Comprehensive Energy Audit
For
Buckland Washeteria

Prepared For

City of Buckland

May 12, 2017

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Table of Contents

PREFACE

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

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Buckland, Alaska. The author of this report is Bailey Gamble, Mechanical Engineer I.

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 2017 by the Rural Energy Initiative 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 Rural Energy Initiative gratefully acknowledges the assistance of Water Plant Operators Erik Weber and Evan Thomas, Jr., City of Buckland Mayor Tim Gavin, City Administrator Cheryl Ticket and Village Safe Water Engineer Debra Addie.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Buckland. The scope of the audit focused on Buckland Washeteria. The water treatment plant, pump house and lift stations are assessed in a separate report. 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.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $10,804 per year. Electricity represents the largest portion with an annual cost of approximately $9,004. This includes about $5,888 paid by the village and about $3,116 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel represents the remaining portion, with an annual cost of approximately $1,797. Recovered heat from the nearby power plant contributes to the heating demand in the washeteria and is currently provided free of charge.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Buckland, the current cost of electricity without PCE is $0.47/kWh and the cost of electricity with PCE is around $0.31/kWh, saving the village over $3,100 a year on electricity for the washeteria.

Table 1.1 lists the total usage of electricity, #1 heating oil and recovered heat in the Buckland water treatment plant, pump house and lift stations before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Washeteria

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	18,993 kWh	14,032 kWh
#1 Oil	264 gallons	171 gallons
Recovered Heat	296.21 million Btu	252.04 million Btu

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 lists several benchmarks for the audited building. More details can be found in section 3.2.2.

Table 1.2: Building Benchmarks for the Washeteria

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	206.0	12.51	$5.62
With Proposed Retrofits	167.8	10.19	$4.07
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

Table 1.3 below summarizes the energy efficiency measures analyzed for the Buckland Washeteria. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Treated Water Storage Tank Heat Add	Remove this heat add system and heat treated water storage tank through the associated heat add system the water treatment plant.	$418 / 13.7 MMBTU	$200	24.56	0.5	2,120.7
2	Lighting - Power Retrofit: Arctic Entry Lighting	Replace with energy efficient LED lighting.	$69 / 0.2 MMBTU	$25	23.38	0.4	230.3
3	Other Electrical - Controls Retrofit: Service Line Heat Tape	Run manually controlled heat tape only for freeze-up recovery or when temperatures drop below -20°F.	$326 / 0.1 MMBTU	$200	13.71	0.6	1,038.1
4	Other Electrical - Controls Retrofit: Sewer Line Heat Tape	Run manually controlled heat tape only for freeze-up recovery or when temperatures drop below -20°F.	$256 / 1.8 MMBTU	$200	10.76	0.8	916.4
5	Setback Thermostat: Buckland Washeteria	Implement a heating setback to 60°F during times when the washeteria is unoccupied. Heating system recommendations must also be implemented in order to implement setback.	$180 / 27.8 MMBTU	$500	4.23	2.8	2,180.4
6	Other Electrical - Controls Retrofit: Sewer Arctic Box Heat Tape	Run manually controlled heat tape only for freeze-up recovery or when temperatures drop below -20°F.	$81 / 0.0 MMBTU	$200	3.43	2.5	260.7
7	Lighting - Combined Retrofit: Bathroom Lighting (Incan)	Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	$175 / 0.5 MMBTU	$450	3.28	2.6	585.7

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
8	Lighting - Combined Retrofit: Exterior	Replace with energy efficient LED fixture with built in daylight sensor.	$252 / 1.8 MMBTU	$700	3.03	2.8	903.5
9	Bathroom Ventilation	Integrate vent fans into occupancy sensor light controls to reduce time on.	$33 / 0.2 MMBTU	$200	1.91	6.1	113.4
10	Heating System	Insulate pipes on hydronic system, improve controls to reduce uncontrolled heat output, clean and tune boilers, provide operator training on boiler operation and maintenance.	$653 / 15.4 MMBTU	$8,000	1.42	12.2	2,207.9
11	Lighting - Combined Retrofit: Bathroom Lighting (Flour)	Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	$81 / 0.2 MMBTU	$560	1.21	6.9	268.6
12	Lighting - Combined Retrofit: Washroom Lighting	Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	$113 / 0.4 MMBTU	$900	1.06	7.9	381.2
13	Other Electrical - Controls Retrofit: Dryer Line Circ Pump	Wire circ pumps on dryer lines to run only when dryers are in operation.	$120 / 0.4 MMBTU	$1,000	1.01	8.3	405.0
14	Lighting - Combined Retrofit: Office Lighting	Replace with energy efficient LED lighting.	$19 / 0.1 MMBTU	$160	1.00	8.4	63.7
15	Air Tightening	Perform air sealing on doors, unused drains and vents to reduce air leakage by 10%.	$55 / 8.5 MMBTU	$500	0.93	9.0	669.8
16	Lighting - Combined Retrofit: Former Mechanical Room Lighting (2 bulb)	Replace with energy efficient LED lighting and install and occupancy sensor.	$39 / 0.1 MMBTU	$410	0.81	10.4	132.0
17	Lighting - Combined Retrofit: Former Mechanical Room Lighting (4 bulb)	Replace with energy efficient LED lighting and install and occupancy sensor.	$83 / 0.3 MMBTU	$890	0.79	10.7	279.1

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
18	Lighting - Power Retrofit: Boiler Room Lighting	Replace with energy efficient LED lighting.	$19 / 0.1 MMBTU	$240	0.67	12.5	64.4
19	Lighting - Power Retrofit: Tank Plenum Lighting	Replace with energy efficient LED lighting.	$1 / 0.0 MMBTU	$25	0.43	19.5	4.3
20	Lighting - Power Retrofit: Watering Point Closet Lighting	Replace with energy efficient LED lighting.	$1 / 0.0 MMBTU	$25	0.43	19.5	4.3
21	Window/Skylight: East Facing Window (Partially Broken)	Replace with energy efficient, triple pane window.	$5 / 0.8 MMBTU	$1,164	0.07	214.9	65.9
22	Window/Skylight: East Facing Windows	Replace with energy efficient, triple pane window.	$3 / 0.5 MMBTU	$2,328	0.02	678.9	41.8
23	Window/Skylight: South Facing Windows	Replace with energy efficient, triple pane window.	$3 / 0.4 MMBTU	$2,328	0.02	891.9	31.3
	TOTAL, all measures		**$2,988 / 73.4 MMBTU**	**$21,206**	**1.56**	**7.1**	**12,968.4**

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 $2,988 per year, or 27.7% of the buildings' total energy costs. These measures are estimated to cost $21,206, for an overall simple payback period of 7.1 years.

