Comprehensive Energy Audit
For
Kiana Water Treatment Plant

Prepared For
City of Kiana

July 12, 2016

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PREFACE

This energy audit was conducted using funds provided by the Department of Energy as part of the Rural Alaskan Communities Energy Efficiency (RACEE) Competition. Coordination with the City of Kiana has been undertaken to provide maximum accuracy in identifying audits 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 Kiana, Alaska. The authors of this report are Bailey Gamble, Mechanical Engineer I; and Chris Mercer, Senior Engineering Project Manager and Certified Energy Manager (CEM).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in July of 2016 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 Richard Teel, Remote Maintenance Worker Chris Cox, and City of Kiana Mayor Darin Douglas.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Kiana. The scope of the audit focused on Kiana Water Treatment Plant and Pump house. 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 $96,490 per year. Fuel represents the largest portion with an annual cost of approximately $54,810. Electricity represents the remaining portion, with an annual cost of approximately $41,680. This includes about $13,800 paid by the city and about $27,880 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Recovered heat from the Alaska Village Electric Cooperative (AVEC) power plant contributes to the heating demand in the plant as well 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 Kiana, the cost of electricity without PCE is $0.49/kWh and the cost of electricity with PCE is $0.165/kWh.

There is a heat recovery system meant to supply recovered heat from the power plant to meet the heating demand in the raw water transmission line and the water storage tank. It is currently functioning only at the raw water heat add.

There is a 10.5 kW solar photovoltaic (PV) array just south of the WTP that supplements the electricity for the water treatment plant. The array went online in August of 2015. The panels are arranged in a 90 degree horseshoe and are tilted at a 65 degree angle. In the past year they produced nearly 7000 kWh of power, saving the City of Kiana approximately $3,200 on electricity.

An energy audit report was also developed for the Kiana Lift Station. This report compliments the WTP energy audit and covers the waste disposal system. This report will be distributed separately from the Kiana Water Treatment Plant Report.

Table 1.1 lists the total usage of electricity, #1 heating oil, and recovered heat in the Kiana WTP before and after the proposed retrofits.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	84,705 kWh	60,211 kWh
#1 Oil	9,966 gallons	5,110 gallons
Recovered Heat	330.62 million Btu	342.48 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 Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	1,197.5	76.40	$59.71
With Proposed Retrofits	756.5	48.26	$35.89
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 Kiana Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**[1]	**Simple Payback (Years)**[2]	**CO_2 Savings**
1	Other Electrical: East Loop Circulation Pump	Shut off pump in summer time.	$2,202	$500	27.21	0.2	8,226.6
2	Lighting: Office Sink Light	Replace with new energy-efficient LED lighting; replace manual switching with occupancy sensor.	$68 + $20 Maint. Savings	$81	12.68	0.9	253.2
3	West Circulation Loop	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$11,114	$12,000	12.55	1.1	42,665.7

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
4	East Circulation Loop	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$10,812	$12,000	12.21	1.1	41,508.0
5	Other Electrical: West Loop Circulation Pump	Shut off pump in summer time.	$801	$500	9.87	0.6	2,990.1
6	Lighting - Combined Retrofit: Main Room Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$2,709 + $200 Maint. Savings	$3,700	9.07	1.3	10,094.3
7	Other Electrical - Controls Retrofit: Lower Well Heat Tape	Use only for freeze-up recovery	$2,110	$1,500	8.71	0.7	7,889.4
8	Other Electrical - Controls Retrofit: Pump house Electric Heaters	Alternate heater use and run at lower setting, set point 50 deg F.	$633	$500	7.84	0.8	2,366.8
9	Setback Thermostat: Kiana Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Kiana Water Treatment Plant space.	$1,169	$2,000	7.75	1.7	4,468.0
10	Lighting - Combined Retrofit: Utilidor Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$236 + $120 Maint. Savings	$980	4.25	2.8	880.5
11	Lighting - Combined Retrofit: Office Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$202 + $80 Maint. Savings	$820	4.00	2.9	752.4
12	Air Tightening: Generator Room, Utilidor	Perform air sealing, close louvers to reduce air leakage by 400 cfm at 50 Pascals.	$351	$1,000	3.21	2.9	1,340.9

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**
13	Heating, Ventilation, and Domestic Hot Water (DHW)	Put boilers on nodes and stage them, install a circ pump on each boiler node controlled by a call for heat to allow boilers to run cold and reduce idle, stack and jacket loss when there is no heat demand.	$4,915	$30,000	2.75	6.1	15,141.4
14	Lighting - Combined Retrofit: Generator Room Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$82 + $80 Maint. Savings	$820	2.31	5.1	304.5
15	Lighting - Combined Retrofit: Storage Room Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$78 + $40 Maint. Savings	$660	2.09	5.6	291.8
16	Lighting - Combined Retrofit: Back Entrance Exterior Light	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$89 + $10 Maint. Savings	$600	1.94	6.1	333.4
17	Lighting - Combined Retrofit: Entry Way Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$76 + $20 Maint. Savings	$580	1.93	6.0	284.4
18	Other Electrical - Controls Retrofit: Raw Water Heat Add Circ Pump	Move Sequest-All injection port so that circ pump may be turned off during the summer.	$262	$2,000	1.09	7.6	976.3
19	Lighting - Combined Retrofit: Bathroom Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$15 + $40 Maint. Savings	$660	0.99	11.9	56.9
20	Water Storage Tank Heat Add	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$556	$12,000	0.63	21.6	2,742.9

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
21	Lighting - Combined Retrofit: Front Entry Exterior Light	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$0 + $10 Maint. Savings	$600	0.20	60.0	0.0
22	Raw Water Heat Add	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$19	$16,000	0.01	832.4	2,395.6
	TOTAL, all measures		**$38,500 + $620 Maint. Savings**	**$99,501**	**4.95**	**2.5**	**145,963.0**

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 $38,500 per year, or 39.9% of the buildings' total energy costs. These measures are estimated to cost $99,501, for an overall simple payback period of 2.5 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**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$2,926	$5,338	$32,696	$1,292	$46,517	$7,665	**$96,492**
With Proposed Retrofits	$1,527	$1,210	$26,563	$1,088	$23,602	$3,942	**$57,992**
Savings	$1,398	$4,128	$6,133	$204	$22,915	$3,723	**$38,500**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Kiana Water Treatment Plant. 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

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

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

1) Kiana Water Treatment Plant: 1,616 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 systems; 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. Kiana Water Treatment Plant

3.1. Building Description

The 1,616 square foot Kiana Water Treatment Plant was constructed in 2002, with a normal occupancy of 1 person. The number of hours of operation for this building average 9 hours per day, considering all seven days of the week. The Kiana WTP serves as the water distribution center for the residents of the village.

