Right: downstream view
Lower Left: sediment view

Cathedral Rapids Creek No. 1 Diversion Site Map



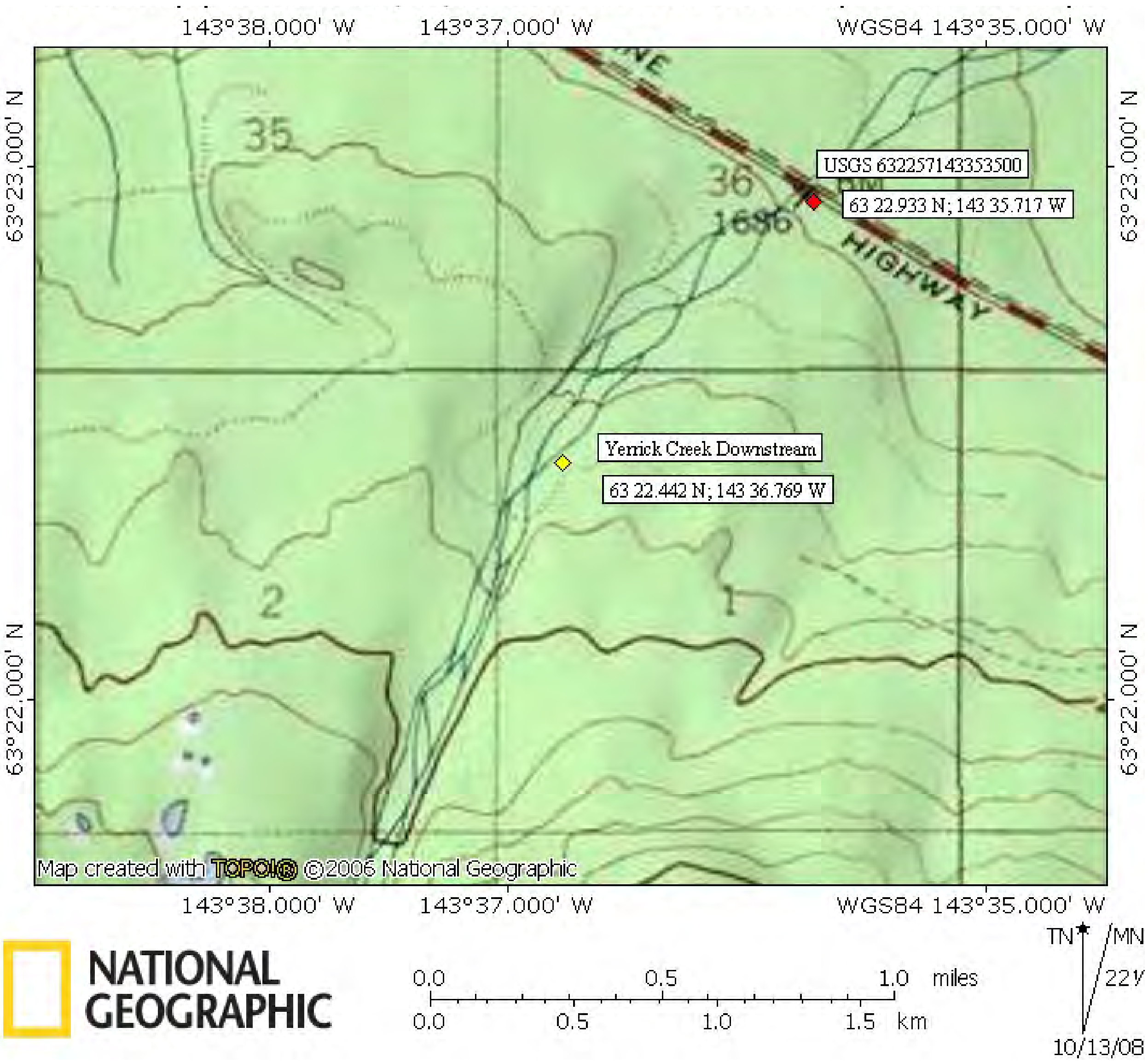
Cathedral Rapids Creek No. 1 Site Photos



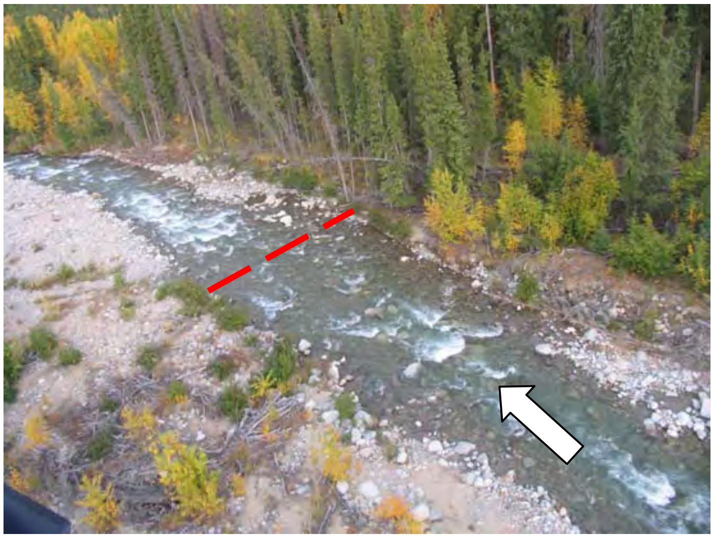


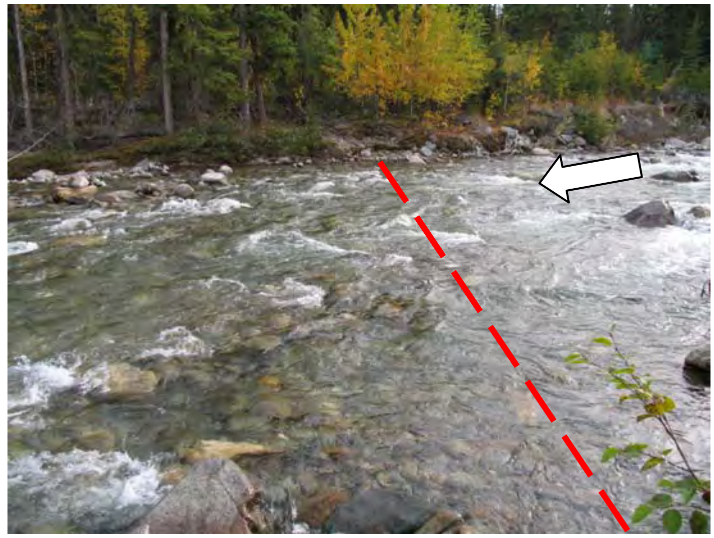
Upper Left: aerial view
Upper Right: site view
Middle Left: upstream view
Middle Right: downstream view
Lower Left: sediment view

Yerrick Creek Downstream Site Map



Yerrick Creek Downstream Site Photos





Upper Left: aerial view
Upper Right: site view
Middle Left: upstream view
Middle Right: downstream view
Lower Left: sediment view

APPENDIX B

ANALYSIS METHODS
LABORATORY DATA REPORT (SGS WO# 1084964)

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YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

~FISH REPORT~

10 June 2009

To: APT – Glen Martin

From: GRAYSTAR – Steve Grabacki

Subject: Report of Fisheries Fieldwork, Yerrick Creek, May-June 2009

I conducted three sampling sessions on Yerrick Creek -- 19-20 May 2009, 27-29 May 2009, and 7 June 2009.

