Adak Renewable Energy Reconnaissance Report

AEA REF Grant #2195450

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TABLE OF CONTENTS

ABSTRACT

The city of Adak is located in western Alaska along the Aleutian chain. The city is a former US Naval base. The Alaska Energy Authority commissioned this reconnaissance report as a first step to define the renewable energy resources on Adak Island and identify the most likely projects that could reduce the community's reliance on diesel fuel for electricity and heating needs.

The report identifies hydroelectric power and wind power as viable renewable energy solutions, with further study required to select the best project. The geothermal resource remains largely unknown. The existing power system is in serious distress. Renewal or replacement of the power plant would be required in order to integrate a renewable resource into the utility's grid.

INTRODUCTION

PROJECT OBJECTIVE AND SCOPE

TDX Power received a grant from the State of Alaska Renewable Energy Fund program to study the existing electrical infrastructure and evaluate the potential use of renewable energy resources for the community of Adak.

This reconnaissance report includes an evaluation of the available resources and recommends further engineering studies of the most promising resources for integration with the electric utility's existing diesel-generated power system.

COMMUNITY OVERVIEW

The City of Adak is a remote community in the Aleutian Islands of Western Alaska. The community is situated on the northern coast of Adak Island, approximately 1200 miles southwest of Anchorage.

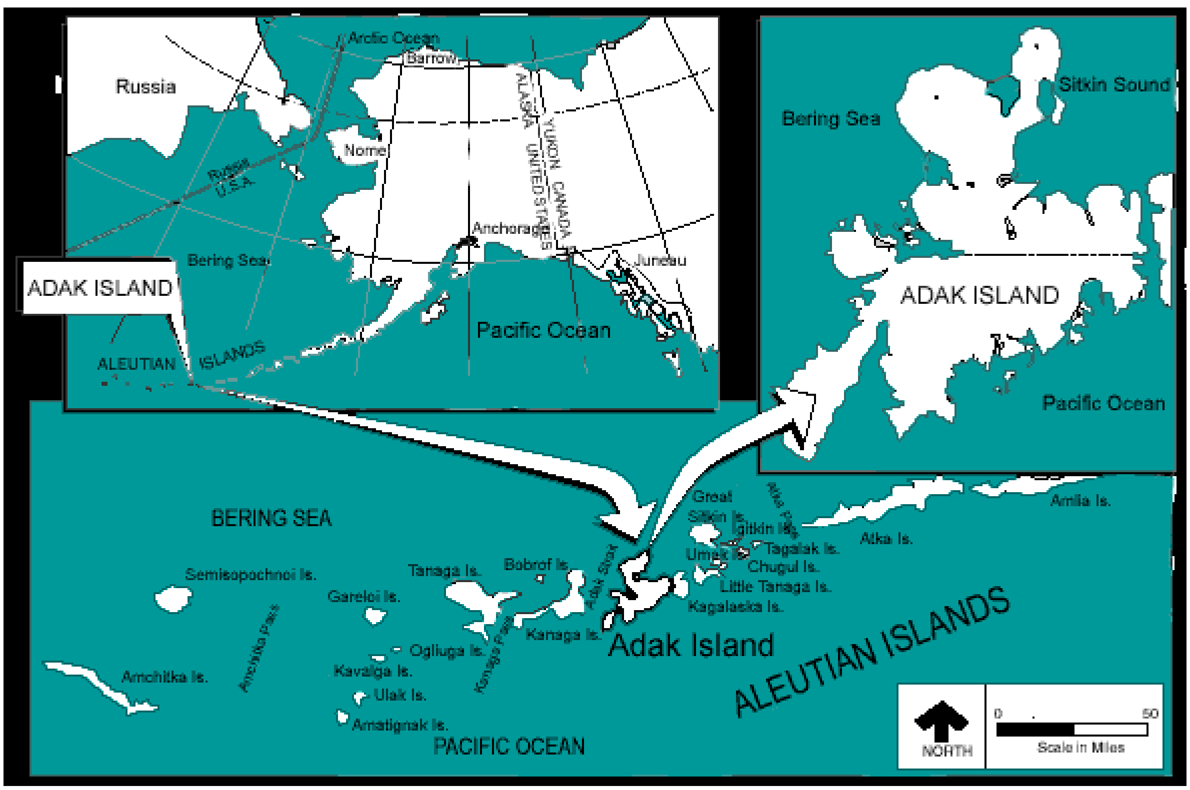

Figure 1 - Adak Map (source: US Navy)

Originally inhabited by Aleut people, Adak's major infrastructure was largely built by the US Navy during and after World War II, when up to 6000 military personnel and family members lived in Adak. The Naval Air Facility Adak (NAF-Adak) was closed and all military personnel were relocated by 1997.

As part of the military's departure, the US government transferred ownership of the land and assets to the Aleut Corporation. According to the 2010 US Census, the population of Adak is currently 326 people – a sharp decline since the days of active military operations. There are utility 195 customers in Adak, of which 105 are residential.

ELECTRIC UTILITY

The existing electrical infrastructure was built to support US Navy operations in Adak. With the closure of NAF-Adak, ownership of the electric utility was transferred to the local government and was later purchased by TDX Power.

The electricity market in Adak is regulated by the State of Alaska through the Regulatory Commission of Alaska. TDX Adak Generating, LLC, a subsidiary of TDX Power, owns and operates the utility under certificate number CPCN 684.

TDX Adak Generating reports that the current electrical load averages roughly 200 – 250kW, with recent annual sales of approximately 1.5 – 2.5 million kWh.

Including the Cost of Power Adjustment (COPA) filing dated April 25, 2011, the price of electricity currently averages $0.79/kWh for residential customers.

TDX Adak Generating ratepayers qualify for the State's power cost equalization program, which subsidizes residential customers and some community facilities. A special contract with Icicle Seafoods, the local fish processing plant, was submitted to the RCA for approval on June 10, 2011. Operation of the plant is expected to cause a dramatic spike in consumption during the peak fish processing months of February, March and April. Neither TDX Adak Generating nor Icicle Seafoods can provide an accurate estimate of the processing load since Icicle has self-generated in the past with a 2200kW genset. The peak fish processing load is expected to be between 1000 – 2000kW, with a more moderate 100kW load for the remainder of the year.

EXISTING INFRASTRUCTURE

The utility is in distress after years of inadequate maintenance. The existing electrical infrastructure is in various stages of disrepair. There is a major and urgent need for renewal and/or replacement both at the powerhouse and at the distribution level. TDX Adak Generating is evaluating options for renewal or replacement of the existing power plant to better serve the existing customers. This upcoming utility work would significantly affect any renewable energy project in Adak. Continued coordination with the utility will be a key factor for successful development of any renewable energy project.

POWER PLANT

The diesel generator based power plant is located on the south side of the airport – opposite the major loads. The power system was built in phases, beginning in the 1950s, to accommodate a growing military operation. The oldest switchgear section, the "2400 Volt Bus," contains three (3) Caterpillar 3516 engines (Generators 3, 4, and 5), each rated at 800kW, 2400 volts. These are the primary generators. Each genset has in excess of 30,000 hours runtime and all are due for complete overhaul.

Two newer switchgear sections, “East Bus” and “West Bus,” contain a total of eight (8) defunct Cooper Bessemer engines, each rated in excess of 2.2MW, 13.8kV. All of the Cooper Bessemer engines are out of service, disconnected, and are not expected ever to produce power again. Generator 6 – Caterpillar 3512, 1100kW, 480V – is tied into the West Bus through a transformer, but is currently out of service.

The 2400V Bus is connected to the East Bus with a step-up transformer (no backup), which is connected to the West Bus, so that Generator 6 could potentially provide backup in case the 2400V Bus fails.

The manually controlled generator switchgear includes Woodward governors and load-share modules. Fuel injection is mechanical. The governors and load-share modules, circa 1982, could potentially by reused in a new switchgear lineup, but more likely all new equipment would be installed.

DISTRIBUTION

Several feeders from the power plant serve the town loads. Several loads are tied to the West Bus (13.8kV). Other loads are tied to the 2400V Bus. But the majority of Adak’s load is served by a 13.8kV feeder tied to the East Bus and fed through a series of substations. Downstream transformers are used to step down to 2400 volts, or 6900 volts (in the case of the harbor).

Distribution wiring is mainly copper. Routing is largely buried, but significant sections of the city utilize overhead distribution. The effects of Adak’s harsh weather can be seen in the condition of transformers, power poles, and junction boxes, many of which do – or will soon – require replacement.

As can be expected with such an old system, changes over time have not been properly documented on the as-built drawings. Also, large sections of the distribution system have been disconnected and abandoned in place due to a lack of use.

RENEWABLE ENERGY OPTIONS

Adak is well situated to make use of local renewable energy sources. Located on the border between the Bering Sea and the North Pacific Ocean, Adak is home to strong, consistent winds. Located on a volcanic island, near-surface geothermal resources may be located nearby. Located on a mountainous hillside near several natural lakes, the potential clearly exists to develop hydroelectric power. These three resources are seen as the most likely candidates for immediate implementation in Adak. Figure 2 shows the areas that show the most promise for development for each resource.

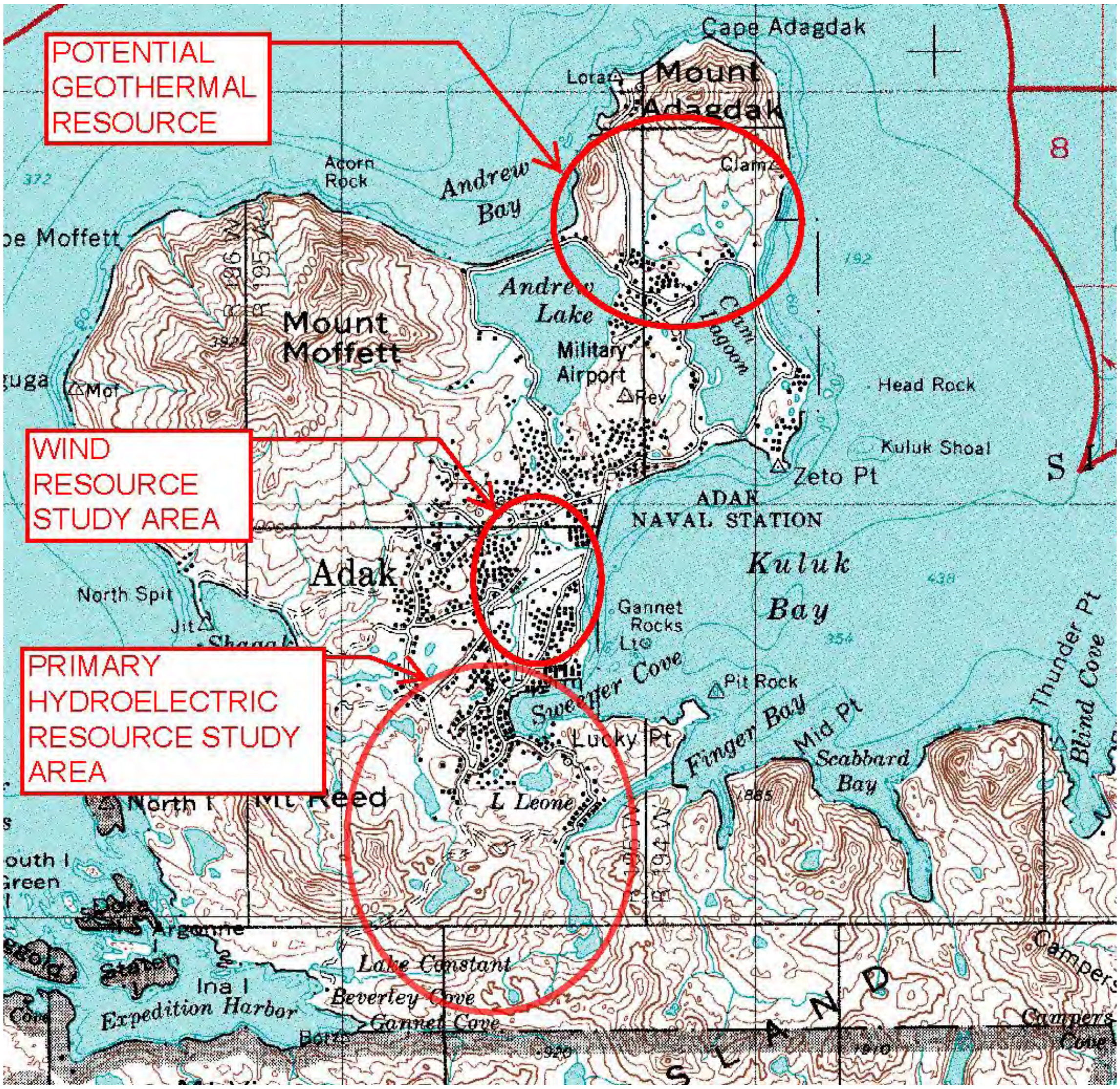

Figure 2 - Renewable Resources near the City of Adak

Although a formal survey has not yet been completed, all indications are that the community of Adak supports the development of renewable energy as a way of stabilizing and possibly reducing the cost of energy in their community. TDX has been working with the City of Adak and the Aleut Corporation to develop plans that address local views and concerns.

OTHER CONSIDERATIONS

The integration of renewable power systems with the existing infrastructure will need to be addressed in order to properly and efficiently size and control all generating assets. The utility's renewal and replacement strategy should consider integration with generating facilities outside the diesel power plant.

An emphasis on uncomplicated systems will help improve operating efficiency over the long term. Maintenance personnel in Adak do not have the breadth of technical or material resources that urban developers are accustomed to. The plant and integration design should consider local expertise and maintenance operations as critical components of a long-term project.

Recommendations

Further engineering studies are required to evaluate the various development options in more detail. Specific recommendations are included for additional wind and hydroelectric studies at the end of those resource assessments.

RECONNAISSANCE LEVEL ASSESSMENTS

Hydroelectric

Hatch USA was hired to evaluate the hydroelectric potential on Adak. The studies were designed to accommodate the existing electrical load. A detailed analysis of potential projects can be found in Appendix A.

Geothermal

Roger Bowers Associates was hired to evaluate the geothermal potential on Adak. The Navy has reportedly drilled geothermal test wells north-west of the City of Adak. We have so far been unable to obtain the results of those tests. An analysis of potential projects can be found in Appendix B, based on the limited available data.

Permitting/Land Use

Solstice Alaska Consulting was hired to evaluate permitting and land use issues related to development of hydroelectric and wind resources. Current knowledge of the geothermal resource does not provide the necessary groundwork for a detailed permitting discussion, and was therefore excluded from the analysis. The discussion of permitting issues can be found in Appendix C.

WIND RESOURCE ASSESSMENT

A wind resource assessment is currently being performed by TDX Power, as detailed below. The results shown are based on the initial findings of that study. Wind power has the potential to displace a large fraction of the 1.5 – 2.5 million kWh of annual diesel generation.

WIND RESOURCE

According to AEA's most recent State-wide wind energy map (2010), Adak has a Class 6 or Class 7 wind resource, i.e. very energetic. A wind resource assessment is currently underway to confirm anecdotal evidence and state-wide wind modeling results.

A 34-meter NRG anemometer tower was erected by the City of Adak in 2006. However the data logger was never installed and therefore no data was collected. The tower reportedly fell during a wind storm prior to the start of this project. The tower was largely salvaged and reused by TDX. The damaged tower sections were discarded. The tower was reinstalled in October 2010 with new sensors, stronger guy cables, and dead man foundations for each cable. The modified tower is approximately 30-meters tall.

The anemometer tower was installed in an open field near the existing power plant.

