Comprehensive Energy Audit
For

Kaltag Water Treatment Plant & Washeteria

Prepared For

City of Kaltag

September 9, 2015

Prepared By:

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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 Kaltag, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) 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 February of 2015 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 Tommy Neglaska and Richard Burnham, and Kaltag City Administrator Jacqueline Nicholas.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Kaltag. The scope of the audit focused on Kaltag Water Treatment Plant & Washeteria. 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 plug loads.

In the near future, a representative of ANTHC will be contacting both the City of Kaltag and the water treatment plant operators to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

The total predicted energy cost for the Kaltag Water Treatment Plant & Washeteria is $76,333 per year. Fuel oil represents the largest portion with an annual cost of $40,964. Electricity represents the remaining portion with an annual cost of $35,369. This includes $13,603 paid by the city and $21,766 paid by the Power Cost Equalization (PCE) program through the State of Alaska. These predictions are based on the electricity and fuel prices at the time of the audit.

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. In Kaltag, the cost of electricity without PCE is $0.53/KWH and the cost of electricity with PCE is $0.20/KWH.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	67,349 kWh	57,148 kWh
#1 Oil	7,124 gallons	4,844 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	571.4	40.17	$37.27
With Proposed Retrofits	407.5	28.64	$28.32
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 Kaltag Water Treatment Plant & Washeteria. 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	Heat Add Controls	Repair heat add controls on raw water heat add loop and set controller to 40 degrees.	$4,335	$3,000	19.57	0.7	15,913.8
2	Heat Add Controls	Repair heat add controls on Loop A and set controller to 40 degrees.	$3,937	$3,000	17.77	0.8	14,451.5
3	Controls Retrofit: Loop B Circulation Pump	Shut off pump during summer months.	$1,817	$2,000	10.67	1.1	6,390.6
4	Controls Retrofit: Tank Access Heat Tape	Shut off heat tape and use only for thawing and/or emergency purposes.	$1,175	$1,500	9.20	1.3	4,131.4
5	Heat Add Controls	Lower set point on Loop B to 40 degrees.	$870	$1,500	7.85	1.7	3,193.3
6	Controls Retrofit: Loop A Circulation Pump	Shut off pump during summer months.	$1,211	$2,000	7.11	1.7	4,260.4
7	Lighting - Power Retrofit: Arctic Entry	Replace with new energy-efficient LED lighting.	$13	$25	5.96	2.0	44.6
8	Air Tightening: WTP Main Entrance Door	Seal cracks around the WTP entrance door and repair door so that it properly closes.	$312	$500	5.80	1.6	1,145.4
9	Heating, Ventilation, and Domestic Hot Water	Add Tekmar to control all three boilers and lower domestic hot water temperature to 120 degrees.	$3,200	$13,000	4.29	4.1	11,754.2
10	Heat Add Controls	Repair heat add controls on tank heat add and lower set point to 45 degrees.	$741	$3,000	3.34	4.1	2,718.3
11	Lighting - Power Retrofit: Washeteria	Replace with new energy-efficient LED lighting.	$192	$1,320	1.64	6.9	667.8
12	Lighting - Power Retrofit: WTP Office	Replace with new energy-efficient LED lighting.	$10	$80	1.37	8.2	34.0
13	Lighting - Power Retrofit: WTP	Replace with new energy-efficient LED lighting.	$257	$2,160	1.33	8.4	890.8
14	Controls Retrofit: Tank Circulation Pump	Shut off pump during summer months.	$207	$2,000	1.22	9.6	729.6
15	Lighting - Power Retrofit: Rest Room CFL	Replace with new energy-efficient LED lighting.	$5	$55	1.11	10.1	19.0
16	Lighting - Power Retrofit: Mechanical Room	Replace with new energy-efficient LED lighting.	$32	$360	0.99	11.3	110.8

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
17	Lighting - Power Retrofit: Mezanine	Replace with new energy-efficient LED lighting.	$14	$480	0.33	34.0	48.9
18	Lighting - Power Retrofit: Dryer Plenum	Replace with new energy-efficient LED lighting.	$4	$160	0.25	44.5	12.5
	TOTAL, all measures		**$18,331**	**$36,140**	**6.92**	**2.0**	**66,516.8**

