Comprehensive Energy Audit
For

Allakaket Water Treatment Plant & Washeteria

Prepared For
City of Allakaket

May 11, 2015

Prepared By:

ANTHC-DEHE
3900 Ambassador Drive, Suite 301
Anchorage, AK 99508

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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 Allakaket, 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 Operator Floyd Saunders and Allakaket Tribal Administrator Elise Bergman.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Allakaket. The scope of the audit focused on Allakaket 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, process loads, heating and ventilation systems, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy cost for the Allakaket Water Treatment Plant & Washeteria is $88,405 per year. Electricity represents the largest piece of energy costs with an annual cost of approximately $66,408 per year. The water treatment plant has a fuel oil cost of approximately $21,996 per year.

The Allakaket Water Treatment Plant & Washeteria received funding from the Environmental Protection Agency and the Indian Health Service to install a heat recovery system from the local power plant to the water treatment plant for the purpose of heating the water treatment plant and washeteria. The system was installed in September 2011 by ANTHC and the savings are reflected in this report. The heat recovery system is shown as a retrofit in this report to illustrate the savings that have been received.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy in rural Alaska affordable. The city of Allakaket is allocated 111,720 KWH annually among community buildings to be eligible for the subsidy. Of this total allocation, 26,340 KWH of PCE eligible KWH was distributed within the community with none of it being used for the Allakaket Water Treatment Plant & Washeteria. Use of the PCE subsidy for the electricity needs of the Allakaket Water Treatment Plant & Washeteria would produce approximately $16,800 per year in additional savings after the findings of this report are implemented. Please note the ANTHC would be glad to work with the community to do what is necessary to obtain the PCE subsidy for the water plant.

The table below lists the total usage of electricity, #1 oil, and recovered heat 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	74,616 KWH	27,855 KWH
#1 Oil	3,142 gallons	776 gallons
Heat Recovery	0.00 million Btu	282.76 million Btu

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	290.6	17.48	$38.37
With Proposed Retrofits	208.5	12.54	$13.12
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 Allakaket 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	Other Electrical - Heat Tape Meter 2	Shut off heat tape and use only for emergency purposes.	$12,720	$2,100	51.01	0.2	35,729.9
2	Other Electrical - Heat Tape Meter 1	Shut off heat tape and use only for emergency purposes.	$24,201	$4,200	48.52	0.2	67,980.1
3	Other Electrical - Controls Retrofit: Lift Station Heat	Lower lift station electric heater set point from 55 to 45 degrees.	$943	$1,000	7.94	1.1	2,649.4
4	Lighting - Power Retrofit: Exterior	Replace with energy-efficient LED lighting.	$650 + $80 Maint.	$1,200	5.13	1.6	1,827.1
5	Heating – Temperature Set Point: Water Tank	Lower the water storage tank temperature setting from 50 to 45 degrees	$403	$1,000	3.74	2.5	1,215.2
6	Lighting - Power Retrofit: Rest Rooms	Replace with energy-efficient LED lighting.	$210 + $30 Maint.	$680	2.94	2.8	584.5
7	Lighting - Power Retrofit: Washeteria	Replace with energy-efficient LED lighting.	$744 + $108 Maint.	$2,450	2.89	2.9	2,066.0
8	Heating – Temperature Set Point: Valve Box	Lower the valve box temperature setting from 60 to 50 degrees.	$245	$1,000	2.28	4.1	738.7
9	Window/Skylight: Windows 2 panes not south	Remove existing glass and install triple-paned windows.	$40	$449	1.54	11.1	121.1
10	Heating, Ventilation and Domestic Hot Water (DHW)	Add a heat recovery system and optimize existing Tekmar boiler control system.	$16,196 + $200 Maint.	$200,000	1.42	12.2	32,552.4
11	Lighting - Power Retrofit: Water Treatment Plant	Replace with energy-efficient LED lighting.	$771 + $300 Maint.	$6,800	1.33	6.4	2,074.4
12	Heating, Ventilation and Domestic Hot Water (DHW)	Add VFDs to Sewer Glycol Pumps	$1,032 + $200 Maint.	$11,000	1.32	8.9	2,878.9
13	Lighting - Power Retrofit: Dryer Plenum	Replace with energy-efficient LED lighting.	$21 + $24 Maint.	$550	0.69	12.4	55.2
	TOTAL, all measures		**$58,177 + $942 Maint.**	**$232,429**	**2.79**	**3.9**	**150,472.7**

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 $58,177 per year, or 65.8% of the buildings' total energy costs. These measures are estimated to cost $232,429, for an overall simple payback period of 3.9 years. Please note that the savings listed here to not include the additional $16,800 per year that can be realized by getting the PCE subsidy the facility is eligible for.