Figure 3 - Adak aerial view showing power plant and met tower

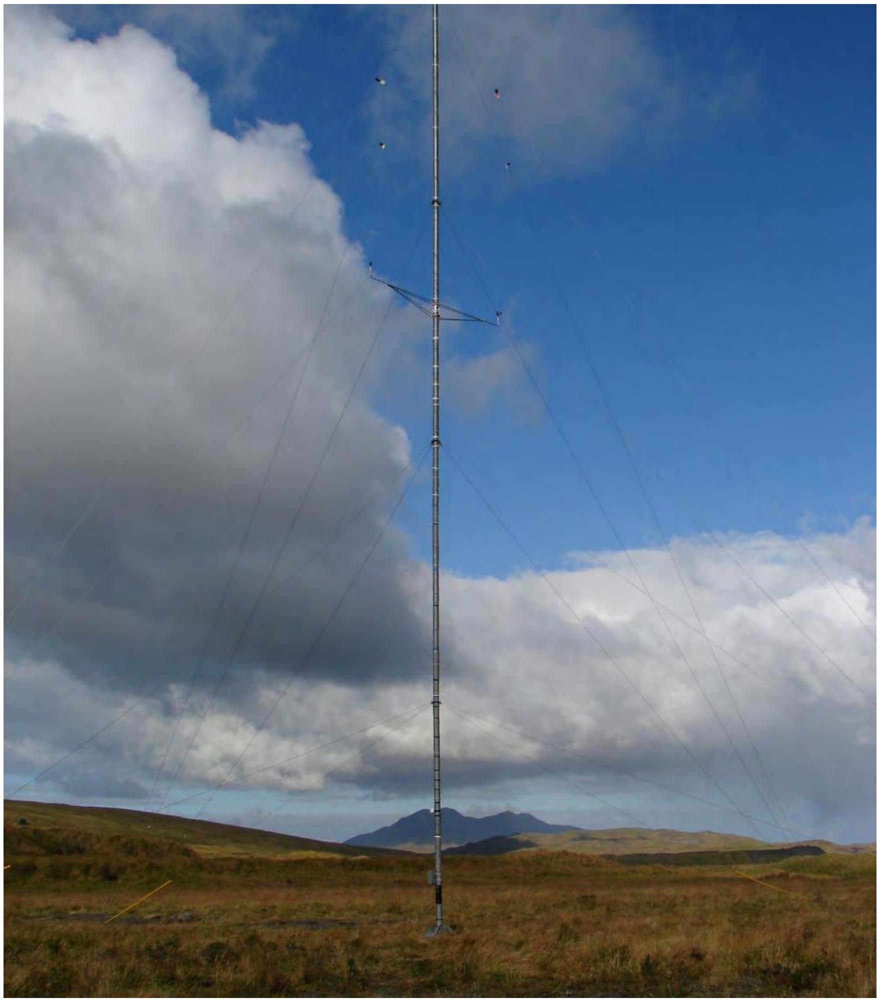

Figure 4 - Anemometer location

Approximately 6 months of data (17 October 2010 – 18 April 2011) have been collected to date. The data tend to confirm the earlier models of an excellent wind resource in Adak, although the wind power classification is 5-6, depending on hub height. The data indicate a mean wind speed of 7.15m/s (Class 5) at 28 meters (anemometer height); with a calculated mean speed of 8.0 – 8.2m/s (Class 6) at 50 meters. Measured monthly means are shown on the bar chart below.

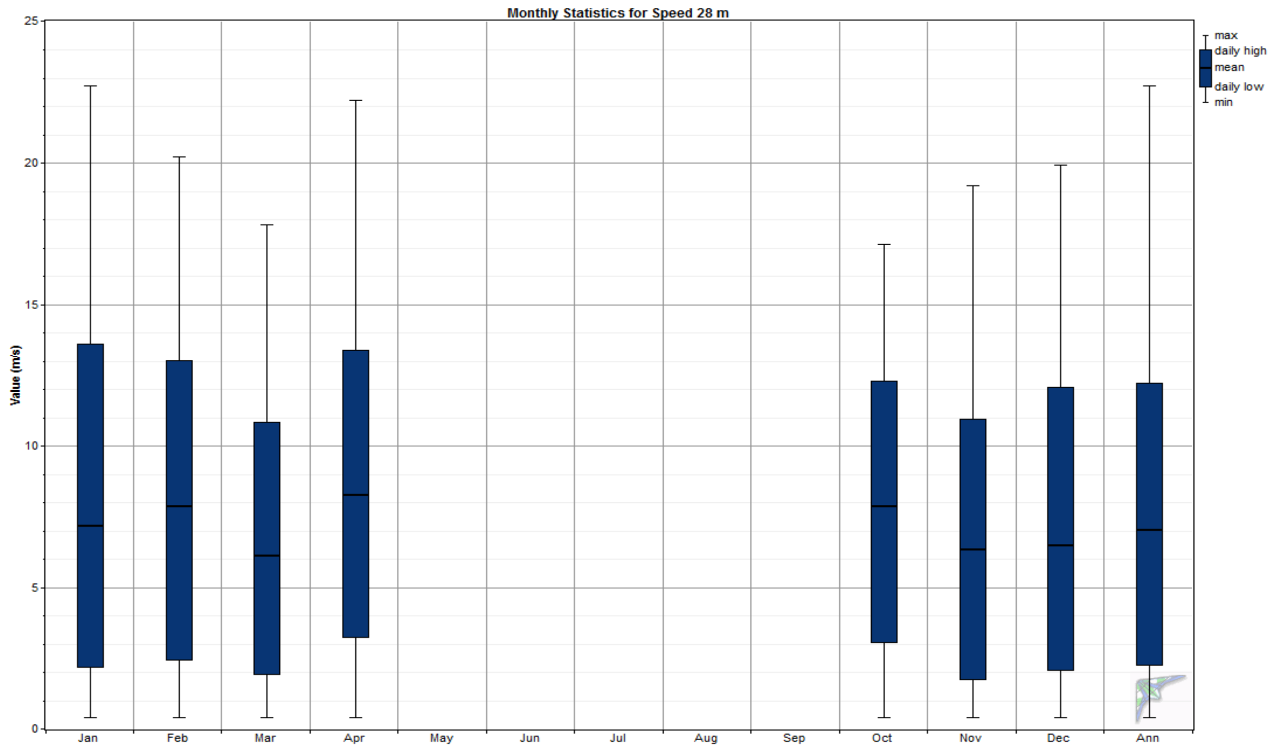

Figure 5 - Monthly wind speed data

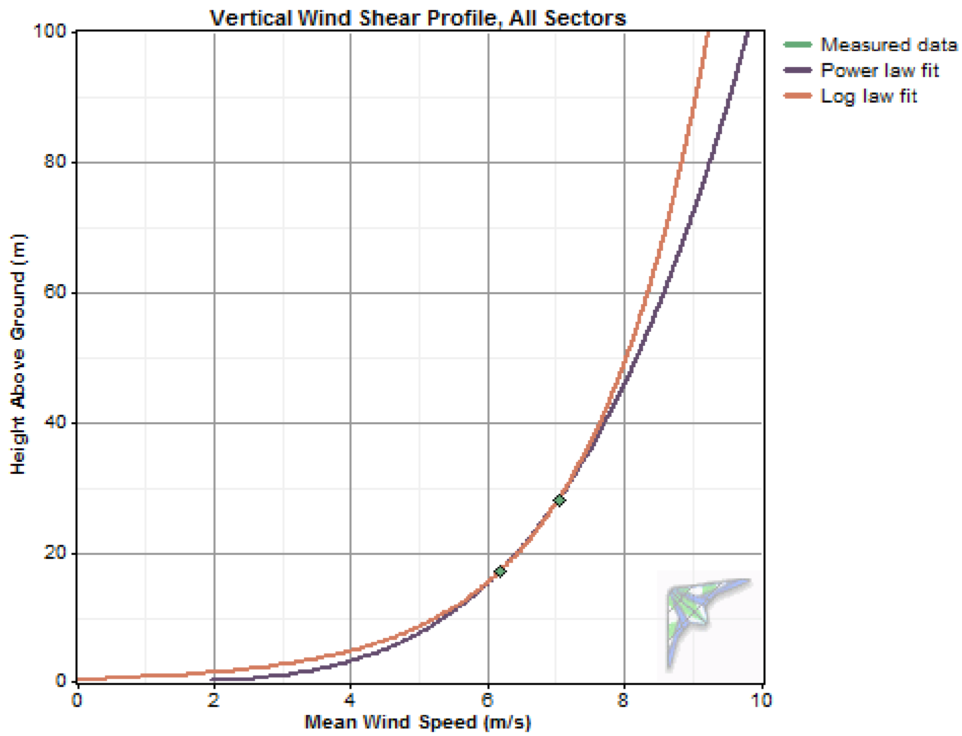

Figure 6 - Wind Shear profile. Power law exponent: 0.262

The primary power winds are out of the south and southeast, as shown on the wind energy rose below.

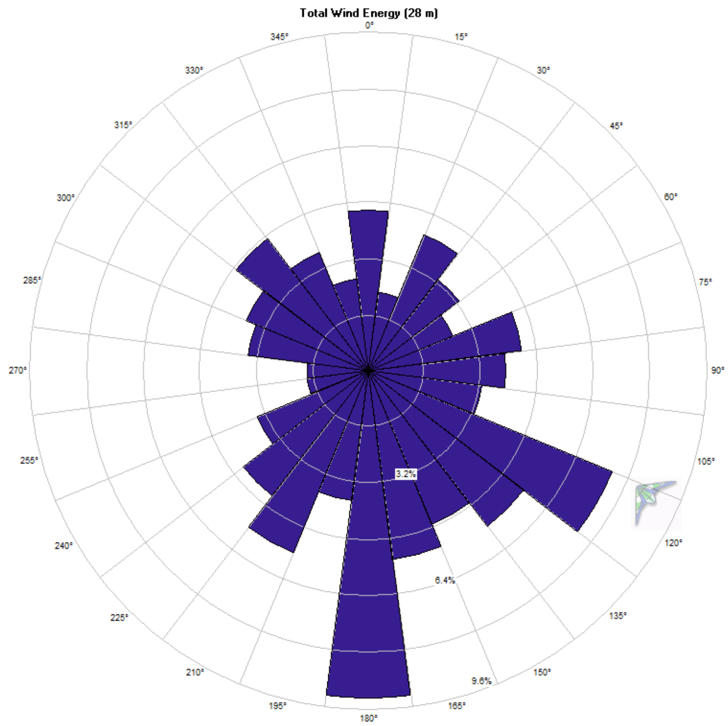

Figure 7 - Wind Energy Rose, showing primary power winds from south and southeast

The data also show high turbulence intensity, which must be fully evaluated during turbine selection and siting. Overall classification in accordance with International Electrotechnical Commission (IEC) Standard 61400-1 [2005] is turbulence Class A, with an average turbulence intensity at 15m/s of 0.155. The following graph shows the turbulence intensity of different segments of the wind resource, including several sectors that are above the Class A limit of 0.16. Figures 8 and 9 illustrate the turbulence intensity from all directions, and both indicate that turbulence is highest with north-east, south, and southwest winds.

The 50-year maximum 10-minute mean wind speed is estimated at 31.1m/s, with a 50-year maximum gust of 87.4 m/s, using the Gumbel distribution function.

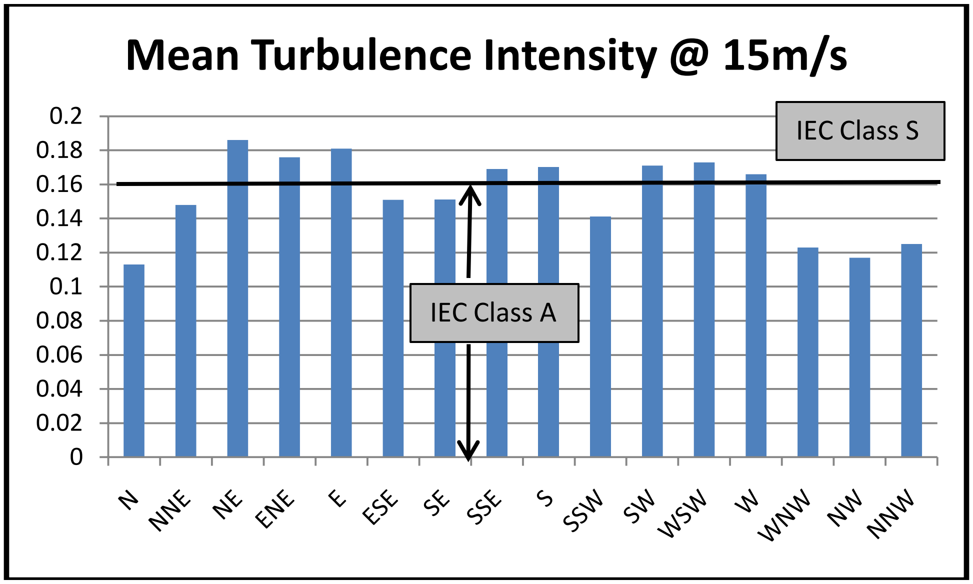

Figure 8 - Mean turbulence Intensity at 15m/s wind speed by direction

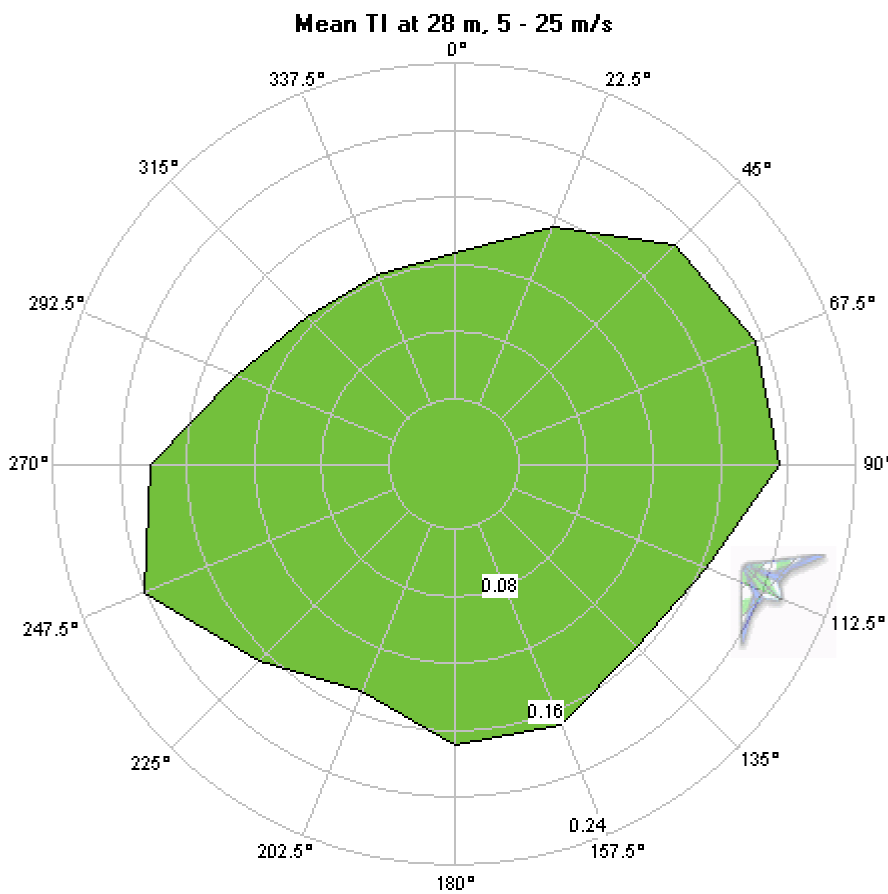

Figure 9 - Mean turbulence Intensity at 5-25m/s wind speed

Figure 10 shows the representative turbulence intensity as a function of wind speed. Relative to the IEC category standards, the measured turbulence in Adak increases with increasing wind speeds. This phenomenon may be due to a flow separation or vortex, likely caused by nearby topography such as a ridge or other terrain feature. As wind speed increases, the size of the vortex would increase and encompass the wind sensors.

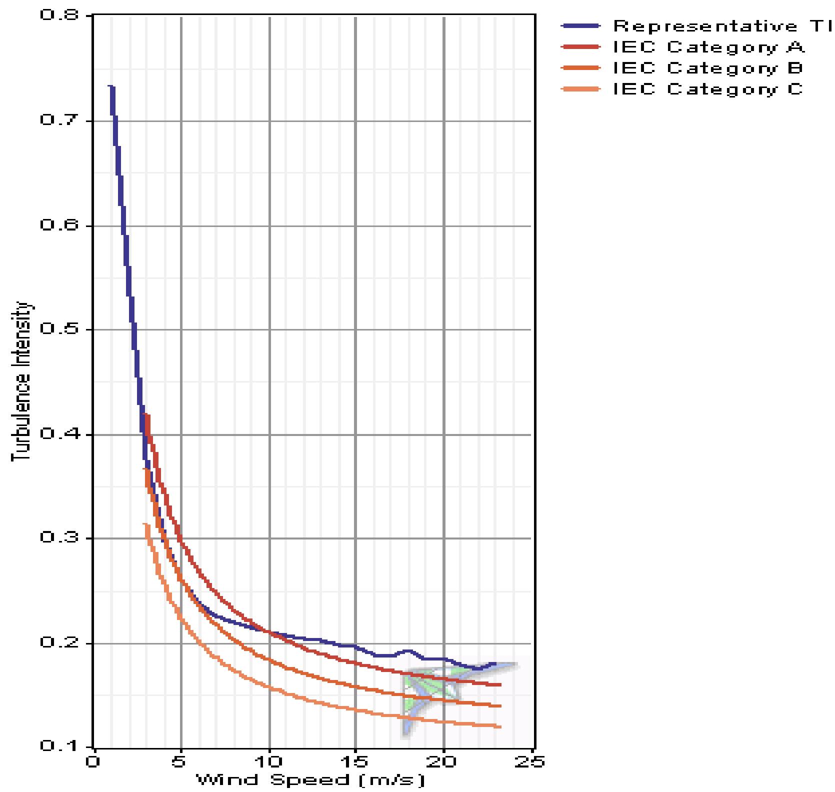

Figure 10 – Measured turbulence intensity as a function of wind speed. IEC turbine categories A B and C shown for reference

TURBINE SITING

Based on the early wind study results, turbine siting should be selected with an emphasis on minimizing turbulence. Increased hub height or a turbine site further from significant terrain features would likely result in a higher energy yield, as well as lower terrain-induced turbulence. A location east or north east of the existing anemometer tower is recommended. However, a site visit would be required to confirm siting. Computational fluid dynamic modeling of topography and wind turbulence is recommended and additional wind measurements may be required at the new site to confirm modeling results.