Table 1.4 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 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Tank Heat**	**Total Cost**
Existing Building	$3,549	$906	$44	$1,402	$1,408	$3,076	$420	**$10,804**
With Proposed Retrofits	$3,325	$526	$11	$953	$538	$2,271	$193	**$7,817**
Savings	$224	$380	$33	$449	$871	$805	$227	**$2,988**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Buckland 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 treatment process and distribution

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 Buckland 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. The Buckland Washeteria is classified as being made up of a single 1,922 square foot activity area.

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. BUCKLAND WASHETERIA

3.1. Building Description

The 1,922 square foot building that houses the Buckland Washeteria was constructed in 1975. The building originally served as the water treatment plant for the community until the new plant was constructed and went online in 2016. The washeteria offers laundromat and shower service, as well as a watering point to village residents. Hours of operation are 8:00 am to 5:00 pm Monday through Saturday. The average occupancy is two people. Use of the washeteria has declined over time as most homes have been connected to the piped water system, however, the facility still sees enough use that the community feels it is worthwhile to keep it operating and available to residents.

A heat recovery system delivers heat captured from the generators at the neighboring power plant to meet the washeteria heating demand. Two boilers serve as back-up, but were not observed to fire during the course of the audit visit.

The washeteria laundry room contains four front loading washers and four hydronic dryers. The building also contains two bathrooms with toilets and shower stalls, an office space, a boiler room and a mechanical room. The mechanical room that formerly housed water treatment equipment now serves as heated storage.

The 183,000 gallon treated water storage tank is connected to the washeteria on the northwestern side of the building. The water is delivered to the storage tank from the neighboring water treatment plant. Heat is added to the raw water through two heat add systems: one located in the water treatment plant and another in the washeteria.

Figure 1: Aerial view of Buckland Washeteria.

<u>Description of Building Shell</u>

The exterior walls of the washeteria are constructed of single stud 2 x 6 lumber with a 16-inch offset. The walls have approximately 5.5 inches of polyurethane insulation damaged by age. There is approximately 1,920 square feet of wall space in the WTP.

The washeteria has a cathedral ceiling. The roof has standard framing with a 24-inch offset and approximately 6 inches of batt insulation damaged by age. There is approximately 2,020 square feet of roof space in the building.

The washeteria is built on pilings. The floor is insulated with about 6 inches of fiberglass insulation. There is approximately 1,922 square feet of floor space in the building.

The building contains a total of 5 windows. All windows are 3' x 2'8" with double pane glass and wood and vinyl frames. One of the windows on the east facing side of the building has a broken pane. The opening and closing mechanisms on all windows are damaged. The windows do not seal properly.

Figure 2: Broken window in the Buckland Washeteria.

There are two insulated metal exterior doors in the washeteria. The laundry room door measures 3' x 6'8" and has an artic. The storage room door measures 3'6" x 6'8".

Description of Heating Plants

The Heating Plants used in the building are:

Washeteria Boiler 1

Nameplate Information:	Weil McLain Boiler
Fuel Type:	#1 Oil
Input Rating:	480,000 BTU/hr
Steady State Efficiency:	83 %
Idle Loss:	0.8 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Firing Rate:	4.2 gph

Washeteria Boiler 2

Nameplate Information:	Weil McLain Boiler
Fuel Type:	#1 Oil
Input Rating:	480,000 BTU/hr
Steady State Efficiency:	unknown, estimated 75 %
Idle Loss:	0 % (not in use at time of audit)
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Firing Rate:	4.2 gph

Recovered Heat

Fuel Type:	Recovered Heat
Input Rating:	250,000 BTU/hr
Steady State Efficiency:	99 %
Idle Loss:	0 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Figure 3: Boilers in Buckland Washeteria.

The space heating and water heating demand in the washeteria is seasonal, while the dryers call for heat year round. A hydronic heating system distributes heat to the various heating loads throughout the building. A significant portion of the heating system piping lacks insulation.

The majority of the demand for heat is met by a heat recovery system. The washeteria contains two Weil McLain boilers that supplement the heat recovery system if needed. The boilers are plumbed directly into the primary hydronic heating loop. This plumbing configuration results in a constant flow of the primary loop's heated glycol through the boilers, essentially heating them while they are off, resulting in unnecessary heat loss. The stacks on the boilers are oversized. At the time of the audit, Boiler 2 was not operational. Boiler 1 was not observed to fire during the audit because the heat recovery system was meeting the entire heating demand of the building.

Heat is added to the water in the treated water storage tank attached to the washeteria building through two heat add systems – one in the water treatment plant and one in the washeteria. At the time of the audit, the majority of the heat for this load was being contributed by the washeteria heat add system, which was set to heat the treated water to 100°F. Water was observed to be exiting the storage tank at 34°F, then returning at 57°F after passing through the heat add. Although the water in the storage tank is not likely to reach the set point temperature of 100°F, this high setting results in the constant addition of heat.

The single wall heat exchanger present in this heat add system presents a contamination risk. A breach in the wall would result in glycol mixing with the treated water. Double wall heat exchangers are recommended for use when potable water is heated by glycol. There are plans to eliminate this heat add system in the future when the treated water storage tank is replaced. The treated water would then be heated entirely from the water treatment plant side.

The hydronic system supplies heat to a hot water generator that heats water for the washing machine, showers and sinks. A secondary heating loop supplies heat to the four hydronic dryers.

Space Heating System

Space heating in the washeteria is provided through a hydronic unit heater with a 1/20 hp fan in the mechanical room and radiators in the office and bathrooms. Another 1/20 hp fan installed in the ceiling pulls warm air down from the attic to the laundry room. The washeteria boiler and mechanical rooms are excessively warm due to heat radiating from the boilers and the uninsulated pipes in the heating system.

Domestic Hot Water System

Hot water for the washeteria is provided by the original 1970s-era, 36 inch diameter, 325 gallon hot water generator.

Figure 4: Heat recovery system heat exchanger in washeteria boiler room.

Heat Recovery Information

A heat recovery system provides heat captured from the diesel generators at the Buckland power plant to a district heating loop that supplies the washeteria, WTP and city office. Heat is transferred from the district loop to the main washeteria heating loop via a heat exchanger in the washeteria boiler room. Figure 4 shows the heat recovery system heat exchanger. Adding insulation around the heat exchanger and associated pipes would reduce unnecessary heat loss.