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**	**Tank Heat**	**Other**	**Total Cost**
Existing Building	$6,822	$2,346	$8,756	$7,534	$53,104	$5,403	$4,440	**$88,405**
With Proposed Retrofits	$2,952	$599	$3,150	$4,933	$15,240	$1,713	$1,642	**$30,228**
Savings	$3,871	$1,747	$5,607	$2,601	$37,864	$3,690	$2,798	**$58,177**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Allakaket Water Treatment Plant & Washeteria. The scope of this project included evaluating building shell, lighting and other electrical systems, 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
- Water consumption, treatment & disposal

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

Details collected from the Allakaket 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.

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

1) Washeteria: 866 square feet
2) Water Treatment Plant: 1,438 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. Allakaket Water Treatment Plant & Washeteria

3.1. Building Description

The 2,304 square foot Allakaket Water Treatment Plant & Washeteria was constructed in 2005, with a normal occupancy of the operator and any washeteria customers. The number of hours of operation for this building average 5.3 hours per day, considering all seven days of the week.

The Allakaket Water Treatment Plant & Washeteria serves as the water gathering point for the residents of the community and as a location for laundromat and shower services. There is one watering point with a 3/4" pipe that provides treated water for community pickup. There are 4 washers and 4 dryers in the washeteria.

Water is pumped into the water treatment from the raw water intake that draws water from a nearby river. The water is pumped through two pressure filters before receiving an addition of chlorine and entering the 100,000 gallon water storage tank. Pressure pumps are used to keep the pressure up for use in the washeteria and showers. The facility has a single watering point that is used by the residents to collect their own water supply. The rest of the water is used in the washing machines and restrooms.

Description of Building Shell

The exterior walls are constructed with single stud 2X6 construction and plywood sheathing. There is approximately 5.5 inches of polyurethane insulation in slightly damaged condition. There is approximately 2240 square feet of wall space.

The roof of the building has a cathedral ceiling with a total of approximately 2415 square feet of roof space. The roof is constructed with standard framing and 24" spacing with 5.5 inches of polyurethane insulation. The roof is in good condition with little damage.

The building is built on pilings with approximately 12 inches of clearance between the pad and the ground. The floor is framed with standard lumber and has 11.5 inches of polyurethane insulation. There is approximately 2304 square feet of floor space.

There are a total of nine windows in the Allakaket Water Treatment Plant & Washeteria. Two windows are double-paned with wood framing and have a total of 11 square feet of window space. These windows are not facing south and do not effectively capture heat from the sun. Four windows are triple-paned with wood framing and have a total of 22 square feet of window space. These windows are not facing south and do not effectively capture heat from the sun. Three windows are triple-paned with wood framing and have a total of 17 square feet. These windows are facing south and do capture some heat from the sun during daylight hours.

There are two exterior doors in the building with one entering the washeteria side of the building and one entering the water treatment plant side of the building. Both doors are metal with an insulated core and combine to have a total of 42 square feet of door space.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler # 1

Nameplate Information:	Weil McLain Series 80 model 580
Fuel Type:	#1 Oil
Input Rating:	595,000 BTU/hr
Steady State Efficiency:	86 %
Idle Loss:	0.75 %
Heat Distribution Type:	Glycol
Boiler Operation:	Dec - Feb

Boiler # 2

Nameplate Information:	Weil McLean Series 80 model 580
Fuel Type:	#1 Oil
Input Rating:	595,000 BTU/hr
Steady State Efficiency:	86 %
Idle Loss:	0.75 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Space Heating Distribution Systems

There are three unit heaters and one cabinet heater present in the water treatment plant and washeteria building. Two unit heaters are present in the main room of the water treatment plant and produce approximately 16,654 BTU/hr. One unit heater is in the dryer plenum and produces approximately 225,000 BTU/hr. There is a cabinet heater in the washeteria side of the building that produces approximately 76,000 BTU/hr.