Raw water is pumped by one of two (upper or lower) well pumps into the pump house along the bank of the Kobuk River, 850 ft. from the WTP. From the pump house, the water is transported through 3 in. HDPE Arctic Pipe to the WTP where it is injected with chemicals before entering the water storage tank (WST). The water is injected with Poly-Phosphate (Sequest-All) liquid polymer for Manganese sequestration and Calcium Hypochlorite for disinfection.

The water is then stored in a 212,000 gallon insulated storage tank. Treated water from the storage tank is pressurized to 60 psi by one of two pressure pumps, and then stored in a hydro pneumatic pressure tank before being distributed to the community through the distribution loops.

The Kiana WTP has two distribution loops; the East and West Loops. Each loop has is heated via heat exchanger by a heated glycol loop tied into the WTP's three boilers. The East Loop, serving the east side of the village, consists of 3700 ft. of 4 in. PVC insulated Arctic Pipe heated to 60 degrees F. The West Loop, serving the west side of the village, consists of 7500 ft. of 4 in. HDPE insulated Arctic Pipe heated to 50 degrees F.

Figure 1: Pressure tanks and circulation loop components in Kiana WTP

Description of Building Shell

The exterior walls of the water treatment plant are constructed with single stud 2x6 lumber construction with a 16-inch offset. The walls have approximately 5.5 inches of R-22 insulated polyurethane panels that are slightly damaged from age. There is approximately 2,040 square feet of wall space in the WTP.

The WTP has a cathedral ceiling with 2x12 lumber construction. The roof has standard framing and a 24-inch offset. The ceiling has approximately 11.5 inches of R-44 insulated polyurethane panels with some damage due to age. There is approximately 1666 square feet of roof space in the building.

The WTP is built on pilings with the floor constructed of 3x12 joists with a 16-inch offset. The floor is insulated with 8 inches of slightly damaged closed cell polystyrene insulation and there is approximately 1616 square feet of floor space in the building.

The building has four total windows, each of which has triple-pane glass and measurements of 3.5' x 3.5'. There are two Northeast facing windows and one Southwest facing window on the main room of the WTP and one Southwest facing window in the WTP storage room.

There are insulated metal doors on the front (Southwest) and back (Northeast) side of the main room of the WTP. The doors are fairly well sealed. The front entrance doors are a double set measuring 6' x 6.75' and the back door is a single door measuring 3' x 6.75'.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler #1

Nameplate Information:	Weil-McLain Gold Oil Boiler, Model No: A/B-WTGO-7
Fuel Type:	#1 Oil
Input Rating:	242,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1 %
Heat Distribution Type:	Glycol
Boiler Operation:	Aug – May
Notes:	2 GPH oil fire rate

Boiler #2

Nameplate Information:	Weil-McLain Gold Oil Boiler, Model No: A/B-WTGO-7
Fuel Type:	#1 Oil
Input Rating:	242,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1 %
Heat Distribution Type:	Glycol
Boiler Operation:	Aug – May
Notes:	2 GPH oil fire rate

Boiler #3

Nameplate Information:	Weil-McLain Gold Oil Boiler, Model No: A/B-WTGO-7
Fuel Type:	#1 Oil
Input Rating:	242,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1 %
Heat Distribution Type:	Glycol
Boiler Operation:	Aug – May
Notes:	2 GPH oil fire rate

Heat Recovery

Fuel Type:	Recovered heat from AVEC power plant
Input Rating:	50,000 BTU/hr
Steady State Efficiency:	99 %
Idle Loss:	0 %
Heat Distribution Type:	Glycol
Boiler Operation:	Aug - May
Notes:	Line loss significant due to poor insulation/holes in insulation.

With the current controls settings and configuration, the heat recovery system supplies all of the heat for the raw water heat add. It should supply the majority of the heat for the water storage tank as well, but flow has been lost in this portion due to as yet unidentified malfunction. The three boilers supply all of the heat for the water storage tank, the two circulation loops and building space heating.

Figure 2: Existing fuel oil boilers.

Figure 3: Heat recovery; heat exchanger where heat from the power plant loop is transferred to the WTP loop.

Space Heating Distribution Systems

There are four unit heaters in the WTP. There are two, one on either end of the main mechanical room, one near the front entrance and one in the utilidor room connecting the WTP to the storage tank. Each of the four unit heater has an estimated rating of 50 MBH.

Heat Recovery Information

There is a heat recovery system that transfers heat from the generator cooling loops at the AVEC power plant to some of the water heating components and the Kiana Water Treatment Plant (WTP). The heated glycol from the heat recovery loop transfers heat via heat exchanger to an isolated heat recovery glycol loop in the WTP. Heat from this loop is configured to transfer heat to the water via heat exchangers at two points. Recovered heat is added to the raw water as it enters the plant. This heated water is circulated back towards the pump house where it is injected back into the main raw water transmission line. Recovered heat is added to the treated water entering the water storage tank as well, however, an undetermined malfunction is currently preventing flow and therefore the transfer of heat in this portion of the system. The heat recovery runs continuously from September to April. The pumps that circulate the heated glycol are turned on and off manually at the beginning and end of the winter heating season by the water treatment plant operator.

