Comprehensive Energy Audit For

Yakutat Water Treatment Plant

Prepared For

City and Borough of Yakutat

March 6, 2018

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PREFACE

This energy audit was conducted using funds provided by the Denali Commission. Coordination with the City of Yakutat has been undertaken to provide maximum accuracy in identifying facilities to audit and coordinating potential follow up retrofit activities.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City and Borough of Yakutat, Alaska. The authors of this report are Cody Uhlig, Senior Project Manager, Professional Engineer (PE), and Certified Energy Manager (CEM); Kelli Whelan, Energy Auditor I (previously AmeriCorps VISTA); and Kevin Ulrich, Assistant Engineering Project Manager, Mechanical Engineer in Training (EIT), and CEM.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in May of 2017 by the ANTHC Rural Energy Initiative. 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 Rural Energy Initiative gratefully acknowledges the assistance of Mayor Ralph Wolfe; City and Borough of Yakutat Manager Jon Erickson, EdD; and Utility Manager Ron Veebe.

1. EXECUTIVE SUMMARY

This report was prepared for the City and Borough of Yakutat. The scope of the audit focused on Yakutat 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, heating and ventilation systems, and electric loads. There is also a report for the Yakutat Wastewater Treatment Plant that complements the contents of this report.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs for the Yakutat Water Treatment Plant are $47,430 per year, with all of the costs devoted to electricity use.

The State of Alaska Power Cost Equalization (PCE) program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Yakutat, the cost of electricity without the PCE subsidy was approximately $0.389 per kilowatt hour (kWh) and the cost with PCE was approximately $0.18 per kWh in 2017.

Table 1.1 lists the total usage of electricity in the Yakutat Water Treatment Plant before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Yakutat Water Treatment Plant

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	121,929 kWh	36,702 kWh

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 lists several benchmarks for the audited building.

Table 1.2: Building Benchmarks for the Yakutat Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBTU/Sq. Ft.)**	**EUI/HDD (Btu/Sq. Ft./HDD)**	**ECI ($/Sq. Ft.)**
Existing Building	1,304.5	143.60	$148.68
With Proposed Retrofits	392.7	43.23	$44.76

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

Table 1.3: Summary of Recommended Energy Efficiency Measures

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: Water Storage Tank Panel Heater	Turn down panel heater and use only in extreme cold situations.	$583	$250	27.39	0.4	2,397.3
2	Plant Operations Upgrade: 15HP Pressure Pump Removal	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly to distribution. Directly related to recommendations 3, 7, 8, and 11.	$30,968	$44,245	10.23	1.4	127,372.9
3	Plant Operations Upgrade: Remove Wood Stave Tank Heat Tape	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendations 2, 7, 8, and 11.	$8	$13	3.77	1.6	32.6
4	Other Electrical: Water Storage Tank Heat Tape	Repair or replace thermostat for heat tape. Shorten length of heat tape	$204	$1,035	2.32	5.1	839.9
5	Lighting: Well House 1 Lighting	Replace with new, energy efficient, LED equivalents.	$2 + $6 Maint. Savings	$30	2.00	3.9	7.0
6	Lighting: Well House 2 Lighting	Replace with new, energy efficient, LED equivalents.	$2 + $6 Maint. Savings	$30	2.00	3.9	7.1
7	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Well Pump 1)	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendation 2, 3, 8, and 11.	$286 + $225 Maint. Savings[3]	$5,003	1.50	9.8	1,176.6

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
8	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Well Pump 2)	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendations 2, 3, 7, and 11.	$782 + $225 Maint. Savings[3]	$13,665	1.08	13.6	3,214.8
9	Heating and Insulation: Well House 1	Install programmable thermostat to maintain temperature. Install R-14 rigid board insulation on walls, ceiling, and floor. Replace door with insulated door. Reduce air leakage through well house building shell upgrades.	$144 + $565 Maint. Savings[4]	$4,800	1.03	6.8	592.4
10	Heating and Insulation: Well House 2	Replace existing non-functional electric heater with similar-sized model that is thermostatically controlled. Install R-14 rigid board insulation on walls, ceiling, and floor. Replace door with insulated door. Reduce air leakage through well house building shell upgrades.	$144 + $566 Maint. Savings[4]	$5,100	0.98	7.2	592.4
11	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Chlorine Pump)	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendation 2, 3, 7, and 8.	$31	$2,060	0.22	65.6	129.2
TOTAL, all measures			**$33,153 + $1,593 Maint. Savings**	**$76,232**	**6.49**	**2.2**	**136,362.2**

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.

[3] The maintenance savings figure in the Plant Operations Upgrade EEMs captures the energy and chemical treatment costs saved by eliminating the water loss at the wood stave tank. At the estimated water loss rate of 10 gallons per minute, approximately 131 pounds of chlorine is wasted every year. The savings from removing the wood stave tank is split between the two well pumps based on their pumping rates.

[4] The maintenance savings figure in the Well House Heating and Insulation EEMs captures an estimated 30% reduction in electrical usage for space heating by installing temperature-controlled thermostats for the electric space heaters.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $33,153 per year, or 69.9% of the buildings' total energy costs. These measures are estimated to cost $76,232, for an overall simple payback period of 2.2 years.