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 $18,331 per year, or 24.0% of the buildings' total energy costs. These measures are estimated to cost $36,140, for an overall simple payback period of 2.0 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**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$8,912	$3,436	$5,749	$2,482	$25,491	$10,107	$14,910	$5,187	**$76,333**
With Proposed Retrofits	$8,719	$3,407	$5,582	$1,791	$21,062	$4,578	$8,739	$4,062	**$58,002**
Savings	$192	$29	$166	$690	$4,429	$5,529	$6,170	$1,125	**$18,331**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Kaltag Water Treatment Plant & Washeteria. 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%/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 and ventilation equipment
- 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 Kaltag Water Treatment Plant & Washeteria 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.

Kaltag Water Treatment Plant & Washeteria is classified as being made up of the following activity areas:

1) Water Treatment Plant: 1,344 square feet
2) Washeteria: 704 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; heating and ventilation; 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. Kaltag Water Treatment Plant & Washeteria

3.1. Building Description

The 2,048 square foot Kaltag Water Treatment Plant & Washeteria was constructed in 1997, with a normal occupancy of one person. The number of hours of operation for this building average approximately 5 hours per day, considering all seven days of the week.

The Kaltag Water Treatment Plant & Washeteria serves as the water distribution center for the residents of the community and also provides laundromat and shower services for public use.

There are three water distribution loops that circulate through town to provide treated water to the community. Loop A runs approximately 3050 ft. and serves the western part of town. The Well Loop runs approximately 2800 ft. and serves part of the eastern side of town including the store. Loop B runs approximately 8900 ft. and serves the remaining part of the eastern side of town including the public facilities and school. All circulation loops use 8" arctic piping.

There are 3 washers and 2 dryers in the washeteria, though at the time of the site visit there were only 2 washers in operation. There are 4 restrooms with showers in the washeteria.

Water is pumped into the water treatment plant from a raw water intake located in a creek outside of town. The water is pumped through two pressure filters and a series of bag filters before receiving an injection of chlorine and soda ash and entering the 212,000 gallon water storage tank. Pressure pumps are used to keep the pressure up for use in the washeteria and showers.

Description of Building Shell

The exterior walls are constructed single stud wood-framed 2X6 construction with 5.5 inches of polyurethane foam insulation. The insulation is slightly damaged and there is approximately 2080 square feet of wall space in the building.

The roof of the building has a cathedral ceiling with standard framing and 24-inch spacing. There is approximately 6 inches of polyurethane foam insulation that is slightly in the building. The roof area is approximately 2187 square feet.

The building is built on pilings with approximately 48 inches of clearance between the pad and the ground. The floor is framed with standard lumber and has 6 inches of polyurethane foam insulation. There is approximately 2048 square feet of floor space in the building.

There are four windows in the building. Two windows are double-paned located in the water treatment plant space and have a total area of approximately 12 square feet. Two windows are triple-paned located in the washeteria space and have a total area of approximately 11 square feet.

There are three total doors in the building with one located in the washeteria and a set of double doors located in the water treatment plant. The washeteria door is metal with an insulated core and has an area of approximately 21 square feet. The water treatment plant doors are metal with an insulated core and have a total area of approximately 42 square feet. The water treatment plant doors have malfunctioning hinges that do not allow proper closure of the doors.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler #1

Nameplate Information:	Weil McLain EH-676
Fuel Type:	#1 Oil
Input Rating:	482,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	Sep - May

Boiler #2

Nameplate Information:	Weil McLain EH-676
Fuel Type:	#1 Oil

Input Rating:	482,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	Sep - May

Boiler #3

Nameplate Information:	Weil McLain P-WGO-6
Fuel Type:	#1 Oil
Input Rating:	234,000 BTU/hr
Steady State Efficiency:	85 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

Space Heating Distribution Systems

There are four unit heaters in the building. Two unit heaters are located in the water treatment plant space and distribute approximately 10,000 BTU each. A third unit heater is located in the mechanical room and distributes approximately 10,000 BTU. A fourth unit heater is present in the washeteria space and distributes approximately 10,000 BTU. There is baseboard heating present in all of the rest rooms as well as in the washeteria space and the washeteria office.