The recovered heat meets the heating demand of the raw water and has the potential to meet a greater proportion of the overall WTP heating demand. In their feasibility study, Coffman Engineering estimates that 90% of heating demand in the WTP could be met by recovered heat if the system were to be upgraded (see Appendix D). Coffman's suggested upgrades include incorporating recovered heat into the WTP building heating system, replacing and insulating pipe where needed, adding marine jackets to the diesel generators and upgrading the thermostatic valve. The cost estimate for these upgrades is $391,000 and could reduce fuel consumption by 8,550 gallons per year.

Alternatively, minor repairs could be made to the heat recovery system; incorporating recovered heat as a node on the building heat loop, re-insulating an exposed section of pipe and replacing the thermostatic valve for an estimated $68,500. These repairs could reduce fuel consumption by 4,200 gallons per year.

Figure 4: Holes and missing insulation on heat recovery pipes.

Description of Building Ventilation System

The existing building ventilation system consists of a hooded stationary vent for operator safety and corrosion control in the utilidor room where chemicals are stored and a set of manually operated louvers in the generator room that allow for the inflow of make-up air when the back-up generator is running.

Lighting

The main room of the WTP has 20 fixtures with four 4 ft. T12 34 W fluorescent light bulbs in each fixture. The lights are usually on during operator hours, so for about 8-9 hours a day year round. They consume approximately 8208 kWh annually.

The entry way of the WTP has one fixture with two 4 ft. T12 40 W fluorescent light bulbs. The light is usually on during operator hours, so for about 8-9 hours a day year round. It consumes approximately 245 kWh annually.

The office of the WTP has two fixtures with four 4 ft. T12 34 W fluorescent light bulbs in each fixture. The lights are usually on during operator hours, so for about 8-9 hours a day year round. They consume approximately 728 kWh annually. There is an additional fixture over the sink that contains two 4 ft. T12 34 W fluorescent bulbs and shares the same schedule. This light consumes 196 kWh annually.

The utilidor room has three fixtures with four 4 ft. T12 34 W fluorescent light bulbs in each fixture. The lights are usually on about half of the time during operator hours, so for about 4 hours a day year round. They consume approximately 695 kWh annually.

The storage room of the WTP has one fixture with four 4 ft. T12 34 W fluorescent light bulbs. The light is usually on half the time during operator hours, so for about 4 hours a day year round. It consumes approximately 232 kWh annually.

The bathroom has one fixture with four 4 ft. T12 34 W fluorescent light bulbs. The light is turned on only when someone is using the bathroom, about 10% of the time during operator hours. It consumes approximately 73 kWh annually.

The generator room has two fixtures with four 4 ft. T12 34 W fluorescent light bulbs in each fixture. The lights are turned on only when the operator needs to grab an item from the room, so about 20% of the time during operator hours. They consume approximately 225 kWh annually.

There are to exterior light fixtures on the WTP. The fixture above the front entrance does not have a bulb and is currently not used. The fixture above the back door contains a 50 W metal halide bulb and supplies light during the darker winter months. This light consumes approximately 253 kWh annually.

Plug Loads

The WTP has a variety of power tools, a telephone, microwave, coffee pot, computer monitor, printer and some other miscellaneous loads that require a plug into an electrical outlet. The use of these items consumes about 570 kWh annually.

Major Equipment

There are two well pumps that are used to draw water from the upper and lower wells and transport it to the WTP. The pumps are each rated for 5 HP. The pumps alternate, pumping water all day every other day. Combined, they consume approximately 16,349 kWh annually

There is a liquid polymer injection pump that injects Poly-phosphate (Sequest-All) into the water as part of the treatment process. The pump is rated at 180 Watts and operates when water is being made (all day every other day). It consumes approximately 789 kWh annually.

There is a chlorine injection pump that injects Calcium Chloride into the water as part of the treatment process. The pump is rated at 168 Watts and operates when water is being made (all day every other day). It consumes approximately 736 kWh annually.

There are two pressure pumps that are used to maintain an operable pressure in the system. The pumps alternate. The pumps are rated for 5 HP. Pump 2 tends to draw more power than pump 1. Pump 2 operates 11% of the time and consumes 2774 kWh annually and pump 1 operates 17% of the time and consumes 2224 kWh annually.

There are two pumps that circulate water in the West Loop during the colder months to prevent freezing in the line. These pumps alternate and are rated for 2 HP and typically operate from September to May, but sometimes run later into the year. They consume a combined 8558 kWh annually.

There are two pumps that circulate water in the East Loop during the colder months to prevent freezing in the line. These pumps alternate and are rated for 5 HP and typically operate from September to May, but sometimes run later into the year. They consume a combined 22,217 kWh annually.

There is a washing machine in the WTP that the operator and other utility staff use to wash an estimated two loads per week. The washing machine is rated at 1200 W and consumes approximately 63 kWh annually.

There is a dryer in the WTP that the operator and other utility staff use to dry an estimated two loads per week. The dry is rated at 3360 Watts and consumes approximately 351 kWh annually.

There are two pumps that circulate raw water through a pair of heat exchangers. The pumps alternate and are rated at 201 Watts. They run continuously all year round, adding heated water to the main raw water transmission line in the winter and ensuring proper mixing of liquid polymer in the summer. They consume 1762 kWh annually.

There are two pumps that circulate water heading into the water storage tank through a pair of heat exchangers. The pumps alternate and are rated at 185 W. They run continuously during the winter heating season and consume 1049 kWh annually.

There are two pumps that circulate glycol on the main building heating loop. These pumps alternate and are rated at 480 Watts. They operated continuously during the winter heating season and consume 2722 kWh annually.

There are two pumps that circulate glycol on the WTP recovered heat loop. These pumps alternate and are rated at 480 Watts. They operated continuously during the winter heating season and consume 2722 kWh annually.

There are two electric space heaters in the pump house. They are turned by the operator during the winter heating season and run simultaneously. They are rated at 1500 Watts and consume approximately 4717 kWh annually.