Table 1.4 below is a breakdown of the annual energy cost across various energy end use types, such as space heating and freeze prevention. 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 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate				
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Total Cost**
Existing Building	$650	$103	$47,678	**$47,430**
With Proposed Retrofits	$1,057	$99	$13,121	**$14,277**
Savings	-$407	$3	$33,557	**$33,153**

Note: The negative space heating savings is primarily due to removing the 15 HP distribution pump in the Water Treatment Plant pump room. AkWarm accounts for heat radiated from large appliances and electrical loads.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Yakutat Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, and heating and ventilation 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% per 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

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 Yakutat 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.

Yakutat Water Treatment Plant is made up of the following activity areas:

1. Pump Room: 256 square feet
2. Chemical Room: 63 square feet
3. Well House 1: 35 square feet (separate building)
4. Well House 2: 35 square feet (separate building)

The structure and space heating in both well houses were modeled separately, and were later appended to the main Water Treatment Plant model. In addition to the activity areas above, there is an unheated garage attached to the main Water Treatment Plant building. This space was omitted from the energy model, because it has an infrequent and typical low energy demand.

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; heating and ventilation; lighting, electrical loads, 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. YAKUTAT WATER TREATMENT PLANT

3.1. Building Description

The 319 square foot Yakutat Water Treatment Plant was constructed in the 1970s as the primary location for all water intake, treatment, and distribution services for the community. The building is staffed for an average of 2 hours per day throughout the week. Figure 1 shows an aerial view of Yakutat with the primary features of the water treatment system marked with red circles. The local fish processing plant is marked by a blue circle.

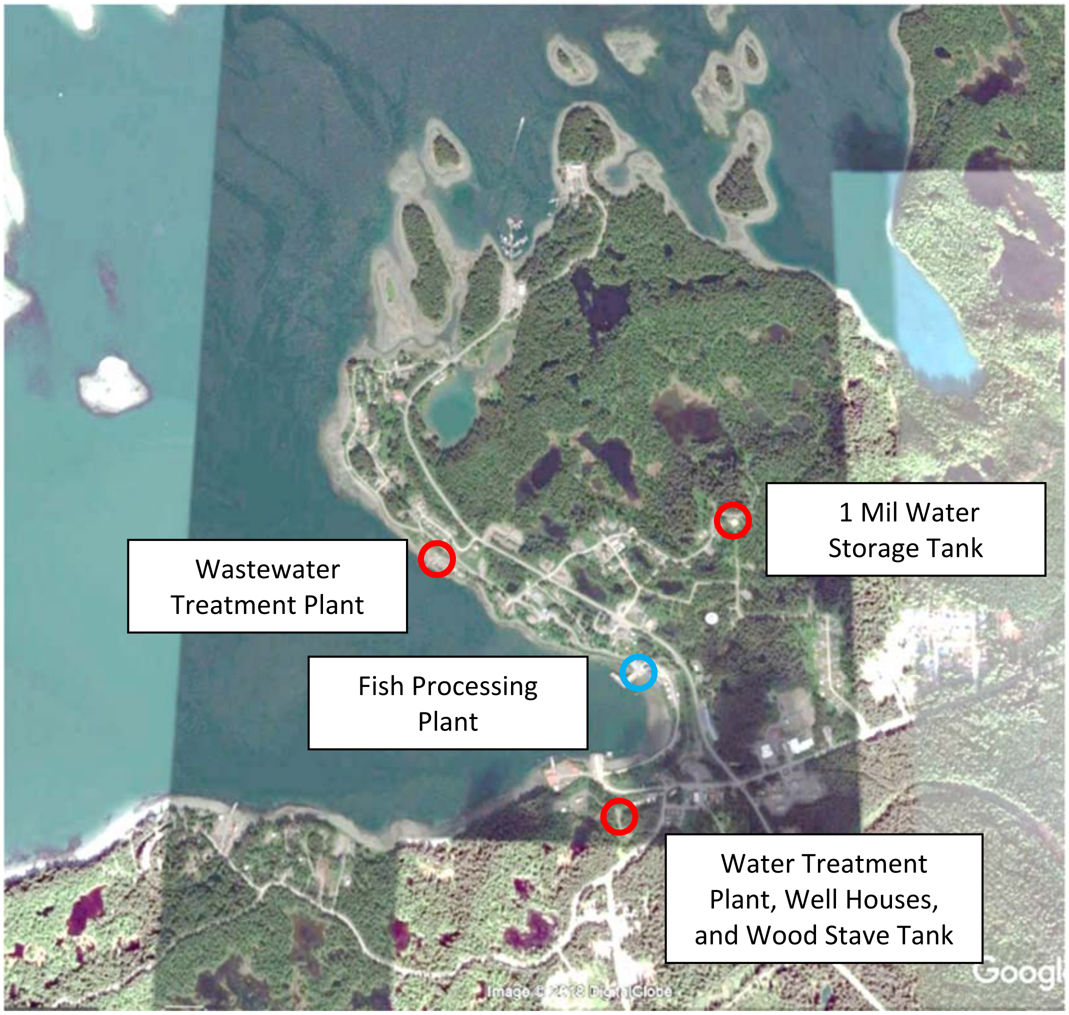


Figure 1: Aerial view of Yakutat water system facilities. Aerial photo courtesy of Google Earth (2018).