The Kaltag Water Treatment Plant and Washeteria does not use glycol for their hydronic heating systems and instead circulates heated water.

Domestic Hot Water System

There is a 150 gallon hot water generator located in the water treatment plant space that is used to provide hot water for the washeteria and showers. The hot water generator is currently set for an output temperature of 140 deg. F. The hot water generator has a circulation pump that is 0.5 HP that circulates the hot water to the desired locations.

Lighting

The water treatment plant space has 18 fixtures with three T8 fluorescent light bulbs in each fixture.

The mechanical room has three fixtures with three T8 fluorescent light bulbs in each fixture.

The dryer plenum has two fixtures with two T8 fluorescent light bulbs in each fixture.

The mezzanine has three fixtures with four T8 fluorescent light bulbs in each fixture.

The water treatment plant office has one fixture with two T8 fluorescent light bulbs in the fixture.

The washeteria room has 11 fixtures with two light bulbs in each fixture.

The plumbing chase has four fixtures with a single CFL 15 Watt light bulb in each fixture.

The arctic entry has a single fixture with a single CFL 20 Watt light bulb in the fixture.

The rest rooms combine to have four fixtures with two 2-ft. T18 fluorescent light bulbs in each fixture. The rest rooms also combine to have four fixtures with a single CFL 15 Watt light bulb in each fixture.

Plug Loads

The water treatment plant has a variety of power tools, a telephone, and some other miscellaneous loads that require a plug into an electrical outlet. The use of these items is infrequent and consumes a small portion of the total energy demand of the building.

Major Equipment

There is a circulation pump that circulates water through Loop A. The pump consumes approximately 9,467 KWH annually.

There is a circulation pump that circulates water through Loop B. The pump consumes approximately 14,201 KWH annually.

There is a circulation pump that circulates water through the Well Loop. The pump consumes approximately 11,723 KWH annually.

There is a circulation pump that circulates water between the water treatment plant building and the water storage tank. The pump consumes approximately 1,622 KWH annually.

There is a heat tape that is used to heat the circulation loop between the water storage tank and the water treatment plant building. The heat tape consumes approximately 2,295 KWH annually.

There is a pressure pump that is used to keep the pressure raised for the showers and washeteria use. The pump consumes approximately 2,840 KWH annually.

There are three clothes washers in the washeteria. The washers consume approximately 470 KWH annually.

There is a dryer pump that circulates heated water through the hydronic system to the dryers. The pump consumes approximately 4,778 KWH annually.

There is a well pump that is used to pump raw water from the well intake to the water treatment plant building. The pump consumes approximately 1,176 KWH annually.

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 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 Kaltag 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	$ 0.53/kWh
#1 Oil	$ 5.75/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Kaltag pays approximately $76,333 annually for electricity and other fuel costs for the Kaltag Water Treatment Plant & Washeteria.