Description of Building Ventilation System

Ventilation in the building is achieved through an open, circular vent in the wall in the boiler room. The air make up vents have been covered by plastic and cardboard, but some air exchange still occurs there as well. Bathroom vent fans move air from the bathroom up to the attic.

Lighting

There are a total of 25 light fixtures containing 53 bulbs in the washeteria. The majority of fixtures contain 4’ T8 fluorescent bulbs. Lighting in the in the washeteria consumes approximately 2,970 kWh annually constituting about 16% of the building’s current electrical consumption. Table 3.1 shows a breakdown of lighting by bulb type.

Table 3.1: Breakdown of Lighting by Bulb Type

Type of bulb	Total Number of Bulbs	Location(s)
32 W4’ T8 fluorescent	46	Mechanic
100 W high pressure sodium	2	WTP exterior
15 W compact fluorescent	2	Pump house and lift station exterior
100 W incandescent	3	Lift station wet well extension lights

Major Equipment

Tables 3.2 contains the details on each of the major electricity consuming mechanical components found in the washeteria. Major equipment consumes approximately 9,946 kWh annually constituting about 52% of the building’s current electrical consumption.

Table 3.2: Major Equipment List

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Recovered Heat Circ Pump	Circulated heated glycol from power plant through washeteria heat exchanger	0.38 HP	Always on	2,498
Main hydronic heating line circ pump x 2	Circulate heated glycol in the main building heating loop	0.25 HP	Always on	1,621
Dryer Line Circ Pump x 2	Circulate heated glycol through hydronic dryers	0.25 HP	Washeteria occupied hours: Monday-Friday 8:00 am – 5:00 pm	917
Treated Water Storage Tank	Prevent freezing by circulating water in	0.25 HP	Always on during winter heating season	886

Heat Add Circ Pump x 2	uptown distribution loop			
Service Line Circ Pump	Circulate water in the service line of pressurized water coming from the WTP	0.15 HP	Always on during winter heating season	471
Washing Machine x 4	Wash clothes	1,176 W	Each on for an estimated 2 hours per day.	2,651
Dryers x 4	Dry clothes, two motors on each dryer turn the drum and fan	2 x .25 HP	Each on for an estimated 2 hours per day.	902
			Total Energy Consumption	9,946

<u>Heat Tape</u>

There are five heat tapes associated with the washeteria. Four of them run all winter long. Table 3.3 lists details for each segment. All heat tapes combined consume approximately 2,845 kWh annually constituting about 15% of the building's electrical consumption.

Table 3.3: Heat Tapes Associated with the Water Treatment Plant

Heat Tape Location	Estimated Length (ft)	Annual Energy Consumption
Water Service Line	40	1,198
Sewer In Floor Line	30	898
Sewer Arctic Box	10	300
Sewer Thaw Line	40	0
Watering Point	15	449
	Total Energy Consumption	2,845

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 City of Buckland owns and operates the diesel power plant that provides electricity to the residents of public as well as all commercial and public facilities. Kotzebue Electric Association provides billing support. The power plant supplies heat recovered from the diesel generators to the washeteria, the City Office and the water treatment plant. Two 100 kW wind turbines were installed and integrated into Buckland's power production system in 2015. Two electric boilers, one in the power plant and one in the water treatment plant, are equipped to receive any energy produced by the wind turbines in excess of community demand. The boiler in the power plant adds additional heat to the heat recovery loop and the boiler in the water treatment plant adds additional heat to the raw water in the water treatment plant. The electric boilers were not observed to generating heat during the audit visit.

The average cost for each type of fuel used in this building is shown below in Table 3.4. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.4: Energy Rates by Fuel Type in Buckland

Fuel Type	Average Energy Cost
Electricity	$ 0.4741/kWh
#1 Oil	$ 6.80/gallons
Recovered Heat	$ 0.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Buckland pays approximately $10,804 annually for electricity and other fuel costs for the Buckland Washeteria.

Figure 5 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.

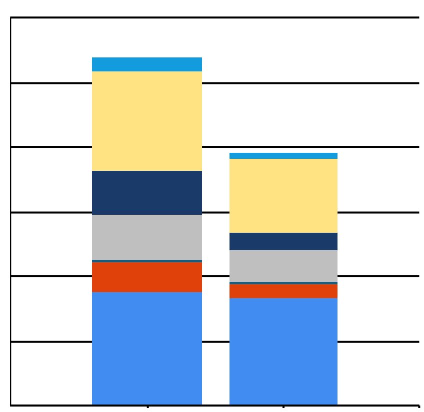


Figure 5: Annual energy costs by end use.

Figure 6 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.

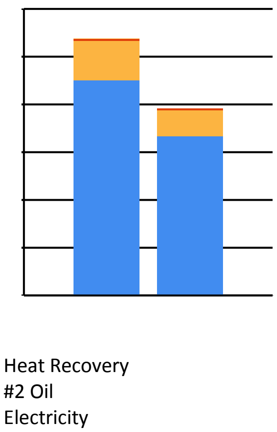


Figure 6: Annual energy costs by fuel type.

Figure 7 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.

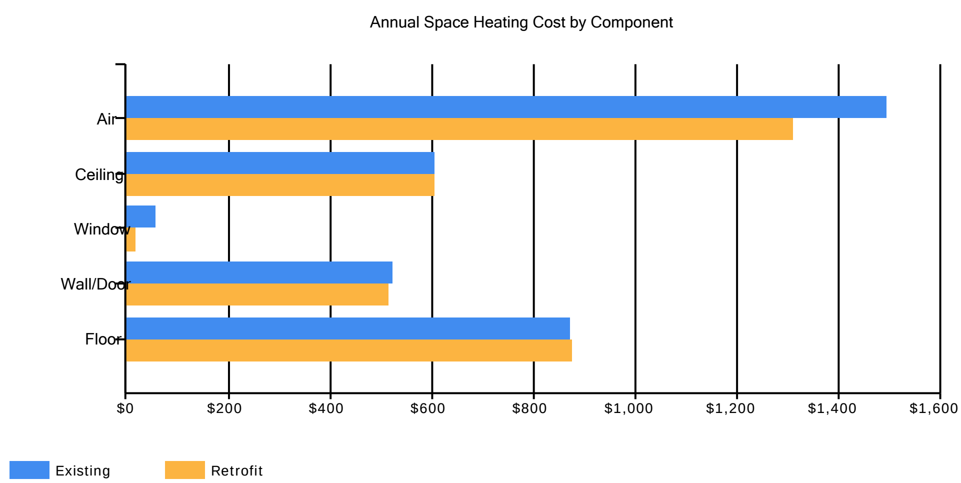


Figure 7: Annual space heating costs by component.