For the first two sessions, the study area included lower Yerrick Creek, from roughly ½-mile above the proposed powerhouse site downstream to the Tanana River. The main purpose of the sampling was to compare spawning aggregations of Arctic grayling above vs. below the proposed powerhouse site. Sampling methods included visual observation with polarized lenses, angling with spin and fly terminal tackle, underwater video, and 3 styles of fish traps (small wire-mesh minnow traps, medium collapsible minnow traps with larger throat, and larger collapsible traps) baited with commercially cured salmon roe.

On the third sampling session, we focused on the creek downstream of the highway. The purpose of this sampling was to observe and capture Arctic grayling in lower Yerrick Creek, and to compare grayling's use of the creek for spring spawning by adults vs. summer feeding by juveniles. Sampling methods included visual observation with polarized lenses, angling with spin and fly terminal tackle, and herding fish through pools into a bag seine.

General Habitat Description

For most of its length, Yerrick Creek is a cascading stream with fast flow and boulder substrate. The stream generally comprises 1-3 channels, within a wide dynamic (scoured) perimeter. Apparent fish habitat consists of widely spaced, very small (~10-foot long) pools behind large boulders or logjams.

Roughly 1 mile before the creek joins the Tanana River, the habitat is significantly different. Flow is much slower, and the habitat is composed mostly of sand. In this "delta" area, there are 3 main channels, several smaller channels which leave and rejoin the larger channels, and at least one large area ("city block" in size) through which the creek flows more-or-less overland, in very shallow channels among dense spruce trees.

In between these two reaches is a transition zone, where flow is intermediate in strength and substrate is small rocks & large gravel. This transition zone is only a few hundred yards long.

Complicating this situation is the fact that the water flowing in the creek is not always continuous with the river. Because of the porous substrate, the water sometimes disappears from the surface, and flows underground.

First Sampling Session

During the field trip of 19-20 May 2009, Yerrick Creek did not flow into (connect to) the Tanana River. Water flow appeared strongest at the uppermost sampling station (above the powerhouse site), and water was flowing in only 1 channel under the highway bridge.

On 19 May, the water disappeared approximately ¾-mile downstream of the bridge, within the rocky streambed. On 20 May, the water had reached about 0.9 miles farther downstream, but disappeared in the sandy substrate. In the sandy delta area, there were a few very small pools with very little flow, and mostly dry substrate.
At the bridge, water temperature was –

10.8°C at about 1630 on 18 May

5.1°C at 1030 on 19 May

1.7°C at 0915 on 20 May

-- this range of daily temperature variation was observed on both sampling trips. (Arctic grayling are thought to spawn at 4°C).

The 3 channels of Yerrick Creek drain into a backwater slough of the Tanana River. Although there was no surface water flow from the creek to the river, there was water in that slough. Water temperature was 10.5°C. We observed approximately 12 grayling in a tight school. The fish appeared to be roughly 250-300 mm in length. They were easily spooked, and did not respond to spinners or flies. We also observed 1 round whitefish, of approximately 300 mm in length, dozens of small (~20 mm) grayling, and hundreds of tiny (<10 mm) fish (species unknown). We captured no fish in the fish traps.

Above the powerhouse site on 19-20 May, we captured 1 Dolly Varden (225 mm FL) in a trap, but observed no other fishes in this area.

Second Sampling Session

During the field trip of 27-29 May 2009, the flow in the creek was much greater, and the water appeared to be more turbid, than it had been a week earlier. At the bridge, the water was flowing in 2 channels (vs. one 1 channel, a week before), and was –

5.1°C at 1010 on 27 May

4.1°C at 0600 on 28 May, after a cool night

7.1°C at 1240 on 28 May

2.8°C at 0610 on 29 May, after a rainy night

3.5°C at 0925 on 29 May

5.3°C at 1455 on 29 May

Yerrick Creek was flowing into the Tanana River (the slough where we had earlier sampled) through its 3 main channels. Just above those confluences, the creek was braided through the forest, with several small channels and overland flows (among the trees). In these small channels, we observed 2 individual grayling (the fish were widely separated, not aggregated).

We observed no fish in the lower creek (below the bridge), on either the rocky or sandy substrates, but we did capture 2 slimy sculpin in a trap. Water temperature in the lower creek was –

6.8°C at 1145 on 28 May

4.5°C at 1135 on 29 May

Above the powerhouse site, we captured 7 Dolly Varden in traps, but observed no other fishes, with any sampling method. Water temperature in this area was –

7.5°C at 1325 on 28 May

3.7°C at 1330 on 29 May

During this second field trip, we found some of the fish traps in different positions from where we had set them. They appeared to have been moved to the shore or (in one case) out of the water by an overnight flood event.

To summarize the first two samplings -- For grayling to spawn in Yerrick Creek, 2 factors are necessary – water temperature of 4-5°C, and continuity of water flow from the creek to the river. As expected, we observed a school of grayling in the Tanana River very near the mouth of Yerrick Creek, before the creek had reached the river. Those fish were apparently waiting to enter the creek. After the creek had reached the river, we observed grayling in the sandy-bottom, slower-flowing "delta" channels of the creek, but no grayling in the rocky-bottom, faster-flowing cascading parts of the creek. Also, we did not observe aggregations of grayling anywhere in Yerrick Creek.

<u>Third Sampling Session</u>

We sampled Yerrick Creek on 7 June 2009. The weather was cool and rainy in the morning, but turned mostly sunny and warm in the afternoon. Water was clear, and 5.4C at 1100.

The purpose of this sampling was to observe and capture Arctic grayling in lower Yerrick Creek, and to compare grayling's use of the creek for spring spawning by adults vs. summer feeding by juveniles. Sampling methods included: visual observation with polarized lenses, angling with spin and fly gear, and herding fish downstream through pools into a bag seine, which was stretched across the creek.

We observed no fishes in the fast flow / boulder substrate zone, or in the slow flow / sand substrate zone. In the transition zone, we captured 1 grayling, and observed 4 individual (not aggregated) grayling: 2 of these were roughly 200 mm long, and 2 fish were approximately 100 mm long. The captured grayling was 208 mm fork length, and did not appear to be in either a pre-spawning or post-spawning condition.

I took scale samples from the captured grayling, and released it in apparent good condition. I drove to Delta, and met with ADFG's Fronty Parker. We discussed my findings, and we pressed and read the sample of scales that I took from the fish I caught on Sunday (6/7). That grayling was 2 or 3 years old, definitely juvenile, not a spawning adult.

Based on my sampling in early September 2008, and on these three sampling sessions in May-June 2009, a picture of grayling use of Yerrick Creek seems to have emerged. Grayling appear to use parts of Yerrick Creek (below and within the bypass reach) for summer feeding, on an opportunistic basis. While I cannot prove that grayling do not spawn in Yerrick Creek, I have found no evidence to support it --

* The creek did not connect to the river at the expected time of grayling spawning.