LOAD PROFILE

The village electrical load profile was synthesized, since actual load data is generally unreliable and limited to mean daily values. The hourly load profile shape was created by scaling the load profile of similarly sized rural Alaskan communities to match Adak's annual electrical generation. The resulting profile has a load factor of 45%. Adak's actual load profile may vary significantly from this synthesized profile, and should be verified during further engineering studies.

The electrical load in Adak generally follows the same seasonal variation as other rural Alaskan communities – higher demand during winter, lower in the summer. However, the local fish processing facility operates seasonally and drastically alters that load during the two month peak season – February and March. The fish plant load is estimated based on information from the operator.

ESTIMATED ENERGY YIELD

Annual estimates of wind generated electricity were prepared for three cases. Cases A and B were designed to minimize complexity and therefore upfront capital costs. Case C shows the potential benefits of a project with a higher fraction of renewables, but also carries additional complication and grid integration costs.

- Case "A" is a single 100kW wind turbine, in conjunction with the existing array of diesel generator sets.
- Case "B" is a single 225kW wind turbine, in conjunction with the existing array of diesel generator sets.
- Case "C" is either a single 500kW wind turbine, or a combination of smaller turbines totaling 500kW, in conjunction with the existing diesel generator sets.

A performance comparison of these three cases is shown in the following table. The data shown in this table are based on preliminary estimates of both annual wind power generation, and annual electrical demand of 1.5 – 2.5 million kWh. Many factors discovered during further engineering studies may significantly alter the results.

Preliminary Annual Wind-Diesel Performance Estimates				
Case	**Wind turbine size**	**Annual yield wind only**	**Auxiliary Loads Electricity**	**Renewables Fraction (of primary load)**
	[kW]	[kWh]	[kWh]	[%]
A	100	255,000	40,000 [16%]	9%
B	225	630,000	180,000 [29%]	19%
C	500	1,285,000	600,000 [47%]	28%

Figure 11 - Wind turbine sizing options

In Case A, the rated turbine output only rarely approaches the synthesized village load, and therefore nearly all power is used to cover the normal (primary) load. In the case of larger turbines, more energy is used in secondary, auxiliary loads. Generally, electricity used for secondary loads is less valuable than that portion used for primary loads. Therefore, minimizing electricity used for auxiliary loads is likely to maximize the return on investment.

The school is a primary target for auxiliary loads due to its large size, location in the main district in town, and its many uses, including as health clinic and community building.

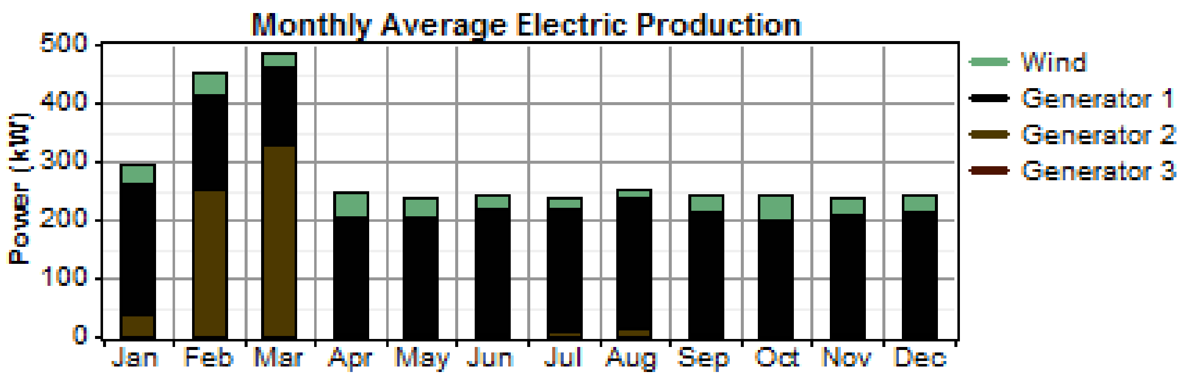

Figure 12 - Case "A" - Monthly generation from 100kW wind turbine

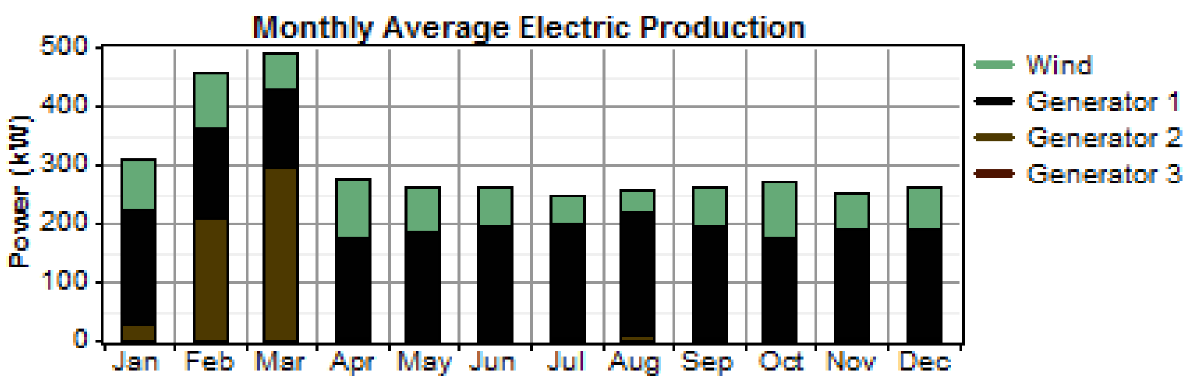

Figure 13 - Case "B" - Monthly generation from 225kW wind turbine

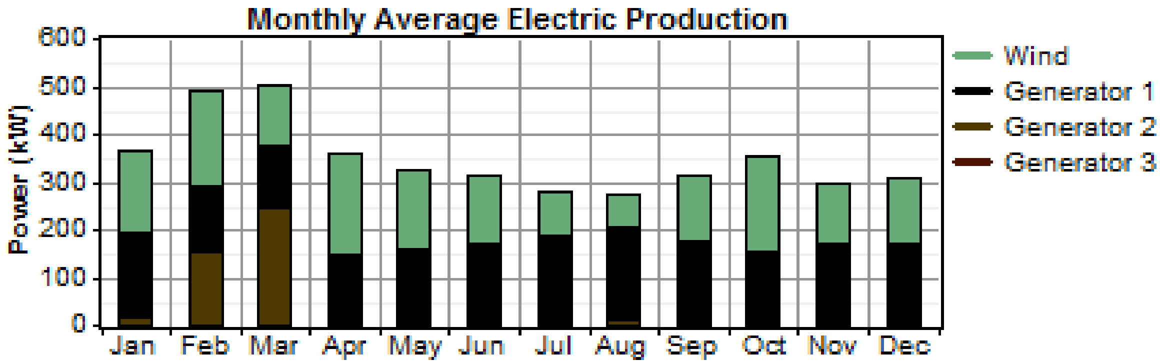

Figure 14 - Case "C" - Monthly generation from 500kW wind turbine

EXISTING INFRASTRUCTURE, INTEGRATION AND LOAD MATCHING

Utility scale wind development on Adak will require integration with the utility's generation and switching equipment. The existing power system was designed and built by the US Navy for a population of up to 6000 residents. The entire system – generation, switching, and distribution – is both grossly oversized for the existing load and in need of extensive renewal or replacement. An analysis of the integration should consider the utility's future plans for generation, switching and distribution repair or replacement. Preliminary options include full power plant replacement or relocation.

Construction of a wind energy project on Adak is not recommended without an upgraded or replaced diesel power plant that allows seamless integration and automatic switching of the wind turbine(s) and diesel gensets. A smaller diesel generator set will be required in order to maximize fuel savings.

It is likely that little or no distribution wiring will be required to connect a wind project to the grid, although the existing infrastructure would need to be evaluated for condition and reuse.

PERMITTING, LEGAL & REGULATORY

The major permitting hurdles expected in Adak are:

- Migratory and/or endangered birds;
- FAA approval
- Existing Hazardous waste (US Navy)

Further discussion of permitting and land use issues can be found in Appendix C.

Based on TDX's recent wind development experience within a Regulated Utility service area, the Regulatory Commission of Alaska is supportive of renewables development, whether owned by the utility, or a third party, if the cost of power is less than the utility's "avoided costs" – i.e. fuel costs. Nonetheless, the approval process for a special contract (power purchase agreement) can take 6 months, assuming no major hurdles are encountered. It is recommended that regulatory approval is obtained prior to construction of the project.

PROJECT DEVELOPMENT TIMELINE AND COST SCHEDULE: LICENSING, DESIGN, CONSTRUCTION; $/KWH

Development of a utility scale wind project on Adak would likely take 3 years, once an appropriate diesel power plant is built. This timeline includes engineering, permitting, procurement and installation. Regulatory approval, barge schedules, turbine and crane availability are all critical pieces that will affect this schedule.

Phase	Begin (Month)	End (Month)
Design replacement power plant with appropriately sized gensets	1	4
Build replacement power plant with appropriately sized gensets	5	12
Initial Engineering and Turbine Selection	13	3
Detailed Engineering	15	18
Permitting	15	18
Turbine Order	18	24
Turbine Delivery and Procurement of other materials	24	30
Shipping – materials and equipment	30	36
Installation	36	42
Startup & Commissioning	42	44

Figure 15 - Diesel and wind project development timeline

The University of Alaska Anchorage's Institute of Social and Economic Research (ISER) conducted a state-wide study of wind-diesel systems in 2010 called "Wind Diesel Systems in Alaska: A Preliminary Analysis," found here: http://www.iser.uaa.alaska.edu/Publications/researchsumm/wind-diesel_summary.pdf. The ISER study found wind development costs to be $4,000 - $15,000 per kW installed capacity. Larger sized projects tend to have somewhat lower prices due to economies of scale associated with the turbine installation. However, control and communication system complexity and price increases with turbine capacity, which can cancel out this decreasing price trend. Based on this finding and local conditions, project costs for Adak's Cases A, B, and C are assumed to be $6,000/kW.

The „Diesel Saved' calculation assumes a diesel genset efficiency of 13kWh/gallon, which is reasonable once appropriately sized generator sets are installed that can operate efficiently down to partial load settings. The calculation also assumes that all „auxiliary' loads provide useful heat to offset oil-fired boilers or furnaces, assumed to have a burner efficiency of 75%.

	Case A 100kW	Case B 225kW	Case C 500kW
Total Construction Cost	$600,000	$1,350,000	$3,000,000
Annual Diesel Saved (gallons)*	17,800	40,500	72,200

*Includes both diesel savings at power plant and heating oil savings from auxiliary loads.

Figure 16 - Construction cost and annual diesel savings estimates for wind project options

ASSUMPTIONS

Assumptions and sources of error in this report include the following:

- Wind resource data has only been collected for 6 months. The study is ongoing.
- Detailed electrical load data is not available, and was synthesized to allow energy modeling. Actual load data may vary significantly from the synthesized data. The utility's recent addition of Icicle Seafoods processing plant to the electrical load will drastically change the utility's load profile. The plant load is currently unknown.
- Cost data is based on industry trends. Each specific component was not priced.

CONCLUSIONS – WIND STUDY

The wind study shows an energetic but turbulent wind resource at the current anemometer location. Successful wind development will hinge on proper siting, sizing, and turbine selection to minimize turbulence and maximize energy yield and revenue.

NEXT STEPS – WIND STUDY

The next step is a more detailed wind study that addresses technical feasibility of wind power development, and should include the following tasks:

- Gather wind data from one complete year (through October 2011)
- Locate alternative turbine sites and evaluate turbulence and energy yield

- Investigate costs and benefits of high vs. low/modest wind power fractions relative to the electrical load, i.e. what size turbine would be appropriate.
- Identify potential auxiliary loads
- Continue to coordinate with utility operators regarding integration requirements and future plans.
- Refine project cost estimates

APPENDIX A

TDX Power
Adak Reconnaissance Study

Final Report

Prepared for:
TDX Power
Anchorage, Alaska

July, 2011

HATCH™

ISO 9001

Table of Contents

Terms, Acronyms, and Abbreviations

TERM	MEANING
AEA	Alaska Energy Authority
BTU	British Thermal Unit
cfs	Cubic feet per second
cyd	Cubic yards
ea	Each
FERC	Federal Energy Regulatory Commission
gal	Gallon
gpd	Gallons per day
gpm	Gallons per minute
HDPE	High density polyethylene
ID	Inside diameter
kVA	Kilo Volt-Amps
kW	Kilo Watt (1000 Watts)
kWh	Kilo Watt-hours
lb	Pound
mgd	Million gallons per day
mi	Mile
mmBTU	1 million BTU's
mo	Month
O&M	Operation and Maintenance
OD	Outside Diameter
SDR	Sidewall Diameter Ratio
sq ft	Square feet
sq mi	Square miles
sq yd	Square yard
TDX	Tanadgusix Corporation
TDX Power	Subsidiary of TDX, owner and operator of regulated utilities in Sand Point, Manley, Adak, and Prudhoe Bay.
USGS	United States Geological Survey

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1. Introduction

TDX Power is evaluating renewable energy options for the city of Adak, Alaska and has tasked Hatch with a reconnaissance level study of the hydroelectric possibilities. The general purpose of this report is to identify potential hydroelectric developments, make a general assessment about economic viability of a project, and report on existing information and issues that need additional work if it is determined that a hydroelectric project may be feasible.

It has been found that there are numerous hydroelectric generation possibilities on the island of Adak. This report identifies the different potential projects and performs a high level comparison of the options. While this report includes a brief analysis of the most likely option, most of the options should be vetted further before making a recommendation for future development.

The scope for this report is a desktop study to primarily analyze hydrology information and investigate hydroelectric potential using existing data. Included in the scope is an estimate of the energy available from the options with a matrix comparing cost and other factors. Finally, a preliminary calculation of storage utilization, useful energy, economic benefit, and range of cost is provided for a selected project.

1.1 Community Overview

Current Population: 326 (2010 U.S. Census Population)
Pronunciation/Other Names: (A-dack); formerly Adak Station
Incorporation Type: 2nd Class City
Borough Located In: Unorganized
School District: Aleutian Region Schools
Regional Native Corporation: Aleut Corporation
The community incorporated as a second-class city in April 2001.

1.1.1 Location:

Adak is the southern-most community in Alaska, on the latitude of Vancouver Island in Canada. The former Navy Air Facility Adak is located off the Alaskan mainland near the center of the Aleutian chain, approximately 1,200 miles west-southwest of Anchorage, Alaska. Flight time to Anchorage is three hours. Adak Island's coordinates are latitude 51°53′0" N, at longitude 176° 38′46" W. The Bering Sea surrounds the island to the north and the Pacific Ocean to the south. Adak is located in the Aleutian Islands Recording District. The area encompasses 122.4 sq. miles of land and 4.9 sq. miles of water.

1.1.2 History

The first inhabitants of Adak Island were the Aleuts. Archaeological evidence reflects occupation as early as 9,000 years ago. The Aleuts hunted whales, seals, otters and sea lions, as well as island birds, and fished Adak's freshwater streams and the surrounding seas. They lived in large, communal, subterranean structures of grass and earth built over driftwood or whalebone frames. The Aleuts developed technologies such as sophisticated kayaks and waterproof clothing to deal with the cool marine environment. Aleut settlements were often located in coves along freshwater streams. Remnants of prehistoric Aleut settlements remain on Adak today.

Russians first visited the Aleutian Islands in the early 1740s and were trading with the Aleuts by the 1750s. As recently as 1827, Adak was a busy trading settlement with a population of 193 Aleuts. By 1830, Russian settlers had occupied Adak and relocated the Aleuts to Russian settlements in Kodiak, the Pribilof Islands, and Sitka. Adak Island became part of the Alaska Territory, which was subsequently purchased from Russia by the United States in 1867. Even after the permanent Aleut villages were abandoned, seasonal and subsistence use of the island continued. By 1910, over hunting by outsiders had nearly depleted the once-abundant sea otter and fur seal populations. In 1913, Adak Island was included in the 2.9-million-acre Aleutian Islands National Wildlife Refuge (renamed the Alaska Maritime National Wildlife Refuge in 1980) established by the President. This refuge was set aside as a preserve and breeding ground for native birds and fur-bearing animals and as an important fisheries habitat. Seasonal and subsistence use of the island by the Aleuts continued up until the time of World War II, when Aleuts in the island chain were evacuated to internment camps.