Groundwater is pumped from two wells, each approximately 175 feet deep. The well heads and plumbing are protected by heated well houses. Raw water is injected with chlorine in the treatment plant before being stored in a nearby 125,000-gallon wood stave storage tank. Built in the 1970s, this tank is particularly leaky (estimated at 10-20 gallons per minute) and has notable damage from years of use (see Figure 2 below). While chlorine is not required for microbial deactivation (the raw water source is groundwater), it is a best practice to help protect public health.

Based on the water level in the reserve tank (1 Mil Water Storage Tank) and demand from the fish processing plant, water is pumped from the wood stave tank by one of two distribution pumps in the water treatment facility to the branched distribution system and the 1 Mil Water Storage Tank. The 1 Mil Water Storage Tank provides head pressure to the distribution system and stores water for emergency use. There is a separate distribution line for the fish processing plant.


Figure 2: Wood Stave Water Storage Tank near the Water Treatment Plant. The image on the right shows the rapid rate of water loss through the bottom and sides of the tank.

Figure 3: 1 Mil Water Storage Tank.

Description of Building Shell

The exterior walls have 2x4 wood framed construction with 16” on-center studs. The stud cavities are assumed to be filled with R-13 fiberglass insulation. The exterior walls are eight feet high from the top of the foundation (approximately 10.5 feet total). The backup generator garage is uninsulated.

The building has a cold attic over the pump and chemical injection rooms. The attic is 2x6 standard truss, wood framed construction with 7.26 inches of R-13 fiberglass batt insulation over the ceiling. The backup generator garage does not have an attic space.

The building is constructed above grade with an insulated crawl space between the building and the ground beneath. The crawlspace is approximately 2.5 feet high and sealed. Rigid foam insulation is present in the floor structure.

There are no windows present in the facility. There are two single-door entrances: one for the chemical room and one for the pump room. These doors are insulated metal doors with no windows. The backup generator garage is accessible through an exterior garage door.

Description of Heating Plants

The heating plants used in the building are:

Pump Room

Nameplate Information:	Taskmaster TPI Corporation Model P3P5103CA1N
Fuel Type:	Electricity
Input Rating:	3300 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air

Figure 4: Pump Room unit heater in the Water Treatment Plant.

Chemical Room

Nameplate Information:	Ceramic ceiling-mounted unit heater
Fuel Type:	Electricity
Input Rating:	312 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air

Well House 1 Unit Heater

Fuel Type:	Electricity
Input Rating:	1500 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air

Figure 5: Well House 1 heater.

Well House 2 Unit Heater

Fuel Type:	Electricity
Input Rating:	1500 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air

Figure 6: Well House 2 heater.

Space Heating Distribution Systems

All space heating is achieved through the use of electric unit heaters and electric space heaters.

Lighting

Lighting in the water treatment plant consumes approximately 263 kWh annually and constitutes approximately 0.2% of the building's current electrical consumption.

Table 3.1: Breakdown of Lighting by Location and Bulb Type

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Pump Room	LED 4ft. T8 Equivalents 17W	4	4	233
Chemical Room	LED A Lamp 10 W	2	1	19
Backup Generator Room	Fluorescent T8 4ft. 32W	2	2	1
Well House 1	Incandescent A Lamp 100W	1	1	5
Well House 2	Incandescent A Lamp 100W	1	1	5
			Total Energy Consumption	**263**

Major Equipment

Table 3.2 contains the details on each of the major electricity consuming mechanical components found in the water treatment plant, well houses, and water storage tanks. Major equipment consumes approximately 119,994 kWh annually constituting about 98.4% of the building's current electrical consumption.

Table 3.2: Major Equipment List

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption (kWh)
10 HP Pressure Pump	Provides pressure to water distribution loops to allow proper circulation.	10 HP	Not in operation during site visit	0
15 HP Pressure Pump	Provides pressure to water distribution loops to allow proper circulation.	15 HP	~19 hrs. per day standard, ~22 hrs. per day in fishing season	81,321
SeaMetrics Flow Computer	Monitors flow of water through the treatment process.	14.4 Watts	Continuous	126
Chlorine Pump	Injects chlorine into the raw water from the wells.	432 Watts	Active when well pumps are running	1,940
Well Pump 1	Pumps water from the well into the water treatment plant.	7.5 HP	~4.5 hrs. per day	9,192
Well Pump 2	Pumps water from the well into the water treatment plant.	7.5 HP	~11 hrs. per day standard, ~16 hrs. per day in fishing season	25,116
Wood Stave Heat Tape	Protects the water line between the water treatment plant and the	200 Watts	Freeze prevention and recovery only	20

	wood stave water storage tank from freezing.			
Water Storage Tank Heat Tape	Protects the pressure transducer on 1 Mil Water Storage Tank from freezing	60 Watts	Continuous	526
Water Storage Tank Panel Heater	Provides heat to the electrical components of the 1 Mil Water Storage Tank control panel to allow proper operation.	200 Watts	Continuous	1,753
Total Energy Consumption				**119,994**

Figure 7: 15 HP (left) and 10 HP (right) pressure pumps in the Pump Room in the Water Treatment Plant. The 10 HP pump is rarely used. The blue turbine at the top of the photo sends water to the fish processing plant.

Figure 8: Chlorine pump in the Chemical Injection Room at the Water Treatment Plant.