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.

Table 3.5: Electrical Consumption Records by Category

Electrical Consumption (kWh)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	791	728	748	634	545	480	472	472	500	624	697	791
DHW	15	13	15	14	15	14	15	15	14	15	14	15
Ventilation Fans	8	7	8	8	8	8	8	8	8	8	8	8
Clothes Drying	77	70	77	74	77	74	77	77	74	77	74	77
Lighting	259	236	252	244	242	234	241	252	244	259	251	259
Other Electrical	846	771	846	819	455	261	269	269	261	269	577	846
Tank Heat	154	140	154	149	50	0	0	0	0	0	84	154

Table 3.6: Fuel Oil Consumption Records by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	0	0	0	0	0	0	0	0	0	0	0	0
DHW	10	9	10	10	10	10	10	10	10	10	10	10
Clothes Drying	12	11	12	12	12	12	12	12	12	12	12	12
Tank Heat	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.7: Recovered Heat Consumption Records by Category

Recovered Heat Consumption (Million Btu)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	24	23	21	14	7	4	2	2	5	13	19	24
DHW	4	4	4	4	4	4	4	4	4	4	4	4
Clothes Drying	5	4	5	5	5	5	5	5	5	5	5	5
Tank Heat	7	7	7	5	1	0	0	0	0	0	3	7

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):

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

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

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

Table 3.8: Buckland 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	18,993 kWh	64,823	3.340	216,507
#1 Oil	264 gallons	34,877	1.010	35,226
Recovered Heat	296.21 million Btu	296,210	1.280	379,149
Total		**395,910**		**630,882**
BUILDING AREA		1,922	Square Feet	
BUILDING SITE EUI		206	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		328	**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 3.9: Buckland Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	206.0	12.51	$5.62
With Proposed Retrofits	167.8	10.19	$4.07
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The HVAC 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 Buckland Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Buckland 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 Buckland. 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 energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Treated Water Storage Tank Heat Add	Remove this heat add system and heat treated water storage tank through the associated heat add system the water treatment plant.	$418 / 13.7 MMBTU	$200	24.56	0.5	2,120.7
2	Lighting - Power Retrofit: Arctic Entry Lighting	Replace with energy efficient LED lighting.	$69 / 0.2 MMBTU	$25	23.38	0.4	230.3
3	Other Electrical - Controls Retrofit: Service Line Heat Tape	Run manually controlled heat tape only for freeze-up recovery or when temperatures drop below -20°F.	$326 / 0.1 MMBTU	$200	13.71	0.6	1,038.1
4	Other Electrical - Controls Retrofit: Sewer Line Heat Tape	Run manually controlled heat tape only for freeze-up recovery or when temperatures drop below -20°F.	$256 / 1.8 MMBTU	$200	10.76	0.8	916.4
5	Setback Thermostat: Buckland Washeteria	Implement a heating setback to 60°F during times when the washeteria is unoccupied. Heating system recommendations must also be implemented in order to implement setback.	$180 / 27.8 MMBTU	$500	4.23	2.8	2,180.4
6	Other Electrical - Controls Retrofit: Sewer Arctic Box Heat Tape	Run manually controlled heat tape only for freeze-up recovery or when temperatures drop below -20°F.	$81 / 0.0 MMBTU	$200	3.43	2.5	260.7
7	Lighting - Combined Retrofit: Bathroom Lighting (Incan)	Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	$175 / 0.5 MMBTU	$450	3.28	2.6	585.7

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
8	Lighting - Combined Retrofit: Exterior	Replace with energy efficient LED fixture with built in daylight sensor.	$252 / 1.8 MMBTU	$700	3.03	2.8	903.5
9	Bathroom Ventilation	Integrate vent fans into occupancy sensor light controls to reduce time on.	$33 / 0.2 MMBTU	$200	1.91	6.1	113.4
10	Heating System	Insulate pipes on hydronic system, improve controls to reduce uncontrolled heat output, clean and tune boilers, provide operator training on boiler operation and maintenance.	$653 / 15.4 MMBTU	$8,000	1.42	12.2	2,207.9
11	Lighting - Combined Retrofit: Bathroom Lighting (Flour)	Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	$81 / 0.2 MMBTU	$560	1.21	6.9	268.6
12	Lighting - Combined Retrofit: Washroom Lighting	Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	$113 / 0.4 MMBTU	$900	1.06	7.9	381.2
13	Other Electrical - Controls Retrofit: Dryer Line Circ Pump	Wire circ pumps on dryer lines to run only when dryers are in operation.	$120 / 0.4 MMBTU	$1,000	1.01	8.3	405.0
14	Lighting - Combined Retrofit: Office Lighting	Replace with energy efficient LED lighting.	$19 / 0.1 MMBTU	$160	1.00	8.4	63.7
15	Air Tightening	Perform air sealing on doors, unused drains and vents to reduce air leakage by 10%.	$55 / 8.5 MMBTU	$500	0.93	9.0	669.8
16	Lighting - Combined Retrofit: Former Mechanical Room Lighting (2 bulb)	Replace with energy efficient LED lighting and install and occupancy sensor.	$39 / 0.1 MMBTU	$410	0.81	10.4	132.0
17	Lighting - Combined Retrofit: Former Mechanical Room Lighting (4 bulb)	Replace with energy efficient LED lighting and install and occupancy sensor.	$83 / 0.3 MMBTU	$890	0.79	10.7	279.1

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
18	Lighting - Power Retrofit: Boiler Room Lighting	Replace with energy efficient LED lighting.	$19 / 0.1 MMBTU	$240	0.67	12.5	64.4
19	Lighting - Power Retrofit: Tank Plenum Lighting	Replace with energy efficient LED lighting.	$1 / 0.0 MMBTU	$25	0.43	19.5	4.3
20	Lighting - Power Retrofit: Watering Point Closet Lighting	Replace with energy efficient LED lighting.	$1 / 0.0 MMBTU	$25	0.43	19.5	4.3
21	Window/Skylight: East Facing Window (Partially Broken)	Replace with energy efficient, triple pane window.	$5 / 0.8 MMBTU	$1,164	0.07	214.9	65.9
22	Window/Skylight: East Facing Windows	Replace with energy efficient, triple pane window.	$3 / 0.5 MMBTU	$2,328	0.02	678.9	41.8
23	Window/Skylight: South Facing Windows	Replace with energy efficient, triple pane window.	$3 / 0.4 MMBTU	$2,328	0.02	891.9	31.3
	TOTAL, all measures		**$2,988 / 73.4 MMBTU**	**$21,206**	**1.56**	**7.1**	**12,968.4**

4.2 Interactive Effects of Projects

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

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

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

4.3 Building Shell Measures

4.3.1 Window Measures

Rank	**Location**	**Size/Type, Condition**	**Recommendation**
21	Window/Skylight: East Facing Window (Partially Broken)	Glass: Single, Glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.52	Replace existing window with energy efficient, triple pane window.