1.1.3 Military Uses of Adak

Since the early 1940s, the northern half of Adak Island has been used for military operations. During World War II, Adak Island became the site of a military base operated by the Army Air Corps for defensive action against Japanese forces occupying Attu and Kiska Islands in the Aleutian chain. In the spring of 1944, Adak's population included at least 32,000 military personnel. In preparation for a major offensive on the Japanese-occupied islands of Kiska and Attu, as many of 90,000 troops on ship or shore were mobilized to the Aleutian arena. Since the war, the military presence on Adak has fluctuated, depending on United States defense policy and federal appropriations, and has generally not exceeded 6,000 persons.

After the war, the base was transferred to the U.S. Air Force (renamed Davis Air Force Base) and, according to Army Corps of Engineers records, encompassed all of Adak Island. The U.S. Air Force withdrew from Adak in 1950, and the Navy assumed all facilities on Adak Island. In 1953, only 15 officers and fewer than 200 enlisted men were assigned to the base. In 1959, Public Land Order No. 1949 withdrew land described as representing approximately 61,000 acres (the resurveyed land mass is 79,200 acres) of Adak Island (approximately the northern half) for use by the Navy.

By 1966, military and civilian personnel totalled almost 1,000, a number that stayed fairly steady through the 1970s. By 1981, the population had doubled by 2,000. In 1984, the Adak Naval Station was renamed Naval Air Station (NAS) Adak. By 1990, over 5,000 people were at the base, almost 3,000 of whom were military, the remainder composed of military dependents and civilian employees. In 1994, NAS Adak was designated as Naval Air Facility (NAF) Adak. As of February 1996, following military draw down and closure of Naval Security Guard Activity (NSGA), approximately 500 military and 50 civilian personnel were stationed on Adak. Subsequent to its listing under Base Realignment and Closure in July 1995, the military mission at Adak was ended on March 31, 1997. The Aleut Corporation purchased Adak's facilities under a land transfer agreement with the Department of the Interior and the U.S. Navy/Department of Defense. This agreement was finalized in March, 2004.

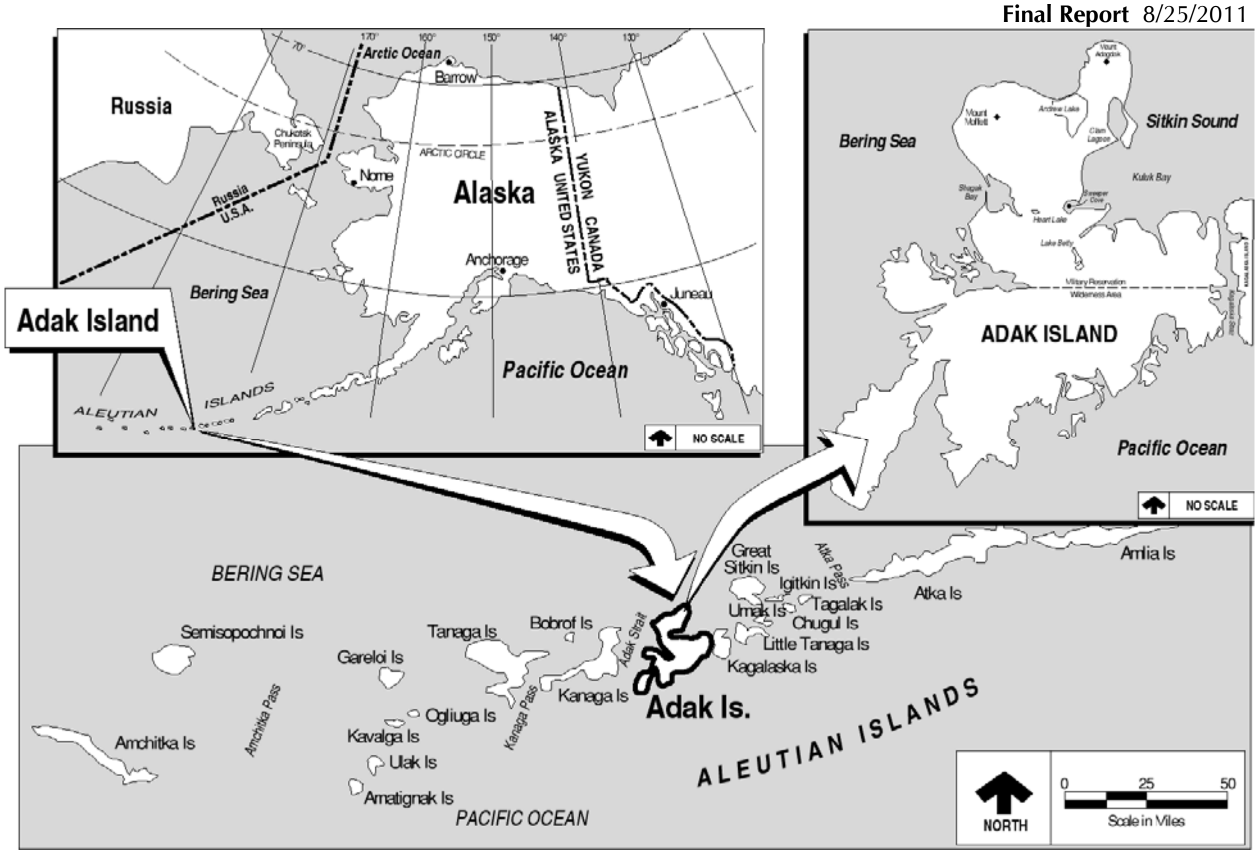

Figure 1 – Adak Location

1.1.4 Climate:

The maritime climate on Adak is characterized by persistently overcast skies, high winds, and frequent, often violent, cyclonic storms originating in the northern Pacific Ocean and Bering Sea. Weather can be localized, with fog, low ceilings, precipitation, and clear weather all occurring within a distance of a few miles. Storms can occur during any season, although the most frequent and severe storms occur during the winter.

Mean annual precipitation for Adak Island is about 66 inches, most of which falls as rain. Average monthly precipitation varies from a low of 3 inches in June and July to a high of 7 to 8 inches in November and December. Snowfall averages over 100 inches per year. Because of the relatively warm temperatures, snow rarely exceeds 1 to 2 feet in depth and is concentrated in the mountains.

Mean monthly temperatures vary from a low of 32.9° F in February to a high of 51.3° in August. The highest temperature recorded on Adak is 75° F (August 1956), and the lowest temperature is 3 degrees F, recorded in January 1963 and February 1964.

1.1.5 Land Ownership:

A land exchange between Aleut Corp., the U.S. Navy, and the Department of the Interior has transferred most of the naval facilities to the Aleut Corporation. A portion of the island remains within the national Maritime National Wildlife Refuge, managed by the U.S. Fish & Wildlife Service.

1.1.6 Facilities:

After World War II, the U.S. Navy developed facilities and recreation opportunities at Adak. A movie theater, roller skating rink, swimming pools, ski lodge, bowling alleys, skeet range, auto hobby shop, photo lab, and racquetball and tennis courts were developed. An $18-million hospital was built in 1990. As of 2009, all of these facilities are closed.

Substantially all of the infrastructure and facilities on Adak are owned by Aleut Corporation, who is currently developing Adak as a commercial center via their subsidiary companies. The former base has two areas with extensive development. The first is the "downtown" area of Adak, where NAF was located and which includes the airfield, port facilities, landfills, sewage treatment facilities, light industrial, administration, commercial, recreational, and residential areas. The second main developed area, formerly used by NSGA, includes the northern part of the island and areas around Clam Lagoon. The NSGA area is no longer used.

Water is derived from Lake Bonnie Rose, Lake De Marie, and Nurses Creek, stored in any of the seven water tanks throughout the community, and piped to facilities and housing units. The wastewater treatment system discharges through a marine outfall line to Kuluk Bay. Husky Road landfill is a class III permitted landfill.

Adak provides a fueling port and crew transfer facility for fishing fleets, and an airport, docks, housing facilities, restaurant, grocery store, and ship supply store are available. The seafood processing facility can process about 500,000 pounds of fish per day. In 2010, two residents held commercial fishing permits.

Adak Airport is a State of Alaska owned & maintained certificated airport. It has two asphalt paved runways; one measures 7,790' long by 200' wide, and the other runway measures 7,605' by 200' wide. Alaska Airlines operates passenger and cargo jet service. There are three deep water docks and fueling facilities. In 2009, the city was in the process of expanding the Sweeper Cove small boat harbor to include new breakwaters, a 315' dock, and new moorage floats. Adak has approximately 16 miles of paved roads, as well as gravel and dirt roads.

1.2 Previous Hydroelectric Studies

A previous study by Ebasco Services Inc. (Ebasco, 1980) looked at four sites:

- Sites 1 and 2 - run of river sites located on the west side of Mt. Moffett (not included in this report).
- Site 3 - Lake Bonnie Rose to Lake De Marie.
- Site 4 - Lake Betty to tidewater.

The reported states "Sites does not have economic hydropower development potential." It also noted that there were environmental concerns with salmon migration in streams with hydropower potential.

Information provided for sites 3 and 4 include the following:

Site	3	4
Intake Location	Lake Bonnie Rose	Lake Betty
Powerhouse Location	Lake De Marie	Tidewater
Average Annual Streamflow (cfs)	14.8	12.8
Total Head (feet)	200	200
Net Head (feet)	180	180
Installed Capacity (kW)	192	166

No other studies investigating hydroelectric potential in Adak have been found.

2. Geography

Adak Island was formed by extreme geologic events, including the tectonic collision of large sections (plates) of the earth's crust and resulting volcanic eruptions. Advancing and receding glaciers, frequent rainfall, and high winds have shaped Adak Island into a dramatic landscape of hills, valleys, cliffs, and floodplains. Very few areas of the island are flat, and grading to create flat areas could not be done easily.

The highest point on Adak Island is Mt. Moffett (elevation approximately 3,875 feet). Some coastal cliffs on the island rise 2,500 feet above sea level.

Island maps used in this report were developed from NASA's shuttle radar topography mission (SRTM) and from the USGS topographic map for Adak. Portions of higher quality topographic maps based off 1:50,000 scale U.S. Defense Mapping Agency maps of Adak (updated in 1974) were made available for use in preparing this report but authorization to reproduce them herein was not obtained. The following Figure shows the general topography and features of the island.

Figure 2 – Adak Topography

The upland topography of Adak is typical of the Aleutian Islands with rolling, steep terrain, volcanic features, and shallow, but often sharp crested, stream valleys. The vegetation primarily consists of grass with no trees or shrubs. Some exposed bedrock and areas of eroding volcanic soils can be found.

Several large lakes are formed in what are likely glacial carved depressions. These are primary candidates for hydropower development. The table below summarizes the lakes in the vicinity of the developed area of Adak.

Table 1 – Lake Summary

Sources	Elevation, ft	Basin Area (at outlet), sq mi	Surface Area, acres
Lake Bonnie Rose	739	1.55	139.2
Lake De Marie	234	3.59	86.7
Heart Lake	153	4.18	36.4
Lake Betty	159	4.43	136.6
Lake Leone	113	0.88	78.3
Mitt Lake	45	0.78	12.4

3. Geology

Adak Island was created during the last 60 million years by a complex set of geologic processes resulting from the collision of the North American and Pacific crustal plates. The resulting rock sequences consist primarily of volcanic rocks with some sedimentary rock. A relatively thin layer of unconsolidated material (generally less than 10 feet think) covers the entire island. Only the downtown area is known to have a thick sequence of unconsolidated material (greater than 100 feet). The northern region of Adak is dominated by the remnants of three volcanoes.

Throughout most of the project area, a 2 to 3 meter thick mantle of tephra blankets other surficial deposits and bedrock. A 1995 geologic map for the area indicates bedrock and tephra deposits in the area around Lake Bonnie Rose and Mitt Lake. The following is reported about the surficial deposits and bedrock in Adak (Waythomas, 1995):

> *Tephra deposits are usually 1.5 to 3.0 m thick and consist of thin beds of fine grained (mostly silt and clay size particles) ash and 3 to 5 beds of lapilli-sized (2-64 rnm) tephra. Locally interbedded with peat. Many of the ash layers are weathered to clay. Somewhat porous, but permeability is limited by fine particle size. Lapilli beds are more porous and permeable than the fine grained tephra layers. Locally water bearing, especially in low-lying areas.*
>
> *Areas of bedrock may include minor amounts of talus and colluviurn. In areas away from Mount Moffett and Mount Adagdak, most of the bedrock consists of Finger Bay Volcanics (Coats, 1956). These rocks are extensively fractured and faulted, and locally exhibit some weathering. Zones of bedrock where fracture density is high may be porous and permeable and may be water bearing.*

4. Site Control

Land ownership and use has not been investigated as part of this study. All of the projects considered in this report are located outside the US Fish and Wildlife Refuge boundary and are presumably entirely owned by the Aleut Corporation.

5. Environmental and Aquatic Resources

This report does not address in any detail the potential environmental impacts of the projects considered. A review of the ADF&G's catalog of anadromous habitat indicates that all of the project options are located on streams that have anadromous fish in their lower reaches. Approximate habitat locations based off the catalog are as follows:

- Lake Bonnie Rose – Lake De Marie - Heart Lake drainage: The upper limit of anadromous habitat is estimated at about elevation 100', reach about 1000' long.

- Lake Leone: The upper limit of anadromous habitat is estimated at elevation 60', reach about 630' long.
- Lake Betty: The upper limit of anadromous habitat is estimated at elevation 30', reach about 2200' long.
- Mt Reed Creek: The upper limit of anadromous habitat is estimated at elevation 250', reach about 1300' long (note: average gradient ~20%).
- Mt Moffett Creek: The upper limit of anadromous habitat is estimated at elevation 20', reach about 1500' long.

It is possible that the catalog is not entirely accurate with some reaches shorter or longer than stated. Also, the areas of habitat, wetted perimeter at various flows, slope, bed material, and usage by species would need to be investigated before making any conclusions about whether modification of flow regimes may have an impact to the aquatic resources.

A potential concern with excavation for installation of pipelines and foundation structures is the presence of contaminated sites and unexploded ordinance. Extensive information regarding site assessment and cleanup activities is available at the environmental cleanup and closure of the former Naval Air Facility, Adak, Alaska website (http://www.adakupdate.com/).

Water quality may be a concern in the design of pipe works and intake equipment. A report on the water system (Bristol, 2010) indicates that the water from Lake Bonnie Rose is "aggressive" with a low pH and a high amount of dissolved oxygen. Cathodic protection is strongly recommended for the water system.

6. Existing Infrastructure

6.1 Existing Generation

Power production data was provided by TDX for 2009 and 2010. This data consists of total monthly energy produced, total fuel used, and average power. Some anomalies exist in the reporting and for this report only the total monthly energy data is used. TDX Power supplied a synthesized hourly load data set for a single year based off this monthly data. This data is shown in the following figure.

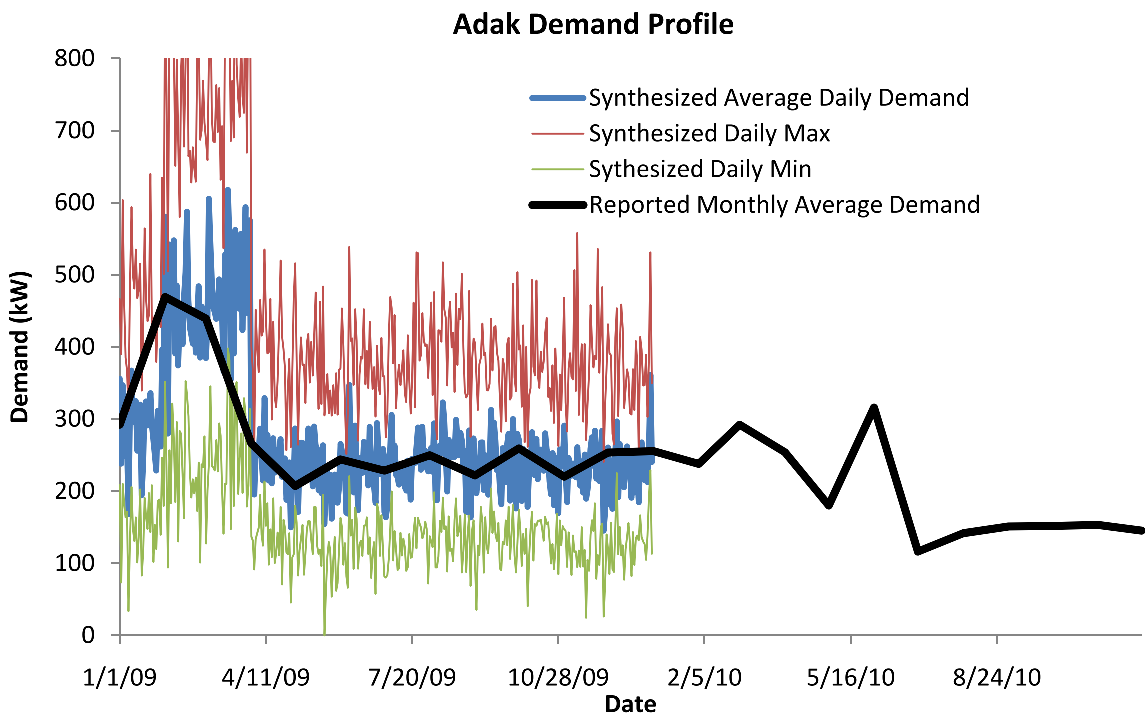

Figure 3 - Adak Demand Profile

From the limited data provided it appears that significant, sustained load changes may be occurring consisting of large jumps down in what is otherwise a flat annual load profile. This lack of consistency and the large magnitude of the changes make it difficult to estimate future loads without additional data from 2011, information on generation planning, and additional monitoring.