Heat Recovery Information

There is a heat recovery system in the water treatment plant that provides heat from the local power plant for water heating and hydronic heat purposes. The system extracts heat from the cooling loops of the power plant generators through a glycol line and transports the heated glycol line to transfer the heat to the water treatment plant through a heat exchanger. The system produces an average of approximately 400,000 BTU/hr.

Lighting

The washeteria has 12 fixtures with three T8 fluorescent light bulbs in each fixture.

The water treatment plant has 25 fixtures with four T8 fluorescent light bulbs in each fixture.

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

The rest rooms have five fixtures with two T8 fluorescent light bulbs in each fixture.

The exterior has four fixtures with a metal halide 70 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 are two electric meters that power the panels that control two heat tape lines. One heat tape line is used to heat the sewer line that runs from the lift station to the lagoon. The other heat tape line is used to heat the water intake line from the well point meter to the washeteria. The first panel controls part of the water intake and sewer line heat tapes and has an annual consumption of approximately 27,192 KWH. The second panel controls the remainder of the water intake and sewer line heat tapes and has an annual consumption of approximately 14,292 KWH.

There is a heat tape line that heats the sewage that is transported from the washeteria to the lift station. The heat tape uses approximately 1,364 KWH annually.

The lift station has an electric heater that is used to keep the pumps and sewage from freezing. The electric heater uses approximately 6,359 KWH annually.

There is a pump in the lift station that pumps the sewage through the sewer line to the sewage lagoon. The pump uses approximately 471 KWH annually.

There are four electric washers in the washeteria that are used for community laundry services. The four washers combine to use approximately 789 KWH annually.

There is a heat tape line that is used to heat the raw water from the well to the well point meter. The heat tape uses approximately 144 KWH annually.

There is a well pump that pumps water from the well to the water treatment plant when the plant is making water. The pump uses approximately 417 KWH annually.

There is a backwash pump that is used to backwash the water treatment system when treating water. This pump uses 578 KWH annually.

There are pressure pumps that are used to pressurize the system. The pressure pumps use approximately 283 KWH annually.

There is a pump for the heat recovery system within the power plant that pumps the heated glycol from the power plant to the water treatment plant. This pump uses approximately 4,821 KWH annually.

There is a pump for the heat recovery system in the water treatment plant that pumps the cooled glycol from the water treatment plant to the power plant. The pump uses approximately 1,994 KWH annually.

There are ventilation fans in each of the four restrooms that use approximately 59 KWH annually.

There is a variety of controls and equipment that is used for general operation of the water treatment plant and washeteria. The controls and equipment combine to use approximately 658 KWH annually.

There is some office equipment as well as a TV and microwave in the water treatment plant office that combine to use approximately 247 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 following is a list of the utility companies providing energy to the building and the class of service provided:

Electricity: Allakaket - APT - Commercial - Sm

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	$ 0.89/KWH
#1 Oil	$ 7.00/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Allakaket Village pays approximately $88,405 annually for electricity and other fuel costs for the Allakaket 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