* I observed no aggregations of grayling anywhere in Yerrick Creek; all grayling observed in the creek in May-June 2009 appeared to be individual fish.

* I observed no adult-size grayling, and the largest grayling observed in June 2009 (the 2- or 3-year-old) did not appear to be in either a pre-spawning or post-spawning condition.

REPORT

FISHERIES BASELINE STUDY

for a

PROPOSED HYDROELECTRIC DEVELOPMENT

on

YERRICK CREEK

near

TOK, ALASKA

prepared for –

ALASKA POWER & TELEPHONE Company
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October 2008

1 -- INTRODUCTION

ALASKA POWER AND TELEPHONE COMPANY (AP&T) has proposed to install a hydroelectric project on Yerrick Creek, near Tok, Alaska. This document is the report of the first year of a fisheries baseline study, in support of that project.

The study area included Yerrick Creek (YER) and Cathedral Rapids Creek #1 (CR1). These streams are small tributaries of the upper Tanana River, in eastern interior Alaska. The fish and fisheries of the upper Tanana River drainage are studied and managed by the Alaska Department of Fish & Game (ADFG, or "the department"). Neither YER nor CR1 are listed in ADFG's Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated Atlas -- http://www.sf.adfg.state.ak.us/SARR/awc/ -- although the Tanana River itself is listed.

YER and CR1 lie within ADFG's Upper Tanana Management Area (UTMA), which is within ADFG's fishery management region III, also known as the Arctic-Yukon-Kuskokwim (AYK) region (Figure 1). The UTMA encompasses Delta Junction, Tok, and several smaller communities (Figure 2).

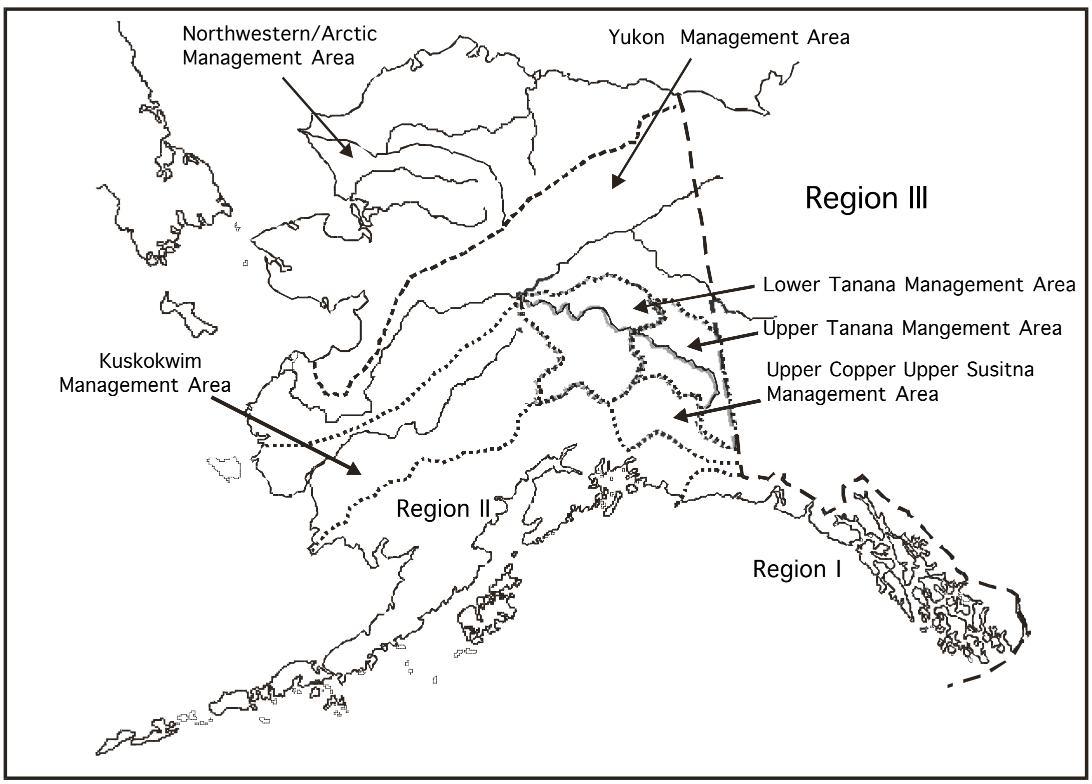

Figure 1 -- Map of ADFG's Sport Fish Regions, and the Six Region III Management Areas
source: Parker 2006

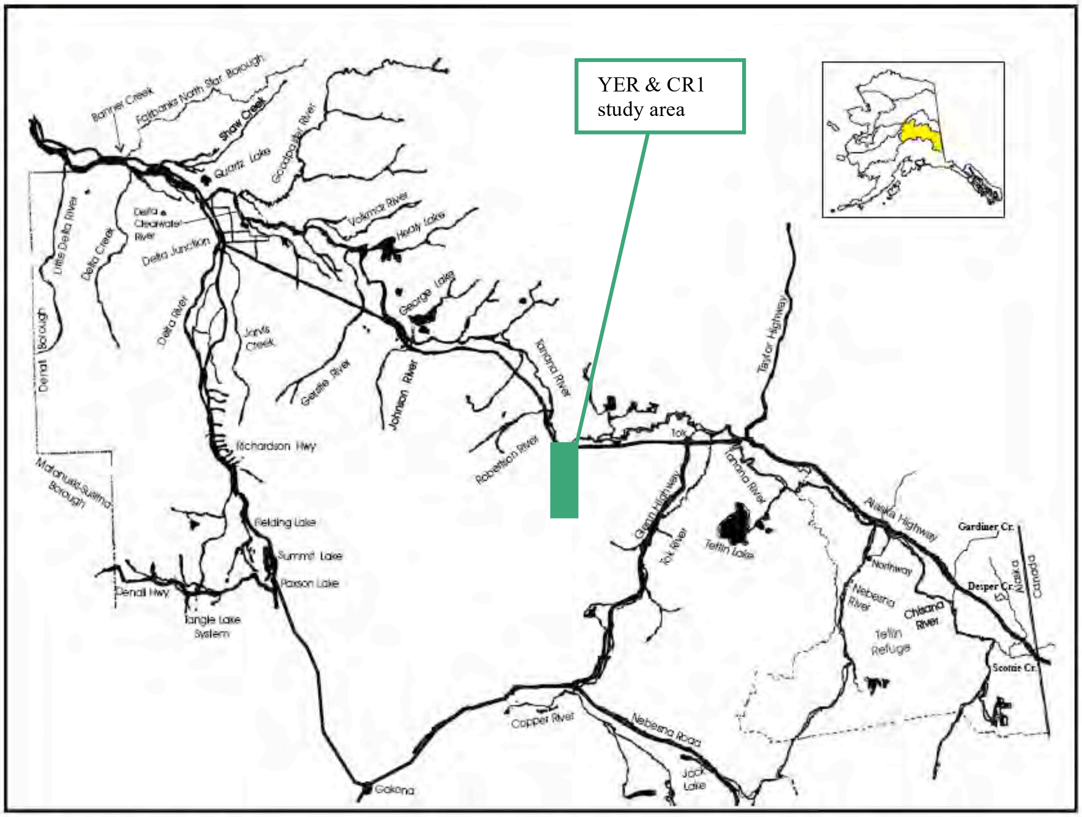

Figure 2 -- Map of the Upper Tanana Management Area within the Tanana River Drainage
source: Parker 2006