Installation Cost	$1,164	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$5
Breakeven Cost	$79	**Simple Payback (yrs)**	215	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	0.1		

Auditors Notes: One of the east-facing washeteria windows has a broken glass pane and open/close mechanism. The window does not seal properly. Replace this 2’8” x 3” window with an energy efficient, triple pane window.

Rank	**Location**	**Size/Type, Condition**	**Recommendation**
22	Window/Skylight: East Facing Windows	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	Replace existing windows with energy efficient, triple pane windows.

Installation Cost	$2,328	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$3
Breakeven Cost	$50	**Simple Payback (yrs)**	679	**Energy Savings (MMBTU/yr)**	0.5 MMBTU
		Savings-to-Investment Ratio	0.0		

Auditors Notes: Two of the east-facing washeteria windows have broken open/close mechanisms and don’t seal properly. Replace these 2’8” x 3’ windows with energy efficient, triple pane windows.

Rank	Location	Size/Type, Condition			Recommendation	
23	Window/Skylight: South Facing Windows	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			Replace existing windows with energy efficient, triple pane windows.	
Installation Cost	$2,328	**Estimated Life of Measure (yrs)**	20		**Energy Savings ($/yr)**	$3
Breakeven Cost	$38	**Simple Payback (yrs)**	892		**Energy Savings (MMBTU/yr)**	0.4 MMBTU
		Savings-to-Investment Ratio	0.0			
Auditors Notes: Auditors Notes: Two of the east-facing washeteria windows have broken open/close mechanisms and don’t seal properly. Replace these 2’8” x 3’ windows with energy efficient, triple pane windows.						

4.3.2 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
15		Air Tightness estimated as: 2883 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 10%.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$55
Breakeven Cost	$466	**Simple Payback (yrs)**	9	**Energy Savings (MMBTU/yr)**	8.5 MMBTU
		Savings-to-Investment Ratio	0.9		
Auditors Notes: Air seal doors, former vents and drains to reduce heat loss and air leakage in the building by an estimated 10%. Close doors to boiler room to isolate outdoor air exchange through air make-up.					

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation				
10	Insulate pipes on hydronic system, improve controls to reduce uncontrolled heat output, valve off unused boiler, clean and tune boilers, provide operator training on boiler operation and maintenance.				
Installation Cost	$8,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$653
Breakeven Cost	$11,332	**Simple Payback (yrs)**	12	**Energy Savings (MMBTU/yr)**	15.4 MMBTU
		Savings-to-Investment Ratio	1.4		

Auditors Notes: The hydronic heating system contains uninsulated pipe that radiates heat resulting in uncontrolled heat output that contributes to excessively high temperatures in the washeteria boiler, mechanical room and attic space. Insulate pipe to reduce heat loss.

Improve heating system controls by installing programmable thermostats in various heating zones to allow for more precise temperature control (mechanical room may be kept cooler than more frequently use laundry room space) and to further reduce heat loss.

One boiler is sufficient to back up the heat recovery system and even meet the entire heating demand of the building in the case that the heat recovery system were to go offline. Valve off the second boiler to reduce flow of glycol and therefore heat loss through this unused boiler. Clean and tune boilers. Provide operators with training on boiler operation, maintenance and troubleshooting.

More efficient, better controlled us of recovered heat in the washeteria will result in more heat being available to the water treatment plant as well, so upgrades to the heating system will result in reduced fuel use in both buildings.

4.4.2 Ventilation System Measures

Rank	Description		Recommendation		
9			Integrate vent fans into occupancy sensor light controls to reduce time on.		
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$33
Breakeven Cost	$382	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	1.9		

Auditors Notes: Install occupancy sensors in both bathrooms to control lights and ventilation fans.

4.4.3 Night Setback Thermostat Measures

Rank	Building Space		Recommendation		
5	Buckland Washeteria		Implement a heating temperature setback in 60°F during times when the washeteria is unoccupied.		
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$180
Breakeven Cost	$2,116	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	27.8 MMBTU
		Savings-to-Investment Ratio	4.2		

Auditors Notes: Programmable thermostats are included in the recommendation to improve controls on the heating system. Program each thermostat to implement a heating temperature setback to 60°F when the washeteria is unoccupied. Train operators in thermostat programming.

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

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

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	**Location**	**Existing Condition**		**Recommendation**	
2	Arctic Entry Lighting	INCAN A Lamp, Std 100W with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$25	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$69
Breakeven Cost	$584	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	23.4		
Auditors Notes: Replace the incandescent bulb in the laundry room arctic entry with its energy efficient LED equivalent.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
7	Bathroom Lighting (Incan)	2 INCAN A Lamp, Std 100W with Manual Switching		Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.	
Installation Cost	$450	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$175
Breakeven Cost	$1,474	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.5 MMBTU
		Savings-to-Investment Ratio	3.3		
Auditors Notes: Replace the incandescent bulbs in the two bathrooms with their energy efficient LED equivalents and install an occupancy sensors to control lighting and ventilation fans.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
8	Exterior	2 HPS 100 Watt StdElectronic with Manual Switching		Replace with LED light fixtures with built in daylight sensors.	
Installation Cost	$700	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$252
Breakeven Cost	$2,122	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	1.8 MMBTU
		Savings-to-Investment Ratio	3.0		
Auditors Notes: Replace the two exterior light fixtures with energy efficient LED light fixtures with built in daylight sensors.					

Rank	Location	Existing Condition			Recommendation
11	Bathroom Lighting (Flour)	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy efficient LED lighting and install occupancy sensor in each of two bathrooms.