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

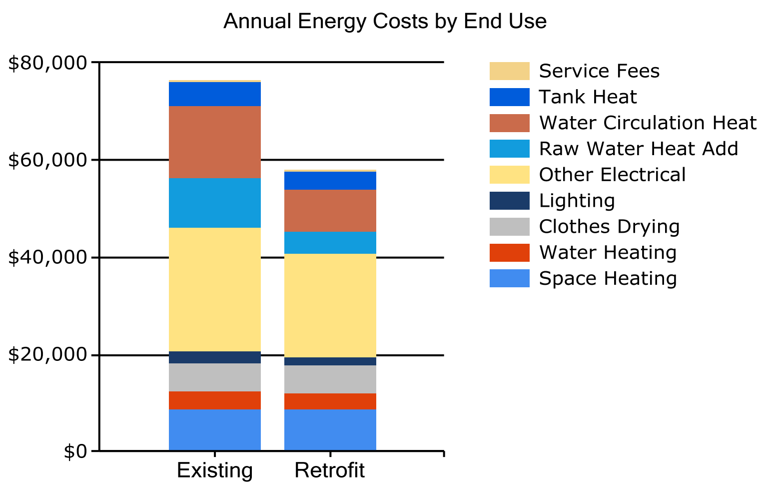


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

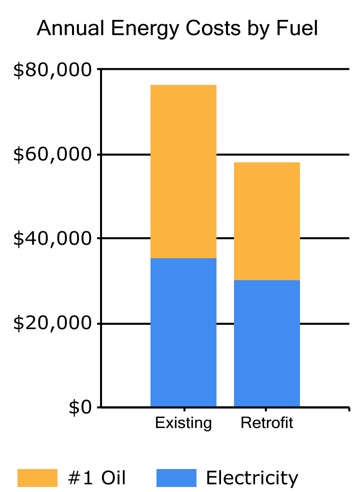
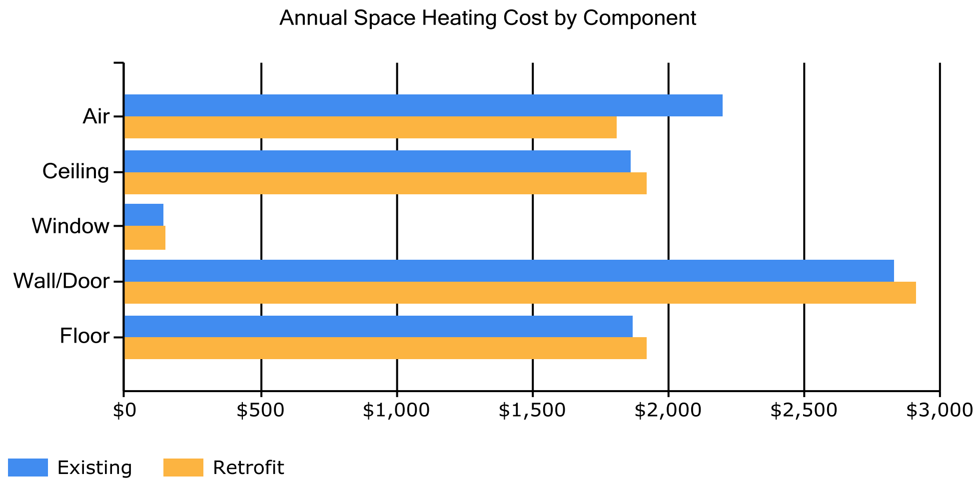


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

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	981	895	980	943	968	936	967	967	936	971	945	982
DHW	114	104	114	110	114	110	114	114	111	114	110	114
Clothes_Drying	38	34	37	36	35	34	35	35	36	37	36	38
Lighting	402	366	402	389	402	389	402	402	389	402	389	402
Other_Electrical	4192	3820	4192	4057	4192	3805	3932	3932	4057	4192	4057	4192
Raw_Water_Heat_Add	32	31	32	25	14	9	6	6	12	20	26	33
Water_Circulation_Heat	54	52	53	40	19	8	6	6	13	30	41	56
Tank_Heat	19	18	19	14	6	2	0	0	4	10	15	20

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	96	91	85	44	6	0	0	0	0	21	62	99
DHW	39	35	39	40	36	36	39	39	51	44	39	39
Clothes_Drying	89	82	89	84	68	64	66	66	92	87	84	89
Raw_Water_Heat_Add	227	215	224	179	94	56	39	41	95	149	184	232
Water_Circulation_Heat	365	349	360	273	121	52	36	38	95	209	283	375
Tank_Heat	134	129	132	99	40	12	0	0	29	74	103	138

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):