Several fish species are found in the UTMA –

Common Name	*Scientific Name*
chinook (king) salmon	*Oncorhynchus tshawytscha*
coho (silver) salmon	*Oncorhynchus kisutch*
chum (keta) salmon	*Oncorhynchus keta*
Arctic grayling	*Thymallus arcticus*
burbot	*Lota lota*
lake trout	*Salvelinus namaycush*
Dolly Varden	*Salvelinus malma*
round whitefish	*Coregonus cylindraceum*
least cisco	*Coregonus sardinella*
humpback whitefish	*Coregonus pidschian*
northern pike	*Esox lucius*

ADFG's Division of Sport Fish publishes an annual Fishery Management Report for Sport Fisheries in the Upper Tanana River Drainage. These reports focus on the more abundant sport-caught fishes: coho salmon, Arctic grayling, northern pike, lake trout, and burbot. Dolly Varden char are not explicitly studied. The most recent available such report (as of October 2008) is Parker 2006.

ADFG has stocked rainbow trout (*Oncorhynchus mykiss*), Arctic char (*Salvelinus alpinus*), coho salmon, Arctic grayling, and lake trout in selected waters of the Upper Tanana area (Parker 2006).

In general, there is less sport fishing effort in the UTMA, as compared to the Lower Tanana Management Area (Parker 2006); for example, in 2005 --

* 33% of anglers in the Tanana River drainage fished in UTMA
* 30% of fishing trips in the Tanana River drainage were in UTMA
* 28% of fishing effort in the Tanana River drainage was in UTMA
* 39% of fish harvest in the Tanana River drainage was in UTMA

In 2005, Arctic grayling comprised over half of the sport fish catch, but less than one-third of the sport fish harvest (fish caught and retained) in UTMA (Parker 2006) –

Species	Catch	% of Catch[d]	Harvest	% of Harvest[e]	% Harvested
Salmon					
* chinook	25	0.03	25	0.15	100.0
* coho[a]	2,830	2.97	267	1.61	9.4
* coho[b]	2,973	3.12	1,002	6.02	33.7
* chum	686	0.72	0	0.0	0.0
Non-Salmon					
* rainbow trout	17,355	18.20	6,336	38.10	36.5
* lake trout	3,651	3.83	569	3.42	15.6
* char[c]	1,453	1.52	463	2.78	31.8
* Arctic grayling	55,943	58.66	5,242	31.52	9.4
* northern pike	8,299	8.70	1,646	9.90	19.8
* whitefish	455	0.48	60	0.36	30.5
* burbot	1,370	1.44	1,021	6.14	74.8
* sheefish	0	0.0	0	0.0	0.0
* other fishes	321	0.34	0	0.0	0.0
TOTAL	95,361		16,631		17.4

[a] – anadromous salmon
[b] – landlocked coho & Chinook salmon
[c] – includes Arctic char & Dolly Varden
[d] – the species' percent of UTMA total catch, calculated from Table 7 in Parker 2006
[e] – the species' percent of UTMA total harvest, calculated from Table 7 in Parker 2006

The preceding table shows that 1.52% of the catch, and 2.78% of the harvest, were composed of "char", which includes both wild Dolly Varden and stocked Arctic char.

Because of their wide distribution and comparatively high abundance, Arctic grayling are important to both sport and subsistence harvesters. As such, they have been extensively studied by ADFG scientists for decades. In the Tanana River drainage, grayling exhibit a wide range of age and size at maturity (Clark 1992). Similar studies have not been conducted for Dolly Varden in the upper Tanana drainage, but anecdotal observations indicate that Dolly Varden in that area may reach maturity and spawn at small sizes (< 200 mm fork length) (J.F. Parker, ADFG, personal communication, 2008), and even while exhibiting so-called "juvenile" characteristics such as parr marks (A.E. Rosenberger, University of Alaska Fairbanks, School of Fisheries & Ocean Sciences, personal communication, 2008).

ADFG has conducted comprehensive fish surveys of the streams of the middle and lower Tanana River drainage, including clear, clear/glacial, glacial, humic/glacial, and humic creeks and rivers, and found no Dolly Varden in any of those habitats (Durst 2001, Hemming & Morris 1999).

Arctic grayling conduct seasonal migrations among overwintering, spawning, and summer feeding habitats, and seasonal changes in water temperature are generally considered to be the triggers for those movements (Ridder 1995, Ridder 1994, and several previous studies cited in those reports. Similar studies have not been conducted for Dolly Varden in the upper Tanana drainage, but anecdotal reports indicate that there may be year-round resident populations of Dolly Varden in the upper reaches of Yerrick Creek (J.F. Parker, ADFG, personal communication, 2008).

In 1988, 367 Tok households were surveyed to determine their subsistence use of fish, game, and plant resources. Most households used subsistence-caught salmon (79.4%) and freshwater fish (71.4%). In the freshwater fish category, the predominant subsistence species were grayling (55.7%), burbot (40.2%), rainbow trout (35.0%), large pike (27.2%), whitefish (25.9%), and lake trout (22.9%). Only 0.9% of Tok households reported using subsistence-caught Dolly Varden. The report does not identify where these various fish species were harvested, but because the Tok data set includes marine fish (27.5%), such as halibut, it appears that Tok residents harvest subsistence fisheries resources far from home, and not only in the local Tok area (McMillan & Cuccarese 1988).

In conclusion, Arctic grayling are the most commonly sport-caught fish in the UTMA, and the second-most common sport-harvested species. Grayling are also taken by subsistence harvesters. Dolly Varden are comparatively uncommon in the UTMA, in both the sport and subsistence harvests, and were not reported by either of two ADFG scientific investigations.

Finally, in the late 1970s and early 1980s, the Alaska Department of Fish & Game's Division of Fisheries Rehabilitation, Enhancement, & Development (FRED) investigated possible sites for salmon hatcheries throughout Alaska. In a survey of Yerrick Creek in February 1980, Raymond (1980) reported –

* the Upper Tanana River Valley has many ingredients for a good hatchery site: year-round highway access, high-gradient streams, and hardly any salmon
* most of the creeks in this area dry up in winter
* there was no evidence of running water at the highway bridge
* there was evidence of running water at two sites: 1 mile and 2 miles upstream of the highway
* water temperature was too low for a flow-through hatchery
* there was plenty of hydropower available

2 -- METHODS

YER is characterized by steep gradient, cascading flows, and large boulder substrate. The channels appear to be dynamic, as judged by cleanliness of the substrate in and near the water: very little periphyton and almost no terrestrial vegetation. There are few pools in YER that appear capable of providing habitat for fishes. Those pools are small, in the range of 10-20 ft long.