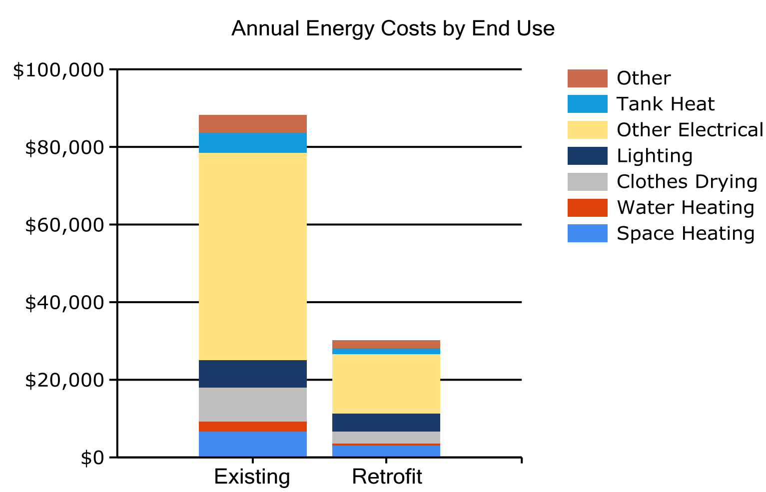


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

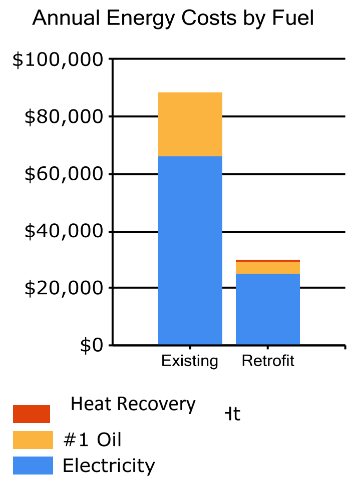
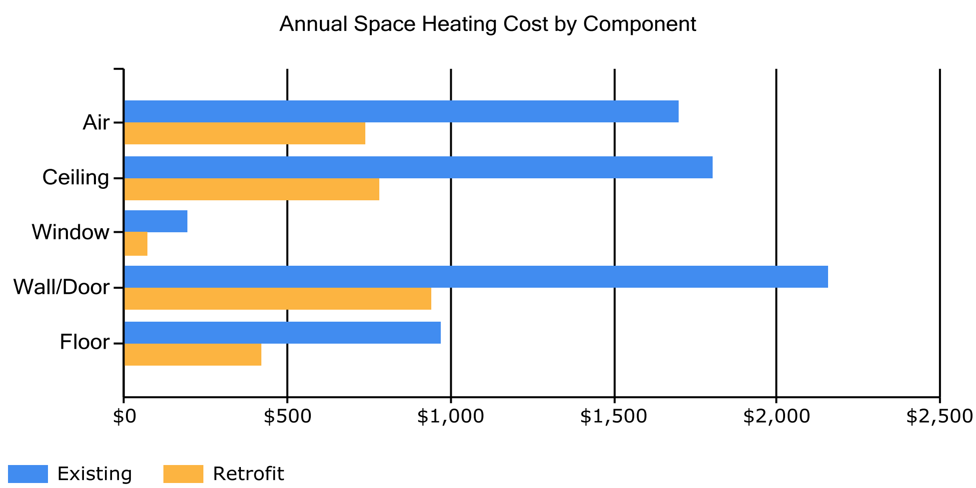


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	252	211	201	143	101	92	95	99	112	159	209	250
DHW	2	2	2	2	2	2	2	2	2	2	2	2
Clothes_Drying	123	112	123	119	123	119	123	123	119	123	119	123
Lighting	753	686	753	729	753	614	634	634	675	753	729	753
Other_Electrical	5079	7572	9975	11181	12864	4293	840	840	813	1386	2277	2547
Tank_Heat	86	78	84	79	79	0	0	0	77	82	82	86
Other	299	273	299	290	146	2	2	2	155	299	290	299

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	161	110	92	41	0	0	0	0	10	53	103	159
DHW	27	25	27	27	30	29	30	30	28	28	26	27
Clothes_Drying	86	79	87	87	95	93	96	96	90	89	84	86
Tank_Heat	116	98	92	58	13	2	1	4	25	61	94	115
Other	27	25	27	27	30	29	30	30	28	28	26	27

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
Allakaket 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	74,616 KWH	254,664	3.340	850,578
#1 Oil	3,142 gallons	414,791	1.010	418,939
Total		**669,455**		**1,269,517**
BUILDING AREA		2,304	Square Feet	
BUILDING SITE EUI		291	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		551	**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	**290.6**	**17.48**	**$38.37**
With Proposed Retrofits	**208.5**	**12.54**	**$13.12**
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 system 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 Allakaket Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Allakaket 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. Equipment cost estimate calculations are provided in Appendix D.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Allakaket. 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
Allakaket Water Treatment Plant & Washeteria, Allakaket, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Other Electrical - Heat Tape Meter 2	Shut off heat tape and use only for emergency purposes.	$12,720	$2,100	51.01	0.2	35,729.9
2	Other Electrical - Heat Tape Meter 1	Shut off heat tape and use only for emergency purposes.	$24,201	$4,200	48.52	0.2	67,980.1
3	Other Electrical - Controls Retrofit: Lift Station Heat	Lower lift station electric heater set point from 55 to 45 degrees.	$943	$1,000	7.94	1.1	2,649.4
4	Lighting - Power Retrofit: Exterior	Replace with energy-efficient LED lighting.	$650 + $80 Maint.	$1,200	5.13	1.6	1,827.1
5	Heating – Temperature Set Point: Water Tank	Lower the water storage tank temperature setting from 50 to 45 degrees	$403	$1,000	3.74	2.5	1,215.2
6	Lighting - Power Retrofit: Rest Rooms	Replace with energy-efficient LED lighting.	$210 + $30 Maint.	$680	2.94	2.8	584.5