There are three heat tapes associated with the WTP and pump house. One runs along the sink drain in the WTP office. It was measured to consume 197 Watts, however, the operator never uses this heat tape. There is a heat tape on the upper and lower well lines. The upper well heat tape is controlled by a breaker. It is rated at 200 Watts, but hasn't been used by the operator either. The lower well heat tape plugs into the wall and can be controlled by a breaker as well. This heat tape is longer and rated at 500 Watts. It was on at the time of the audit. The operator has never turned it on or off himself, so it has likely been on continuously for the past few years. This heat tape consumes 4383 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.

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

The Alaska Village Electric Collaborative (AVEC) is the electric utility and runs the power plant in the City of Kiana. The utility provides electricity to the residents of Kiana as well as all commercial and public facilities.

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

Table 3.1: Energy Rates for Each Fuel Source in Kiana

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.4920/kWh
#1 Oil	$ 5.50/gallons
Heat Recovery	$ 0.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the City of Kiana pays approximately $96,492 annually for electricity and other fuel costs for the Kiana Water Treatment Plant.

Figure 2 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.

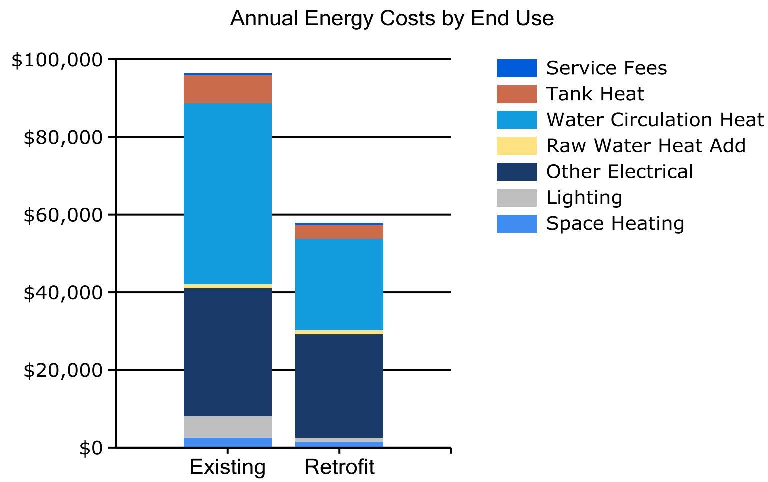


Figure 2: Annual Energy Cost by End Use

Figure 3 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.

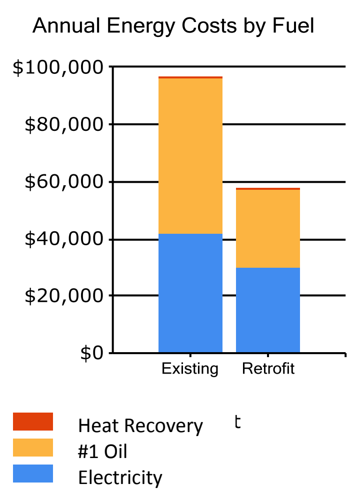


Figure 3: Annual Energy Cost by Fuel Type

Figure 4 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.

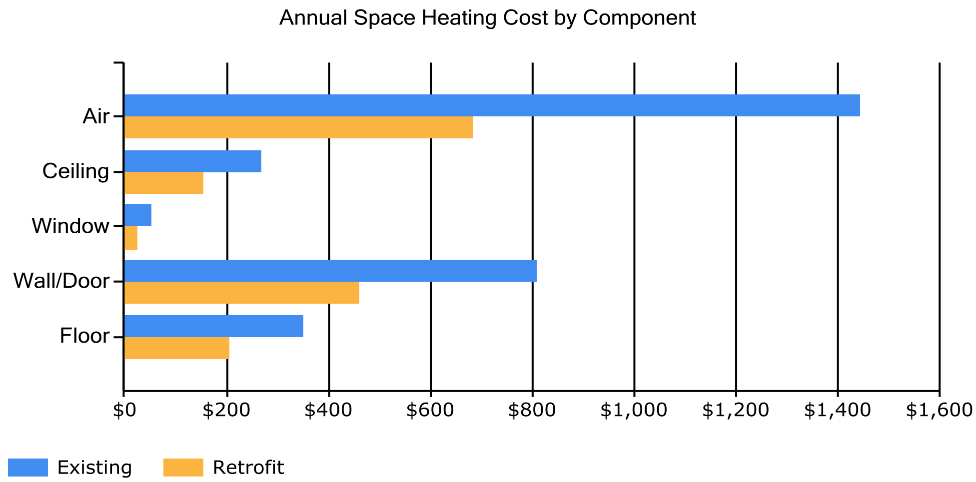


Figure 4: Annual Space Heating Cost by Component

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.

Table 3.2: Electrical Consumption Records by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	521	479	479	397	173	5	0	0	122	393	445	522
Lighting	921	840	921	892	921	892	921	921	892	921	892	921
Other Electrical	6414	5845	6414	6207	5224	4107	4244	4244	4807	6414	6207	6414
Raw Water Heat Add	336	305	337	331	179	0	0	0	128	347	330	335
Water Circulation Heat	115	104	115	111	52	0	0	0	37	115	111	115
Tank Heat	46	44	44	30	6	0	0	0	1	21	34	47

Table 3.3: 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	47	46	22	0	0	3	0	41	0	0	10	48
Water Circulation Heat	1096	999	1097	1063	484	0	0	0	382	1100	1063	1096
Tank Heat	231	224	219	151	27	0	0	0	4	104	171	237

Table 3.4: Recovered Heat Consumption Records by Category

Recovered Heat Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Raw Water Heat Add	41	38	41	40	19	0	0	0	13	41	40	41
Tank Heat	3	3	3	2	0	0	0	0	0	1	2	3

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):

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

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

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

Table 3.5: Kiana WTP 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	84,705 kWh	289,097	3.340	965,584
#1 Oil	9,966 gallons	1,315,482	1.010	1,328,637
Recovered Heat	330.62 million Btu	330,623	1.280	423,198
Total		**1,935,202**		**2,717,419**
BUILDING AREA		1,616	Square Feet	
BUILDING SITE EUI		1,198	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,682	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.6: Kiana WTP Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**1,197.5**	**76.40**	**$59.71**
With Proposed Retrofits	**756.5**	**48.26**	**$35.89**
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 Kiana Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Kiana 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 Kiana. 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 load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1: List of Energy Efficiency Recommendations by Economic Priority

