Comprehensive Energy Audit
For
Alakanuk Water Treatment Plant

Prepared For
City of Alakanuk

November 27, 2015

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PREFACE

This energy audit was conducted using funds from the United States Department of Agriculture Rural Utilities Service as well as the State of Alaska Department of Environmental Conservation. Coordination with the State of Alaska Remote Maintenance Worker (RMW) Program and the associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Alakanuk, Alaska. The authors of this report are Gavin Dixon and Kevin Ulrich, Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in March of 2013 by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators and the City of Alakanuk.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Alakanuk. The scope of the audit focused on Alakanuk Water Treatment Plant. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC systems, water treatment, water distribution, sewage collection, other sanitation processes and plug loads. This audit is an update of the energy audit produced in March 2013. This audit takes into consideration the unsubsidized cost of electricity, the certain elimination of the water treatment plant's heat recovery benefits, and recent technology innovations to more accurately reflect the energy savings potential in the Alakanuk Water Treatment Plant.

In the near future, a representative of ANTHC will be contacting both the City of Alakanuk and the water treatment plant operators to follow up on the recommendations made in this audit report. ANTHC will work to complete the recommendations within the 2016 calendar year.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy cost for the Alakanuk Water Treatment Plant is $180,981 per year. Electricity represents the largest portion of the energy costs with an annual cost of $118,195. This includes electricity costs paid by the city and the Power Cost Equalization (PCE) program through the State of Alaska. Fuel oil represents the remaining portion of the expected energy costs with a predicted annual cost of $62,787 for #1 fuel oil.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy affordable in rural Alaska. This facility currently receives the PCE subsidy from the state of Alaska. In Alakanuk, the cost of electricity without PCE is $0.52/KWH and the cost of electricity with PCE is $0.21/KWH. The prices used to determine energy efficiency retrofits in this energy audit reflect the real cost of electricity as opposed to the subsidized price.

Currently the Alakanuk Water Treatment Plant receives free heat benefits from the nearby power plant in the form of heat recovery from the Alaska Village Electric Cooperative (AVEC) diesel generators. In April 2016 this power plant will be shut down. This heat benefit is estimated to be about 50% of the water treatment plant heating fuel consumption, or about 5,000 gallons of #1 fuel oil annually. This number may be higher depending on the performance of the generators in the AVEC plant. There is no data on the heat utilization from the existing heat recovery system as it is not metered.

The table below lists the total usage of electricity and #1 oil in the water treatment plant before and after the proposed retrofits.

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	228,111 kWh	126,745 kWh
#1 Oil	14,808 gallons	7,362 gallons

Benchmark figures facilitate comparing energy use between different buildings. The table below lists several benchmarks for the audited building. More details can be found in section 3.2.2.

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	666.7	49.98	$44.14
With Proposed Retrofits	342.5	25.68	$23.73
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

Table 1.1 below summarizes the energy efficiency measures analyzed for the Alakanuk Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
1	Other Electrical - Controls Retrofit: Generator Block Heater	Unplug Generator Block Heater	$630	$100	38.85	0.2	2,141.4
2	Lighting - Power Retrofit: Building Fluorescent Lighting	Replace fluorescent lights in the facility with four foot LED replacement bulbs.	$2,548 + $100 Maint.	$2,500	6.54	0.9	8,752.8
3	Setback Thermostat: Water Treatment, Mechanical, Lab, Vacuum, Generator, Office	Install setback thermostats to reduce building temperatures to 55 degrees when the facility is not occupied, such as at night.	$568	$1,200	6.40	2.1	2,801.7
4	Water Storage Tank Heating	Replace damaged controls, install a tank mixer, and control the heated temperature of the water storage tank to 40 degrees Fahrenheit.	$5,468	$12,500	5.88	2.3	26,672.3
5	Other Electrical - Controls Retrofit: Raw Water Line Heat Tape	The heat tape for the raw water line should be shut off in the summer time and during periods when the raw water pump is operating. This retrofit calls for training for the operator and insulation repairs at any locations that may be at risk of increased freezing on portions of the raw water line.	$4,264	$5,000	5.28	1.2	14,926.0

Table 1.1 PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
6	Vacuum Glycol lines zone 2,3,4	Fix controls and reduce heat to 45 degrees on return temperature. This retrofit calls for the replacement of the glycol distribution pumps with premium efficiency pumps, repair of any failed valves, heat exchangers, and thermostats and the implementation of reduce heating temperatures on the circulated glycol lines.	$7,840	$20,000	5.26	2.6	38,147.6
7	Other Electrical - Controls Retrofit: Other Appliances	Unplug appliances when not in use.	$191	$250	4.72	1.3	653.4
8	Lighting - Power Retrofit: Building Fluorescent Lighting	Replace fluorescent lights in the facility with four foot LED replacement bulbs.	$3,688 + $100 Maint.	$5,000	4.68	1.3	12,675.8
9	Water Circulation Loops 2,3,4	Fix controls, valves, and temperature gauges in order to reduce heat to 40 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	$6,870	$20,000	4.61	2.9	33,383.1
10	Vacuum Glycol lines zone 1,5	Fix controls and reduce heat to 45 degrees on return temperature. This retrofit calls for the replacement of the glycol distribution pumps with premium efficiency pumps, repair of any failed valves, heat exchangers, and thermostats and the implementation of reduce heating temperatures on the circulated glycol lines.	$6,656	$20,000	4.48	3.0	32,521.4
11	Water Circulation Loops 1,5	Fix controls, valves, and temperature gauges in order to reduce heat to 40 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	$6,231	$20,000	4.16	3.2	29,995.8