Table 4.1 Allakaket Water Treatment Plant & Washeteria, Allakaket, 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**
7	Lighting - Power Retrofit: Washeteria	Replace with energy-efficient LED lighting.	$744 + $108 Maint.	$2,450	2.89	2.9	2,066.0
8	Heating – Temperature Set Point: Valve Box	Lower the valve box temperature setting from 60 to 50 degrees.	$245	$1,000	2.28	4.1	738.7
9	Window/Skylight: Windows 2 panes not south	Remove existing glass and install triple-paned windows.	$40	$449	1.54	11.1	121.1
10	Heating, Ventilation and Domestic Hot Water (DHW)	Add a heat recovery system and optimize existing Tekmar boiler control system.	$16,196 + $200 Maint.	$200,000	1.42	12.2	32,552.4
11	Lighting - Power Retrofit: Water Treatment Plant	Replace with energy-efficient LED lighting.	$771 + $300 Maint.	$6,800	1.33	6.4	2,074.4
12	Heating, Ventilation and Domestic Hot Water (DHW)	Add VFDs to Sewer Glycol Pumps	$1,032 + $200 Maint.	$11,000	1.32	8.9	2,878.9
13	Lighting - Power Retrofit: Dryer Plenum	Replace with energy-efficient LED lighting.	$21 + $24 Maint.	$550	0.69	12.4	55.2
	TOTAL, all measures		**$58,177 + $942 Maint.**	**$232,429**	**2.79**	**3.9**	**150,472.7**

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

4.3.2 Window Measures

Rank	Location	Size/Type, Condition	Recommendation
9	Window/Skylight: Windows 2 panes not south	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Remove existing glass and install triple-paned windows.

Installation Cost	$449	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$40
Breakeven Cost	$690	**Savings-to-Investment Ratio**	1.5	**Simple Payback yrs**	11

Auditors Notes: Remove existing glass and install triple-paned windows with low-E argon gas between the panes.

4.4 Mechanical Equipment Measures

4.4.1 Heating/Domestic Hot Water Measure

Rank	Recommendation
10	Add a heat recovery system and optimize existing Tekmar boiler control system.

Installation Cost	$200,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$16,196
				Maintenance Savings (/yr)	$200
Breakeven Cost	$284,691	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	12

Auditors Notes: The heat recovery system will use excess heat from the generator cooling loop in the power plant to heat the hydronic heating loop in the water treatment plant.

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	
4	Exterior	4 MH 70 Watt StdElectronic with Manual Switching			Replace with energy-efficient LED lighting.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	10		**Energy Savings (/yr)**	$650
					Maintenance Savings (/yr)	$80
Breakeven Cost	$6,160	**Savings-to-Investment Ratio**	5.1		**Simple Payback yrs**	2

Auditors Notes: Replace the existing fluorescent lighting with energy-efficient LED lighting. This involves removing the magnetic light bulb and existing wall pack and replacing it with an LED wall pack. Maintenance savings is due to longer bulb life.

Rank	Location	Existing Condition			Recommendation	
6	Rest Rooms	5 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy-efficient LED lighting.	
Installation Cost	$680	**Estimated Life of Measure (yrs)**	10		**Energy Savings (/yr)**	$210
					Maintenance Savings (/yr)	$30
Breakeven Cost	$2,000	**Savings-to-Investment Ratio**	2.9		**Simple Payback yrs**	3

Auditors Notes: Replace the existing fluorescent lighting with energy-efficient LED lighting. This involves removing the T8 light bulbs and existing ballasts and replacing them with four 17 Watt LED light bulbs per fixture. Maintenance savings is due to longer bulb life.