CR1 is much smaller and steeper than YER. It is essentially one long, cascading run, with strong current and large boulder substrate. Small pools are apparent only at very low flows. For example, in June (lower flow than in September), a pool of roughly 10 ft wide x 20 ft long x 2 ft deep was observed at WP 037: 63°21.595'N 143°43.005'W elevation: 2,239 ft but this pool could not be located in early September, when flow was greater. Similarly, a few smaller pools were observed in June, but by early September, the dynamic channel appeared to have shifted so that they were no longer apparent.

During sampling visits in summer 2008, the wetted perimeters of both streams were much smaller (narrower) than their respective dynamic channels (area of clean boulders).

The fish sampling stations on YER and CR1 were selected to bracket the area of interest to AP&T's proposed project (Figure 3) –

* Station UYC: upper Yerrick Creek, well above the hydropower impoundment site
* Station UMY: middle/upper Yerrick Creek, above the impoundment site
* Station YCI: Yerrick Creek, in the general vicinity of the proposed impoundment
* Station MYC: middle Yerrick Creek, between the impoundment and the powerhouse
* Station LYC: lower Yerrick Creek, downstream of the proposed powerhouse
* Station CRI: Cathedral Rapids Creek #1, in the vicinity of the proposed impoundment

The purpose of this study was to characterize the seasonal presence and distribution of fishes in the two streams.

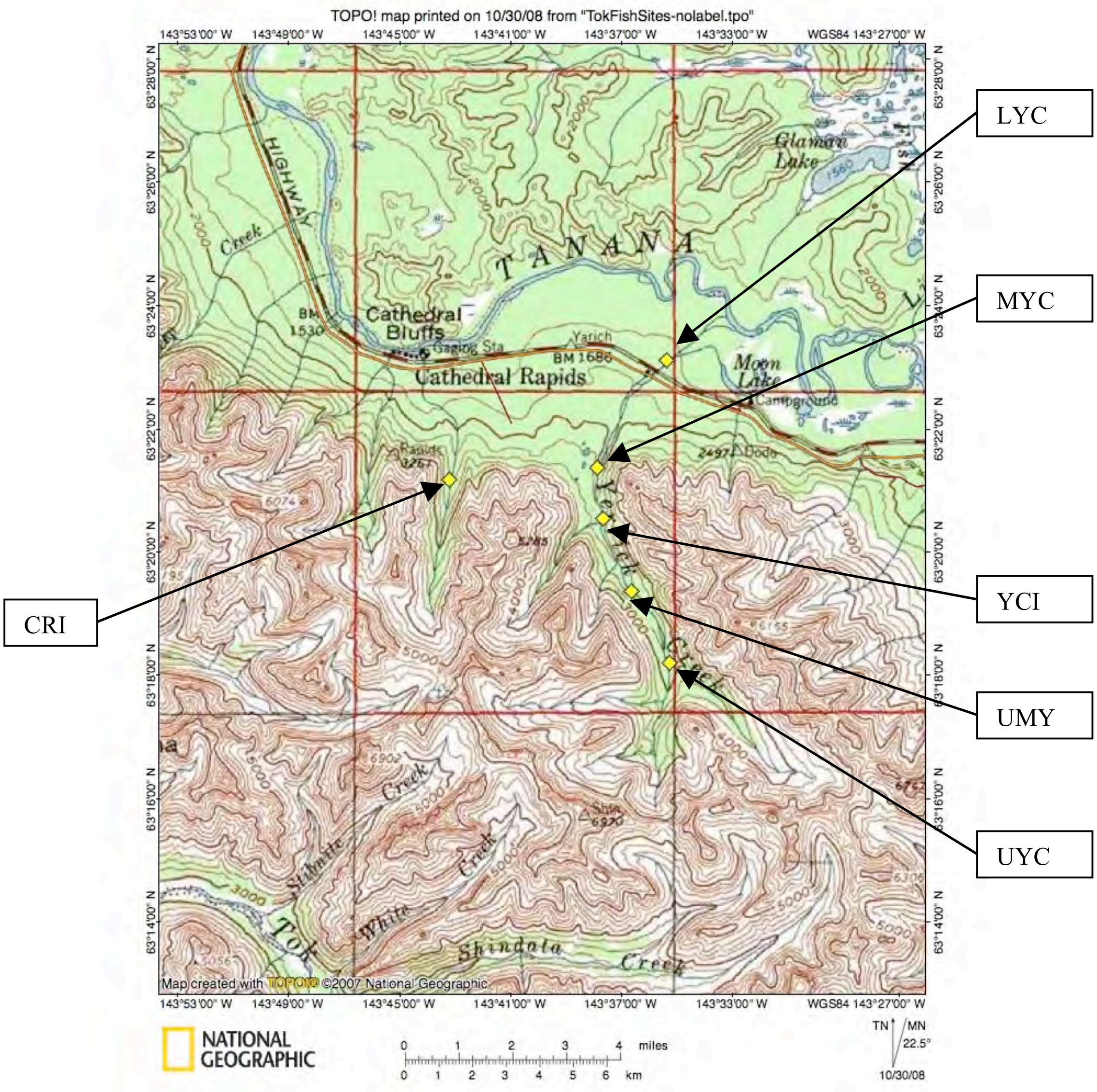

Figure 3 -- Sampling Sites for the 2008 Fisheries Baseline Study

The two creeks were visited on foot and examined, but not sampled, 6-7 June 2008. Fish habitat was generally characterized, and the locations of possible fish-bearing pools were recorded.

Sampling, supported by helicopter, was conducted –

* 3-4 September 2008 (YER and CR1); this sampling was originally scheduled for early August, in order to sample fish in their summer habitats, but because of unusually heavy and prolonged rains and flooding in the Tok area, the trip was postponed twice until early September; nevertheless, the weather and water were warm and summer-like, but the water flow was still noticeably higher than in June

* 29-30 September 2008 (YER only); this sampling was intended to sample fish immediately before freeze-up, in order to understand the species winter habitats; the water flows were lower than in early September

Sampling methods included --

* electrofisher + bag seine (the electrofisher was used to herd the fish into the bag seine, rather than stunning them); it was difficult to maintain the seine in the current at some sites, and impossible at other sites; also, this was more effective in late September, because flow was less than in early September; where it was not possible to maintain the bag seine in strong current, electrofishing was performed as best as possible along the sides of the stream and in small backwater areas; in most cases, electrofishing was performed by two people: one bearing the backpack unit, and the other using a dipnet

* minnow traps baited with commercially cured salmon eggs and left to soak overnight in pools, where pools could be found; fewer pools were visible during early September (higher flow) vs. in late September (lower flow), so that traps were not set at all sites in early September

GPS coordinates, as displayed on a brand new Garmin GPS unit, do not appear to match the apparent location as displayed in Figure 3, which is drawn from a brand new version of the TOPO! mapping software. It is not clear if the error is within the GPS unit, the software, or in the interaction between the two. In this report, the GPS readings are listed in Appendix A, and the apparent location is shown in Figure 3.