Table 1.1 PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
12	Other Electrical - Combined Retrofit: Water Storage Tank Heat Tape	The heat tape for the water storage tank circulation line should only be used for thaw recovery. This retrofit calls for improved insulation and training for the operators on new parameters to reduce the usage of electric heat tape on the water storage tank heat tape.	$2,348	$5,000	3.95	2.1	8,217.7
13	Lighting - Power Retrofit: Exterior Lighting	Replace exterior lighting with LED wall packs with photocell controls.	$560	$1,500	3.14	2.7	1,958.6
14	Other Electrical - Controls Retrofit: Vacuum Pumps	Replace the existing Vacuum sewage collection Pumps with Mink Aqua oil less vacuum pumps, with variable frequency drives; additionally replace leaky vacuum valves and failed vacuum toilets.	$23,226 + $12,500 Maint.	$100,000	3.00	2.8	77,516.6
15	Setback Thermostat: Garage, and Upstairs	Replace existing thermostats with programmable thermostats. Program the thermostats to heat the facility to only 55 degrees when the facility is unoccupied, such as at nights.	$423	$1,200	4.72	2.8	2,050.8
16	Air Tightening: Doors and Windows	Perform weather stripping and caulking to reduce air leakage throughout the facility. Focus on repair of the	$919	$2,500	3.39	2.7	4,459.2
17	Other Electrical - Power Retrofit: Utility Building Glycol	Replace building heating pumps with Grundfos Magna VFD integrated pumps or similar.	$1,236	$3,500	2.15	2.8	3,867.6
18	HVAC And DHW	Increase boiler efficiency through instruction of better maintenance techniques, installation of new burners, and replacement of faulty valves and boiler equipment.	$2,254	$15,000	1.37	6.7	10,502.1

Table 1.1 PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
19	Sewage Outfall Glycol Line	Fix controls, valves, and temperature gauges in order to reduce heat to 50 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	$1,885	$20,000	1.26	10.6	9,057.5
20	Other Electrical - Combined Retrofit: Pressure Pump	Replace blown pressure bladders on each pressure tank, replace pressure pump with premium efficiency pump and motor and replace controls. Evaluate potential reduction in pressure settings to reduce run time on the pump for additional savings.	$5,891	$45,000	1.09	7.6	19,425.1
	TOTAL, all measures		**$96,395**	**$300,250**	**3.21**	**3.1**	**339,726.5**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

[2] Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $83,695 per year, or 46.2% of the buildings' total energy costs. These measures are estimated to cost $300,250, for an overall simple payback period of 3.1 years

Table 1.2 below is a breakdown of the annual energy cost across various energy end use types, such as space heating and water heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.2

Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Lighting**	**Refrigeration**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Other**	**Total Cost**
Existing Building	$1,093	$166	$11,786	$139	$90,624	$24,744	$19,442	$32,926	**$180,981**
With Proposed Retrofits	$3,945	$168	$4,693	$140	$48,747	$10,937	$13,184	$15,413	**$97,286**
Savings	-$2,851	-$1	$7,093	-$1	$41,877	$13,808	$6,258	$17,513	**$83,695**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Alakanuk Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, HVAC equipment, motors, and pumps. Measures were analyzed based on life-cycle-cost techniques, which include the initial cost of the equipment, life of the equipment, annual energy cost, annual maintenance cost, and a discount rate of 3.0%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information was gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is used and what opportunities exist within a building. The entire site was surveyed to inventory the following to gain an understanding of how each building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment (optional) & disposal

The building site visit was performed to survey all major building components and systems. The site visit included detailed inspection of energy consuming components. Summary of building occupancy schedules, operating and maintenance practices, and energy management programs provided by the building manager were collected along with the system and components to determine a more accurate impact on energy consumption.

Details collected from Alakanuk Water Treatment Plant enable a model of the building's energy usage to be developed, highlighting the building's total energy consumption, energy consumption by specific building component, and equivalent energy cost. The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the building.

Alakanuk Water Treatment Plant is classified as being made up of the following activity areas:

1) Water Treatment, Mechanical, Lab, Vacuum, Generator, and Office: 2,936 square feet
2) Garage, and Upstairs: 1,164 square feet

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:

- Occupancy hours
- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; HVAC; lighting, plug load, and other electrical improvements; and motor and pump systems that will reduce annual energy consumption.

EEMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. Energy savings are calculated based on industry standard methods and engineering estimations.

Our analysis provides a number of tools for assessing the cost effectiveness of various improvement options. These tools utilize **Life-Cycle Costing**, which is defined in this context as a method of cost analysis that estimates the total cost of a project over the period of time that includes both the construction cost and ongoing maintenance and operating costs.

Savings to Investment Ratio (SIR) = **Savings** divided by **Investment**

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the Department of Energy are included. Future savings are discounted to the present to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation includes the labor and materials required to install the measure. An SIR value of at least 1.0 indicates that the project is cost-effective—total savings exceed the investment costs.

Simple payback is a cost analysis method whereby the investment cost of a project is divided by the first year's savings of the project to give the number of years required to recover the cost of the investment. This may be compared to the expected time before replacement of the system or component will be required. For example, if a boiler costs $12,000 and results in a savings of $1,000 in the first year, the payback time is 12 years. If the boiler has an expected life to replacement of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the project life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money). Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

Measures are implemented in order of cost-effectiveness. The program first calculates individual SIRs, and ranks all measures by SIR, higher SIRs at the top of the list. An individual measure must have an individual SIR>=1 to make the cut. Next the building is modified and re-simulated with the highest ranked measure included. Now all remaining measures are re-evaluated and ranked, and the next most cost-effective measure is implemented. AkWarm goes through this iterative process until all appropriate measures have been evaluated and installed.

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first, and then cycling through the list to find the next most cost effective measure. Implementation of more than one EEM often affects the savings of other EEMs. The savings may in some cases be relatively higher if an individual EEM is implemented in lieu of multiple recommended EEMs. For example implementing a reduced operating schedule for inefficient lighting will result in relatively high savings. Implementing a reduced operating schedule for newly installed efficient lighting will result in lower relative savings, because the efficient lighting system uses less energy during each hour of operation. If multiple EEM's are recommended to be implemented, AkWarm calculates the combined savings appropriately.

Cost savings are calculated based on estimated initial costs for each measure. Installation costs include labor and equipment to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers.

2.4 Limitations of Study

All results are dependent on the quality of input data provided, and can only act as an approximation. In some instances, several methods may achieve the identified savings. This report is not intended as a final design document. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

3. Alakanuk Water Treatment Plant

3.1. Building Description

The 4,100 square foot Alakanuk Water Treatment Plant was constructed in 1982, with a normal occupancy of 3 people. The number of hours of operation for this building average 11 hours per day, considering all seven days of the week.

Water is sourced from the river and treated with a package water treatment plant about six hours a day all year long. For two weeks in the spring and fall water is treated 24 hours a day. Water is stored in two large water storage tanks; one at the water treatment plant, the other storage tank is connected to the community water system at the Washeteria.