The existing generation equipment consists of oversized, for the current load, caterpillar 3516 diesel generators. TDX Power reports that one new high efficiency unit is being installed that will be sized for the current and expected future demand.

6.2 Water System

Lake Bonnie Rose and Lake De Marie have existing dams at their outlets for collection of water. As indicated in the Design Analysis Report for the water system (Bristol, 2010), the current source of raw water is from Lake Bonnie Rose.

There is an existing 10" or 12" pipeline, circa 1990's (Bristol 2010), that brings water from Lake Bonnie Rose to a PRV located at elevation 306' and set to 70 psi (PRV-1). There are numerous tanks and PRV's that serve various distribution areas. Water tank capacity on Adak is 3.7 million gals with 1.9 million gallons in use ("A" and "B" tanks). The Adak system operator has reported that the overflow elevation of tanks A and B is 235.8' and 231.9' respectively.

TDX Power reports, based on a discussion with the City of Adak Public Works Director, that water flow at PRV-1 is about 215 gpm (0.5 cfs). This includes continuous, unmetered overflow at the A-tanks. Actual water use is unknown. Domestic water use is presumed to be 215 gpm in the analysis for the selected hydroelectric power with storage option. Future modifications to the water system suggests construction of a new water treatment plant with design flows of 35 to 70 gpm (Bristol, 2010).

Water use with the fish plant online is estimated, by the public works director, to be up to 800 gpm (1.8 cfs). The water system report (Bristol, 2010) indicates there are plans to convert the fish processing service to raw water supply. No information on the timing or future supply source of this use has been obtained and it is not included in the hydropower analysis.

6.3 Competing Water Uses

The Aleut Corporation has applied to the DEC for the rights to drain water from Lake Bonnie Rose, Lake Betty and Lake De Marie. The reported use for the water is for bulk water export sales. The amount of water requested is up to 500,000 gallons per day (0.77 cfs) from each of the lakes. Since all the water from Lake Bonnie Rose and Lake De Marie, both part of the same drainage system, could be withdrawn from just the lower lake (lake De Marie), the separate requests for withdrawals from Lake Bonnie Rose and Lake De Marie seem to indicate that rapid and large draw down from the lakes is desired. However, there is also a significant amount of water storage tankage connected to both Lake Bonnie Rose and Lake De Marie that may be involved in the bulk water sales.

The method of filling a container vessel in the port, whether through rapid drawdown of the lakes or utilizing the tank system, will determine how hydroelectric operation would be curtailed during the filling process. Future coordination and more information on the bulk water sales plans will be required for determining the economic benefits of the hydroelectric project. The withdrawal of water for bulk water sales is not included in this analysis given the present uncertainty of the venture. It is noted that bulk water sales is not in total conflict with a hydroelectric project and with coordination could be an efficient operation and good partnership.

7. Hydrology

Short, steep-gradient streams draining radially from Mt. Moffett, Mt. Adagdak, and other upland areas characterize the surface water hydrology of the northern portion of Adak Island. Perennial flow is maintained by snowmelt in the mountains and seepage from the shallow surficial soils. Numerous lakes and sediment deposits occur along stream courses.

The USGS has measured stream flows at two locations on Adak Island in addition to numerous sites on Amchitka, two on Shemya, and one at Cold Bay. The following table summarizes the data for these sites.

Table 2 – USGS Stream Gauge Summary

				No. of Records w/ Data		Basin Area	Unit Flow (cfs/mi^2)	
Station ID	Station Name	Begin Date	End Date	Days	Years	Sq Mi	Avg	Med
15297610	RUSSELL C NR COLD BAY AK[1]	10/1/1981	6/23/2011	7663	21.0	30.9	8.2	6.7
15297617	SWEEPER C AT ADAK IS AK	10/1/1992	4/22/1996	1300	3.6	1.0	4.1	2.7
15297625	MOFFETT C AT ADAK IS AK	10/1/1993	4/22/1996	935	2.6	4.5	6.0	4.9
15297640	LIMPET C ON AMCHITKA IS AK	11/1/1967	9/30/1972	1796	4.9	1.7	3.1	2.1
15297650	FALLS C ON AMCHITKA IS AK	4/1/1968	2/19/1972	1420	3.9	1.0	2.1	1.6
15297655	CLEVENGER C ON AMCHITKA IS AK	4/1/1968	5/23/1974	2244	6.1	0.3	3.8	2.7
15297680	BRIDGE C ON AMCHITKA IS AK	11/1/1967	8/28/1974	2493	6.8	3.0	1.5	0.8
15297690	WHITE ALICE C ON AMCHITKA IS AK	4/1/1968	8/27/1974	2340	6.4	0.8	2.8	2.0
15297767	LK C AT SHEMYA AFB AK	11/21/1970	11/30/1972	741	2.0	1.0	1.8	1.4
15297773	GALLERY C AT SHEMYA AFB AK	11/22/1970	11/30/1972	740	2.0	1.0	0.9	0.8

Note 1: Gauging at Russell Creek was discontinued on 12/31/1986 and restarted on 10/1/1995.

The short data records for the Adak streams, only 3.6 years and 2.6 years for Sweeper Creek and Moffett Creek respectively, present a general concern that an average water year may not be represented. The Russell Creek drainage has data spans 30 years but is missing 9 years from the period 1987 to 1996. There is about a 7 month overlap between the Russell Creek data and the Adak gauges. However, comparison of the two data sets over this short time does not reveal any meaningful comparison regarding year to year variability.

An additional means of identifying adverse water years is through comparing rainfall data with streamflow measurements. The rainfall data for Adak is shown below.

Table 3 – Rainfall Data

ADAK, ALASKA-500026, Monthly Total Precipitation (inches)
File last updated on Oct 22, 2010
*** Note *** Provisional Data *** After Year/Month 199603
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1949	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	6.45	7.30	7.93	12.96	34.64
1950	3.95	2.63	3.39	2.54	3.23	1.35a	2.44	6.42	10.04	5.58	2.54	7.65	51.76
1951	7.57	9.23c	4.65c	6.76g	4.20c	2.15b	3.42	3.22	4.22	10.62	8.65	11.63	69.56
1952	5.00a	5.86b	7.43a	2.48a	5.89a	9.38a	3.43	1.89	4.69	9.82	10.51a	2.54	68.92
1953	9.86	7.22	11.08	7.12	6.47	4.48	0.43a	5.78	5.49	6.41	12.92	4.37	81.63
1954	6.01	6.96	7.97a	2.44	16.10	5.62	4.79	4.59	7.75	6.79	6.12	13.78	88.92
1955	17.34	5.88	4.13	4.75	5.45a	3.20	5.11	2.33	4.80a	12.52a	11.66	13.47	90.64
1956	3.92	6.95	11.99	5.01a	6.82a	4.34	4.38	9.52	10.70	3.38a	5.51	9.46	81.98
1957	12.92	4.40	7.02	9.95	6.05	6.79	1.03b	2.71	5.21	7.10	4.68	8.78	76.64
1958	6.71	2.77	8.31	5.24	5.69	3.74	3.07	1.57	7.47	11.22	11.19	9.61	76.59
1959	3.13	7.15	7.38	3.88	5.25	3.80	2.50	4.44	7.44	7.15	7.23	4.62	63.97
1960	4.35	2.79	2.55	2.31	3.29	1.43	3.04	2.98	2.49	5.31	2.94	3.87	37.35
1961	5.74	2.81	2.33	2.26	2.82	2.97	4.86	2.41	4.74	6.85	7.85	4.90	50.54
1962	5.35	6.44	9.63	1.42	1.68	4.07	2.28	3.95	2.71	8.09	6.14	5.34	57.10
1963	5.30	1.97	8.67	3.79	5.98	3.52	2.17	0.00z	4.50	6.10	6.78	10.16	58.94
1964	4.30	6.10	7.10	6.87	1.12	2.50	2.15	3.68	11.30	5.87	7.12	8.65	66.76
1965	4.80	5.67	5.86	10.17	3.05	3.16	3.88	2.39	5.37	6.66	8.18	6.96	66.15
1966	5.71	8.21	2.57	4.43	5.76	1.36	2.16	6.72	3.76	3.02	11.65	6.72	62.07
1967	7.69	5.05	5.65	4.75	0.64	1.61	6.10	5.28	6.01	7.81	9.59	9.64	69.82
1968	8.89	3.75	3.67	4.99	1.34	1.91	2.37	2.49	3.10	4.95	6.65	8.09	52.20
1969	10.28	5.26	4.28	4.19	3.29	2.04	1.22	4.53	6.77	4.20	7.40	4.17	57.63
1970	6.10	3.76	3.39	6.25	1.55	1.92	2.81	4.75	0.00z	7.83	4.81	0.00z	43.17
1971	3.67	2.07	6.92	3.80	2.54	0.00z	3.41	2.25	6.72	5.47	10.62	0.00z	47.47
1972	6.20	2.93	3.43	2.57	3.01	3.02	2.33	3.78	0.00z	8.71	9.12	0.00z	45.10
1973	2.71	0.00z	6.06	0.00z	2.77	2.95	2.74	5.31	7.83	4.60	8.67	8.01	51.65
1974	5.58	3.78	3.76	5.89	5.37	1.63	4.66	7.34	4.57	3.02	9.89	6.71	62.20
1975	4.03	3.84	5.58	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	7.28	6.48	27.21
1976	3.92o	1.07q	3.89	3.34	2.60	1.55	3.56	3.81	4.56	7.49	3.16o	0.00z	30.80
1977	3.56	3.81	4.85	2.91	3.81	2.68	1.98	4.50	0.00z	6.07	4.98	5.87	45.02
1978	0.00z	4.44	3.99	3.93	3.37	3.17	1.84	2.99	0.00z	6.23	0.00z	8.19	38.15
1979	6.75	4.72	5.53	6.64	0.00z	3.04	2.86	0.00z	4.26	10.01	6.06	6.53	56.40
1980	0.00z	0.00z	6.44	4.36	3.53	3.46	1.68	5.34	4.55	5.66	9.21	5.90	50.13
1981	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00
1982	0.00z	0.00z	0.00z	0.00z	0.00z	3.74	4.92	4.53	6.21	4.08	8.34	4.21	36.03
1983	3.65	4.72	3.03	2.23	1.76	1.70a	2.35	3.60	4.74	7.66	7.34	6.59	49.37
1984	4.97	4.27	0.00z	4.55	2.74	1.67	1.76	0.00z	5.35	4.05	0.00z	6.79	36.15
1985	3.43	2.96a	4.77	3.65	3.71	3.37	1.34	0.00z	4.66	0.00z	0.00z	0.00z	27.89
1986	3.38	3.04	4.17	6.00	3.60	2.22	0.71	0.00z	4.74	0.00z	7.74	0.00z	35.60
1987	0.00z	3.96	0.00z	0.00z	1.92	4.88	0.00z	3.31	0.00z	7.47	0.00z	0.00z	21.54
1988	0.00z	2.80	4.66	2.92	4.43	0.00z	3.57	0.00z	0.00z	6.64	6.22	0.00z	31.24
1989	6.22	2.79	2.96	0.00z	2.76	0.00z	1.28	0.00z	7.34	3.30	0.00z	4.30	30.95

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1990	6.60	3.62a	6.11	1.97	4.36	0.90	2.47	6.20	5.01	2.58	3.10	0.00z	42.92
1991	11.39	1.75	6.94	3.79	3.55	3.48	2.76	2.93	7.12	4.64	0.00z	5.74	54.09
1992	0.00z	4.91	5.63	1.61	1.58	5.37	0.00z	3.42	6.35	6.92	6.14	7.54	49.47
1993	9.35	5.35	4.91	3.61	2.30	3.17	3.89	7.62	4.84	9.81	7.02	4.46	66.33
1994	5.66	6.31	3.84	1.43	2.69	2.87	2.48k	4.89f	3.76h	5.40k	3.38f	4.81k	22.80
1995	1.41k	4.10i	1.38d	3.54a	1.73i	0.67d	1.71c	3.45a	7.38f	6.32e	2.69	7.00g	19.76
1996	3.57f	3.51f	4.98g	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00
1997 to	2010	No	Data										
MEAN	6.27	4.57	5.43	4.19	3.86	3.09	2.82	4.22	5.78	6.56	7.43	7.28	65.65
S.D.	3.05	1.81	2.34	2.05	2.53	1.66	1.30	1.79	2.01	2.30	2.55	2.80	13.77
SKEW	1.69	0.55	0.81	1.14	2.81	1.52	0.47	0.93	0.99	0.46	0.00	0.71	0.05
MAX	17.34	9.23	11.99	10.17	16.10	9.38	6.10	9.52	11.30	12.52	12.92	13.78	90.64
MIN	2.71	1.75	1.38	1.42	0.64	0.67	0.43	1.57	2.49	2.58	2.54	2.54	37.35
NO YRS	37	40	42	39	41	41	41	36	37	42	38	35	21

The lack of significant overlap between the rainfall data and Russell Creek, Sweeper Creek, and Moffett Creek prevents using the rainfall record for an evaluation of year to year variability in the streamflow records. However, a limited comparison can be made on a monthly basis. There appears to be a general lack of deviation in the observed rainfall and runoff measurements compared with the long term mean rainfall. Based on this limited comparison and the general lack of data, it is concluded that the measured runoff at Sweeper Creek and Moffett Creek are generally representative of long term average runoff quantities and patterns.

The two Adak sites, despite being only 4 miles apart, exhibit significantly different runoff characteristics. The typical annual runoff profile from Moffett Creek is has peaks and valleys inverted from that of Sweeper Creek. During the summer months Moffett Creek has higher unit runoff than during the winter months. Sweeper Creek is the opposite with higher runoff rates in the winter than in the summer. Moffett Creek also exhibits a higher amount of unit runoff overall on an annual basis.

A review of the other USGS gauged drainages along the Aleutian Islands and Alaska Peninsula exhibit a similar trend with Russell Creek having a significantly higher unit runoff and all of the remaining sites exhibiting runoff similar to Sweeper Creek. This dichotomy is illustrated in the following chart.

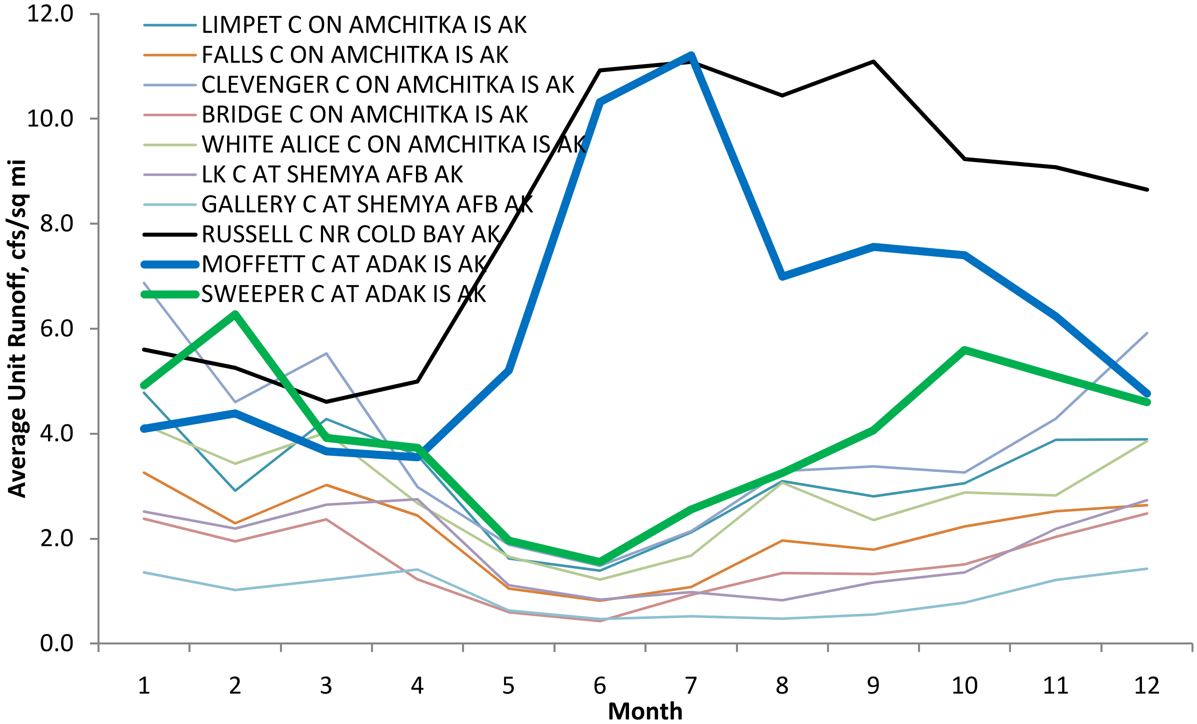

Figure 4 – USGS Monthly Average Streamflow Chart

A review of the locations of the drainages indicates that Moffet Creek and Russell Creek have catchment areas located in relatively high elevations with ridges and valleys whereas the other drainages are located in relatively flat and open areas. Notwithstanding other factors in the data sets, it is possible that the higher elevations, ridges, and valleys allow for snow drifting and accumulation that becomes a significant contributor to runoff in those drainages during the summer months. And during the winter months it is likely that the high altitude results in winter precipitation falling as snow and, with lower temperatures, results in reduced runoff.