3 -- RESULTS

Fish sampling was conducted under ADFG Fish Resource Permit SF2008-172. A report of those activities was submitted to ADFG on 27 October 2008, and is attached to this report as Appendix A. Two species of fish were captured: Dolly Varden (DV) and Arctic grayling (AG). All fishes were measured and released alive, in apparent good condition. The results of the 2008 fish sampling were –

YERRICK CREEK – 3-4 September 2008

Station UYC

** 1 minnow trap + electrofish ~40 yds of stream

DV (5): 127, 122, 120, 127, 117 mm fork length (FL)

Station YCI
** 2 minnow traps + electrofish ~160 yds of stream
DV (4): 135, 110, 102, 115 mm FL
AG (3 possible males): 220, 235, 190 mm FL
AG (1 possible female): 207 mm FL
AG (7 undetermined sex): 165, 150, 148, 190, 148, 162, 148 mm FL

Station MYC
* not possible to set bag seine: current too strong, too wide in run, too deep & fast
* not possible to set minnow trap: current too strong, no slow water
* water still high & fast >10 days after latest rain; thalweg depth 3.5-4.0 ft
* attempted electrofishing along ~50 yards of shoreline: sighted 1 fish ~150mm, species unknown

Station LYC
* set of seine not very good; current very strong
* electrofish ~35 yards downstream to seine: no fish observed
* no other fish-able sites nearby or anywhere below old pipeline corridor
* no minnow trap set here

YERRICK CREEK – 29-30 September 2008

Station UYC
** 1 minnow trap
DV (3): 175, 126, 145 mm FL

Station UMY
** 1 minnow trap + electrofish ~ 25 yds of stream
DV (4): 125, 147, 159, 142 mm FL
+ 1 DV sighted

Station YCI
** 2 minnow traps + electrofish ~40 yds of stream
DV (14): 124, 131, 167, 133, 131, 137, 136, 128, 125, 123, 141, 105, 130, 80 mm FL
DV (1 possible gravid female?): 149 mm FL

Station MYC

* 1 minnow trap + electrofish ~100 yds of stream

DV (2): 122, 98 mm FL
DV (1 w/ white-edged fins, possible spawning male?): 164 mm FL
AG (1): 162 mmFL
+ sighted 3 small fish, each <100 m FL

Station LYC

* 1 minnow trap + electrofish ~100 yds of stream

AG (1): 79 mm FL

CATHEDRAL RAPIDS CREEK #1 – 3-4 September 2008

Station CRI

* electrofished ~0.1 mile of CR1, roughly near the approximate impound site

no fish sighted or captured

* no minnow trap set (no pools)

4 – CONCLUSIONS

Yerrick Creek is used by Dolly Varden and Arctic grayling, in occasional small pools separated by long sections of cascading runs.

Dolly Varden were captured in the middle and upper reaches of the creek (including the proposed impoundment area), while Arctic grayling were captured in the middle and lower sections. In this sampling, Arctic grayling were captured less often than were Dolly Varden.

Dolly Varden were commonly encountered in both late summer and late fall (immediately before freeze-up), which suggests that they are year-round residents, including over winter. [Inferring the over-winter habitat of Dolly Varden based on pre-freeze-up surveys and sampling is used by ADFG biologists in other Alaska streams (Scanlon 2008).]

The capture of a possibly gravid female and possibly spawning male suggests that Dolly Varden might spawn in the middle reaches of this stream.

This apparent distribution is consistent with general anecdotal observations of these species in UTMA –

* dwarf Dolly Varden are thought to be year-round residents of upper Yerrick Creek

* Arctic grayling migrate seasonally into and out of lower Yerrick Creek

No fish were captured or sighted in Cathedral Rapids Creek #1, and fish habitat appears to be very scarce. It is not clear to what extent, if any, this cascading stream is used by either fish species.

5 -- RECOMMENDATIONS

The 2008 fisheries sampling has provided useful characterizations of fish presence and distribution in Yerrick Creek and Cathedral Rapids Creek #1, in late summer, late fall, and by inference, over-winter. These data, when supplemented by a sampling in late spring or early summer of 2009, will yield a picture of yearly habitat use of these two streams. This future sampling should be performed at a very low water stage, to allow for thorough electrofishing at all stations.

6 – LITERATURE CITED

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APPENDIX A

Report for FRP SF2008-172

Report of Activities and Collections

27 October 2008

Fish Resource Permit SF2008-172

Stephen T. Grabacki, FP-C; 907-272-5600; graystar@alaska.net

Location: Yerrick Creek (YER) and Cathedral Rapids Creek #1 (CR1)

The two creeks were examined but not sampled 6-7 June 2008. Fish habitat was generally characterized, and the GPS locations of possible fish-bearing pools were recorded.

Sampling was conducted 3-4 September 2008 (YER and CR1), and 29-30 September 2008 (YER only), with electrofisher + bag seine (the electrofisher was used to herd the fish into the bag seine, rather than stunning them), and minnow traps baited with commercially cured salmon eggs and left to soak overnight.

GPS coordinates, as displayed on Grabacki's brand new Garmin GPS unit, do not appear to match the apparent location as displayed on the attached map. In this report, the GPS readings are listed in the text, and the apparent location is shown on the map.

(1) RESULTS FROM 3-4 SEPTEMBER 2008

YERRICK CREEK (YER)

Upper YER, above fork, western channel, well above impoundment, 04SEP08
63°18.204'N 143°35.387'W elevation: 2,830 ft
Minnow trap set 03SEP08@1915, retrieved 04SEP08@1030 –
    DV (1): 127 mmFL
Electrofished 2 channels –
* single channel, ~40 yards
* Y-shaped channel, ~80 yards
    DV (4): 122, 120, 127, 117 mmFL
All fish in apparent good condition, released alive

Pool at/near impoundment site (above Mike's camp), 03SEP08
Waypoint 009, elevation: 2,284 ft
63°20.435'N   143°37.852'W
Electrofished pool & run, ~30 yards –

DV (1): 115 mmFL
AG (3 possible males): 220, 235, 190 mmFL
AG (1 possible female): 207 mmFL
AG (5 undetermined sex): 150, 148, 190, 148, 162, 148 mmFL

All fishes in apparent good condition, and released alive
Minnow trap set 1430, retrieved 0955 (04SEP08) –

DV (2): 110, 102 mmFL
Fish in apparent good condition, released alive

Pool below impoundment site, 03SEP08
Waypoint 008, elevation: 2,263 ft
63°20.589'N   143°37.684'W
Electrofished 2 channels –
* main channel, ~80 yards: no fish captured or sighted
* side channel, ~50 yards: 1 fish sighted + 2 fish captured –

Arctic grayling (AG) 165mm fork length (FL), apparent good condition, released alive
Dolly Varden (DV) 135 mmFL, apparent good condition, released alive
(DV bore parr marks)

Minnow trap set 1300, retrieved 0930 (04SEP08): no catch

Middle YER, near big cut in hill on west bank
Waypoint 024 on Mike Warner's GPS: 63°21.411'N   143°37.852'W   elevation: 2,100 ft
Not possible to set bag seine: current too strong, too wide in run, too deep & fast below pool
Water still high >10 days after latest rain; thalweg depth 3.5-4.0 ft
Attempted electrofishing along ~50 yards of shoreline: sighted 1 fish ~150mm, species unknown
Same conditions downstream ~0.5 mile
Might be able to work this site in lower flow

Lower YER, below highway bridge
63°23.062'N   143°35.538'W   elevation: 1,971 ft
Set bag seine below a slight pool
Set of seine not very good; current very strong; lead line not on bottom in some places
My assistant was the anchor for one end of the seine
Electrofished ~35 yards downstream to seine: no fish observed
No other fish-able sites nearby or anywhere below old pipeline corridor

Observation: In June, flow at upper YER was greater than at lower YER. In September, there was stronger flow at mid- and lower YER sites. Judging by wet marks on the rocks, the water level was dropping.