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**[1]	**Simple Payback (Years)**[2]	**CO_2 Savings**
1	Other Electrical: East Loop Circulation Pump	Shut off pump in summer time.	$2,202	$500	27.21	0.2	8,226.6
2	Lighting: Office Sink Light	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$68 + $20 Maint. Savings	$81	12.68	0.9	253.2
3	West Circulation Loop	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$11,114	$12,000	12.55	1.1	42,665.7
4	East Circulation Loop	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$10,812	$12,000	12.21	1.1	41,508.0

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
5	Other Electrical: West Loop Circulation Pump	Shut off pump in summer time.	$801	$500	9.87	0.6	2,990.1
6	Lighting - Combined Retrofit: Main Room Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$2,709 + $200 Maint. Savings	$3,700	9.07	1.3	10,094.3
7	Other Electrical - Controls Retrofit: Lower Well Heat Tape	Use only for freeze-up recovery	$2,110	$1,500	8.71	0.7	7,889.4
8	Other Electrical - Controls Retrofit: Pump house Electric Heaters	Alternate heater use and run at lower setting, setpoint 50 deg F.	$633	$500	7.84	0.8	2,366.8
9	Setback Thermostat: Kiana Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Kiana Water Treatment Plant space.	$1,169	$2,000	7.75	1.7	4,468.0
10	Lighting - Combined Retrofit: Utilidor Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$236 + $120 Maint. Savings	$980	4.25	2.8	880.5
11	Lighting - Combined Retrofit: Office Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$202 + $80 Maint. Savings	$820	4.00	2.9	752.4
12	Air Tightening: Generator Room, Utilidor	Perform air sealing, close louvers to reduce air leakage by 400 cfm at 50 Pascals.	$351	$1,000	3.21	2.9	1,340.9
13	Heating, Ventilation, and Domestic Hot Water (DHW)	Establish boilers on nodes and stage them, install a circ pump on each boiler node controlled by a call for heat to allow boilers to run cold and reduce idle, stack and jacket loss when there is no heat demand.	$4,915	$30,000	2.75	6.1	15,141.4

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
14	Lighting - Combined Retrofit: Generator Room Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$82 + $80 Maint. Savings	$820	2.31	5.1	304.5
15	Lighting - Combined Retrofit: Storage Room Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$78 + $40 Maint. Savings	$660	2.09	5.6	291.8
16	Lighting - Combined Retrofit: Back Entrance Exterior Light	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$89 + $10 Maint. Savings	$600	1.94	6.1	333.4
17	Lighting - Combined Retrofit: Entry Way Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$76 + $20 Maint. Savings	$580	1.93	6.0	284.4
18	Other Electrical - Controls Retrofit: Raw Water Heat Add Circ Pump	Move Sequest-All injection port so that circ pump may be turned off during the summer.	$262	$2,000	1.09	7.6	976.3
19	Lighting - Combined Retrofit: Bathroom Lights	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$15 + $40 Maint. Savings	$660	0.99	11.9	56.9
20	Water Storage Tank Heat Add	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$556	$12,000	0.63	21.6	2,742.9
21	Lighting - Combined Retrofit: Front Entry Exterior Light	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$0 + $10 Maint. Savings	$600	0.20	60.0	0.0

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**
22	Raw Water Heat Add	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	$19	$16,000	0.01	832.4	2,395.6
	TOTAL, all measures		**$38,500 + $620 Maint. Savings**	**$99,501**	**4.95**	**2.5**	**145,963.0**

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 were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
12	Generator Room, Utilidor		Air Tightness estimated as: 2800 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 400 cfm at 50 Pascals.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$351	
Breakeven Cost	$3,208	**Savings-to-Investment Ratio**	3.2	**Simple Payback yrs**	3	
Auditors Notes: There is a louver in the generator room that remains open all the time. Controls should be programmed to open it only when the back-up generator is operating.						

4.4 Mechanical Equipment Measures

4.4.1 Heating Measure

Rank	Recommendation				
13	Put boilers on nodes and stage them. Install a circulating pump on each boiler node controlled by a call for heat. This will allow boilers to run cold more often and reduce idle, stack and jacket losses.				
Installation Cost	$30,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$4,915
Breakeven Cost	$82,419	**Savings-to-Investment Ratio**	2.7	**Simple Payback yrs**	6
Auditors Notes: This will allow boilers to run cold more often and reduce idle, stack and jacket losses. For an additional investment of $32,500, the heat recovery system could be upgraded and incorporated as a fourth node on the building heat loop. This would allow the WTP to reduce fuel consumption by an additional 4200 gallons per year.					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
9	Kiana Water Treatment Plant			Implement temperature setback of 55 degrees F during unoccupied periods.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,169
Breakeven Cost	$15,506	**Savings-to-Investment Ratio**	7.8	**Simple Payback yrs**	2
Auditors Notes: The temperature in the WTP can be lowered when the building is unoccupied during the evening and night.					

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	Office Sink Light	FLUOR (2) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching		d	
Installation Cost	$81	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$68
				Maintenance Savings (/yr)	$20
Breakeven Cost	$1,027	**Savings-to-Investment Ratio**	12.7	**Simple Payback yrs**	1
Auditors Notes: This fixture has two bulbs to be replaced with LEDs. It would be operated by the same occupancy sensor as the main office lights. LED use less energy and last longer allowing for less frequent bulb replacement.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
6	Main Room Lights	20 FLUOR (4) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$3,700	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,709
				Maintenance Savings (/yr)	$200
Breakeven Cost	$33,573	**Savings-to-Investment Ratio**	9.1	**Simple Payback yrs**	1
Auditors Notes: This room contains 20 fixtures with four bulbs in each fixture for a total of 80 bulbs to be replaced with LEDs. LEDs use less energy and last longer allowing for less frequent bulb replacement.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
10	Utilidor Lights	3 FLUOR (4) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$980	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$236
				Maintenance Savings (/yr)	$120
Breakeven Cost	$4,160	**Savings-to-Investment Ratio**	4.2	**Simple Payback yrs**	3
Auditors Notes: This room contains three fixtures with 4 bulbs each for a total 12 bulbs to be replaced with LEDs. LEDs use less energy and last longer allowing for less frequent bulb replacement.					