Installation Cost	$560	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$81
Breakeven Cost	$679	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	1.2		

Auditors Notes: Replace a total of four 4’ T8 fluorescent bulbs in the two bathrooms with their energy efficient LED equivalents and install an occupancy sensors to control lighting and ventilation fans. Occupancy sensor costs are split between two bathroom light and ventilation recommendations.

Rank	Location	Existing Condition			Recommendation
12	Laundry Room Lighting	5 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy efficient LED lighting and install occupancy sensor.

Installation Cost	$900	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$113
Breakeven Cost	$955	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
		Savings-to-Investment Ratio	1.1		

Auditors Notes: Replace a total of ten 4’ T8 fluorescent bulbs in the laundry room with their energy efficient LED equivalents.

Rank	Location	Existing Condition			Recommendation
14	Office Lighting	FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy efficient LED lighting.

Installation Cost	$160	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$19
Breakeven Cost	$160	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	1.0		

Auditors Notes: Replace a total of four 4’ T8 fluorescent bulbs in the office with their energy efficient LED equivalents.

Rank	Location	Existing Condition			Recommendation
16	Former Mechanical Room Lighting (2 bulb)	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with energy efficient LED lighting and install occupancy sensor.

Installation Cost	$410	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$39
Breakeven Cost	$331	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.8		

Auditors Notes: Replace a total of four 4’ T8 fluorescent bulbs in the 2 bulb fixtures in the mechanical room with their energy efficient LED equivalents and install occupancy sensor.

Rank	Location	Existing Condition		Recommendation	
17	Former Mechanical Room Lighting (4 bulb)	4 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting and install occupancy sensor.	
Installation Cost	$890	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$83
Breakeven Cost	$700	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	0.8		
Auditors Notes: Replace a total of sixteen 4’ T8 fluorescent bulbs in the 4 bulb fixtures in the mechanical room with their energy efficient LED equivalents. Controlled by the same occupancy sensor recommended in the previous measure.					

Rank	Location	Existing Condition		Recommendation	
18	Boiler Room Lighting	3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$19
Breakeven Cost	$162	**Simple Payback (yrs)**	12	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.7		
Auditors Notes: Replace a total of six 4’ T8 fluorescent bulbs in the boiler room with their energy efficient LED equivalents.					

Rank	Location	Existing Condition		Recommendation	
19	Tank Plenum Lighting	FLUOR CFL, Spiral 15 W with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$25	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1
Breakeven Cost	$11	**Simple Payback (yrs)**	19	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.4		
Auditors Notes: Replace the compact fluorescent bulb in the treated water storage tank plenum with its energy efficient LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
20	Watering Point Closet Lighting	FLUOR CFL, Spiral 15 W with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$25	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1
Breakeven Cost	$11	**Simple Payback (yrs)**	19	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.4		
Auditors Notes: Replace the compact fluorescent bulb in the watering point closet with its energy efficient LED equivalent.					

4.5.3 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
3	Service Line Heat Tape		Heat Tape with Manual Switching		Turn heat tape off. Use for freeze-up recovery or during periods of extreme cold only.	
Installation Cost	$200		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$326
Breakeven Cost	$2,742		**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	13.7		
Auditors Notes: A circulating pump in the washeteria circulates water in this line so the heat tape should not needed to prevent freezing. Use heat tape only for freeze-up recovery or when temperatures drop below -20 deg F.						

Rank	Location		Description of Existing		Efficiency Recommendation	
4	Sewer Line Heat Tape		Heat Tape with Manual Switching		Turn heat tape off. Use for freeze-up recovery or during periods of extreme cold only.	
Installation Cost	$200		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$256
Breakeven Cost	$2,152		**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	1.8 MMBTU
			Savings-to-Investment Ratio	10.8		
Auditors Notes: Use heat tape for freeze-up recovery or when temperatures drop below -20 deg F.						

Rank	Location		Description of Existing		Efficiency Recommendation	
6	Sewer Arctic Box Heat Tape		Heat Tape with Manual Switching		Turn heat tape off. Use for freeze-up recovery or during periods of extreme cold only.	
Installation Cost	$200		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$81
Breakeven Cost	$686		**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	3.4		
Auditors Notes: Use heat tape for freeze-up recovery or when temperatures drop below -20 deg F.						

Rank	Location		Description of Existing		Efficiency Recommendation	
13	Dryer Line Circ Pump		Circ Pump with Manual Switching		Run circ pump only when dryers call for heat.	
Installation Cost	$1,000		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$120
Breakeven Cost	$1,014		**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
			Savings-to-Investment Ratio	1.0		
Auditors Notes: The circulating pump on the loop that sends heated glycol through the hydronic dryers is manually controlled by the operators and runs constantly during washeteria occupied hours. Upgrade pump controls so that the pumps turn on only when dryers are running and there is a demand for heat in this loop.						

4.5.6 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1		Treated Water Storage Tank Heat Add		Decommission water storage tank heat add system in washeteria and heat water storage tank through the associated heat add in the water treatment plant.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$418
Breakeven Cost	$4,911	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	13.7 MMBTU
		Savings-to-Investment Ratio	24.6		

Auditors Notes: The treated water storage tank heat-add in the washeteria includes a single wall heat exchanger. Single wall heat exchangers are not recommended for use in cases where glycol and potable water are present. A breach in the heat exchanger wall present the risk of glycol contaminating the community drinking water supply. Since there is another heat-add system dedicated to the treated water storage tank in the water treatment plant, decommission the heat-add in the washeteria and allow water treatment plant to cover storage tank heating demand.

There are plans in place to remove this heat exchanger when the treated water storage tank is replaced.

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.

ANTHC is currently working with the City of Buckland in an effort to realize the retrofits identified in this report through funding from the Rural Alaskan Village Grant (RAVG) program. ANTHC will continue to work with Buckland to secure any additional funding necessary to implement the recommended energy efficiency measures.