Yerrick Creek is characterized by steep gradient, cascading flows, and large boulder substrate. The channels appear to be dynamic, as judged by cleanliness of the substrate in and near the water: very little periphyton and almost no terrestrial vegetation. There are few pools in YER that appear capable of providing habitat for fishes. Those pools are small, in the range of 10 ft long. Besides the pools that we sampled, other small pools were observed (in June) at –

* 63°22.308'N 143°37.007'W elevation: 1,847 ft
* 63°22.123'N 143°37.104'W elevation: not recorded
* 63°21.572'N 143°37.608'W elevation: 2,050 ft (pool near spur of hill)
* 63°21.582'N 143°37.638'W elevation: 1,930 ft
* 63°21.257'N 143°37.913'W elevation: 2,220 ft (pool near scree slope; 1 AG seen in June)

CATHEDRAL RAPIDS CREEK #1 (CR1)

Station CRI

Electrofished ~0.1 mile of CR1, roughly near the approximate impound site

* from WP 012: 63°21.086'N 143°43.153'W elevation: 2,495 ft
* to WP 011: 63°21.175'N 143°43.163'W elevation: 2,442 ft

No fish sighted or captured

No minnow trap set (no pools)

Note: this site was not really a pool or pools; it was a reach of the stream near the impound site, where we could reasonably set the bag seine and conduct electrofishing.

CR1 is much smaller and steeper than YER. It is essentially one long, cascading run, with strong current and large boulder substrate. In June (lower flow than in September), a pool of roughly 10 ft wide x 20 ft long x 2 ft deep was observed at WP 037: 63°21.595'N 143°43.005'W elevation: 2,239 ft but this pool could not be located in early September. Similarly, a few smaller pools were observed in June, but by early September, the dynamic channel appeared to have shifted so that they were no longer apparent.

(2) RESULTS FROM 29-30 SEPTEMBER 2008

YERRICK CREEK (YER)

Station UYC
Upper YER
Waypoint 026, elevation: 2,811 ft
63° 18.193'N 143°35.406'W
Minnow trap set 29SEP08@1415; retrieved 30SEP08@1320 --
    DV (3): 175, 126, 145 mmFL
All fish in apparent good condition, released alive

Station UMY
Upper YER, below WP 026
Waypoint 029, elevation: 2,548 ft
63° 19.371'N 143°36.591'W
Nice pool at big dead spruce and snag
Minnow trap set 29SEP08@1440; retrieved 30SEP08@ 1235 –
    DV (3): 147, 159, 142 mm FL
All fish in apparent good condition, released alive.
Electrofished 2 pools, ~25 linear yards of stream –
    DV (1): 125 mm FL
    + 1 DV sighted
Fish in apparent good condition, released alive

Station YCI
Pools near impoundment site
Waypoint 030, elevation: 2,242 ft
63° 20.606'N 143°37.686'W
2 minnow traps set 29SEP08@1500, retrieved 30SEP08@1115 –
    DV (12): 149*, 133, 131, 137, 136, 128, 125, 123, 141, 105, 130, 80 mm FL
    * possible gravid female?
All fish in apparent good condition, released alive.
Electrofished pools near impoundment site, ~25 linear yards of stream –
    no fish sighted or captured
Electrofished pool at fork of 3 channels ~100 yards above impoundment site
Waypoint 032, elevation: 2,204 ft
63° 20.521'N 143° 37.773'W
    DV (3): 124, 131, 167 mm FL
All fish in apparent good condition, released alive

Station MYC
Middle YER, near big spur of hill (“razorback”) on west bank
Waypoint 031, elevation: 2,026 ft
63° 21.623’N   143° 37.565’W
Minnow trap set 29SEP08@1550, retrieved 30SEP08@1400 –

DV (3): 164*, 122, 98 mmFL

* white-edged fins, possible spawning male?

Electrofished ~100 linear yards of stream, in various small pools –
AG (1): 162 mmFL

+ sighted 3 small fish, each <100 m FL

Fish in apparent good condition, released alive

Station LYC
Lower YER, below highway bridge
Waypoint 025, elevation: 1,717 ft
63° 22.878’N   143°36.438’W
Minnow trap set 29SEP08@1350, retrieved 30SEP08@1000 –

* no catch

Electrofished ~100yards of stream –

AG (1): 79 mm FL

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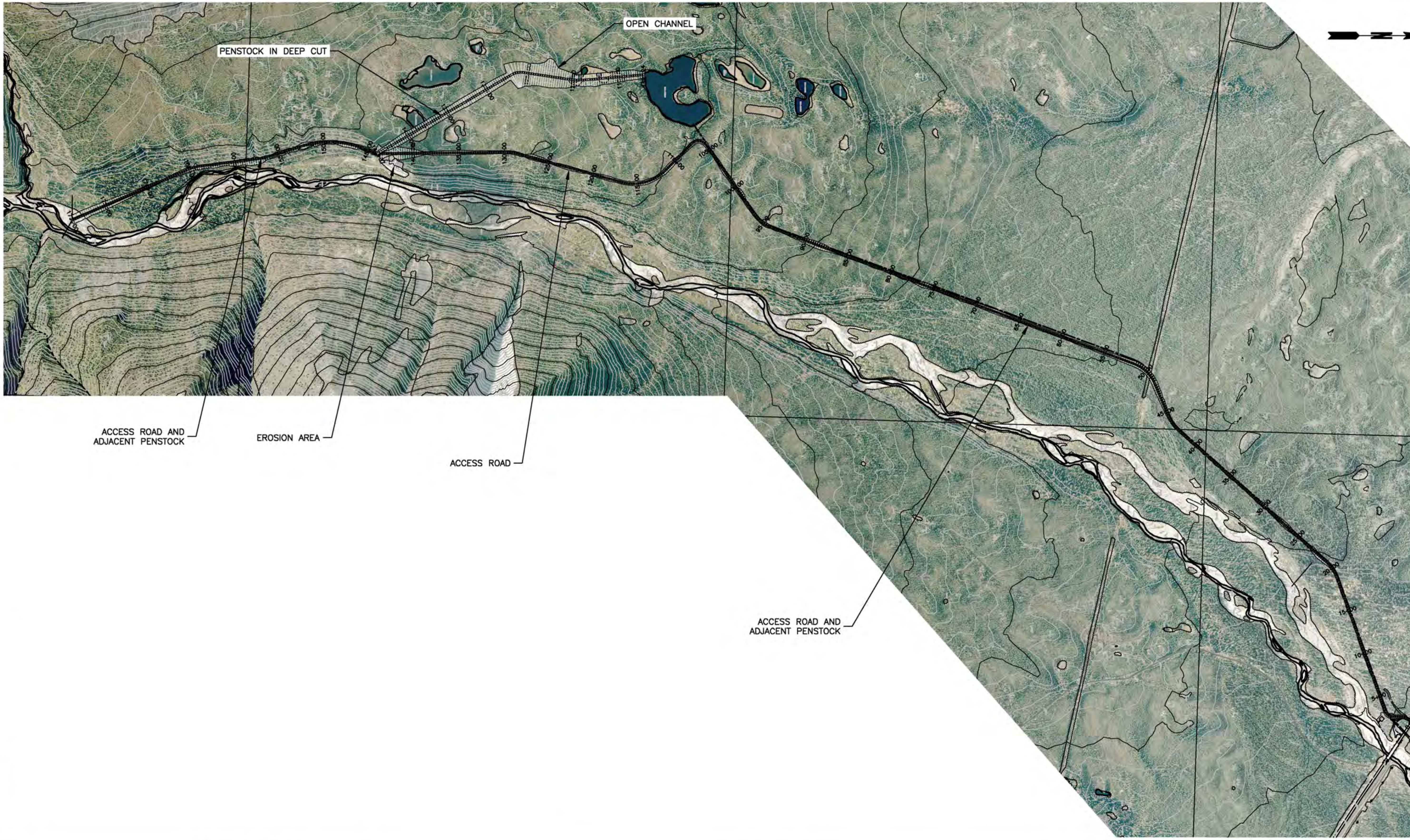
YERRICK CREEK HYDRO ASSESSMENT