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. One kW of electric demand is equivalent to 1,000 Watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

The Alaska Village Electric Cooperative (AVEC) currently provides electricity to the residents of Yakutat as well as to all public and commercial facilities. AVEC purchased the utility from Yakutat Power, Inc. after the energy audit site visit.

The average cost of electricity is shown below in Table 3.3. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.3: Energy Cost Rates for Each Fuel Type

Average Energy Cost (as of May 2017)	
Description	**Average Energy Cost**
Electricity	$ 0.389/kWh

3.2.1.1 Total Energy Use and Cost Breakdown

At 2017 rates, the City and Borough of Yakutat pays approximately $47,430 annually for electricity for the Yakutat Water Treatment Plant, well houses, and water storage and distribution system. This figure does not include utility subsidies such as PCE.

Figure 9 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.

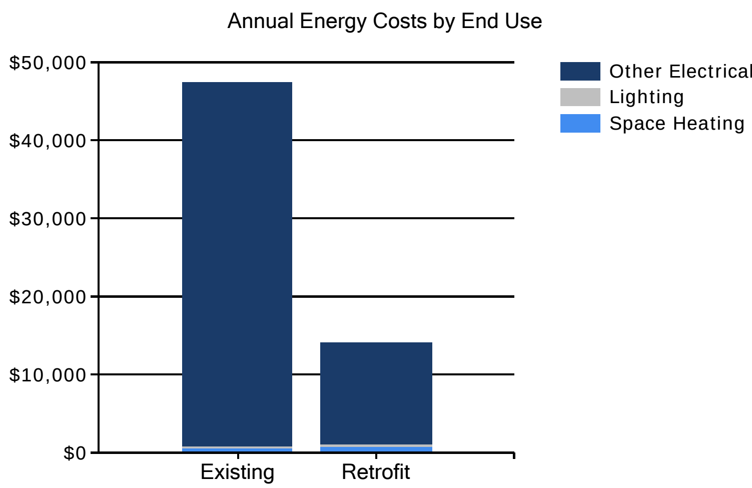


Figure 9: Annual energy costs by end use.

Figure 10 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.

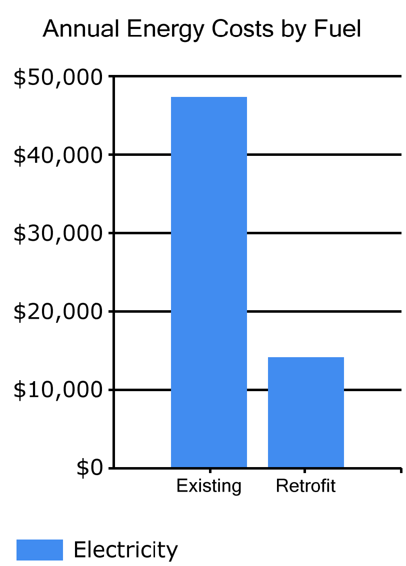


Figure 10: Annual energy costs by fuel type.

Figure 11 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 and 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.

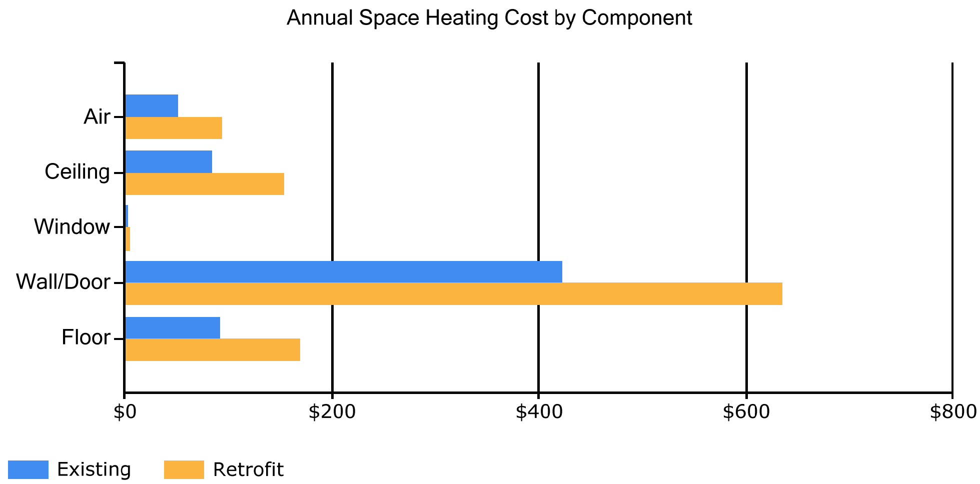


Figure 11: Annual space heating costs.

Note: The negative space heating savings is primarily due to removing the 15 HP distribution pump in the Water Treatment Plant pump room. AkWarm accounts for heat radiated from large appliances and electrical loads.

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.