APPENDICES

Appendix A – Scanned Energy Billing Data

1. Electricity Billing Data

11:05 AM
02/28/17
Cash Basis

City of Buckland
Transaction Detail By Account
January through December 2016

cwh $0.47/kwh

Type	Date	Num	Na...	Memo	Original A...	Paid Amount	Balance
Electricity							
Check	02/25/2016	35729	KO...	~~Account 2230~~	66.38	66.38	66.38
Check	02/25/2016	35729	KO...	~~Account 4160~~	631.12	631.12	697.50
Check	02/25/2016	35729	KO...	~~Account 4182~~	2,095.80	2,095.80	2,793.30
Check	02/25/2016	35729	KO...	~~Account 4224~~	6.84	6.84	2,800.14
Check	03/10/2016	35759	KO...	~~Acct 2230 - R...~~	151.23	151.23	2,951.37
Check	03/10/2016	35769	KO...	~~Acct 4182 - N...~~	2,667.40	2,667.40	5,618.77
Check	03/10/2016	35759	KO...	~~Acct 4160 - U...~~	703.10	703.10	6,321.87
Check	04/21/2016	35838	KO...	~~Acct # 4224~~	0.89	0.89	6,322.76
Check	04/21/2016	35838	KO...	~~Acct # 4182~~	2,095.80	2,095.80	8,418.56
Check	04/21/2016	35838	KO...	~~Acct # 4160~~	293.74	293.74	8,712.30
Check	04/21/2016	35838	KO...	~~Acct # 2230~~	145.28	145.28	8,857.58
Check	05/09/2016	35872	KO...	~~ACCT #4224~~	8.94	8.94	8,866.52
Check	05/09/2016	35872	KO...	~~ACCT #4182~~	1,690.94	1,690.94	10,557.46
Check	05/09/2016	35872	KO...	~~ACCT #4160~~	457.00	457.00	11,014.46
Check	05/09/2016	35872	KO...	~~ACCT #2230~~	119.68	119.68	11,134.14
Check	06/02/2016	35929	KO...	~~ACCT #2230~~	73.53	73.53	11,207.67
Check	06/02/2016	35929	KO...	~~ACCT #4160~~	479.19	479.19	11,686.86
Check	06/02/2016	35929	KO...	~~ACCT #4182~~	1,286.06	1,286.06	12,972.92
Check	06/02/2016	35929	KO...	~~ACCT #4224~~	5.06	5.06	12,977.98
Check	08/15/2016	36104	KO...	~~Acct #4224~~	6.84	6.84	12,984.82
Check	08/15/2016	36104	KO...	~~Acct #4182~~	381.06	381.06	13,365.88
Check	08/15/2016	36104	KO...	~~Acct #4160~~	279.77	279.77	13,645.65
Check	08/15/2016	36104	KO...	~~Acct #2230~~	150.34	150.34	13,795.99
Check	08/15/2016	36104	KO...	~~Acct #2090~~	4.17	4.17	13,800.16
Check	08/17/2016	36120	KO...	~~ACCT #2080~~	645.85	645.85	14,446.01
Check	08/17/2016	36120	KO...	~~ACCT #4160~~	269.46	269.46	14,715.47
Check	08/17/2016	36120	KO...	~~ACCT #4182~~	342.49	342.49	15,057.96
Check	08/17/2016	36120	KO...	~~ACCT #4224~~	3.67	3.67	15,061.63
Check	09/09/2016	36170	KO...	~~Acct #2080~~	242.20	242.20	15,303.83
Check	09/09/2016	36170	KO...	~~Acct #2090~~	4.90	4.90	15,308.73
Check	09/09/2016	36170	KO...	~~Acct #2230~~	156.57	156.57	15,465.30
Check	09/09/2016	36170	KO...	~~Acct #4160~~	314.25	314.25	15,779.55
Check	09/09/2016	36170	KO...	~~Acct #4182~~	464.81	464.81	16,244.36
Check	09/09/2016	36170	KO...	~~Acct #4224~~	5.51	5.51	16,249.87
Check	11/07/2016	36295	KO...	~~ACCT #2080~~	211.92	211.92	16,461.79
Check	11/07/2016	36295	KO...	~~ACCT #2230~~	170.94	170.94	16,632.73
Check	11/07/2016	36295	KO...	~~ACCT #4160~~	404.93	404.93	17,037.66
Check	11/07/2016	36295	KO...	~~ACCT #4182~~	464.81	464.81	17,502.47
Check	11/07/2016	36295	KO...	~~ACCT #4224~~	13.77	13.77	17,516.24
Check	12/06/2016	36360	KO...	~~ACCT #2080~~	280.96	280.96	17,797.20
Check	12/06/2016	36360	KO...	~~ACCT #4160~~	467.68	467.68	18,264.88
Check	12/06/2016	36360	KO...	~~ACCT #4182~~	1,328.40	1,328.40	19,593.28
Check	12/06/2016	36360	KO...	~~ACCT #4224~~	5.65	5.65	19,598.93
Total Electricity						19,598.93	19,598.93
TOTAL						19,598.93	19,598.93

0.47
0.22
$6.
242.20

4224 New lift Station 3 300 - 206
4182 New water Plant - 500 gal tank - 300
4160 Lift Station 1 3000 - 206
2330 Raw Water Pump 300 - Ø
2080 Washeteria 500 - 53
2090 City Fuel Farm
LS 2 300 - 206

Page 1

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Buckland Washeteria	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: PO Box 49	**Auditor Name:** Bailey Gamble
City: Buckland	**Auditor Address:** 4500 Diplomacy Dr., Suite 454 Anchorage, AK 99508
Client Name: Erik Weber	
Client Address: PO Box 49 Buckland, AK 99727	**Auditor Phone:** (907) 729-4501
	Auditor FAX:
Client Phone: (907) 494-2152	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,922 square feet	**Design Space Heating Load:** Design Loss at Space: 38,887 Btu/hour with Distribution Losses: 38,887 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 59,279 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Buckland	**Design Outdoor Temperature:** -40 deg F
Weather/Fuel City: Buckland	**Heating Degree Days:** 16,462 deg F-days
Utility Information	
Electric Utility: City of Buckland Power Plant	**Average Annual Cost/kWh:** $0.474/kWh