The drainages for Mt. Reed Creek and Lake Bonnie Rose both have catchments with ridges and valleys at higher elevations and therefore the runoff in these basins is expected to be similar to the Moffet Creek drainage. The lower drainage areas of Heart Lake and Lake Leone are presumed to have runoff rates similar to the Sweeper Creek. And the mid altitude drainages of Lake De Marie and Lake Betty are expected to exhibit runoff rates that equal the average of the other two.

The procedure for determining runoff rates for drainages in this analysis was to calculate the daily average[1] unit flow from all years of the record for each of the Adak data sets. This resulted in two data sets, one for Moffett Creek and one for Sweeper Creek, containing an average year of daily unit runoff flows. Then, based on the general altitude for the basin, the unit runoff for each project option was calculated by combining the Moffett Creek and Sweeper Creek data sets appropriately and scaling by the appropriate basin area. The values to derive daily flows for each of the projects options are shown below.

[1] The average unit flow is appropriate if storage is utilized whereas for the run-of-river projects on Moffett Creek and Mt Reed Creek the median flow is used.

Table 4 – Project Streamflow Derivation

Source	Daily Unit Flow	Basin Area (sq mi)	Tributary Flow
Lake Bonnie Rose	25%*Sweeper Creek Average + 75%*Moffett Creek Average	1.55	
Lake De Marie	50%*Sweeper Creek Average + 50%*Moffett Creek Average	3.59 – 1.55	Lake Bonnie Rose
Heart Lake	100%*Sweeper Creek Average + 0%*Moffett Creek Average	4.18 – 3.59	Lake De Marie
Lake Betty	50%*Sweeper Creek Average + 50%*Moffett Creek Average	4.43	
Mt Reed	25%*Sweeper Creek Median + 75%*Moffett Creek Median	2.39	
Moffett	0%*Sweeper Creek Median + 100%*Moffett Creek Median	2.78	

The following table is the resulting monthly average flow for each of the project intake locations.

Table 5 – Derived Monthly Average Streamflows (cfs) for Each Project Location

Month	Lake Bonnie Rose	Lake De Marie	Heart Lake	Lake Betty	Mt Reed	Moffet
1	6.7	15.9	18.7	20.0	8.8	10.3
2	7.5	18.3	21.9	23.4	10.3	11.2
3	5.8	13.5	15.8	16.8	7.8	9.3
4	5.7	13.2	15.4	16.4	8.2	10.0
5	6.8	14.1	15.3	15.9	10.4	14.5
6	12.6	24.7	25.6	26.3	19.3	28.7
7	14.0	28.1	29.6	30.5	21.3	31.2
8	9.4	19.8	21.7	22.7	13.8	19.4
9	10.4	22.2	24.6	25.8	15.4	21.0
10	10.8	24.0	27.3	28.8	14.8	18.9
11	9.2	20.8	23.8	25.1	13.4	16.7
12	7.3	16.9	19.6	20.7	10.3	12.4
Average	8.8	19.3	21.6	22.7	12.8	17.0

8. Project Options and Initial Evaluation

Initial analysis found about 13 individual hydroelectric project configurations near Adak. A simple approach to comparing these individual options was adopted to identify the options with the best potential for development. The following discussion presents this approach. Not included in this analysis is the multitude of options possible when the individual projects are combined. Current loads appear to have dropped enough from historic levels such that a single hydroelectric development should meet the majority of demand. The table below summarizes the results of the initial project identification and assessment.

Table 6 – Project Options and Analysis Matrix

No	Source	Source Elev	Powerhouse Location	Powerhouse Elevation	Design Flow	Penstock Length	Penstock Diameter	Net Head	Power	Transmission Length	Cost Score	Energy Score	Environ Score	Average Score
		ft		ft	cfs	ft	in	ft	kW	ft	1 to 5	1 to 5	1 to 5	1 to 5
1	Lake Bonnie Rose	739	Lake DeMarie	249	10.6	5,517	16	443	318	2,519	2.3	3.1	3.5	2.9
2	Lake Bonnie Rose	739	Ocean	25	10.6	9,765	16	632	453	0	1.5	4.9	2.8	3.1
3	Lake Bonnie Rose	739	Ocean	25	10.6	15,032	18	644	462	7,390	0.0	5.0	2.0	2.3
4	Lake Bonnie Rose	739	Heart Lake	168	10.6	13,862	18	506	363	4,772	0.5	3.7	2.5	2.2
5	Lake DeMarie	234	Heart Lake	168	23.1	1,733	24	57	90	5,596	2.9	0.0	3.5	2.1
6	Lake DeMarie	234	Ocean	25	23.1	7,519	26	183	286	7,390	0.5	2.6	2.0	1.7
7	Lake Betty	159	Lake Betty PH	30	27.2	1,306	22	114	210	3,682	2.9	1.6	3.8	2.8
8	Lake Bonnie Rose	739	Exist PRV	300	3.5	0	10	358	85	0	5.0	0.7	4.5	3.4
9	Lake Bonnie Rose	739	Exist PRV	300	10.6	8,413	18	399	287	0	1.8	2.6	4.0	2.8
10	Lake Bonnie Rose	739	Mitt Lake	60	10.6	7,905	16	613	440	0	1.8	4.7	3.5	3.3
11	Heart Lake	153	Ocean	25	25.9	3,752	26	111	195	7,390	1.9	1.4	2.0	1.8
12	Mt Reed	400	Ocean	25	15.4	2,543	18	350	364	11,784	2.1	3.7	1.3	2.4
13	Moffet	400	Ocean	25	20.4	10,017	24	334	461	0	0.2	5.0	4.0	3.1

Scores shown in the table are ranked using a low number to representative a negative or detrimental aspect (such as high cost) and a high number to represent a positive aspect (such as high energy output or low environmental impact).

Some of the projects utilize the same source and destination elevation but have different pipeline routes and powerhouse locations. It is expected that many of the above options would prove feasibly impractical. Due to the desktop level of analysis and the number and complexity of issues, particularly the uncertainty related to aquatic resources, water supply, and demand, all of the options that are possible have been retained in this report for reference purposes in future feasibility efforts.

The initial analysis presented above does not include storage or useable energy (demand constrained) considerations. The design flow for each configuration, except option 8 using the existing pipeline, is selected as the average annual flow, as calculated previously for each basin, times 120%. The total annual energy production is based on the design flow times a capacity factor. The capacity factor for option 8 is 100% while the other options use a 60% capacity determined from energy analysis using the estimated daily hydrology data. Actual useful capacity factors will be dictated by system load, local hydrology, water system demands, bulk water sales (if any), environmental bypass flows, and storage capability. Transmission lengths were determined by the shortest distance from the powerhouse location to the nearest building group.

At this stage in the analysis the results are considered relatively accurate and should only be used for comparison among projects in this study and as a basis for future planning and analysis efforts. A project scoring system was developed for assessing and ranking each project based on cost, energy produced, and environmental attributes. The environmental factors assigned are based on estimated impacts to aquatic issues and the physical footprint of the project.

Scoring of cost is derived by calculating a cost factor that is based on the pipeline diameter, length, and transmission length. The project with the lowest cost factor has the highest score whereas the highest cost project has the lowest score. Similar to the cost scoring, the ranking of energy is derived by scoring the project with the highest energy output a 5 and the project with the lowest output a 0. Environmental scores are derived based on a qualitative evaluation of the amount of bypassed reach, the percentage of bypassed flows, and the amount of new trail required for the pipeline and transmission lengths combined.

The results show that two developments rank the highest:

- Option 8 - Utilizing the existing water system pipeline and installing a power recovery turbine in place of the PRV.
- Option 10 – Constructing a storage project utilizing Lake Bonnie Rose for the intake and locating a powerhouse on Mitt Lake.

9. Lake Bonnie Rose to Mitt Lake Project Analysis

Option 10, the configuration with an intake at Lake Bonnie Rose and a powerhouse at Mitt Lake, with more capacity and higher energy output, appears to be the most feasible option for meeting a majority of energy generation needs economically at this stage of analysis . Option 10 is also a storage project and is analyzed in more detail in this section. The additional analysis includes the impact of storage and the ability to meet the energy needs of the synthesized hourly demand. The estimated useable storage for the lake is the surface area times a depth of 5 feet. Also included in the analysis is a requirement to supply 0.5 cfs of water for domestic purposes.

The results indicate that Lake Bonnie Rose has daily and some seasonal storage value. The analysis of the performance using the hourly demand data and storage is an approximation that does not include varying efficiency, headloss, minimum diesel loading and run time, or ice and snow effects on storage. For this level of study, the results are generally adequate to test the viability of the concept and determine if feasibility efforts should be considered.

The results of the hourly energy analysis show that, for most of the year, the hydroelectric project could displace diesel generation entirely. The following chart shows the results of the analysis.

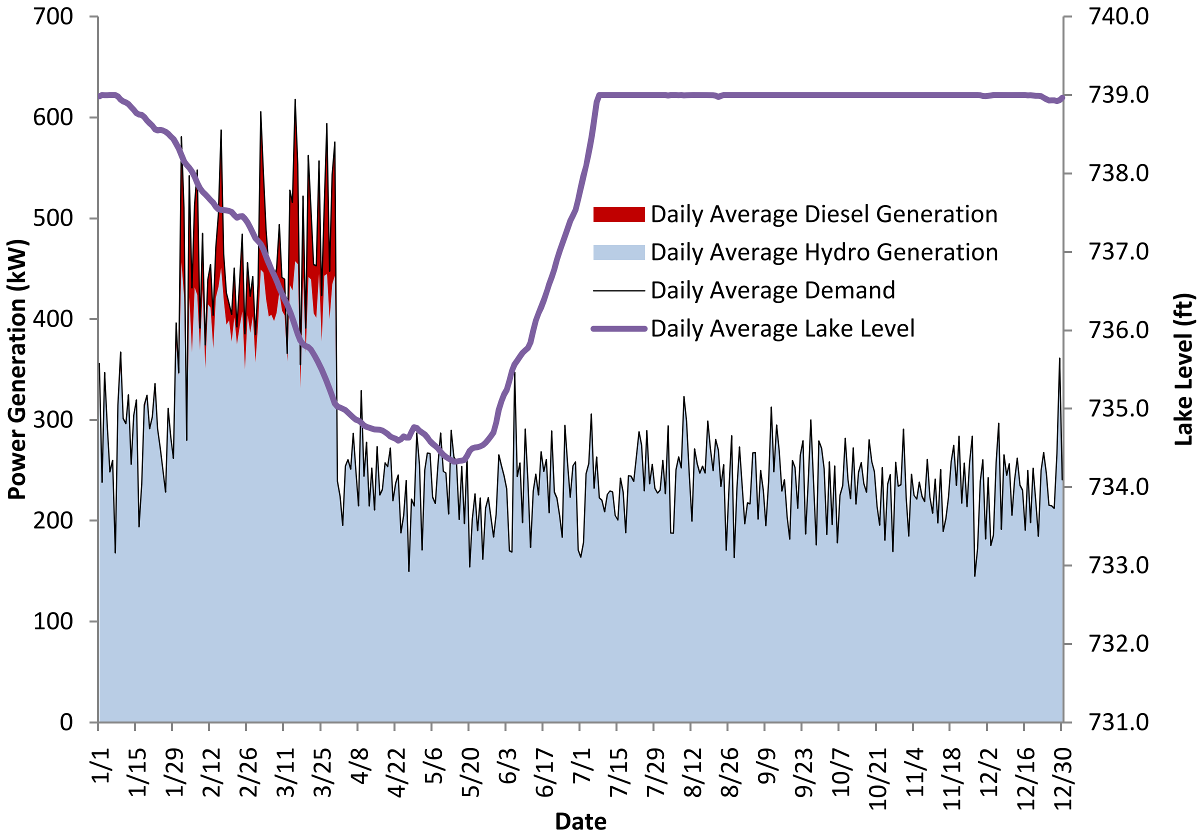

Figure 5 – Option 10 (Lake Bonnie Rose to Mitt Lake) Performance Chart

The table below shows the energy distribution with the hydroelectric project as part of the generation system and the estimated annual fuel savings.

Table 7 – Option 10 (Lake Bonnie Rose to Mitt Lake) Performance Summary

Parameter	Result
Available Energy from Hydroelectric	2,600,000 kWh
Hydroelectric Capacity Factor	67%
Annual Energy Demand	2,450,000 kWh
Fraction of Demand Met by Hydro	2,330,000 kWh
Fraction of Demand Met by Diesel	110,000 kWh
Estimated Diesel Efficiency	14 kWh/gal
Current Diesel Fuel Use	175,000 gal
Diesel Fuel Use with Hydroelectric	7,900 gal
Annual Fuel Savings with Hydro	167,100 gal

Using an estimated cost of diesel fuel in Adak of $4.50 per gallon, the annual savings in fuel would be about $750,000. Over a 30 year period with a discount rate of 3% this equates to a present value of about 14.7 million dollars. For comparison, it is estimated that the capital costs for similar rural hydroelectric projects should be in the range of about $7,500 per kW to $15,000 per kW. Thus, at 440 kW, option 10 is expected to cost from 3.3 million to 6.6 million dollars.

10. Recommendations

The preliminary analysis indicates that a hydroelectric project in Adak is economically viable. Many issues need to be examined in further detail including competing water uses and aquatic issues that could reduce power potential or drive up costs with a subsequent lowering of benefits. Full consideration of other resources and impacts is necessary to determine the best development scenario. Additional feasibility study is warranted to collect site specific data, perform visual inspection of the options, and refine the analysis to determine recommended project(s), conceptual designs, and costs. Recommendations include:

- Obtain current satellite image and perform a satellite photogrammetric or LIDAR survey over the entire project area (from Moffet drainage south to the Aleutian Wilderness boundary).
- Monitor and log 15 minute demand data to determine daily load fluctuations. Also log hourly or daily demand with peaks over a longer period.
- Investigate bulk water sale plans and coordinate development efforts for the water system and bulk sales.
- Install and maintain two or more stream gauges in Adak. At a minimum one should be placed at the outlet of Lake Bonnie Rose and one after Heart Lake.
- Investigate the additional permitting and mitigation required for the basin diversion of water.
- Investigate the existing dams and evaluate the storage potential.
- Perform feasibility level studies to further evaluate issues related to aquatic habitat, incorporate stream gauge work into the hydrology analysis, and develop more detailed project cost estimates, size and storage recommendations, and conceptual designs.
- Investigate future load growth (or decline), fish processor loads, and further evaluate demand requirements and the possible option of constructing multiple hydroelectric projects.

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APPENDIX B

Geothermal Potential of Adak Island, Alaska
A Preliminary Assessment
(Draft Report)

Introduction

The purpose of this report is to provide a preliminary assessment of the geothermal potential on Adak Island. Much work was done on the geothermal potential of Adak by the U.S. Navy. The Navy conducted numerous studies and drilled at least one test well to test for a viable geothermal resource. As part of this preliminary assessment, copies of the Navy's technical reports were requested and the Navy has agreed to supply the documents. However, as of the date of this draft report, the documents have not yet been received and hence this assessment does not include a summary of the Navy's findings.

It is believed that the studies conducted by the Navy and its contractors will form a solid basis for any new work to develop the geothermal resources on the island. Other studies referenced in this assessment show there are adequate indicators of a geothermal resource that could be developed to supply electricity to the island.

Potential resource size, location

Older reports show only one hot spring on the island. References of the hot spring, located at the shoreline on the east side of Andrew Bay, date back to the 1800's. Waring (1965) lists a lone hot spring on the island. Motyka, Liss, Nye, and Moorman (1993) show the Andrew Bay hot spring and a warm spring on the west side of the island (Figure 1). In their 1993 report, they list the Andrew Bay hot spring as having a surface temperature of 71°C (160°F) and calculated geothermometer temperatures as high as 157°C (315°F). The geothermometers are indicators of subsurface temperatures derived from chemical analyses of the geothermal waters.