Rank	Location	Existing Condition			Recommendation	
11	Office Lights	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching			Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$820	**Estimated Life of Measure (yrs)**	15		**Energy Savings (/yr)**	$202
					Maintenance Savings (/yr)	$80
Breakeven Cost	$3,283	**Savings-to-Investment Ratio**	4.0		**Simple Payback yrs**	3
Auditors Notes: This room has two fixtures with 4 bulbs each for a total of 8 bulbs to be replaced with LEDs. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

Rank	Location	Existing Condition			Recommendation	
14	Generator Room Lights	2 FLUOR (4) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching			Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$820	**Estimated Life of Measure (yrs)**	15		**Energy Savings (/yr)**	$82
					Maintenance Savings (/yr)	$80
Breakeven Cost	$1,894	**Savings-to-Investment Ratio**	2.3		**Simple Payback yrs**	5
Auditors Notes: This room has two fixtures with 4 bulbs each for a total of 8 bulbs to be replaced with LEDs. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

Rank	Location	Existing Condition			Recommendation	
15	Storage Room Lights	FLUOR (4) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching			Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$660	**Estimated Life of Measure (yrs)**	15		**Energy Savings (/yr)**	$78
					Maintenance Savings (/yr)	$40
Breakeven Cost	$1,381	**Savings-to-Investment Ratio**	2.1		**Simple Payback yrs**	6
Auditors Notes: This room has one fixture with 4 bulbs for a total of 4 bulbs to be replaced with LEDs. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

Rank	Location	Existing Condition			Recommendation	
16	Back Entrance Exterior Light	MH 50 Watt StdElectronic with Manual Switching			Replace with new energy-efficient LED lighting and add new daylight sensor.	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	15		**Energy Savings (/yr)**	$89
					Maintenance Savings (/yr)	$10
Breakeven Cost	$1,167	**Savings-to-Investment Ratio**	1.9		**Simple Payback yrs**	6
Auditors Notes: This fixture contains only one bulb to be replaced with LEDs. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

Rank	Location		Existing Condition		Recommendation	
17	Entry Way Lights		FLUOR (2) T12 4' F40T12 40W Standard StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost		$580	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$76
					Maintenance Savings (/yr)	$20
Breakeven Cost		$1,118	**Savings-to-Investment Ratio**	1.9	**Simple Payback yrs**	6
Auditors Notes: This fixture contains two bulbs to be replaced with LEDs. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

Rank	Location		Existing Condition		Recommendation	
19	Bathroom Lights		FLUOR (4) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost		$660	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$15
					Maintenance Savings (/yr)	$40
Breakeven Cost		$653	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	12
Auditors Notes: This fixture contains 4 bulbs to be replaced with LEDs. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

Rank	Location		Existing Condition		Recommendation	
21	Front Entry Exterior Light		FLUOR CFL, Spiral 26 W with Manual Switching		Replace with new energy-efficient LED lighting and add new daylight sensor.	
Installation Cost		$600	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$
					Maintenance Savings (/yr)	$10
Breakeven Cost		$119	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	60
Auditors Notes: This fixture contains one bulb to be replaced with an LED. LEDs use less energy and las longer allowing for less frequent bulb replacement.						

4.5.3 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	East Loop Circ Pump		Pump with Manual Switching		Shut pump off in the summer.	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,202
Breakeven Cost		$13,604	**Savings-to-Investment Ratio**	27.2	**Simple Payback yrs**	0
Auditors Notes: Circulation pumps may be shut down earlier than they recently have been, once ground temperatures are above freezing, to reduce electrical cost during the summer months.						

Rank	Location		Description of Existing		Efficiency Recommendation	
5	West Loop Circ Pump		Pump with Manual Switching		Shut pump off in the summer	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$801	
Breakeven Cost	$4,935	**Savings-to-Investment Ratio**	9.9	**Simple Payback yrs**	1	
Auditors Notes: Circulation pumps may be shut down earlier than they recently have been, once ground temperatures are above freezing, to reduce electrical cost during the summer months.						

Rank	Location		Description of Existing		Efficiency Recommendation	
7	Lower Well Heat Tape		Heat Tape with Manual Switching		Install a switch and use only for freeze-up recovery.	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,110	
Breakeven Cost	$13,061	**Savings-to-Investment Ratio**	8.7	**Simple Payback yrs**	1	
Auditors Notes: This heat tape is currently controlled by a breaker and left of year round. A switch should be installed and it should only be used as recovery in the case that the line were to freeze.						

Rank	Location		Description of Existing		Efficiency Recommendation	
8	Pump house Electric Heaters		2 Electric Heater with Manual Switching		Alternate heater in use and run at a lower setting.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$633	
Breakeven Cost	$3,918	**Savings-to-Investment Ratio**	7.8	**Simple Payback yrs**	1	
Auditors Notes: Reduce heating setpoint to 50 degrees when pump house is unoccupied.						

Rank	Location		Description of Existing		Efficiency Recommendation	
18	Raw Water Heat Add Circ Pump		Pump with Manual Switching		Turn off during the summer.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$262	
Breakeven Cost	$2,180	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	8	
Auditors Notes: Move location of Sequest-All injection point so that this circulation pump may be shut off during the summer.						

4.5.6 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
3		West Circ Loop Heat Add Load		Replace controls, heat exchanger, corroded copper pipe, Belimo valve, and circulation pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	
Installation Cost	$12,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$11,114
Breakeven Cost	$150,608	**Savings-to-Investment Ratio**	12.6	**Simple Payback yrs**	1
Auditors Notes: Replace corroded copper pipe to reduce leakage and ensure proper positioning of temperature sensors (sensor on East Loop has fallen out due to surrounding corrosion). Both solenoid valves on the circ loops were hot, suggesting they are activated, but there is no clear indicator as to whether their default position is open or closed. Replace solenoid valves with Belimo valves to eliminate confusion and ensure that flow occurs at the correct times. Replace aging heat exchangers to increase efficiency of heat transfer. The suggested improvements would make heating control more accurate and reliable and give the operator confidence to lower the operating temperature by 10 degrees F, saving on heating costs.					