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

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

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

Table 3.4
Kaltag Water Treatment Plant & Washeteria 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	67,349 kWh	229,863	3.340	767,741
#1 Oil	7,124 gallons	940,384	1.010	949,787
Total		**1,170,246**		**1,717,529**
BUILDING AREA		2,048	Square Feet	
BUILDING SITE EUI		571	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		839	**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	**571.4**	**40.17**	**$37.27**
With Proposed Retrofits	**407.5**	**28.64**	**$28.32**
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 heating and ventilation 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 Kaltag Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Kaltag 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 Kaltag. 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 heating and ventilation 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
Kaltag Water Treatment Plant & Washeteria, Kaltag, 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	Heat Add Controls	Repair heat add controls on raw water heat add loop and set controller to 40 degrees.	$4,335	$3,000	19.57	0.7	15,913.8
2	Heat Add Controls	Repair heat add controls on Loop A and set controller to 40 degrees.	$3,937	$3,000	17.77	0.8	14,451.5
3	Controls Retrofit: Loop B Circulation Pump	Shut off pump during summer months.	$1,817	$2,000	10.67	1.1	6,390.6
4	Controls Retrofit: Tank Access Heat Tape	Shut off heat tape and use only for thawing and/or emergency purposes.	$1,175	$1,500	9.20	1.3	4,131.4
5	Heat Add Controls	Lower set point on Loop B to 40 degrees.	$870	$1,500	7.85	1.7	3,193.3
6	Controls Retrofit: Loop A Circulation Pump	Shut off pump during summer months.	$1,211	$2,000	7.11	1.7	4,260.4
7	Lighting - Power Retrofit: Arctic Entry	Replace with new energy-efficient LED lighting.	$13	$25	5.96	2.0	44.6

Table 4.1 Kaltag Water Treatment Plant & Washeteria, Kaltag, 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**
8	Air Tightening: WTP Main Entrance Door	Seal cracks around the WTP entrance door and repair door so that it properly closes.	$312	$500	5.80	1.6	1,145.4
9	Heating, Ventilation, and Domestic Hot Water	Add Tekmar to control all three boilers and lower domestic hot water temperature to 120 degrees.	$3,200	$13,000	4.29	4.1	11,754.2
10	Heat Add Controls	Repair heat add controls on tank heat add and lower set point to 45 degrees.	$741	$3,000	3.34	4.1	2,718.3
11	Lighting - Power Retrofit: Washeteria	Replace with new energy-efficient LED lighting.	$192	$1,320	1.64	6.9	667.8
12	Lighting - Power Retrofit: WTP Office	Replace with new energy-efficient LED lighting.	$10	$80	1.37	8.2	34.0
13	Lighting - Power Retrofit: WTP	Replace with new energy-efficient LED lighting.	$257	$2,160	1.33	8.4	890.8
14	Controls Retrofit: Tank Circulation Pump	Shut off pump during summer months.	$207	$2,000	1.22	9.6	729.6
15	Lighting - Power Retrofit: Rest Room CFL	Replace with new energy-efficient LED lighting.	$5	$55	1.11	10.1	19.0
16	Lighting - Power Retrofit: Mechanical Room	Replace with new energy-efficient LED lighting.	$32	$360	0.99	11.3	110.8
17	Lighting - Power Retrofit: Mezanine	Replace with new energy-efficient LED lighting.	$14	$480	0.33	34.0	48.9
18	Lighting - Power Retrofit: Dryer Plenum	Replace with new energy-efficient LED lighting.	$4	$160	0.25	44.5	12.5
	TOTAL, all measures		**$18,331**	**$36,140**	**6.92**	**2.0**	**66,516.8**

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. When the building is in cooling mode, these items contribute to the overall cooling demands of the building; therefore, lighting efficiency improvements will reduce cooling requirements in air-conditioned buildings. Conversely, lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties and cooling benefits 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)	
8	WTP Main Entrance Door		Air Tightness estimated as: 1000 cfm at 50 Pascals		Seal cracks around the WTP entrance door and repair door so that it properly closes.	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	10	**Installation Cost**	$500
Breakeven Cost		$2,898	**Savings-to-Investment Ratio**	5.8	**Breakeven Cost**	$2,898
Auditors Notes: The door hinges do not properly hold the weight of the door and the operators use a makeshift door prop to keep the door closed. The hinges need to be fixed and then weather stripping could be added to fill in any additional gaps.						