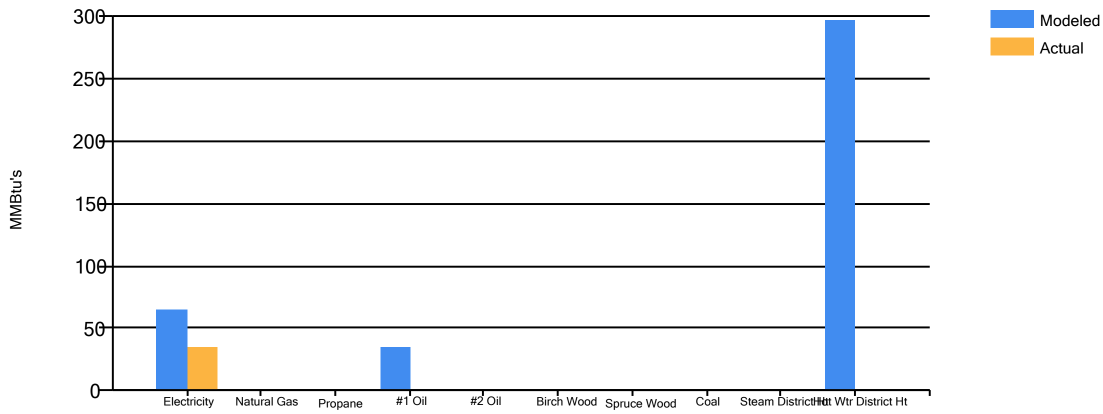
Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Tank Heat**	**Total Cost**
Existing Building	$3,549	$906	$44	$1,402	$1,408	$3,076	$420	**$10,804**
With Proposed Retrofits	$3,325	$526	$11	$953	$538	$2,271	$193	**$7,817**
Savings	$224	$380	$33	$449	$871	$805	$227	**$2,988**

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	206.0	12.51	$5.62
With Proposed Retrofits	167.8	10.19	$4.07
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

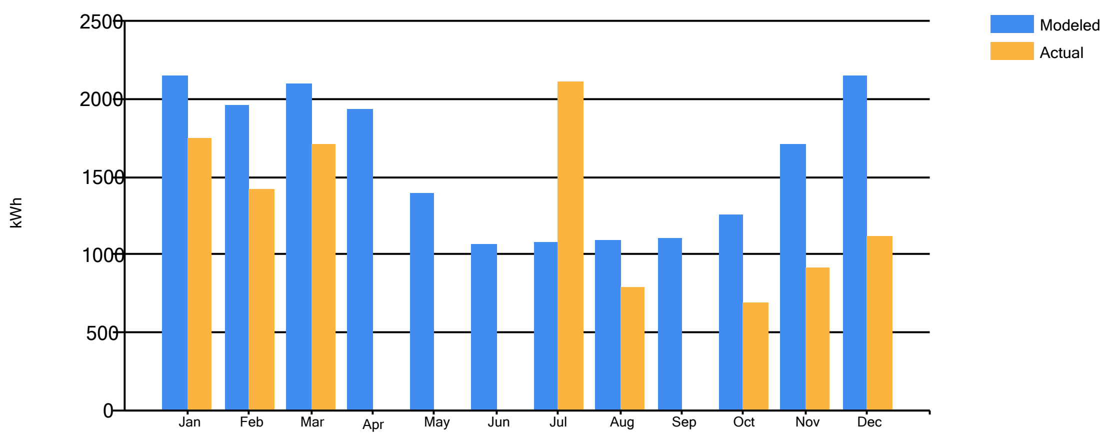
Appendix C – Actual Fuel Use versus Modeled Fuel Use

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

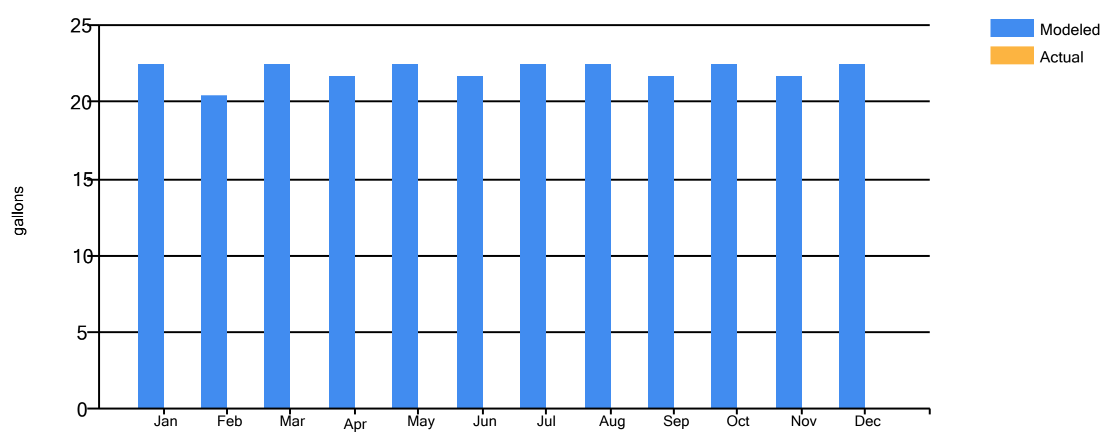
Annual Fuel Use



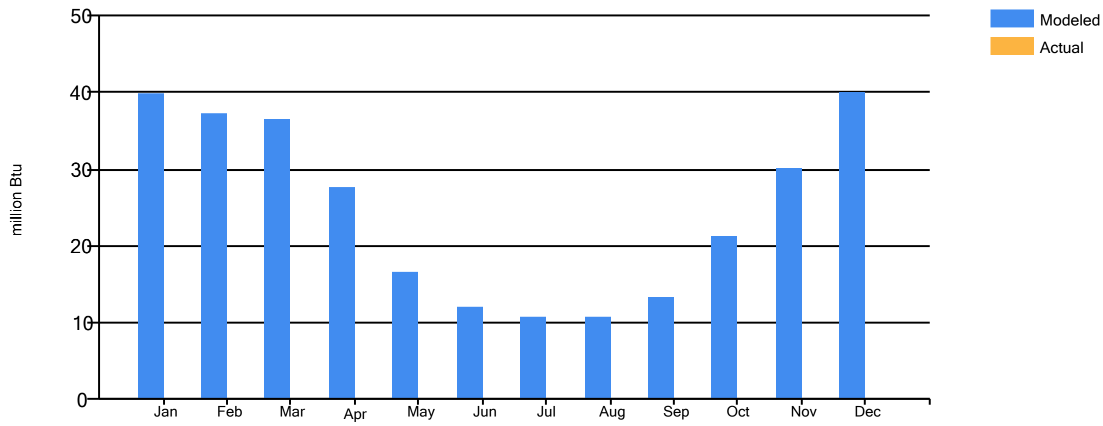
Electricity Fuel Use



#1 Fuel Oil Fuel Use



Recovered Heat Fuel Use


Modeled
Actual
million Btu
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Appendix D - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	6.2	6.2	6.1	5.9	5.0	4.6	4.5	4.5	4.6	4.9	5.6	6.2
As Proposed	5.0	5.0	4.9	4.7	4.2	4.0	4.0	4.0	4.0	4.2	4.6	5.0

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016