Table 3.4: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	387	309	265	79	7	7	7	7	7	7	247	342
Lighting	23	21	22	22	22	22	22	22	22	23	22	23
Other Electrical	9,680	8,821	10,673	11,230	10,608	9,364	9,677	10,104	10,530	10,262	9,367	9,680

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 U.S. Environmental Protection Agency (U.S. 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 3.5 for details):

$$\text{Building Site EUI} = \frac{(\text{Electric Usage in kBTU} + \text{Fuel Usage in kBTU})}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{(\text{Electric Usage in kBTU} * \text{SS Ratio} + \text{Fuel Usage in kBTU} * \text{SS Ratio})}{\text{Building Square Footage}}$$

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

Table 3.5: Building EUI Calculations for the Yakutat Water Treatment Plant

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	121,929 kWh	416,143	3.340	1,389,918
Total		**416,143**		**1,389,918**
BUILDING AREA		319	Square Feet	
BUILDING SITE EUI		1,305	kBTU/Ft²/Yr.	
BUILDING SOURCE EUI		**4,357**	**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 3.6: Building Benchmarks for the Yakutat Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBTU/Sq. Ft.)**	**EUI/HDD (Btu/Sq. Ft./HDD)**	**ECI ($/Sq. Ft.)**
Existing Building	1,304.5	143.60	$148.68
With Proposed Retrofits	392.7	43.23	$44.76
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. Any heating and ventilation systems and central heating 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 Yakutat Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Yakutat was used for analysis. From this, the model was 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

1. The model is based on typical mean year weather data for Yakutat. 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.

2. The heating 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 heating loads across different parts of the building.

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: Summary List of Recommended Energy Efficiency Measures Ranked by Economic Priority

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: Water Storage Tank Panel Heater	Turn down panel heater and use only in extreme cold situations.	$583	$250	27.39	0.4	2,397.3
2	Plant Operations Upgrade: 15HP Pressure Pump Removal	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly to distribution. Directly related to recommendations 3, 7, 8, and 11.	$30,968	$44,245	10.23	1.4	127,372.9
3	Plant Operations Upgrade: Remove Wood Stave Tank Heat Tape	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendations 2, 7, 8, and 11.	$8	$13	3.77	1.6	32.6
4	Other Electrical: Water Storage Tank Heat Tape	Repair or replace thermostat for heat tape. Shorten length of heat tape	$204	$1,035	2.32	5.1	839.9
5	Lighting: Well House 1 Lighting	Replace with new, energy efficient, LED equivalents.	$2 + $6 Maint. Savings	$30	2.00	3.9	7.0
6	Lighting: Well House 2 Lighting	Replace with new, energy efficient, LED equivalents.	$2 + $6 Maint. Savings	$30	2.00	3.9	7.1
7	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Well Pump 1)	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendation 2, 3, 8, and 11.	$286 + $225 Maint. Savings[3]	$5,003	1.50	9.8	1,176.6

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**
8	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Well Pump 2)	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendations 2, 3, 7, and 11.	$782 + $225 Maint. Savings[3]	$13,665	1.08	13.6	3,214.8
9	Heating and Insulation: Well House 1	Install programmable thermostat to maintain temperature. Install R-14 rigid board insulation on walls, ceiling, and floor. Replace door with insulated door. Reduce air leakage through well house building shell upgrades.	$144 + $565 Maint. Savings[4]	$4,800	1.03	6.8	592.4
10	Heating and Insulation: Well House 2	Replace existing non-functional electric heater with similar-sized model that is thermostatically controlled. Install R-14 rigid board insulation on walls, ceiling, and floor. Replace door with insulated door. Reduce air leakage through well house building shell upgrades.	$144 + $566 Maint. Savings[4]	$5,100	0.98	7.2	592.4
11	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Chlorine Pump)	Remove wood stave tank from piping arrangement. Tie piping together and plumb well pump directly from well to distribution. Directly related to recommendation 2, 3, 7, and 8.	$31	$2,060	0.22	65.6	129.2
TOTAL, all measures			**$33,153 + $1,593 Maint. Savings**	**$76,232**	**6.49**	**2.2**	**136,362.2**

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.

[3] The maintenance savings figure in the Plant Operations Upgrade EEMs captures the energy and chemical treatment costs saved by eliminating the water loss at the Wood Stave Tank. At the estimated water loss rate of 10 gallons per minute, approximately 131 pounds of chlorine is wasted every year. The savings from removing the wood stave tank is split between the two well pumps based on their pumping rates.

[4] The maintenance savings figure in the Well House Heating and Insulation EEMs captures an estimated 30% reduction in electrical usage for space heating by installing temperature-controlled thermostats for the electric space heaters.

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

4.3 Electrical & Appliance Measures

4.3.1 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 heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.3.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition			Recommendation	
5	Well House 1 Lighting	INCAN A Lamp, Std 100W			Replace with new, energy efficient, LED equivalents.	
Installation Cost		$30	**Estimated Life of Measure (yrs)**	9	**Energy Savings ($/yr)**	$2
Breakeven Cost		$60	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	2.0	**Maintenance Savings ($/yr)**	$6
Auditors Notes: Replace the bulb with a 12 W LED equivalent.						

Rank	Location	Existing Condition			Recommendation	
6	Well House 2 Lighting	INCAN A Lamp, Std 100W			Replace with new, energy efficient, LED equivalents.	
Installation Cost		$30	**Estimated Life of Measure (yrs)**	9	**Energy Savings ($/yr)**	$2
Breakeven Cost		$60	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	2.0	**Maintenance Savings ($/yr)**	$6
Auditors Notes: Replace the bulb with a 12 W LED equivalent.						