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation					
9	Add Tekmar to control all three boilers and lower domestic hot water temperature to 120 degrees.					
Installation Cost		$13,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$3,200
Breakeven Cost		$55,759	**Savings-to-Investment Ratio**	4.3	**Simple Payback yrs**	4
Auditors Notes: There are currently no functioning controls on the boilers and they are operated manually. Add a Tekmar controller to create an operation sequence and reduce the run time of the boilers. The addition of a Tekmar system will require additional plumbing the mechanical system around the boilers and the addition of a small pump for each boiler. The pumps would turn on when the individual boiler is fired by the Tekmar system. More expansion tanks will be needed to accommodate the increase in temperature difference that will be present if the Tekmar shuts the boilers off for a long period of time.						

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	
7	Arctic Entry		FLUOR CFL, A Lamp 20W with Manual Switching		Replace with new energy-efficient LED lighting.	
Installation Cost		$25	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$13
Breakeven Cost		$149	**Savings-to-Investment Ratio**	6.0	**Simple Payback yrs**	2
Auditors Notes: Replace 20 watt CFL with 10 watt LED.						

Rank	Location		Existing Condition		Recommendation	
11	Washeteria		11 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting.	
Installation Cost		$1,320	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$192
Breakeven Cost		$2,159	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	7
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast.						

Rank	Location		Existing Condition		Recommendation	
12	WTP Office		FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting.	
Installation Cost		$80	**Estimated Life of Measure (yrs)**	15	**Installation Cost**	$80
Breakeven Cost		$110	**Savings-to-Investment Ratio**	1.4	**Breakeven Cost**	$110
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast.						

Rank	Location		Existing Condition		Recommendation	
13	WTP		18 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting.	
Installation Cost		$2,160	**Estimated Life of Measure (yrs)**	15	**Installation Cost**	$2,160
Breakeven Cost		$2,873	**Savings-to-Investment Ratio**	1.3	**Breakeven Cost**	$2,874
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast.						

Rank	Location		Existing Condition		Recommendation	
15	Rest Room CFL		4 FLUOR CFL, A Lamp 15W with Manual Switching, Occupancy Sensor		Replace with new energy-efficient LED lighting.	
Installation Cost		$55	**Estimated Life of Measure (yrs)**	15	**Installation Cost**	$55
Breakeven Cost		$61	**Savings-to-Investment Ratio**	1.1	**Breakeven Cost**	$61
Auditors Notes: Replace 15 watt CFLs with 10 watt LEDs.						

Rank	Location		Existing Condition		Recommendation	
16	Mechanical Room		3 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching, Occupancy Sensor		Replace with new energy-efficient LED lighting.	
Installation Cost		$360	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$32
Breakeven Cost		$357	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	11
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast.						

Rank	Location		Existing Condition		Recommendation	
17	Mezzanine		3 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting.	
Installation Cost		$480	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$14
Breakeven Cost		$158	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	34
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast.						

Rank	Location		Existing Condition		Recommendation	
18	Dryer Plenum		2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching, Occupancy Sensor		Replace with new energy-efficient LED lighting.	
Installation Cost		$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4
Breakeven Cost		$40	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	45
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast.						

4.5.2 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
3	Loop B Circulation Pump		Circulation Pump with Manual Switching		Shut off pump during summer months.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,817
Breakeven Cost		$21,344	**Savings-to-Investment Ratio**	10.7	**Simple Payback yrs**	1
Auditors Notes: Shut off loop B circulation pump for 3 summer months. The pumps are used to keep the water moving during the cold months and are not needed during warmer weather periods. Pressure switches will be required for the pressure tank so that the water system can maintain pressure when the circulation pumps are shut off. The pressure tanks will have to be adjusted higher in the summer months to compensate for the circulation pump shutdown and will have to be adjusted lower in the fall to compensate for the circulation pump start and to avoid over- pressurizing the system and causing leaks in the distribution pipes.						

Rank	Location		Description of Existing		Efficiency Recommendation	
4	Tank Access Heat Tape		Electric Heat Tape with Manual Switching		Shut off heat tape and use only for thawing and/or emergency purposes.	
Installation Cost		$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,175
Breakeven Cost		$13,799	**Savings-to-Investment Ratio**	9.2	**Simple Payback yrs**	1
Auditors Notes: Shut off tank access electric heat tape, it should be used for thaw purposes only.						