There are five circulation zones with a total of over 13,000 feet of piping in which water is supplied to the majority of the residents and commercial buildings in town. Homes are serviced by a vacuum sewer system which operates out of the water treatment plant. The sewage is then pumped to a sewage lagoon. Vacuum lines are kept from freezing with a series of circulating glycol lines.

Description of Building Shell

The exterior walls are constructed with 2x6 metal stud walls with an inch of rigid insulation.

The roof of the building is a warm roof with 7.5 inches of polyurethane insulation.

The floor of the building is built on pilings with 5.5 inches of polyurethane insulation.

Typical windows throughout the building are double paned glass windows with vinyl frames.

Doors are metal with a polyurethane core. There is an old metal garage door as well.

Description of Heating Plants

The heating plants used in the building are:

Weil-McLain 88 Boiler

Nameplate Information:	Model No 788
Fuel Type:	#1 Oil
Input Rating:	187,440 BTU/hr
Steady State Efficiency:	67 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - Jun
Notes:	Burner is a WR83-0-18 1.5 HP Gordon Platt 3-phase motor and the nozzles are rated for 4.5 gph.

Weil-McLain 88 Boiler

Fuel Type:	#1 Oil
Input Rating:	187,440 BTU/hr
Steady State Efficiency:	67 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	Sep - Jun

Space Heating Distribution System

There are several unit heaters throughout the building; however the building is primarily heated by the byproduct heat from electrical loads and jacket losses off the boilers.

Domestic Hot Water System

There is an insulated 35 gallon hot water tank, and the facility uses about 3 gallons of hot water per day primarily for operators to occasionally wash their hands.

Heat Recovery Information

The water treatment plant is currently utilizing heat recovery from the adjacent diesel power plant owned and operated by the Alaska Village Electric Cooperative (AVEC). Excess heat captured in the power plant cooling system is piped to the water plant and recovered for use to reduce the need to operate the facilities fuel oil fired boilers. AVEC is shutting down the power plant in April 2016 in order to complete an intertie to the power plant in the nearby community of Emmonak. This audit is modeled to represent zero heat recovery benefit. The fuel use impact from losing the heat recovery system will be dramatic, and would represent an increase of at least 50% in fuel consumption.

Lighting

Lighting in the building is made up primarily of T12 Magnetic fixture fluorescent lighting. Exterior lighting is made up of five low pressure sodium fixtures with failed photocell controls.

Plug Loads

The largest plug loads in the facility are from the mini refrigerator, computers, and printer. There are also a variety of cell phone chargers, time clocks, and kitchen appliances with small electrical loads. There is additionally a comfort fan in the mechanical room.

Major Equipment

The largest pieces of energy using equipment in the facility are the two 10 horsepower vacuum pumps. The two vacuum pumps have oil heaters to preheat the lubricating oil for the pumps, which require almost one kilowatt of electricity when in operation. At least one of the vacuum pumps is running constantly and occasionally both will be running. The pumps require significant amounts of oil which must be refilled multiple times per day. Leaks in the community sewage collection system are responsible for part of the run time on the vacuum pumps. Vacuum pumps of this style have been known to regularly overheat; cases of fires directly resulting from excessive temperatures from the vacuum pumps have been observed in the sanitation systems in Emmonak, Chevak, and Kotlik. A fire resulting from the vacuum pump can result in millions of dollars in damage; water treatment plants of the type in Alakanuk can cost in excess of $5 million to build.

There are two large Cornell discharge pumps which discharge sewage to the sewage lagoon. Taco and BTG circulation pumps sized from 1 to 1 ½ horsepower circulate glycol for the vacuum sewer lines and the force main to the sewage lagoon.

Taco circulation pumps sized from ¾ horsepower to 1 horsepower circulate water for the community water system. Similar pumps provide for glycol circulation loops to prevent freezing in the sewage collection utilidors.

There is a 3 horsepower high head glycol pump for the sewage force main in the facility. Additionally there is a two horsepower taco glycol pump for the utility building.

A Paco 50 gpm pressure pump 3.5 horsepower pressure pump pressurizes the water system to 70 psi. Additional pressure pumps provide a lead lag operation if the first pump cannot supply the pressure needs of the community. The pressure pumps charge five pressure tanks, of which all five were observed to have "burst" pressure bladders, which are causing excessive cycling and runtime on the pressure pump.

The package water treatment system has several mixing motors, a backwash pump, a desludge pump, and a five horsepower river pump from which the building receives untreated water. The river pump operates constantly during peak water usage needs in the spring and fall, and approximately six hours per day for the remainder of the year.

There are two 1 horsepower water circulation pumps which circulate water to the water storage tank.

There are three main heat tapes. The largest and most energy intensive heat tape is in the raw water line. This heat tape is currently left on at all times to provide an extra measure of safety in ensuring the raw water line does not freeze.

There is also high electricity using heat tape on the sewage force main to the sewage lagoon, as well as a heat tape on the circulating line to the water storage tank.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour.

The fuel oil usage profile shows the fuel oil usage for the building. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The Alaska Village Electric Cooperative (AVEC) provides electricity to the residents of Alakanuk as well as all the commercial and public facilities.

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.52/kWh
#1 Oil	$ 4.24/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Alakanuk pays approximately $180,981 annually for electricity and other fuel costs for the Alakanuk Water Treatment Plant.