4.3.2 Other Electrical Measures

Rank	Location	Description of Existing			Efficiency Recommendation	
1	Water Storage Tank Panel Heater	Electric Heater			Turn down panel heater at the 1 Mil Tank and use only in extreme cold situations.	
Installation Cost		$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$583
Breakeven Cost		$6,847	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	5.1 MMBTU
			Savings-to-Investment Ratio	27.4		
Auditors Notes: Turn down panel heater and use only in extreme cold situations.						

Rank	Location	Description of Existing			Efficiency Recommendation	
2	Plant Operations Upgrade: 15HP Pressure Pump Removal	Baldor Industrial Motor (15 HP)			Remove wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution. Directly related to recommendations 3, 7, 8, and 11.	
Installation Cost		$44,245	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$30,968
Breakeven Cost		$452,439	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	271.7 MMBTU
			Savings-to-Investment Ratio	10.2		
Auditors Notes: Approximately 10 gallons per minute of water is lost at the wood stave tank, amounting to 8.2% of the water production (estimated at 122 GPM in May 2017). The cost of the retrofit is a portion of the estimated $50,000 for an engineering plan set, permitting process, and State of Alaska DEC approval; $10,000 for the retrofit itself; and $4980 for labor costs. This retrofit cost is distributed between the chlorine pump, both well pumps, the 15HP pressure pump, and the Wood Stave heat tape based on their electrical consumption at the time of the onsite visit. The maintenance cost is the amount of electricity saved by using the pump 8.2% less (based on electrical prices in May 2017).						

Rank	Location		Description of Existing		Efficiency Recommendation	
3	Plant Operations Upgrade: Remove Wood Stave Tank Heat Tape		Heat Tape- approximately 40 feet at 5W/ft.		Remove wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution. Directly related to recommendations 2, 7, 8, and 11.	
Installation Cost		$13	**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	$8
Breakeven Cost		$49	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	3.8		

Auditors Notes: Approximately 10 gallons per minute of water is lost at the wood stave tank, amounting to 8.2% of the water production (estimated at 122 GPM in May 2017). The cost of the retrofit is a portion of the estimated $50,000 for an engineering plan set, permitting process, and State of Alaska DEC approval. This retrofit cost is distributed between the chlorine pump, both well pumps, the 15HP pressure pump, and the Wood Stave heat tape based on their electrical consumption at the time of the onsite visit. The maintenance cost is the amount of electricity saved by using the pump 8.2% less (based on electrical prices in May 2017). This savings is applied only to the chlorine pump and the two well pumps.

Rank	Location		Description of Existing		Efficiency Recommendation	
4	Other Electrical: Water Storage Tank Heat Tape		Heat Tape- approximately12 feet at 5W/ft.		Repair thermostat for heat tape and eliminate unnecessary heat tape usage. Use only for emergency thaw purposes.	
Installation Cost		$1,035	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$204
Breakeven Cost		$2,399	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	1.8 MMBTU
			Savings-to-Investment Ratio	2.3		

Auditors Notes: The wood stave tank is not needed for contact time for chlorine and the pressure pumps provide enough pressure for system distribution. The 1 Mil gallon water storage tank is the primary water storage location, so the wood stave tank is unnecessary.

Additionally, with the wood stave tank leaking an estimated 10 GPM of treated water, this leads to excessive pumping and chemical costs. Assume this avoids 10 GPM of leaks, which results in 131 lbs. of chlorine waste. This is divided between both well pumps.

Rank	Location		Description of Existing		Efficiency Recommendation	
7	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Well Pump 1)		Franklin Electric Submersible Pump (7.5 HP)		Remove wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution. Directly related to recommendation 2, 3, 8, and 11.	
Installation Cost		$5,003	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$286
Breakeven Cost		$7,527	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	2.5 MMBTU
			Savings-to-Investment Ratio	1.5	**Maintenance Savings ($/yr)**	$225

Auditors Notes: Remove the wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution.

Assume this avoids 10 GPM of leaks, resulting in 131 lbs. of chlorine waste. This cost savings is divided between both Well Pumps 1 and 2 as maintenance savings.

Approximately 10 gallons per minute of water is lost at the wood stave tank, amounting to 8.2% of the water production (estimated at 122 GPM in May 2017). The cost of the retrofit is a portion of the estimated $50,000 for an engineering plan set, permitting process, and State of Alaska DEC approval; $10,000 for the retrofit itself; and $4980 for labor costs. This retrofit cost is distributed between the chlorine pump, both well pumps, the 15HP pressure pump, and the Wood Stave heat tape based on their electrical consumption at the time of the onsite visit. The maintenance cost is the amount of electricity saved by using the pump 8.2% less (based on electrical prices in May 2017).

Rank	Location		Description of Existing		Efficiency Recommendation	
8	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Well Pump 2)		Franklin Electric Submersible Pump (7.5 HP)		Remove wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution. Directly related to recommendations 2, 3, 7, and 11.	
Installation Cost		$13,665	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$782
Breakeven Cost		$14,767	**Simple Payback (yrs)**	14	**Energy Savings (MMBTU/yr)**	6.9 MMBTU
			Savings-to-Investment Ratio	1.1	**Maintenance Savings ($/yr)**	$225

Auditors Notes: Remove the wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution.

Assume this avoids 10 GPM of leaks, resulting in 131 lbs. of chlorine waste. This cost savings is divided between both Well Pumps 1 and 2 as maintenance savings.