Rank	Location	Existing Condition			Recommendation	
7	Washeteria	12 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy-efficient LED lighting.	
Installation Cost	$2,450	**Estimated Life of Measure (yrs)**	10		**Energy Savings (/yr)**	$744
					Maintenance Savings (/yr)	$108
Breakeven Cost	$7,086	**Savings-to-Investment Ratio**	2.9		**Simple Payback yrs**	3

Auditors Notes: Replace the existing fluorescent lighting with energy-efficient LED lighting. This involves removing the T8 light bulbs and existing ballasts and replacing them with four 17 Watt LED light bulbs per fixture. Maintenance savings is due to longer bulb life.

Rank	Location	Existing Condition			Recommendation	
11	Water Treatment Plant	25 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy-efficient LED lighting.	
Installation Cost	$6,800	**Estimated Life of Measure (yrs)**	10		**Energy Savings (/yr)**	$771
					Maintenance Savings (/yr)	$300
Breakeven Cost	$9,030	**Savings-to-Investment Ratio**	1.3		**Simple Payback yrs**	6

Auditors Notes: Replace the existing fluorescent lighting with energy-efficient LED lighting. This involves removing the T8 light bulbs and existing ballasts and replacing them with four 17 Watt LED light bulbs per fixture. Maintenance savings is due to longer bulb life.

Rank	Location	Existing Condition		Recommendation	
13	Dryer Plenum	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy-efficient LED lighting.	
Installation Cost	$550	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$21
				Maintenance Savings (/yr)	$24
Breakeven Cost	$377	**Savings-to-Investment Ratio**	0.7	**Simple Payback yrs**	12
Auditors Notes: Replace the existing fluorescent lighting with energy-efficient LED lighting. This involves removing the T8 light bulbs and existing ballasts and replacing them with four 17 Watt LED light bulbs per fixture. Maintenance savings is due to longer bulb life.					

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Heat Tape Meter 2	Sewer line heat tape runs during the winter and water line heat tape runs through the summer.		Turn off heat tapes and use glycol heat add system.	
Installation Cost	$2,100	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$12,720
Breakeven Cost	$107,115	**Savings-to-Investment Ratio**	51.0	**Simple Payback yrs**	0
Auditors Notes: Repair sewer line glycol pumps and associated heat add system. Shut off the heat tape and use it only for emergency purposes.					

4.5.3 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Heat Tape Meter 1	Sewer line heat tape runs during the winter and water line heat tape runs through the summer.		Turn off heat tapes and use glycol heat add system.	
Installation Cost	$4,200	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$24,201
Breakeven Cost	$203,799	**Savings-to-Investment Ratio**	48.5	**Simple Payback yrs**	0
Auditors Notes: Repair sewer line glycol pumps and associated heat add system. Shut off the heat tape and use it only for emergency purposes.					

Rank	Location	Description of Existing		Efficiency Recommendation	
3	Lift Station Heat	Lift Station Electric Heat with Manual Switching		Lower the lift station temperature setting from 55 to 45 degrees.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$943
Breakeven Cost	$7,943	**Savings-to-Investment Ratio**	7.9	**Simple Payback yrs**	1
Auditors Notes: Lower lift station electric heater set point from 55 to 45 degrees.					

4.5.6 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Water Storage Tank	Tank Heat Add		Lower the water storage tank temperature setting from 50 to 45 degrees	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$403
Breakeven Cost	$3,744	**Savings-to-Investment Ratio**	3.7	**Simple Payback yrs**	2
Auditors Notes: Lower the water storage tank temperature setting from 50 to 45 degrees					

Rank	Location	Description of Existing		Efficiency Recommendation	
8		Tank Annex Heat Load		Lower the valve box temperature setting from 60 to 50 degrees.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$245
Breakeven Cost	$2,276	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	4
Auditors Notes: The valve box is located outside of the water treatment plant building and requires a lot of heat to keep from freezing.					

Rank	Location	Description of Existing		Efficiency Recommendation	
12		Glycol Heat for Sewer Main		Add VFDs to Sewer Glycol Pumps	
Installation Cost	$11,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,032
				Maintenance Savings (/yr)	$200
Breakeven Cost	$14,499	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: VFD pumps would allow the pumps to vary the flow rate according to the conditions and reduce electric load when it is not required.					