Figure 3.1 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the “Retrofit” bar in the figure to the “Existing” bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

Figure 3.1
Annual Energy Costs by End Use

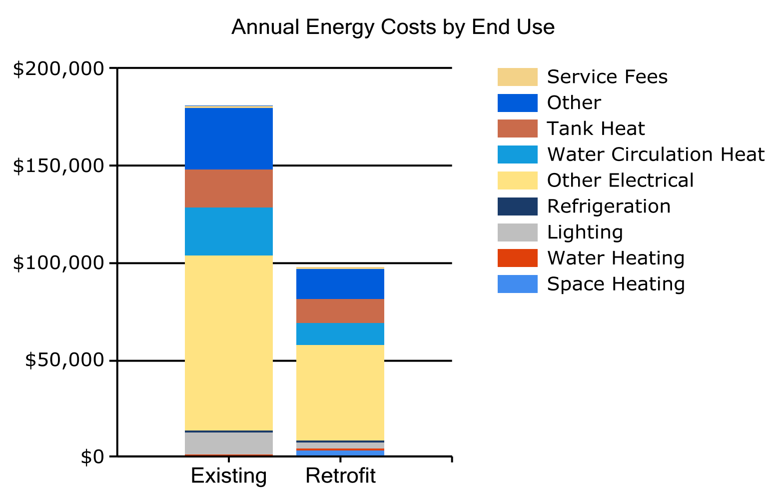


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

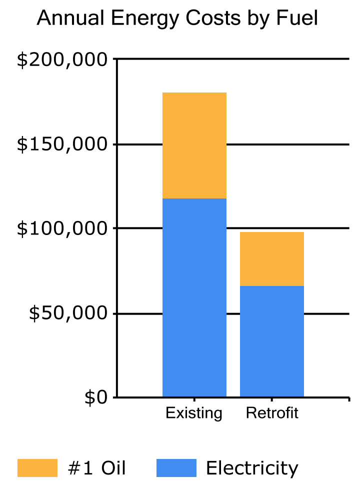
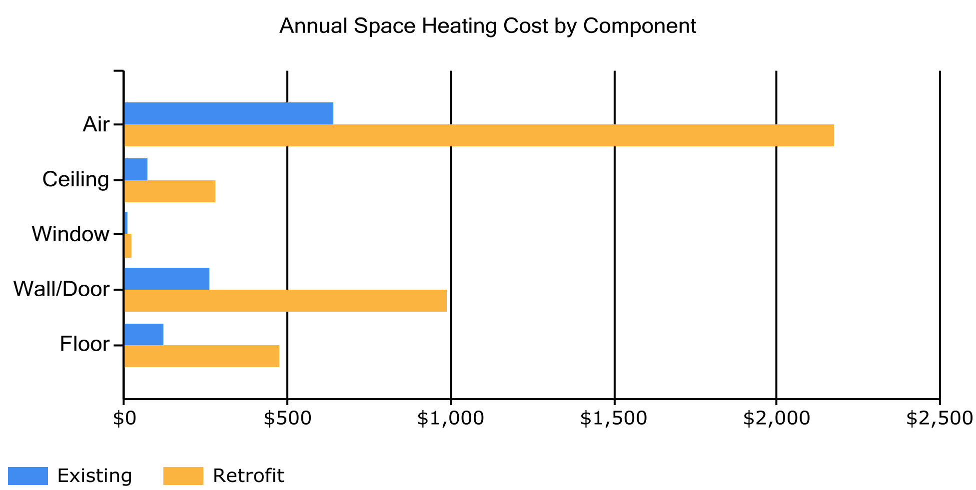


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown. Space heating costs are expected to increase significantly in the Alakanuk water treatment plant because the retrofit recommendations require such a reduction in boiler runtime and pump run time, which will reduce space heating benefits gained from jacket losses from the boilers and byproduct heat from pumping.

Figure 3.3
Annual Space Heating Cost by Component



The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Electrical Consumption (kWh)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	45	38	3	0	0	6	7	7	4	0	0	45
DHW	1	1	1	1	2	1	1	1	9	1	1	1
Lighting	1931	1760	1931	1869	1931	1869	1931	1931	1869	1931	1869	1931
Refrigeration	23	21	23	22	23	22	23	23	22	23	22	23
Other_Electrical	16607	15134	16607	16071	13216	12132	12536	12536	12132	15317	16071	16607
Water_Circulation_Heat	1443	1316	1460	1433	55	0	0	0	0	846	1424	1443
Water Storage Tank_Heat	1011	917	978	854	26	0	0	0	0	471	898	1012
Other	2206	2012	2227	2182	82	0	0	0	0	1280	2169	2205

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	72	61	5	0	0	8	8	8	5	0	0	72
DHW	2	2	2	2	3	2	2	2	17	2	2	2
Water_Circulation_Heat	726	662	727	704	35	0	0	0	0	403	703	726
Water Storage Tank_Heat	696	625	623	448	12	0	0	0	0	213	520	697
Other	932	849	932	903	45	0	0	0	0	518	902	932

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.
The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{(\text{Electric Usage in kBtu} + \text{Fuel Oil Usage in kBtu} + \text{similar for other fuels})}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{(\text{Electric Usage in kBtu X SS Ratio} + \text{Fuel Oil Usage in kBtu X SS Ratio} + \text{similar for other fuels})}{\text{Building Square Footage}}$$

where "SS Ratio" is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.4
Alakanuk Water Treatment Plant EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	228,111 kWh	778,542	3.340	2,600,332
#1 Oil	14,808 gallons	1,954,676	1.010	1,974,223
Total		**2,733,218**		**4,574,554**
BUILDING AREA		4,100	Square Feet	
BUILDING SITE EUI		667	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,116	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**666.7**	**49.98**	**$44.14**
With Proposed Retrofits	**342.5**	**25.68**	**$23.73**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. **EUI/HDD: Energy Use Intensity per Heating Degree Day.** **ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.**			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The HVAC systems and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Alakanuk Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Alakanuk was used for analysis. From this, the model was be calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Alakanuk. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.
• The model does not model HVAC systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

The energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures are summarized in Table 4.1. Please refer to the individual measure descriptions later in this report for more detail.