Rank	Location		Description of Existing		Efficiency Recommendation	
6	Loop A Circulation Pump		Circulation Pump with Manual Switching		Shut off pump during summer months.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,211
Breakeven Cost		$14,230	**Savings-to-Investment Ratio**	7.1	**Simple Payback yrs**	2
Auditors Notes: Shut off loop A circulation pump for 3 summer months. The pumps are used to keep the water moving during the cold months and are not needed during warmer weather periods. Pressure switches will be required for the pressure tank so that the water system can maintain pressure when the circulation pumps are shut off. The pressure tanks will have to be adjusted higher in the summer months to compensate for the circulation pump shutdown and will have to be adjusted lower in the fall to compensate for the circulation pump start and to avoid over- pressurizing the system and causing leaks in the distribution pipes.						

Rank	Location		Description of Existing		Efficiency Recommendation	
14	Tank Circulation Pump		Circulation Pump with Manual Switching		Shut off pump during summer months.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$207
Breakeven Cost		$2,437	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	10
Auditors Notes: Shut off tank circulation pump for 3 summer months. The pumps are used to keep the water moving during the cold months and are not needed during warmer weather periods. Pressure switches will be required for the pressure tank so that the water system can maintain pressure when the circulation pumps are shut off. The pressure tanks will have to be adjusted higher in the summer months to compensate for the circulation pump shutdown and will have to be adjusted lower in the fall to compensate for the circulation pump start and to avoid over- pressurizing the system and causing leaks in the distribution pipes.						

4.5.3 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1			Raw Water Heat Add Load		Repair heat add controls on raw water heat add loop and set controller to 40 degrees.	
Installation Cost		$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4,335
Breakeven Cost		$58,715	**Savings-to-Investment Ratio**	19.6	**Simple Payback yrs**	1
Auditors Notes: The heat add controls are not functional and there is no limit to the heat added to the raw water loop. Repair the controls and set the raw water temperature for 40 deg. F. Either the controller or solenoid is not working.						

Rank	Location		Description of Existing		Efficiency Recommendation	
2			Loop A Water Circulation Heat Load		Repair heat add controls on Loop A and set controller to 40 degrees.	
Installation Cost		$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3,937
Breakeven Cost		$53,317	**Savings-to-Investment Ratio**	17.8	**Simple Payback yrs**	1
Auditors Notes: The heat add controls are not functional and there is no limit to the heat added to the circulation loop. Repair the controls and set the circulation loop temperature for 40 deg. F.						

Rank	Location		Description of Existing		Efficiency Recommendation	
5			Loop B Water Circulation Heat Load		Lower set point on Loop B to 40 degrees.	
Installation Cost		$1,500	**Estimated Life of Measure (yrs)**	15	**Installation Cost**	$1,500
Breakeven Cost		$11,782	**Savings-to-Investment Ratio**	7.9	**Breakeven Cost**	$11,782
Auditors Notes: The heat add controls are functional on this circulation loop but the set point is currently set at 45 deg. F. Lower set point to 40 deg. F to reduce unnecessary heat loads.						

Rank	Location	Description of Existing		Efficiency Recommendation	
10		Water Storage Tank Heat Load		Repair heat add controls on tank heat add and lower set point to 45 degrees.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Installation Cost**	$3,000
Breakeven Cost	$10,029	**Savings-to-Investment Ratio**	3.3	**Breakeven Cost**	$10,029

Auditors Notes: The heat add controls are not functional and there is no limit to the heat added to the water storage tank loop. Repair the controls and set the water storage tank loop temperature for 45 deg. F.

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 both the City of Kaltag and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Kaltag Water Treatment Plant & Washeteria	**Auditor Company:** ANTHC-DEHE
Address: PO Box 9	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Kaltag	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Tommy Neglaska & Richard Burnham	
Client Address: PO Box 9 Kaltag, AK 99748	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 534-9222	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 2,048 square feet	**Design Space Heating Load:** Design Loss at Space: 24,092 Btu/hour with Distribution Losses: 28,343 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 43,207 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Kaltag	**Design Outdoor Temperature:** -26.2 deg F
Weather/Fuel City: Kaltag	**Heating Degree Days:** 14,225 deg F-days
Utility Information	
Electric Utility: AVEC-Kaltag - Commercial - Sm	**Average Annual Cost/kWh:** $0.525/kWh

Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$8,912	$3,436	$5,749	$2,482	$25,491	$10,107	$14,910	$5,187	**$76,333**
With Proposed Retrofits	$8,719	$3,407	$5,582	$1,791	$21,062	$4,578	$8,739	$4,062	**$58,002**
Savings	$192	$29	$166	$690	$4,429	$5,529	$6,170	$1,125	**$18,331**

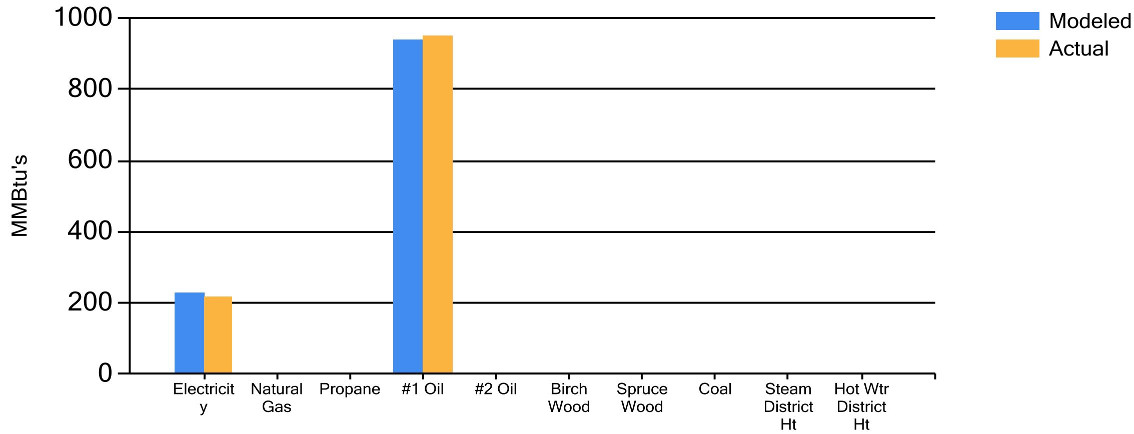
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	571.4	40.17	$37.27
With Proposed Retrofits	407.5	28.64	$28.32

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.

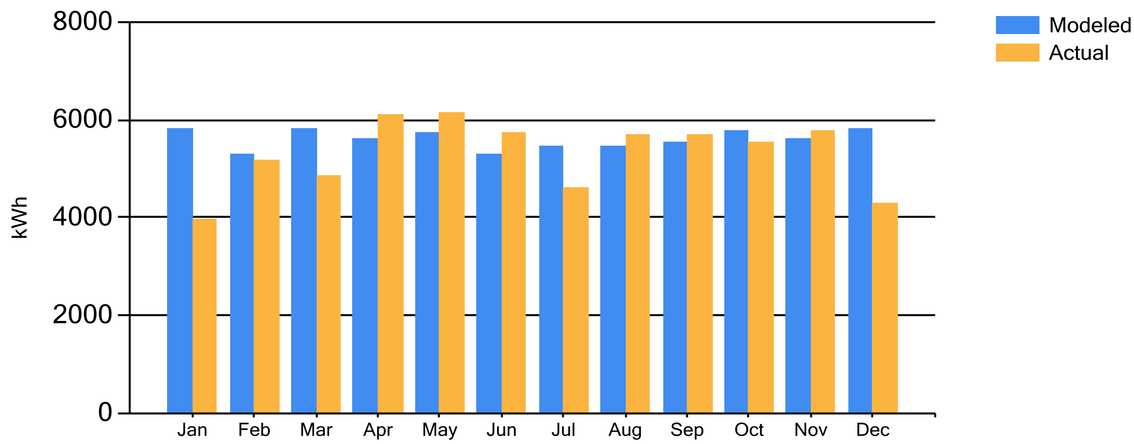
Appendix B – Actual Fuel Use versus Modeled Fuel Use

The Orange bars show Actual fuel use, and the Blue bars are AkWarm's prediction of fuel use.

Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use