The success of a geothermal resource is dependent on three primary factors: heat, fluid, and permeability. The temperatures have to be high enough to use existing technology. Fluid (water) is necessary to transport the heat (flow rate) to the surface, and permeability (usually faults and fractures in the rock) is necessary to provide the "plumbing" for the fluid.

The potential size of the resource is unknown until the Navy's work is evaluated and possible further field studies, including drilling, are conducted. However, if the subsurface resource temperatures approach 300°F, the resource does not have to be very large to generate enough electricity to supply the island's needs.

Based on available information, the primary target area for the potential geothermal resource is the northeast part of the island as shown in Figure 2. This target area is the peninsula formed by Mt. Adagda and borders Andrew Bay on the east.

Resource evaluation, design

At least one early reconnaissance geophysical survey was done an aeromagnetic survey by Zietz and Henderson (1949). The geology has been mapped by Coats (1956) and by Waythomas (1995). It is assumed that the Navy used these studies as a foundation for their work starting in the 1970's.

Additional mapping of the target area may be required, depending on the adequacy of the Navy surveys. It may also be beneficial to run some geophysical surveys using new technology. Such surveys would include high-resolution aeromagnetics and new sophisticated electrical resistivity surveys that have been developed in the past few years.

In 2005, Dinicola, Simonds, and Defawe issued a report on numerous shallow monitoring holes that were drilled as part of the environmental assessment of groundwater contamination at certain sites on the Naval Base. If these monitor wells are still open, it would be worthwhile to take temperature measurements in those holes. Another cost-effective method of geothermal exploration is to measure soil temperatures at shallow depths (approximately 3 feet). This type of survey can be used to detect shallow, hot-water upflow.

A final design for resource evaluation will have to wait on the review of the Navy's geothermal work on the island.

Required infrastructure

Infrastructure required for the development of a geothermal power plant includes wells, pipelines, power plant, power lines, and roads. The well field will consist of production and injection wells. The number of wells needed will depend on temperatures and flow rates. Insulated pipelines will be needed from the wells to the power plant, and from the power plant to the injection wells.

Many technical advancements have been made in binary geothermal power plants over the last five years. There are now several companies that manufacture modular units in a range of sizes. The power plant modules have to be sized to the resource, but a small plant adequate to fill the island's needs would be a simple installation. A small modular installation would have a small footprint, likely on the order of 100 feet by 100 feet, or less. Other necessary infrastructure such as roads and power lines, would be minimal.

Permitting, legal, regulatory, licensing issues

Geophysical, geochemical, and geological surveys generally do not require permits as long as they don't require road building or other surface-disturbing activities.

Temperature-gradient drilling will likely require permits from the State of Alaska. Drilling of test wells, production wells, and injection wells will also require state permits. Power plant construction, including the supporting infrastructure of roads, pipelines, and power lines will all require permits from various state agencies.

Integration with existing diesel plant

The present power load for the remaining inhabitants on the island is relatively small. An adequate geothermal resource and one or two small modular, binary power plants could easily replace the existing diesel power plant. Geothermal power is base load; it can generate electricity continuously and some plants are known to operate more than 98% of every year. Annual shutdown for maintenance work should be minimal, and the diesel plant can become a backup unit, rather than the primary generation.

If the geothermal resource is hot enough to generate electricity, and is located close enough to the village, then options should be explored to utilize the power plant effluent (cooled geothermal water) for space heating homes and buildings. This direct use of geothermal fluids for space heating has been used for hundreds of years. Such utilization of the power plant effluent would be dependent on various factors, including the effluent temperature, distance from the power plant to the buildings, and chemistry of the geothermal fluids.

An economic feasibility study of a geothermal power plant for Adak Island was conducted by Bruce (1979). This study is a useful starting point, but the economics have changed over the years and should be much more attractive today, thanks to the advancement in technology and the rising fossil fuel prices.

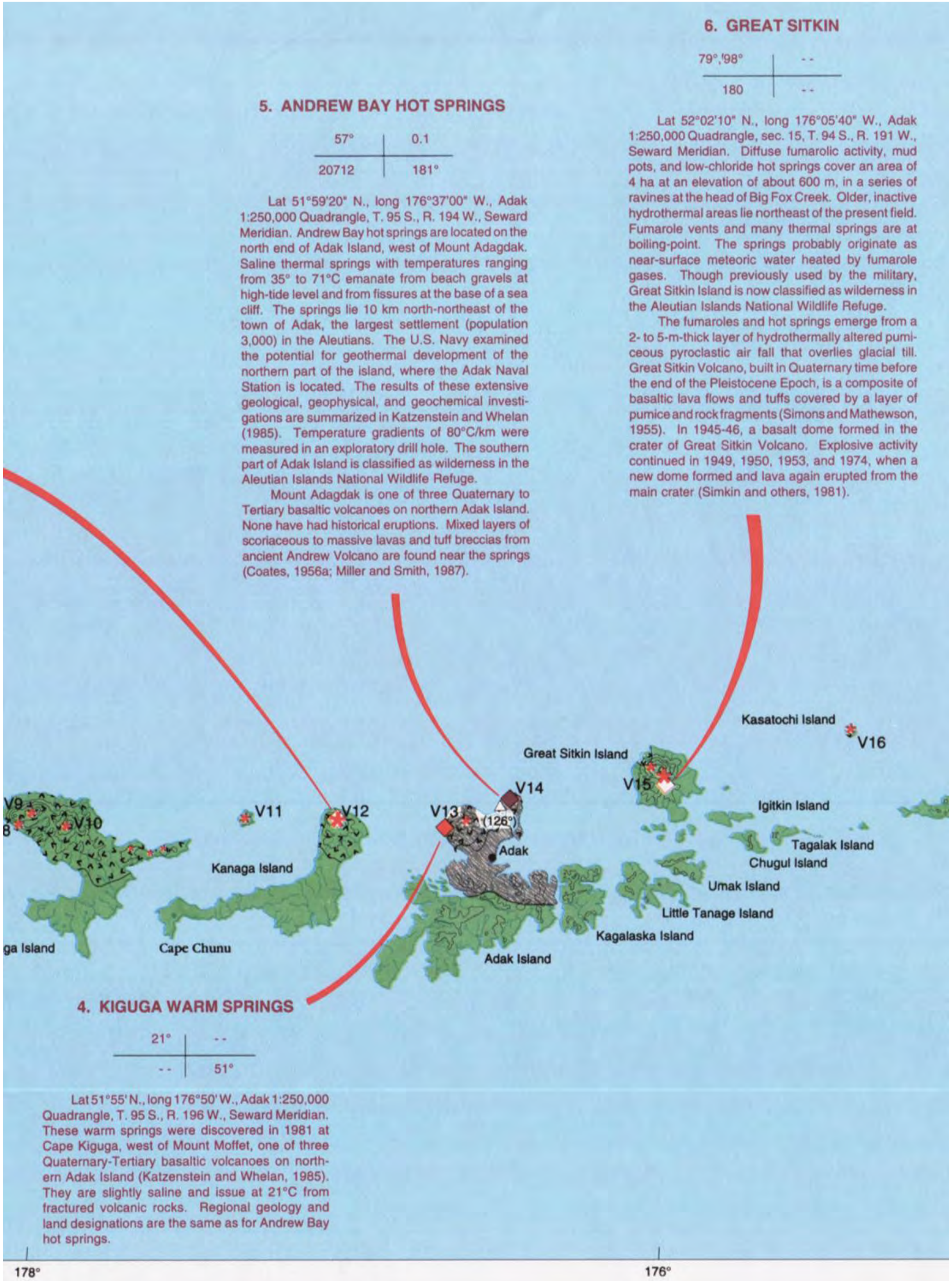

Figure 1. Geothermal springs (extracted from Motyka, et al, 1993).

Figure 2. Geothermal target area, northern Adak Island.

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APPENDIX C

Solstice Alaska Consulting, Inc.
Memorandum

Date: July 26, 2011

To: Martin Miller, TDX Power

From: Robin Reich and Colleen Miller

Subject: Adak Alternative Energy Permitting and Land Requirements

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Introduction

Solstice Alaska Consulting, Inc. (Solstice) was contacted to determine potential permit requirements for the development of potential renewable energy resources, including wind, hydroelectric, and geothermal, on Adak Island.

Our assumptions for the project are as follows:

Wind Option

TDX is considering installing a wind turbine on property near the airport in Adak. The project would include a 150-foot turbine constructed on a solid fill pad on property owned by the Aleut Corporation (S 10, T 96 S, R 195 W, Seward Meridian, 51° 52' 20.50" N/176° 39' 19.86" W). This project would include a powerline from the turbine to an existing power plant located approximately 500 feet from the turbine.

Geothermal Option

TDX is considering developing a geothermal power project on the north end of Adak Island near Mount Adagdak. It is unlikely that this project would be economically viable to develop; however, information on potential permitting needs is included in this memo.

Hydroelectric Options

Because preliminary analysis indicates that a hydroelectric project in Adak is economically viable, TDX is considering three hydroelectric feasibility options in Adak. After a detailed analysis of 13 potential hydroelectric options, the most feasible proposed hydroelectric option was determined to be a water storage project with an intake at Lake Bonnie Rose, a penstock that continues to a powerhouse near Mitt Lake, and a discharge to Mitt Lake.

Federal Permits and Authorizations

Below is a list of potential permits and authorizations that could be required for the development of alternative energy options in Adak. This list is based on our knowledge of the options, site characteristics, and permitting requirements. The list includes a short background on the regulated resource in the Adak area.

1. Wetlands (Section 404 and Section 10) Permit

Background
Section 404 of the Clean Water Act regulates discharge of dredged and fill material into waters of the United States, including wetlands. Section 10 of the Rivers and Harbors Act regulates construction, excavation, or deposition of materials in, over, or under ordinary high water of any navigable water of the United States. In short, any person, firm or agency (including federal, state and local government) planning to place structures or conduct work in navigable waters of the United States, or discharge (dump, place or deposit) dredged or fill material in waters of the U.S. must first obtain a permit from the U.S. Army Corps of Engineers (USACE).

Based on the *Aleutians West Coastal Resource Service Area Coastal Management Plan*, wetlands under the jurisdiction of the USACE are common throughout the western Aleutian Islands. U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory mapping has not been completed for Adak, and it is unlikely that wetlands have been formally delineated and mapped in the area. Also, navigable marine waters exist in the Adak area.

Potential Permitting Requirements
Hydroelectric, Wind, and Geothermal Options: It is likely that a wetland permit would be required for all proposed renewable energy projects; however, it is recommended that prior to submitting an application, a preliminary wetlands jurisdictional determination is completed to determine the extent of wetlands in the project area. A USACE wetland permit would be required if the project requires dredging or the placement of fill in wetlands. Also, a wetlands permit would be required if any project components were placed below ordinary high water of any navigable stream.

If the project is constructed in undisturbed areas, it is likely that a wetlands survey and the submittal of a preliminary jurisdictional determination and a wetland permit application would be required. Potential impacts to wetlands could be reduced by constructing the project within previously disturbed areas and by incorporating existing infrastructure.

Responsible Agency: USACE

Statutes: Section 404 of the Clean Water Act (1977) and Section 10 of the Rivers and Harbors Act (1890)

Timing*:* A 30 day public review is required for all projects requiring an Individual Permit.

Contact*:* Section USACE, Regulatory Branch
P.O. Box 6898
Elmendorf AFB, AK 99506-6898
Phone: 907.753.2724
Fax: 907.753.5567

2. National Historic Preservation Act Section 106 Consultation

Background
Section 106 of the National Historic Preservation Act (NHPA) requires Federal agencies or Federal actions (e.g. a federally-issued permit) to take into account the effects of their undertakings on historic properties. The project must consult the Alaska Department of Natural Resources (ADNR) State Historic Preservation Office (SHPO) regarding potential impacts to cultural and historic resources in the vicinity of the project.

There is the potential to find cultural or historic resources in the Adak project area. Archeological evidence indicates that the Aleuts occupied the island as early as 9,000 years ago. Remnants of prehistoric Aleut settlements remain on the island. Russians first visited the island in the mid-1700s and began trading with the Aleuts. Since the early 1940s, the northern half of Adak Island has been used for military operations, and the military was present until 1997.[1] Based on the high probability of finding cultural and historic sites on Adak associated with Alaska Natives and the U.S. military, it is recommended that the project consult with the SHPO.

Potential Permitting Requirements
Hydroelectric, Wind, and Geothermal: Since there is the potential that there are cultural or historic resources in alternative energy project option areas, to make the permitting process more efficient, consultation with the SHPO should occur during the permitting process. The project could wait for the federal permitting agencies to complete this consultation as a part of their process; however, Solstice has found that completing the NHPA consultation with the SHPO helps to move the permitting process forward.

If the project is constructed in undisturbed areas, it is likely that a cultural resources survey would be required and the SHPO would require the submittal of a finding of effects letter. If the project would result in impacts to buildings more than 50 years old, it is likely that SHPO would require the submittal of a finding of effects letter. Potential impacts to cultural resources could be reduced by constructing the project within previously disturbed areas and by incorporating existing infrastructure, such as road right-of-ways.

Responsible Agency: ADNR SHPO

Statute: Section 106 of the National Historic Preservation Act (1966)

Timing: SHPO is required to respond within 30-days of the submittal of a findings letter. If no response is received, the project can assume there would be no impacts to historic properties.

[1] URS Corp. and US Navy. Adak Update: Environmental cleanup and closure of the former Naval Air Facility, Adak, Alaska. 2009. Accessed on June 17, 2011 at: http://www.adakupdate.com/index.html

Notes: The SHPO could request a field survey for cultural resources, which could increase the timing on this process. The SHPO could also find that the project could impact cultural resources. If this is the case, further consultation would be needed.

Contact*:* Judith Bittner, State Historic Preservation Officer
550 West 7th Avenue, Suite 1380
Anchorage, AK 99501
Phone: 907.269.8721
Fax: 907.269.8908
judy_bittner@dnr.state.ak.us

3. Endangered Species Act Clearance

Background
If a project involves a Federal action (e.g. a Federal permit, funding, or action on Federal lands), a consultation required by Section 7 of the Endangered Species Act (ESA) must be performed for any activities that may affect species or critical habitat of species formally listed as threatened or endangered.

The following ESA-listed species may be found in the project area: Aleutian shield fern, an endangered species managed by the USFWS; the northern sea otter and Steller's eider, threatened species managed by the USFWS; and the Steller sea lion, fin whale, humpback whale, sperm whale, blue whale and north Pacific right whale, endangered species managed by the National Marine Fisheries Service (NMFS). Critical habitat for Aleutian shield fern has not been established, but it is possible that the ferns are located within project option areas. Critical habitat for Steller sea lion surrounds Adak Island, but no haul out or rookery sites are in the vicinity of the project options. Critical habitat for northern sea lions in the area is from mean high tide seaward. Critical habitat for the whale species is also off shore. (Sea otters, Steller sea lions, and whale species are also regulated under the MMPA, which has separate consultation requirements that could occur concurrently with this process.)

Potential Permitting Requirements
Hydroelectric, Wind, and Geothermal: To make any federal permitting process for this project more efficient, consultation with the USFWS and the NMFS regarding impacts to listed threatened or endangered species is recommended to assist in moving the permitting process forward. The project could wait for the permitting agencies to complete this consultation as a part of their process; however, Solstice has found that completing the ESA consultation helps to move the permitting process forward.

Responsible Agency: USFWS, NMFS

Statutes: Section 7 of the Endangered Species Act (1973)

Timing: The USFWS has 30 days to respond to a findings letter sent by the Federal action agency or project proponent on behalf of the agency.

Contact: Ellen Lance,
U.S. Fish and Wildlife Service
Branch Chief, Endangered Species
605 West 4th Avenue, Rm G-61
Anchorage, Alaska 99501
Phone: 907.271.1467
Ellen_Lance@fws.gov

Brad Smith
NOAA Fisheries
Protected Resources
222 West 7th Ave.
Anchorage, AK 99517
Phone: 907.271.3023
Brad.Smith@NOAA.gov

4. Federal Aviation Administration Determination of No Hazard to Air Navigation

Background
Federal Aviation Administration (FAA) Advisory Circular 70/7460-1K states that any person/organization who intends to construct any of the following must notify FAA:

- any construction or alteration exceeding 200 ft above ground level
- any construction or project:
  - within 20,000 ft of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with its longest runway more than 3,200 ft
  - within 10,000 ft of a public use or military airport which exceeds a 50:1 surface from any point on the runway of each airport with its longest runway no more than 3,200 ft
  - within 5,000 ft of a public use heliport which exceeds a 25:1 surface

The Adak Airport and its surrounding regulated airspace is located in the heart of the community of Adak.