Table 4.1
Alakanuk Water Treatment Plant , Alakanuk, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Other Electrical - Controls Retrofit: Generator Block Heater	Unplug Generator Block Heater	$630	$100	38.85	0.2	2,141.4
2	Lighting - Power Retrofit: Building Fluorescent Lighting	Replace fluorescent lights in the facility with four foot LED replacement bulbs.	$2,548 + $100 Maint.	$2,500	6.54	0.9	8,752.8
3	Setback Thermostat: Water Treatment, Mechanical, Lab, Vacuum, Generator, Office	Install setback thermostats to reduce building temperatures to 55 degrees when the facility is not occupied, such as at night.	$568	$1,200	6.40	2.1	2,801.7

Table 4.1 Alakanuk Water Treatment Plant , Alakanuk, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
4	Water Storage Tank Heating	Replace damaged controls, install a tank mixer, and control the heated temperature of the water storage tank to 40 degrees Fahrenheit.	$5,468	$12,500	5.88	2.3	26,672.3
5	Other Electrical - Controls Retrofit: Raw Water Line Heat Tape	The heat tape for the raw water line should be shut off in the summer time and during periods when the raw water pump is operating. This retrofit calls for training for the operator and insulation repairs at any locations that may be at risk of increased freezing on portions of the raw water line.	$4,264	$5,000	5.28	1.2	14,926.0
6	Vacuum Glycol lines zone 2,3,4	Fix controls and reduce heat to 45 degrees on return temperature. This retrofit calls for the replacement of the glycol distribution pumps with premium efficiency pumps, repair of any failed valves, heat exchangers, and thermostats and the implementation of reduce heating temperatures on the circulated glycol lines.	$7,840	$20,000	5.26	2.6	38,147.6
7	Other Electrical - Controls Retrofit: Other Appliances	Unplug appliances when not in use.	$191	$250	4.72	1.3	653.4
8	Lighting - Power Retrofit: Building Fluorescent Lighting	Replace fluorescent lights in the facility with four foot LED replacement bulbs.	$3,688 + $100 Maint.	$5,000	4.68	1.3	12,675.8
9	Water Circulation Loops 2,3,4	Fix controls, valves, and temperature gauges in order to reduce heat to 40 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	$6,870	$20,000	4.61	2.9	33,383.1

Table 4.1 Alakanuk Water Treatment Plant , Alakanuk, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
10	Vacuum Glycol lines zone 1,5	Fix controls and reduce heat to 45 degrees on return temperature. This retrofit calls for the replacement of the glycol distribution pumps with premium efficiency pumps, repair of any failed valves, heat exchangers, and thermostats and the implementation of reduce heating temperatures on the circulated glycol lines.	$6,656	$20,000	4.48	3.0	32,521.4
11	Water Circulation Loops 1,5	Fix controls, valves, and temperature gauges in order to reduce heat to 40 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	$6,231	$20,000	4.16	3.2	29,995.8
12	Other Electrical - Combined Retrofit: Water Storage Tank Heat Tape	The heat tape for the water storage tank circulation line should only be used for thaw recovery. This retrofit calls for improved insulation and training for the operators on new parameters to reduce the usage of electric heat tape on the water storage tank heat tape.	$2,348	$5,000	3.95	2.1	8,217.7
13	Lighting - Power Retrofit: Exterior Lighting	Replace exterior lighting with LED wall packs with photocell controls.	$560	$1,500	3.14	2.7	1,958.6
14	Other Electrical - Controls Retrofit: Vacuum Pumps	Replace the existing Vacuum sewage collection Pumps with Mink Aqua oil less vacuum pumps, with variable frequency drives; additionally replace leaky vacuum valves and failed vacuum toilets.	$23,226 + $12,500 Maint.	$100,000	3.00	2.8	77,516.6

Table 4.1 Alakanuk Water Treatment Plant , Alakanuk, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
15	Setback Thermostat: Garage, and Upstairs	Replace existing thermostats with programmable thermostats. Program the thermostats to heat the facility to only 55 degrees when the facility is unoccupied, such as at nights.	$423	$1,200	4.72	2.8	2,050.8
16	Air Tightening: Doors and Windows	Perform weather stripping and caulking to reduce air leakage throughout the facility. Focus on repair of the	$919	$2,500	3.39	2.7	4,459.2
17	Other Electrical - Power Retrofit: Utility Building Glycol	Replace building heating pumps with Grundfos magna vfd integrated pumps or similar.	$1,236	$3,500	2.15	2.8	3,867.6
18	HVAC And DHW	Increase boiler efficiency through instruction of better maintenance techniques, installation of new burners, and replacement of faulty valves and boiler equipment.	$2,254	$15,000	1.37	6.7	10,502.1
19	Sewage Outfall Glycol Line	Fix controls, valves, and temperature gauges in order to reduce heat to 50 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	$1,885	$20,000	1.26	10.6	9,057.5
20	Other Electrical - Combined Retrofit: Pressure Pump	Replace blown pressure bladders on each pressure tank, replace pressure pump with premium efficiency pump and motor and replace controls. Evaluate potential reduction in pressure settings to reduce run time on the pump for additional savings.	$5,891	$45,000	1.09	7.6	19,425.1
	TOTAL, all measures		**$96,395**	**$300,250**	**3.21**	**3.1**	**339,726.5**

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure in the list are implemented. If some EEMs are not implemented, savings for the remaining EEMs will be affected. For example, if ceiling insulation is not added, then savings from a project to replace the heating system will be increased, because the heating system for the building supplies a larger load.

In general, all projects are evaluated sequentially so energy savings associated with one EEM would not also be attributed to another EEM. By modeling the recommended project sequentially, the analysis accounts for interactive affects among the EEMs and does not "double count" savings.

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis

4.3 Building Shell Measures

4.3.1 Air Sealing Measures

Rank	**Location**	**Existing Air Leakage Level (cfm@50/75 Pa)**		**Recommended Air Leakage Reduction (cfm@50/75 Pa)**	
16	Doors and Windows	Air Tightness estimated as: 8400 cfm at 50 Pascal's		Perform air sealing to reduce air leakage by 1000 cfm at 50 Pascal's.	
Installation Cost	$2,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$919
Breakeven Cost	$8,476	**Savings-to-Investment Ratio**	3.4	**Simple Payback yrs**	3
Auditors Notes: Caulk and install weather stripping on all doors and windows. Make sure the makeup vents are closed when backup diesel generators and boilers are not running.					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	**Recommendation**				
18	Increase boiler efficiency through better maintenance techniques, replacement of burners, etc.				
Installation Cost	$15,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$2,254
Breakeven Cost	$20,527	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	7
Auditors Notes: The existing burner heads for the boilers are outdated and need to be replaced. The boilers show signs of needed maintenance, operators could benefit from boiler maintenance training. Several components of the boiler system, including several valves, the nozzles, and the fuel supply system could be replaced with improved modern equipment to increase efficiency of the heating system.					