Approximately 10 gallons per minute of water is lost at the wood stave tank, amounting to 8.2% of the water production (estimated at 122 GPM in May 2017). The cost of the retrofit is a portion of the estimated $50,000 for an engineering plan set, permitting process, and State of Alaska DEC approval; $10,000 for the retrofit itself; and $4980 for labor costs. This retrofit cost is distributed between the chlorine pump, both well pumps, the 15HP pressure pump, and the Wood Stave heat tape based on their electrical consumption at the time of the onsite visit. The maintenance cost is the amount of electricity saved by using the pump 8.2% less (based on electrical prices in May 2017).

Rank	Location		Description of Existing		Efficiency Recommendation	
11	Plant Operations Upgrade: Energy Savings due to Water Loss Elimination (Chlorine Pump)		LMI Milton Roy Model C141-36. 20.00 GPH max. Speed set to "15".		Remove wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution. Directly related to recommendation 2, 3, 7, and 8.	
Installation Cost		$2,060	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$31
Breakeven Cost		$459	**Simple Payback (yrs)**	66	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
			Savings-to-Investment Ratio	0.2		

Auditors Notes: Remove the wood stave tank from piping arrangement. Tie piping together and pump directly from well to distribution.

Approximately 10 gallons per minute of water is lost at the wood stave tank, amounting to 8.2% of the water production (estimated at 122 GPM in May 2017). The cost of the retrofit is a portion of the estimated $50,000 for an engineering plan set, permitting process, and State of Alaska DEC approval; $10,000 for the retrofit itself; and $4980 for labor costs. This retrofit cost is distributed between the chlorine pump, both well pumps, the 15HP pressure pump, and the Wood Stave heat tape based on their electrical consumption at the time of the onsite visit. The maintenance cost is the amount of electricity saved by using the pump 8.2% less (based on electrical prices in May 2017).

4.3.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
9		Heating and Insulation: Well House 1		Install programmable thermostat to maintain proper temperature in real time. Install R-14 rigid board insulation on walls, ceiling, and floor. Replace door with insulated door. Reduce air leakage through well house building shell upgrades.	
Installation Cost	$4,800	**Estimated Life of Measure (yrs)**	8	**Energy Savings ($/yr)**	$144
Breakeven Cost	$4,968	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr)**	$565
Auditors Notes: All of the insulation measures will reduce the overall heat demand of the well house and make the space more efficient for heating purposes. The programmable thermostat will prevent the well house from being heated more than necessary to prevent freezing problems.					

Rank	Location	Description of Existing		Efficiency Recommendation	
10		Heating and Insulation: Well House 2		Replace existing non-functional electric heater with similar-sized model that is thermostatically controlled. Install R-14 Rigid board insulation on walls, ceiling, and floor. Replace door with insulated door. Reduce air leakage through well house building shell upgrades.	
Installation Cost	$5,100	**Estimated Life of Measure (yrs)**	8	**Energy Savings ($/yr)**	$144
Breakeven Cost	$4,975	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr)**	$566
Auditors Notes: All of the insulation measures will reduce the overall heat demand of the well house and make the space more efficient for heating purposes. An electric space heater with a programmable thermostat will prevent the well house from being heated more than necessary to prevent freezing problems.					

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.

In the near future, a representative of ANTHC will be contacting the City and Borough of Yakutat to follow up on the recommendations made in this report. ANTHC will provide assistance in understanding the report and implementing the recommendations as desired by the City and Borough.

APPENDICES

Appendix A – Scanned Energy Billing Data

1. Electricity Billing Data

Utility: AVEC (previously Yakutat Power, Inc.)
Reading: Monthly
Units: kWh

Month	Water Treatment Plant[1]	1 Mil Tank
June 2016	8,080	982
July 2016	9,040	825
August 2016	11,000	1,178
September 2016	10,000	1,867
October 2016	9,160	2,813
November 2016	6,720	2,673
December 2016	8,720	2,201
January 2017	10,440	2,666
February 2017	10,480	2,150
March 2017	14,080	2,756
April 2017	16,040	1,967
May 2017	11,640	4,177

[1] Water Treatment Plant electrical data includes both well houses, the well pumps, the distribution pumps and controls, the chemical add room loads, and the wood stave tank heat tape.

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Yakutat Water Treatment Plant (CBY Arco Well)	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: Water Tank Rd (off of Ocean Cape Rd.)	**Auditor Name:** Cody Uhlig and Kelli Whelan
City: Yakutat	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: Jon Erikson, EdD	
Client Address: P.O. Box 160 Yakutat, AK 99689	**Auditor Phone:** (907) 729-3589
	Auditor FAX: (907) 729-4047
Client Phone: (907) 784-3323	**Auditor Comment:**
Client FAX: (907) 784-3281	
Design Data	
Building Area: 319 square feet	**Design Indoor Temperature:** 55 deg F (building average)
Typical Occupancy: 2 people	**Design Outdoor Temperature:** 2.1 deg F
Actual City: Yakutat	**Heating Degree Days:** 9,084 deg F-days
Weather/Fuel City: Yakutat	
Utility Information	
Electric Utility: Alaska Village Electric Cooperative	**Average Annual Cost/kWh:** $0.389/kWh

Annual Energy Cost Estimate				
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Total Cost**
Existing Building	$650	$103	$46,678	**$47,430**
With Proposed Retrofits	$1,057	$99	$13,121	**$14,277**
Savings	-$407	$3	$33,557	**$33,153**

Building Benchmarks			
Description	**EUI (kBTU/Sq. Ft.)**	**EUI/HDD (Btu/Sq. Ft./HDD)**	**ECI ($/Sq. Ft.)**
Existing Building	1,304.5	143.60	$148.68
With Proposed Retrofits	392.7	43.23	$44.76

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 C – Photographs from AkWarm Program

Figure 12: Wood Stave Tank (left). Yakutat Water Treatment Plant exterior (right).