Rank	Location	Description of Existing		Efficiency Recommendation	
4		East Circ Loop Heat Add Load		Replace controls, heat exchanger, corroded copper pipe, Belimo valve, and circulation pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	
Installation Cost	$12,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$10,812
Breakeven Cost	$146,521	**Savings-to-Investment Ratio**	12.2	**Simple Payback yrs**	1
Auditors Notes: Replace corroded copper pipe to reduce leakage and ensure proper positioning of temperature sensors (sensor on this loop has fallen out due to surrounding corrosion). Both solenoid valves on the circ loops were hot, suggesting they are activated, but there is no clear indicator as to whether their default position is open or closed. Replace solenoid valves with Belimo valves to eliminate confusion and ensure that flow occurs at the correct times. Replace aging heat exchangers to increase efficiency of heat transfer. The suggested improvements would make heating control more accurate and reliable and give the operator confidence to lower the operating temperature by nearly 20 degrees F, saving on heating costs.					

Rank	Location	Description of Existing		Efficiency Recommendation	
20		Water Storage Tank Heat Load		Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circulation pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.	
Installation Cost	$12,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$556
Breakeven Cost	$7,528	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	22
Auditors Notes: The piping on this section has corroded resulting in multiple pinhole leaks that the operator has repaired with various tapes and paint on sealants. There is currently no flow through the recovered heat loop of this heat add system, suggesting that pipes may be clogged. Replace corroded copper pipe to reinstate flow through heat recovery loop, reduce leakage and ensure proper functioning of temperature sensors (one on East circ loop has fallen out due to surrounding corrosion). Replace solenoid valves with Belimo valves to eliminate confusion and ensure that flow occurs at the correct times. Replace aging heat exchangers to increase efficiency of heat transfer. The suggested improvements would make heating control more accurate and reliable and allow the heat recovery system to meet a greater proportion of the heat demand, reducing fuel consumption. Accurate heating control at the storage tank is necessary in order to be able to lower the setpoint temperature on the circ loops and realize the benefits of the suggested circ loop heat add repairs.					

Rank	Location	Description of Existing	Efficiency Recommendation
22		Raw Water Heat Add Load	Replace controls, heat exchanger, corroded copper pipe, Belimo valve, circ pump to provide ability and confidence to maintain lower operating temperature of 40 degrees.

Installation Cost	$16,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$19
Breakeven Cost	$226	**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	832

Auditors Notes: Replace corroded copper pipe to reduce leakage and ensure proper functioning of temperature sensors (one on East circ loop has fallen out due to surrounding corrosion). Replace aging motorized valves with Belimo valves to ensure ability to control flow through heat exchangers. Replace aging heat exchangers to increase efficiency of heat transfer. The suggested improvements would make better heating control possible and give the operator confidence to lower the operating temperature. Accurate heating control of the raw water is necessary in order to be able to lower the setpoint temperature on the circ loops and realize the benefits of the suggested circ loop heat add repairs.

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 Kiana in the development of a proposal based on the retrofits identified in this report as part of the RACEE competition. If accepted into the third round of this competition, the suggested retrofits could be funded by the DOE as part of RACEE. Regardless of the results of the RACEE competition, ANTHC will continue to work with the City of Kiana to secure project funding and implement the energy efficiency measures identified in this report.

APPENDICES

Appendix A– Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Kiana Water Treatment Plant	**Auditor Company:** ANTHC
Address: Kiana	**Auditor Name:** Bailey Gamble and Chris Mercer
City: Kiana **Client Name:** Richard Teel	**Auditor Address:** 4500 Diplomacy Dr., Suite 545 Anchorage, AK 99508
Client Address:	**Auditor Phone:** (907) 729-4501 **Auditor FAX:** (907) 729-3729
Client Phone: (907) 475-5115 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 1,616 square feet	**Design Space Heating Load:** Design Loss at Space: 28,362 Btu/hour with Distribution Losses: 29,855 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 45,511 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Kiana	**Design Outdoor Temperature:** -45 deg F
Weather/Fuel City: Kiana	**Heating Degree Days:** 15,675 deg F-days
Utility Information	
Electric Utility: AVEC-Kiana - Commercial - Sm	**Average Annual Cost/kWh:** $0.492/kWh

Annual Energy Cost Estimate							
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$2,926	$5,338	$32,696	$1,292	$46,517	$7,665	**$96,492**
With Proposed Retrofits	$1,527	$1,210	$26,563	$1,088	$23,602	$3,942	**$57,992**
Savings	$1,398	$4,128	$6,133	$204	$22,915	$3,723	**$38,500**

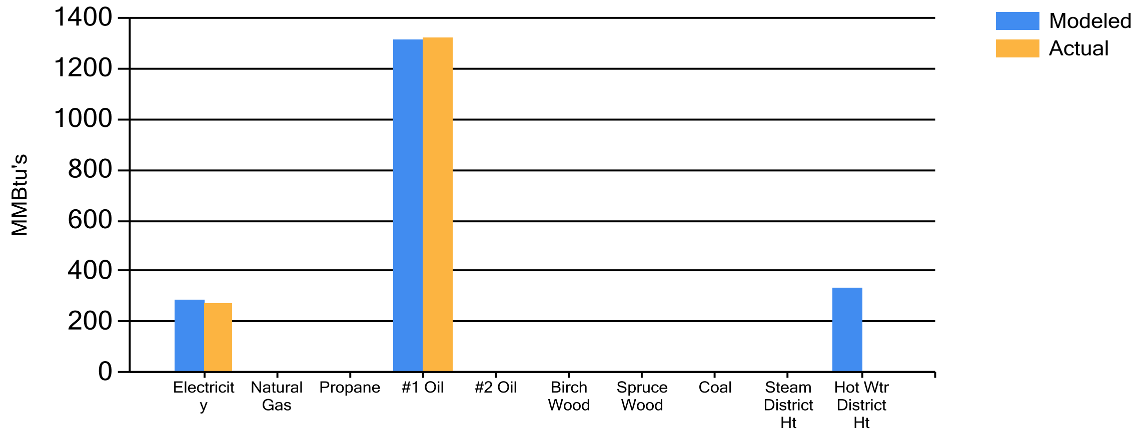
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	1,197.5	76.40	$59.71
With Proposed Retrofits	756.5	48.26	$35.89

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.