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
3	Water Treatment, Mechanical, Lab, Vacuum, Generator, Office			Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Water Treatment, Mechanical, Lab, Vacuum, Generator, Office space.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$568
Breakeven Cost	$7,674	**Savings-to-Investment Ratio**	6.4	**Simple Payback yrs**	2
Auditors Notes: Install a setback thermostat and maintain a temperature of 55 degrees whenever the building is not occupied such as at nights, and on weekends.					

Rank	Building Space			Recommendation	
15	Garage, and Upstairs			Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Garage, and Upstairs space.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$423
Breakeven Cost	$5,669	**Savings-to-Investment Ratio**	4.7	**Simple Payback yrs**	3
Auditors Notes: Install a setback thermostat and maintain a temperature of 55 degrees whenever the building is not occupied such as at nights, and on weekends.					

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating and cooling loads. The building cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
2	Building Fluorescent Lighting	23 FLUOR (2) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching		Replace with 23 LED (2) 17W Module Electronic	
Installation Cost	$2,500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,548
				Maintenance Savings (/yr)	$100
Breakeven Cost	$16,351	**Savings-to-Investment Ratio**	6.5	**Simple Payback yrs**	1
Auditors Notes: Recommend replacing existing fluorescent lighting with direct replacement LED bulbs rated at 17 watts. Existing fluorescent fixtures can be utilized, but the ballast will need to be removed and disposed of properly. LED lighting will last longer, provide sufficient lighting within the facility, and function better in cold temperatures.					

Rank	Location		Existing Condition		Recommendation	
8	Building Fluorescent Lighting		26 FLUOR (4) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching		Replace with 26 LED (4) 17W Module Electronic	
Installation Cost		$5,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$3,688
					Maintenance Savings (/yr)	$100
Breakeven Cost		$23,389	**Savings-to-Investment Ratio**	4.7	**Simple Payback yrs**	1
Auditors Notes: Recommend replacing existing fluorescent lighting with direct replacement LED bulbs rated at 17 watts. Existing fluorescent fixtures can be utilized, but the ballast will need to be removed and disposed of properly. LED lighting will last longer, provide sufficient lighting within the facility, and function better in cold temperatures.						

Rank	Location		Existing Condition		Recommendation	
13	Exterior Lighting		5 HPS 50 Watt Electronic with On/Off Photo switch		Replace with 5 LED 20W Module Electronic	
Installation Cost		$1,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$560
Breakeven Cost		$4,712	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	3
Auditors Notes: Replace Exterior Lighting with LED wall packs featuring photocells. LED’s will last longer, function more effectively in cold temperatures and consume significant less electricity.						

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Generator Block Heater		Block Heater for Generator (Inside) with Manual Switching		Improve Manual Switching	
Installation Cost		$100	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$630
Breakeven Cost		$3,885	**Savings-to-Investment Ratio**	38.9	**Simple Payback yrs**	0
Auditors Notes: The generator is in conditioned heated space and does not need the electric block heater to be plugged in.						

Rank	Location		Description of Existing		Efficiency Recommendation	
5	Heat Tape		Raw Water Line Heat Tape with Manual Switching		Improve Manual Switching	
Installation Cost		$5,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$4,264
Breakeven Cost		$26,394	**Savings-to-Investment Ratio**	5.3	**Simple Payback yrs**	1
Auditors Notes: Heat tape should be turned off in the summer, as well as whenever the well pump is being used. The flow of the water should be enough to prevent freezing, and the heat tape can be used for recovery only. This retrofit will provide for training for the operations and repairs of insulation and controls improvements as needed to automatically control heat tape usage for the raw water line.						

4.3.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
7	Other Appliances	12 Microwave, time clocks, printer, desktop, monitor, speakers, router, phone, calculator, cb radio, fax machine with Manual Switching		Improve Manual Switching	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$191
Breakeven Cost	$1,180	**Savings-to-Investment Ratio**	4.7	**Simple Payback yrs**	1
Auditors Notes: Shutting down computers, printers, radios, and other appliances at the end of the day and on weekends would save a significant amount of electricity.					

Rank	Location	Description of Existing		Efficiency Recommendation	
12	Heat Tape	Heat Tape for Water Tank with Manual Switching		Replace with Heat Tape for Water Tank and Improve Manual Switching	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$2,348
Breakeven Cost	$19,769	**Savings-to-Investment Ratio**	4.0	**Simple Payback yrs**	2
Auditors Notes: This heat tape should be used only as recovery. The circulation of water in the tank through the line should be enough to prevent freez-ups. The heat tape can be used for recovery should a freeze up occur. This retrofit will provide training and wall signs to remind operators of the proper operational parameters and provide for any insulation and controls needs to automatically limit usage of the heat tape for the water line to the storage tank.					

Rank	Location	Description of Existing		Efficiency Recommendation	
14	Vacuum Pumps	2 Air Vac Vacuum Pumps with Other Controls		Improve Other Controls	
Installation Cost	$100,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$23,226
				Maintenance Savings (/yr)	$12,500
Breakeven Cost	$299,972	**Savings-to-Investment Ratio**	3.0	**Simple Payback yrs**	3
Auditors Notes: Repair vacuum leaks in junction boxes and homes, replace Vacuum pumps with oil less pumps to reduce electrical load, increase equipment lifespan, and reduce the risk of fire. Maintenance savings are significant, with oil less pumps operators will no longer have to change oil multiple times per day, nor will they require the purchase of oil. This measure should also install variable frequency drives to reduce loading of the vacuum pumps when needed.					

Rank	Location	Description of Existing		Efficiency Recommendation	
17	Utility Building Glycol	Taco Circ Pump with Manual Switching		Replace with Taco Circ Pump	
Installation Cost	$3,500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$1,236
Breakeven Cost	$7,530	**Savings-to-Investment Ratio**	2.2	**Simple Payback yrs**	3
Auditors Notes: Replace with a Grundfos Magna pump to reduce electrical consumption.					

Rank	Location	Description of Existing		Efficiency Recommendation	
20	Pressure Pump	Paco 50 gpm pressure pump, 5.0 hp with Manual Switching		Replace with Paco 50 gpm pressure pump, 5.0 hp and Improve Manual Switching	
Installation Cost	$45,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$5,891
Breakeven Cost	$48,899	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	8
Auditors Notes: The hydro pneumatic pressure tanks for the system are water logged and system pressure is set too high. For a relatively flat landscape, an upper pressure limit of 50 psi is satisfactory. The pressure pump should run about 6-8 hours per day on average. Includes replacement of the bladders in all five pressure tanks and installation of a premium efficiency pressure pump.					