Potential Permitting Requirements
Wind: An aeronautical study number has been applied to the project: 2011-WTW-6362-OE for the proposed location of the wind turbine. FAA will issue a determination of No Hazard to Air Navigation or Presumed Hazard to Air Navigation, depending on the outcome of their analysis. It may be necessary to lower the height of the turbine or change the location of the turbine if the FAA determines that the construction of the turbine would result in a hazard to air navigation.

Hydroelectric and Geothermal: There would likely be no FAA permitting requirements associated with a hydroelectric or geothermal project.

Responsible Agency: Federal Aviation Administration

Statutes: Title 14 of the Code of Federal Regulations CFR Part 77

Timing: The FAA usually addresses permit applications within one month.

Notes: If the FAA issues a Notice of Presumed Hazard to air navigation determination, the height or location of the turbine may need to be changed.

Contact:

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Wind Turbines
AJV-15, Obstruction Evaluation Group
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Renton, WA 98055
Phone: 404.305.7083
Fax: 404.305.7080
Chris.Cody@faa.gov

Robert van Haastert
Supervisor, Obstruction Evaluation Group, AJV-15
FAA Alaskan Regional Office
222 W. 7th Ave., #14
Anchorage, AK 99513
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5. Essential Fish Habitat Consultation

Background

The Magnuson Stevens Fishery and Conservation and Management Act (MSFCMA) defines Essential Fish Habitat (EFH) as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The MSFCMA directs federal agencies to consult with NOAA Fisheries when any activities may have an adverse effect on EFH. An adverse effect is defined as "any impact which reduces quality and/or quantity of EFH." An impact can be direct, indirect, site-specific or habitat-wide, including individual, cumulative, or synergistic consequences and actions.

The marine waters surrounding Adak provide EFH for the following species: walleye pollock, squid, skate, sculpin, rock sole, and northern rockfish. No Habitat Areas of Particular Concern are found at the project location. Anadromous streams are also considered EFH for salmon species. Based on Alaska Department of Fish and Game's (ADF&G) *Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes*, there are about 12 anadromous streams around the community of Adak. (See Section 7 of this memo for more details on anadromous streams.)

Potential Permitting Requirements

Hydroelectric and Geothermal: To make the permitting process more efficient, consultation with NOAA Fisheries regarding impacts to EFH is recommended to assist in moving any federal permitting process forward. The project could wait for the permitting agencies to complete this consultation as a part of their process; however, Solstice has found that completing the EFH consultation helps to move the permitting process forward. If a hydroelectric project is pursued and the project involves a trans-basin discharge, consultation with NOAA Fisheries regarding potential impacts to salmon would be required. Potential impacts to EFH could be minimized by avoiding a trans-basin water discharge.

Wind: There would likely be no EFH issues associated with a wind project.

Responsible Agency: NOAA Fisheries

Statutes: The Magnuson Stevens Fishery and Conservation and Management Act

Timing: It is expected that NOAA Fisheries would respond to a findings letter sent by the Federal action agency or project proponent on behalf of the agency within 30 days.

Contact:

Geothermal:
Jeanne Hanson, Field Office Supervisor
NOAA Fisheries
Habitat Conservation
222 West 7th Avenue, Room 517
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Phone: 907.271.3029
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Jeanne.hanson@noaa.gov

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State Permits and Authorizations

6. Coastal Zone

Background

The Alaska Coastal Management Program (ACMP) ended on July 1, 2011 and the local coastal management plans are without statutory authority and are therefore unenforceable. Municipal coastal districts will need to make policy decisions on whether to retain their local coastal management plans within their municipal code or ordinance, and how that plan will be implemented through the local permitting process. Although the currently approved plans will be without statutory authority and will be unenforceable at the State and Federal level, a municipal coastal district may choose to retain its plan and implement it solely at the local level.

7. Fish Habitat (Title 16) Permit

Background
The ADF&G has statutory responsibility for protecting freshwater anadromous fish habitat and providing free passage for anadromous and resident fish in fresh water bodies. Any activity or project that is conducted below the ordinary high water mark of an anadromous fish stream requires a Fish Habitat Permit.

Approximately 12 streams around the community of Adak have spawning and rearing habitat for coho, chum, sockeye and pink salmon and Dolly Varden. These streams have been included in *the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes*. A map showing the location of anadromous streams listed in the Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes, Effective June 1, 2011 is attached (Figure 1).

Potential Permitting Requirements
Hydroelectric: Because the development of a hydroelectric project in Adak could involve impacts to anadromous fish streams, it is likely that a Fish Habitat Permit would be needed. A Fish Habitat Permit is needed for any work in an anadromous stream.

If a hydroelectric project is pursued and the project involves a trans-basin discharge, it is likely that the ADF&G would have significant concerns and would require a fish habitat study to be conducted in the project area. It may also be necessary to conduct a hydrology study to determine the project effects of reduced stream flow on fish. ADF&G may require mitigation for impacts to fish habitat. Potential impacts to anadromous streams could be minimized by avoiding a trans-basin water discharge; however, a fisheries field study and Fish Habitat Permit would likely be required for any alternative that is carried forward.

The Aleut Corporation is preparing a Fish Resource report to submit to ADNR as a requirement prior to the granting of water rights. If this report is available to the public, it may contain useful information for the hydroelectric project option.

Wind: It is likely that the development of a wind project in Adak would avoid impacts to anadromous streams; therefore, a Fish Habitat Permit would not be required.

Geothermal: Not enough information is available to determine whether the development of a geothermal project would impact anadromous streams.

Responsible Agency*:* Alaska Department of Fish and Game, Division of Habitat

Statutes*:* AS 16.05.841-871 (Fish and Game, Fish and Game Code)

Timing*:* For simple projects, ADF&G typically processes Fish Habitat Permits within one month. Trans-basin hydroelectric project permitting could take up to 6 months.

Contact: Monte Miller
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333 Raspberry Road
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Phone: 907.267.2312
monte.miller@alaska.gov

8. Water Rights

Background
A project must establish water rights if it plans on diverting, impounding, or withdrawing a "significant" amount of water for use. A significant amount is defined as:

- Consumptive use of more than 5,000 gallons of water from a single source in a single day
- The regular daily or recurring consumptive use of more than 500 gallons per day (gpd) from a single source for more than 10 days per calendar year
- The non-consumptive use of more than 30,000 gpd from a single source
- Any water use that may adversely affect the water rights of other appropriators or the public interest.

A water right is a legal right to use surface or ground water under the Alaska Water Use Act (AS 46.15). A water right allows a specific amount of water from a specific water source to be diverted, impounded, or withdrawn for a specific use. When a water right is granted, it becomes appurtenant to the land where the water is being used for as long as the water is used. If the land is sold, the water right transfers with the land to the new owner, unless ADNR approves its separation from the land.

To obtain water rights in Alaska, the applicant must submit an application for water rights to the ADNR office in the area of the water use. After the application is processed, the applicant may be issued a permit to drill a well or divert the water. Once the applicant has established the full amount of water that would be used beneficially and complied with all of the permit conditions, a certificate of appropriation may be issued. This is the legal document that establishes water rights.

No water rights have been established on the island of Adak; however, several entities have applied for water rights within the project vicinity (Township 96 South, Range 195 West, Seward Meridian). The following table summarizes the parties who have applied for water rights and the status of the application.

Entity	Application Date	LAS No.	Type of Water Rights	Section(s)	Status (Date)
Aleut Enterprise Corporation	1/14/2000	23026	subsurface	36	CLOSED (2/9/2010)
Aleut Enterprise Corporation	1/14/2000	23027	subsurface	33, 34	CLOSED (2/9/2010)
Aleut Enterprise Corporation	1/14/2000	23028	subsurface	23, 28	CLOSED (2/9/2010)
Adak Reuse Corporation (transferred to City of Adak)	9/9/2000	23305	subsurface	20	Application Received (9/9/2000)
Adak Reuse Corporation (transferred to City of Adak)	9/9/2000	23306	subsurface	34	Application Received (9/9/2000)
Aleut Corporation	7/13/2010	27733	Surface	34	Application Received (7/13/2010)
Aleut Corporation	7/13/2010	27735	Surface	21	Application Received (7/13/2010)
Aleut Corporation	7/13/2010	27736	Surface	35	Application Received (7/13/2010)
Alaska Department of Natural Resources	7/1/1992	27979	Instream Reservation	26	Application Received (7/1/1992)
Alaska Department of Natural Resources	7/1/1992	27980	Instream Reservation	20	Application Received (7/1/1992)

The Adak Reuse Corporation was dissolved, and all water rights applications have been transferred to the City of Adak. It is unclear why the Adak Reuse Corp applied for subsurface water rights.

The City of Adak has applied for the rights to 950,000 gallons/day for drinking water. It may be possible to run water through a hydroelectric system, and then treat that water for drinking water. This would have to be approved by Alaska Department of Environmental Conservation (ADEC).

The Aleut Corporation has plans to develop a commercial resource development project that would export potable water to overseas markets, and they have applied for water rights for Lake Bonnie Rose, Lake De Marie, and Lake Betty. The water would be transported to the Adak dock via existing transmission pipes and loaded onto ships with food-grade tanks. There would be no water treatment before transport and no dock storage for untreated water. A public notice was published for this project on 7/26/2010 by the State of Alaska Department of Natural Resources, Division of Coastal and Ocean Management for this project to export potable water to overseas markets. This project would use the existing transmission lines from Lake Betty and Lake De Marie to withdraw and transport water. According to Krissy Plett, ADNR, the penstock from Lake Betty would need to be completely replaced. The penstock from Lake De Marie would need to be repaired.

Solstice is on the "interested parties" list for this permit application, and will be notified by email when the background reports (including a fisheries report) are submitted and the public notice for the water rights application is published.

Potential Permitting Requirements

Hydroelectric and Geothermal: TDX would have to secure water rights in order to operate a hydroelectric project. It is recommended that TDX cooperate with the City of Adak and/or the Aleut Corporation when determining the amount of water that would be required during hydroelectric generation. It may be possible to use the same water for both hydroelectric generation and drinking water for the community or transport to overseas markets. However, TDX would be required to obtain water rights from ADNR for the amount of water to be used for hydroelectric and geothermal generation, and ADEC would have to approve the use of water for both power generation and drinking water.

Wind: It is unlikely that a wind project would require water rights.

Responsible Agency: State of Alaska Department of Natural Resources Division of Mining, Land, and Water

Statute: Alaska Water Use Act (AS 46.15)

Timing: Securing water rights for a hydroelectric project could take up to 6 months. The Water Resources Section should be contracted for a pre-application meeting prior to preparing and submitting an application. Issuance of a water use permit requires a 30-day agency and public review after the application is determined to be complete by ADNR. Once the project is constructed and the full amount of water that would be used is determined, a certification is issued for water rights.

Fee: An application filing fee is required for water rights permit applications. The fee varies with proposed water consumption.

Contact: Krissy Plett
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Phone: 907.269.8641
kristina.plett@alaska.gov

9. Land Ownership

Background

TDX must gain site control before constructing any alternative energy option on Adak Island. The entity that owns the project location could grant a lease, an easement, or a sale of the property depending on what would be installed on the land.

The Aleut Corporation, the City of Adak, and the USFWS own the majority of the land on Adak Island. The Adak Naval Air Station officially closed on March 31, 1997, and a land exchange between Aleut Corporation, the U.S. Navy, and the Department of the Interior transferred most of the naval facilities to the Aleut Corporation. A portion of the island, primarily away from the community, is within the Maritime National Wildlife Refuge, managed by the USFWS. The community formed a second-class city government in April 2001, and the City owns most of land within the city limits.[2]

Adak Airport is a State of Alaska owned and maintained certificated airport within city limits. It has two asphalt paved runways; one measures 7,790 feet long by 200 feet wide, and the other runway measures 7,605 feet by 200 feet wide.

Currently, TDX owns the equipment at the power plant, but leases the building and land from the City of Adak.

Potential Permitting Requirements

Hydroelectric: It is likely that hydroelectric options would be on Corporation and City land. It is unlikely that the hydropower alignments would affect refuge land.

Wind: The wind turbine option would be located on land owned by the Aleut Corporation. It would be necessary to obtain site control, most likely a lease, from the Aleut Corporation for the placement of the wind turbine. TDX would need to work with the Corporation and the City to establish an easement for the power line between turbine and the power plant.

Geothermal: It is likely that the geothermal option would be location on Aleut Corporation lands. If the potential geothermal resource is on Maritime National Wildlife Refuge land, it is not recommended that this option is pursued.

Timing: Acquiring site control can be a long process. It is recommended that moving forward with site control negotiations begin immediately following selection of an alternative energy option.

Notes: Because of significant environmental and legal requirements associated with project development on refuge lands, Solstice recommends avoiding land within the Alaska Maritime National Wildlife Refuge.

Contact: Aleut Corporation
4000 Old Seward Highway, Ste. 300
Anchorage, Alaska 99503
Phone: 907.561.4300
Fax: 907.563.4328
receptionist@aleutcorp.com

[2] State of Alaska Department of Commerce, Community, and Economic Development Community and Regional Affairs. Alaska Community Database Community Information Summaries. 2011. Adak. Accessed on June 17, 2011 at: http://www.dced.state.ak.us/dca/commdb/CIS.cfm

Mike Swetzof, Mayor
City of Adak
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National Wildlife Refuge System-Alaska
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Danielle_jerry@fws.gov

10. Contamination

Background

Projects that would be constructed on lands that are considered contaminated must be coordinated with the agency responsible for their cleanup. In the case of Adak, the cleanup effort is lead by the U.S. Navy.

According to the U.S. Navy Adak Update webpage [http://www.adakupdate.com/envrest.html], 32 contaminated sites exist on Adak, including Solid Waste Management Units or landfills, unexploded ordnance areas, and polychlorinated biphenyl (PCB) spill sites, which have contaminated groundwater, surface water, sediments, and soil.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), otherwise known as Superfund; enacted in 1980, provides for liability, compensation, cleanup and emergency response for hazardous substances released to the environment.[3] The Adak Naval Air Station is listed as a superfund site, and cleanup is currently underway.[4] Additional information is available on the Adak Update website, which is managed by the Navy.

Environmental restoration projects began on Adak under the Navy Assessment and Control of Installation Pollutants program with an initial assessment study (IAS) in 1986. In 1988, site inspections were conducted at areas identified in the IAS. In 1989, a Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) was completed by the U.S. Environmental Protection Agency (EPA)

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[3] Environmental Protection Agency. 2011. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Accessed on June 17, 2011 at: http://www.epa.gov/agriculture/lcla.html#Summary%20of%20CERCLA

[4] Environmental Protection Agency. 2007. Cleanup in Region 10: Adak Naval Air Station. Accessed on June 17, 2011 at: http://yosemite.epa.gov/r10/cleanup.nsf/1a16218b78d8c4d58825674500015b42/2588a83be2a7af12882565070000c34e!OpenDocument

under the RCRA corrective action program. Adak was proposed for the EPA's National Priorities List (NPL) in October 1992 and it was officially placed on the NPL in May 1994. Clean-up activities have been ongoing.

Potential Permitting Requirements

Hydroelectric, Wind, and Geothermal: The potential for contamination should also be determined and considered when exploring any renewable energy options. It is recommended that TDX contact the Navy prior to finalizing an alignment or site for a renewable energy project to attempt to avoid any site and to ensure that the Navy approves of the location of ground-disturbing activities. An online dig permit application can be filled out at this website: [http://www.adakupdate.com/ICs/digpermit_rev.html].

Responsible Agency: U.S. Navy, Environmental Protection Agency, Alaska Department of Environmental Conservation

Timing: It is unknown at this time how long the consultation process with the U.S. Navy would take regarding contamination.

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Code EV3 1101 Tautog Circle
Silverdale, WA 98315-1101
Telephone: 1-866-239-1219
Fax: (360) 396-0857

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11. Water Quality Certification

Background

In accordance with Section 401 of the Clean Water Act, any applicant for a federal license or permit to conduct an activity that might result in a discharge into waters of the U.S., including wetlands, must also obtain certification from the ADEC that the discharge will comply with the Clean Water Act, the Alaska Water Quality Standards, and other applicable State laws. By agreement between the USACE and ADEC, an application for a wetland permit may also serve as an application for ADEC 401 water quality certification.

Potential Permitting Requirements

Hydroelectric, Wind, and Geothermal: It is likely that a wetland permit would be required for all proposed renewable energy projects; therefore, a Water Quality Certification would be required for all proposed renewable energy projects. The USACE wetland permit application serves as the application for the ADEC 401 water quality certification, so no additional steps are required.

Responsible Agency: Alaska Department of Environmental Conservation

Statute: Section 401 of the Clean Water Act

Timing: This process occurs concurrently with the USACE wetland permit application process

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Attachments: Figure 1: Anadromous Streams

Figure 1: Adak Alternative Energy Permitting and Land Requirements
Anadromous streams