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 Allakaket 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: Allakaket Water Treatment Plant & Washeteria	**Auditor Company:** ANTHC-DEHE
Address: P O Box 50	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Allakaket	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Floyd Saunders	
Client Address: P O Box 50 Allakaket, AK 99720	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 968-2398	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 2,304 square feet	**Design Space Heating Load:** Design Loss at Space: 0 Btu/hour with Distribution Losses: 0 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 0 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: Allakaket	**Design Outdoor Temperature:** -45 deg F
Weather/Fuel City: Allakaket	**Heating Degree Days:** 16,625 deg F-days
Utility Information	
Electric Utility: Allakaket - APT - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/KWH: $0.890/KWH	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Tank Heat**	**Other**	**Total Cost**
Existing Building	$6,822	$2,346	$8,756	$7,534	$53,104	$5,403	$4,440	**$88,405**
With Proposed Retrofits	$2,952	$599	$3,150	$4,933	$15,240	$1,713	$1,642	**$30,228**
Savings	$3,871	$1,747	$5,607	$2,601	$37,864	$3,690	$2,798	**$58,177**

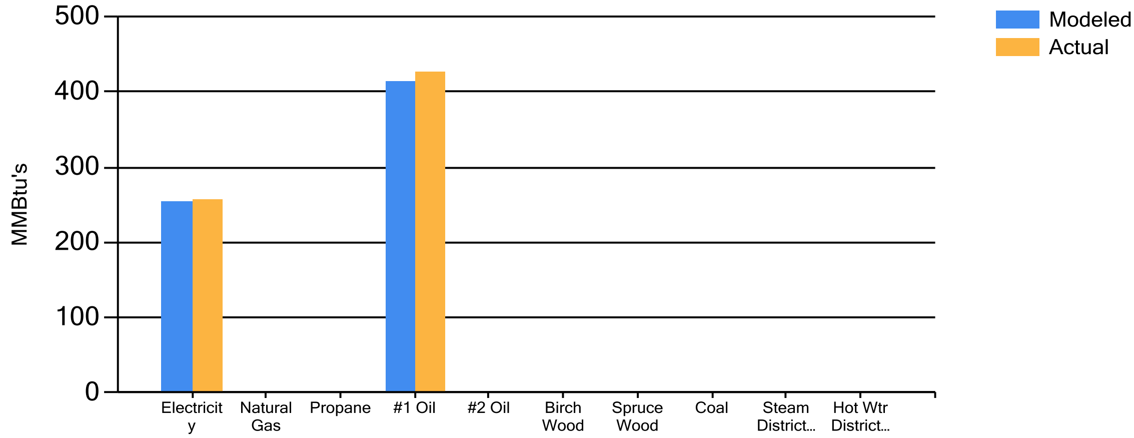
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	290.6	17.48	$38.37
With Proposed Retrofits	208.5	12.54	$13.12

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.

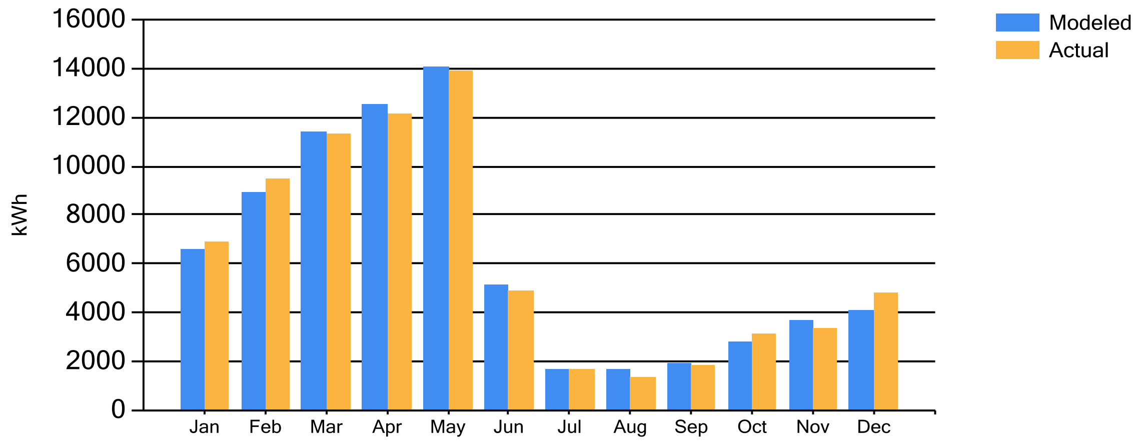
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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