GRANT AGREEMENT NO. 2195345

FINAL REPORT

~DESIGN DIAGRAMS~



I:\Engineering\ arry Coupe\Projects\Yerrick Creek\Drawings\Penstock and Road\Penstock 7.dwg, Plan, 6/4/2009 3:26:18 PM

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	APPR

SCALE: 1"=500'
DESIGNED: LDC
DRAWN: LDC
CHECKED:

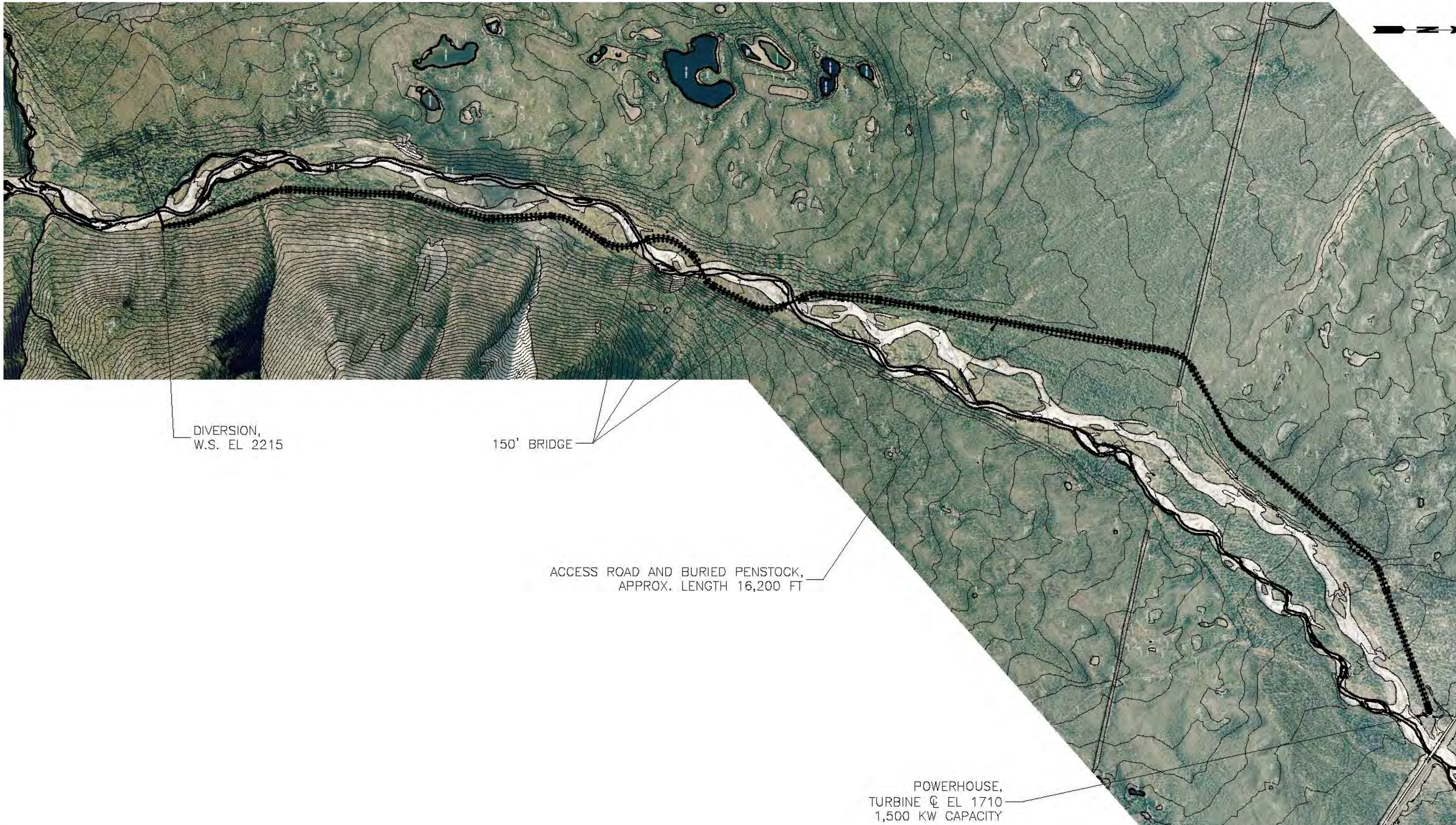
AP&T
ALASKA POWER & TELEPHONE COMPANY

500 0 500 1000 FT
1" = 500'

YERRICK CREEK HYDROELECTRIC PROJECT

GENERAL PLAN
DEEP CUT ALTERNATIVE

DATE: 6-4-
PROJECT NUMBER
SHEET NUMBER



ISSUE NO.	DATE	DESCRIPTION	BY	CHK	APPR

SCALE: 1"=500'
DESIGNED: LDC
DRAWN: LDC
CHECKED:

AP&T
ALASKA POWER & TELEPHONE COMPANY

500 0 500 1000 FT
1" = 500'

YERRICK CREEK HYDROELECTRIC PROJECT

PENSTOCK ALIGNMENT UPPER VALLEY OPTION

DATE: MARCH 18
PROJECT NUMB
SHEET NUMBER

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	APPR

SCALE: 1"=500'
DESIGNED: LDC
DRAWN: LDC
CHECKED:

AP&T
ALASKA POWER &
TELEPHONE COMPANY

500 0 500 1000 FT
1" = 500'

YERRICK CREEK
HYDROELECTRIC PROJECT

GENERAL PLAN
MOOSE CAMP ALTERNATIVE

DATE: 2-18-09
PROJECT NUMBER:
SHEET NUMBER:
ISSUE NO.