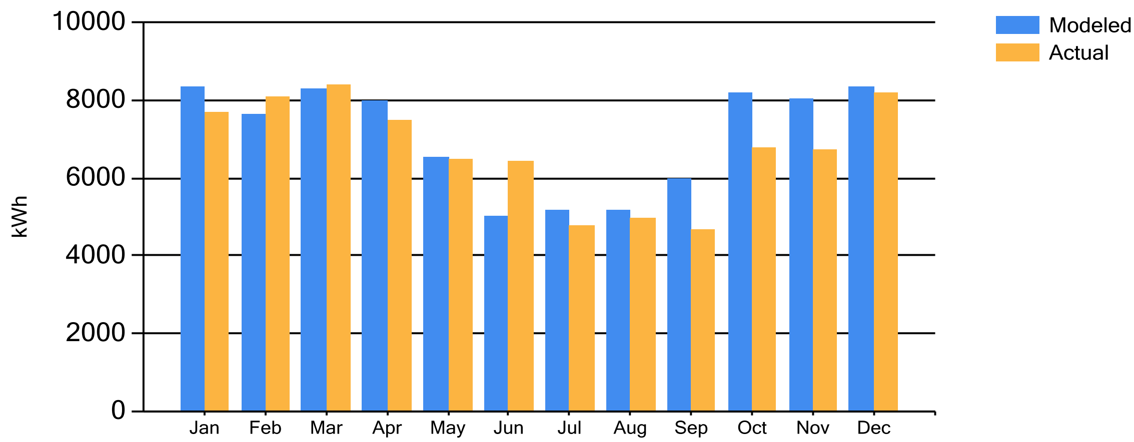
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

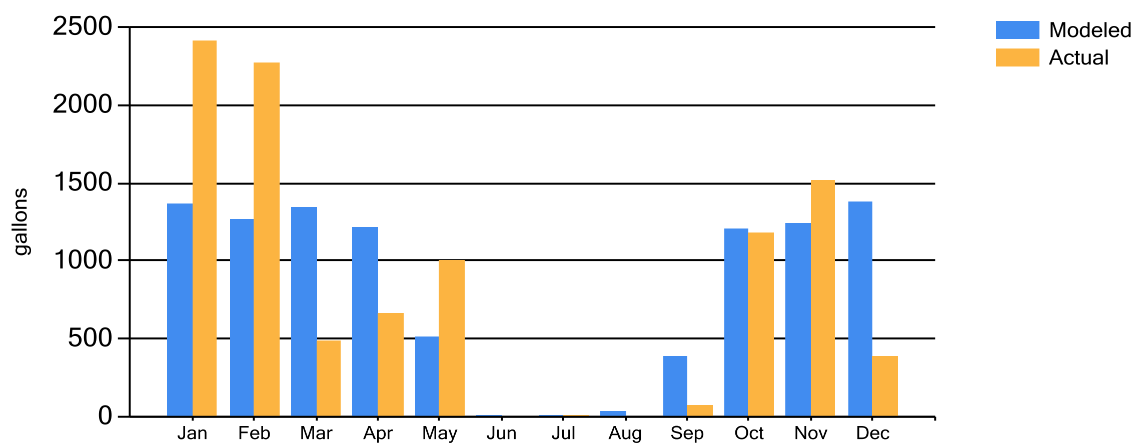
Annual Fuel Use



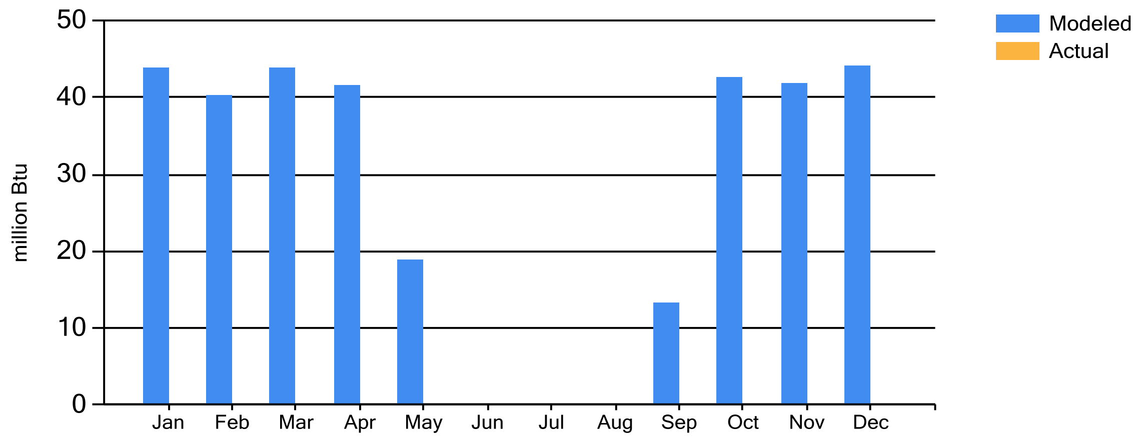
Electricity Fuel Use



#1 Fuel Oil Fuel Use



Recovered Heat Use



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

Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	19.4	19.4	19.3	19.2	17.2	15.7	15.7	15.7	16.8	19.1	19.3	19.4
As Proposed	16.1	16.1	16.0	15.9	13.0	10.6	10.6	10.6	12.3	15.8	16.0	16.1

AkWarmCalc Ver 2.5.3.0, Energy Lib 3/7/2016