4.3.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
4		Water Storage Tank		Fix controls and reduce heat to 40 degrees on return temperature	
Installation Cost	$12,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5,468
Breakeven Cost	$73,498	**Savings-to-Investment Ratio**	5.9	**Simple Payback yrs**	2
Auditors Notes: The water storage tank is currently over heated. Reducing heating levels of the water stored in the tank will reduce fuel consumption for the facility. Water should be heated to maintain a 40 degree temperature in the tank. Replacement of failed temperature controls, including the old controller, failed valves, and temperature gauges, will be required to be able to control temperature to the lower temperature. Additionally a tank mixer should be installed to prevent tank stratification and reduce potential ice damage, as well as ensure temperatures are mixed throughout the tank.					

Rank	Location	Description of Existing		Efficiency Recommendation	
6		Vacuum Lines 2,3,4		Fix controls and reduce heat to 45 degrees on return temperature.	
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$7,840
Breakeven Cost	$105,263	**Savings-to-Investment Ratio**	5.3	**Simple Payback yrs**	3
Auditors Notes: The heated glycol lines are intended to supply heat to ensure that the sewage collection system in the community does not freeze and fail to function. Currently the glycol is kept too warm, beyond the necessary limits for preventing freezing. Replacement of heating controls including valves, a differential temperature controller, aqua stats and a high efficiency pump are required to accurately and effectively control the glycol lines to a lower temperature.					

Rank	Location	Description of Existing		Efficiency Recommendation	
9		Water Circulation 2,3,4		Fix controls and reduce heat to 40 degrees on return temperature. Includes replacement of pumps with premium efficiency pumps.	
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$6,870
Breakeven Cost	$92,190	**Savings-to-Investment Ratio**	4.6	**Simple Payback yrs**	3
Auditors Notes: The water circulation lines for the community are heated beyond what is needed to prevent freezing. Reducing the temperature in the water circulation lines will reduce fuel consumption dramatically. Heating controls, including a differential temperature controller, valves, cleaning or replacement of the heat exchanger, and a high efficiency pump and motor are required to accurately and effectively maintain lower temperatures in the circulating loops.					

Rank	Location	Description of Existing		Efficiency Recommendation	
10		Vacuum Lines 1,5		Fix controls and reduce heat to 40 degrees on return temperature.	
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$6,656
Breakeven Cost	$89,533	**Savings-to-Investment Ratio**	4.5	**Simple Payback yrs**	3
Auditors Notes: The heated glycol lines are intended to supply heat to ensure that the sewage collection system in the community does not freeze and fail to function. Currently the glycol is kept too warm, beyond the necessary limits for preventing freezing. Replacement of heating controls including valves, a differential temperature controller, aqua stats and a high efficiency pump are required to accurately and effectively control the glycol lines to a lower temperature.					

Rank	Location	Description of Existing		Efficiency Recommendation	
11		Water Circulation 1,5		Fix controls and reduce heat to 40 degrees on return temperature.	
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$6,231
Breakeven Cost	$83,265	**Savings-to-Investment Ratio**	4.2	**Simple Payback yrs**	3

Auditors Notes: The water circulation lines for the community are heated beyond what is needed to prevent freezing. Reducing the temperature in the water circulation lines will reduce fuel consumption dramatically. Heating controls, including a differential temperature controller, valves, cleaning or replacement of the heat exchanger, and a high efficiency pump and motor are required to accurately and effectively maintain lower temperatures in the circulating loops.

Rank	Location	Description of Existing		Efficiency Recommendation	
19		Sewer Outfall Line		Fix controls and reduce heat to 45 degrees on return temperature.	
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,885
Breakeven Cost	$25,168	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	11

Auditors Notes: The glycol line in the sewer outfall force main from the water plant is crucial to preventing freezing; however the glycol is currently being kept warmer than necessary. Installation of new controls, including repair or replacement of the existing heat exchanger, a new differential temperature control, new aqua stats, new more effective valves, and a high efficiency pump and motor will reduce energy consumption dramatically.

5. ENERGY EFFICIENCY ACTION PLAN

Through inspection of the energy-using equipment on-site and discussions with site facilities personnel, this energy audit has identified several energy-saving measures. The measures will reduce the amount of fuel burned and electricity used at the site. The projects will not degrade the performance of the building and, in some cases, will improve it.

Several types of EEMs can be implemented immediately by building staff, and others will require various amounts of lead time for engineering and equipment acquisition. In some cases, there are logical advantages to implementing EEMs concurrently. For example, if the same electrical contractor is used to install both lighting equipment and motors, implementation of these measures should be scheduled to occur simultaneously.

This audit was conducted with the intention of applying for a Department of Energy Office of Indian Energy grant to fund the improvements. Alakanuk is a tribal community and is reliant upon the water and sewer system to maintain a healthy community. Due to the environmental challenges of the landscape in Alakanuk, the water treatment plant requires significant energy use to operate. Reducing energy consumption in the water treatment plant will help to reduce the cost of providing water and sewer and assure access to the health benefits of clean water for the community of Alakanuk.

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Alakanuk Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: AUK-WTP-1011	**Auditor Name:** Carl Remley, Art Ronimus, Gavin Dixon
City: Alakanuk	**Auditor Address:** 4500 Diplomacy Drive, Suite 454, Anchorage, AK 99508 Anchorage, Alaska 99508
Client Name: Hilda Stern	
Client Address: PO Box 167 Alakanuk, Alaska 99554	**Auditor Phone:** (907) 729-3543
	Auditor FAX: ( ) -
Client Phone: (907) 238-3313	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 4,100 square feet	**Design Space Heating Load:** Design Loss at Space: 76,578 Btu/hour with Distribution Losses: 80,608 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 122,879 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 3 people	**Design Indoor Temperature:** 65 deg F (building average)
Actual City: Alakanuk	**Design Outdoor Temperature:** -39 deg F
Weather/Fuel City: Alakanuk	**Heating Degree Days:** 13,339 deg F-days
Utility Information	
Electric Utility: AVEC-Alakanuk - Commercial - Sm	**Average Annual Cost/kWh:** $0.52/kWh

Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Lighting**	**Refrigeration**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Other**	**Total Cost**
Existing Building	$1,093	$166	$11,786	$139	$90,624	$24,744	$19,442	$32,926	**$180,981**
With Proposed Retrofits	$3,945	$168	$4,693	$140	$48,747	$10,937	$13,184	$15,413	**$97,286**
Savings	-$2,851	-$1	$7,093	-$1	$41,877	$13,808	$6,258	$17,513	**$83,695**

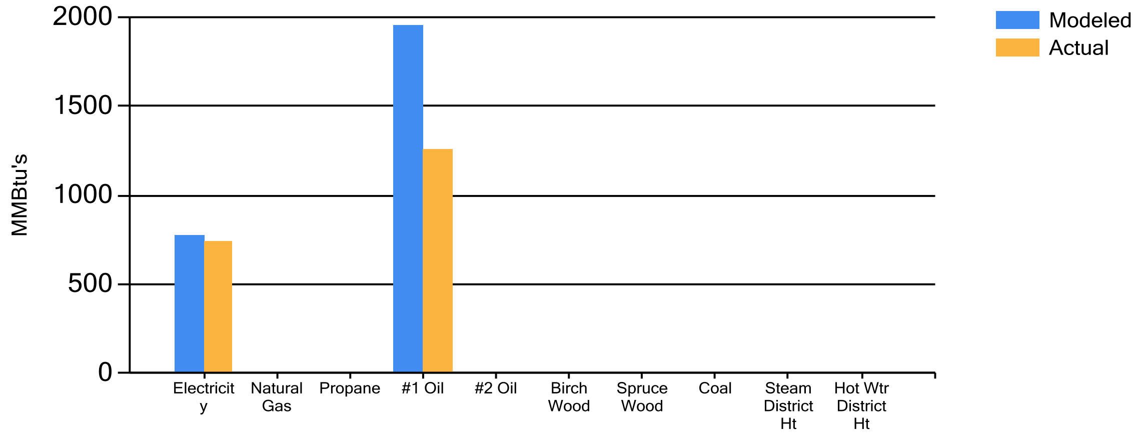
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	666.7	49.98	$44.14
With Proposed Retrofits	342.5	25.68	$23.73

EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

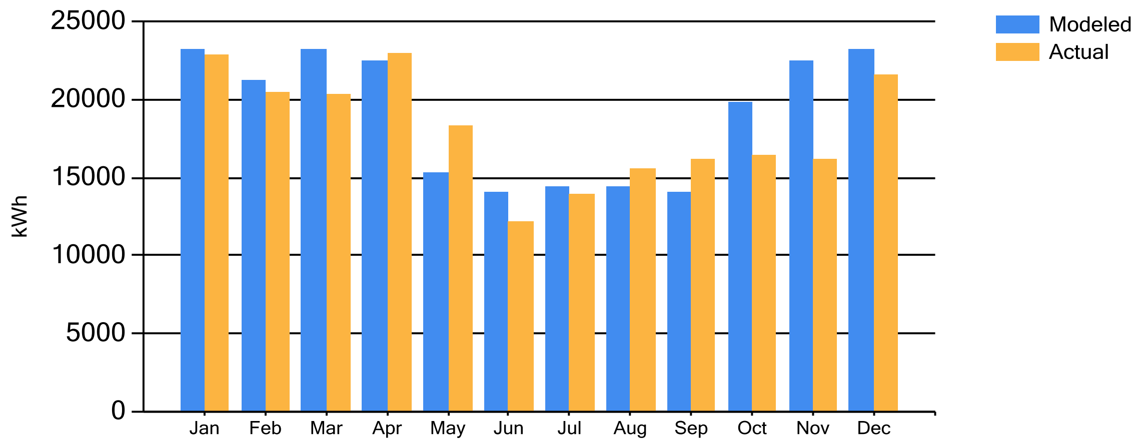
Appendix B – Actual Fuel Use versus Modeled Fuel Use

The Orange bars show Actual fuel use, and the Blue bars are AkWarm's prediction of fuel use. It should be noted that the actual consumption of fuel use in Alakanuk is lower than modeled because the usage of heat recovery from the nearby electric power plant was eliminated from the energy model. This model represents the future operating parameters of the Alakanuk Water Treatment Plant once the heat recovery system is decommissioned.

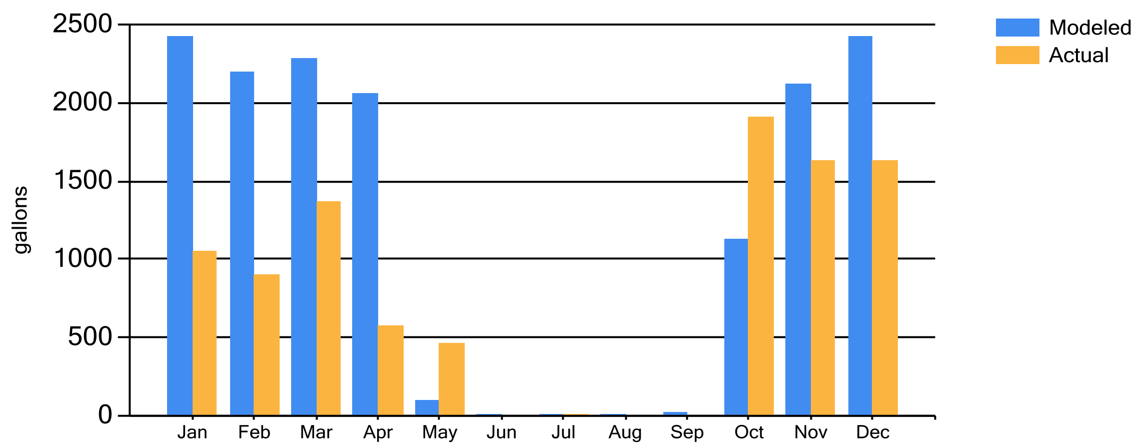
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	33.4	33.4	33.4	33.4	25.4	23.8	23.8	23.8	23.8	30.4	33.4	33.4
As Proposed	23.5	23.5	23.5	23.5	12.7	13.3	13.3	13.3	13.3	17.9	23.5	23.5

AkWarmCalc Ver 2.4.1.0, Energy Lib 3/30/2015