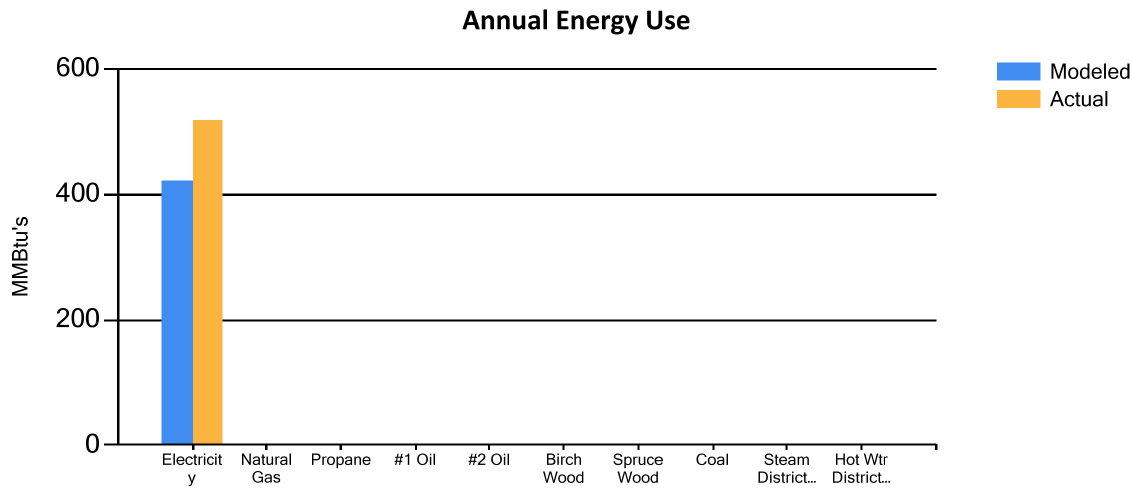
Figure 13: Well house exterior (door is open). Both well houses are identical structures.

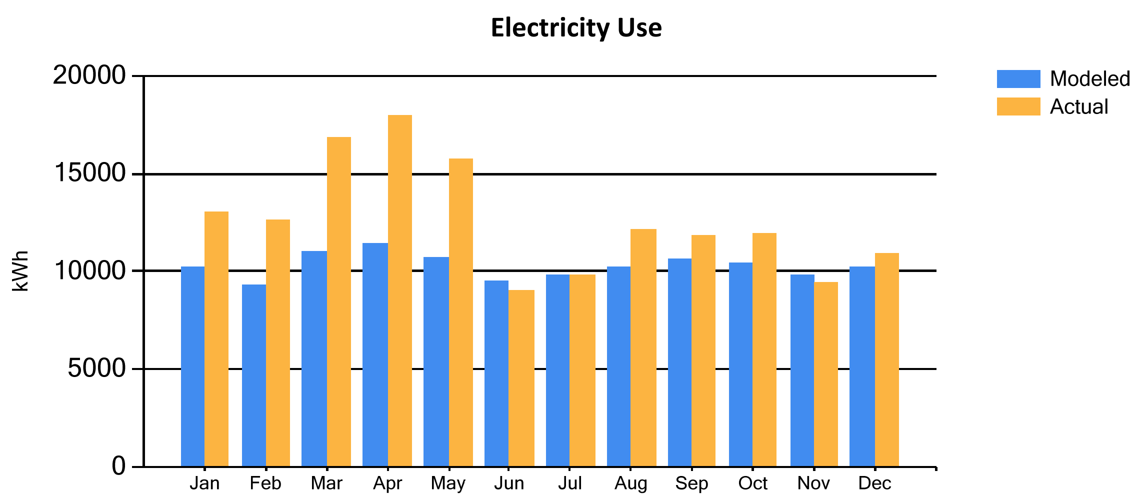
Figure 14: Water Treatment Plant Pump Room interior.

Figure 15: Chemical Injection Room interior. The ceramic unit heater is the square object attached to the ceiling.

Appendix D – Actual Fuel Use versus Modeled Fuel Use

The graphs below show the modeled energy usage results of the energy audit process compared to the actual energy usage report data. The model was completed using AkWarm modeling software. The orange bars show actual fuel use, and the blue bars are AkWarm's prediction of fuel use.





Note on Electricity Use: the higher usage rate in March through May 2017 appeared to be an anomaly when compared to data from previous years (2016 and 2015).

Appendix E - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	26.2	25.5	24.9	24.4	24.3	24.3	24.3	24.3	24.3	24.3	24.3	23.9
As Proposed	15.6	14.6	13.7	13.0	12.7	12.7	12.7	12.7	12.7	12.8	12.6	11.8

AkWarmCalc Ver 2.8.0.0, Energy Lib 3/3/2017