Comprehensive Energy Audit
For

Minto Water Treatment Plant

Prepared For

Native Village of Minto

October 19, 2015

Prepared By:

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Table of Contents

PREFACE

This energy audit was conducted using funds from the United States Department of Agriculture Rural Utilities Service as well as the State of Alaska Department of Environmental Conservation. Coordination with the State of Alaska Remote Maintenance Worker (RMW) Program and the associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The Village of Minto, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Kevin Ulrich. Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in May of 2015 by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Dudley Smith and Jeremy Charlie, Minto Tribal Administrator Bessie Titus, and Minto First Chief Carla Smith.

1. EXECUTIVE SUMMARY

This report was prepared for the Village of Minto. The scope of the audit focused on Minto Water Treatment Plant. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, heating and ventilation systems, and plug loads.

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

The total predicted energy cost for the Minto Water Treatment Plant is $30,971 per year. Electricity represents the largest portion with an annual cost of $27,080. This includes $10,903 paid by the village and $16,898 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The next largest portion of energy costs is from the heat recovery system used from the Alaska Village Electric Cooperative (AVEC) power plant located in the same building. The recovered heat has an annual cost of $2,857. Fuel oil represents the remaining portion of the building energy consumption with an annual cost of $311. The vast majority of the building heating loads are met through the use of an existing heat recovery system from the power plant to the water treatment plant.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy affordable in rural Alaska. In Minto, the cost of electricity without PCE is $0.52/KWH and the cost of electricity with PCE is $0.20/KWH.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	53,790 kWh	45,120 kWh
#1 Oil	61 gallons	60 gallons
Hot Wtr District Ht	388.73 million Btu	375.08 million Btu

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

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	321.0	20.67	$17.13
With Proposed Retrofits	297.0	19.13	$14.67
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day.			

ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Minto Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
1	Controls Retrofit: Circulation Pump Loop 3	Shut off circulation pump from April 30th to October 1st.	$410	$500	9.63	1.2	1,475.0
2	Controls Retrofit: Circulation Pump Loop 2	Shut off circulation pump from April 30th to October 1st.	$268	$500	6.29	1.9	964.4
3	Lighting - Power Retrofit: WTP Lighting - Work Area	Replace with new energy-efficient LED lighting.	$527	$1,000	6.15	1.9	1,781.8
4	Lighting - Power Retrofit: WTP Lighting Non Work Area	Replace with new energy-efficient LED lighting.	$394	$1,000	4.60	2.5	1,329.2
5	Other Electrical - Power Retrofit: Well Circulation Pump	Replace existing circulation pumps with Grundfos Alpha pumps	$539	$1,000	4.52	1.9	1,818.3
6	Controls Retrofit: Circulation Pump Loop 1	Shut off circulation pump from April 30th to October 1st.	$138	$500	3.24	3.6	497.1
7	Heating, Ventilation, and Domestic Hot Water	Replace existing glycol circulation pumps with Grundfos Magna pumps.	$1,320	$6,000	3.19	4.5	4,456.3
8	Lighting - Power Retrofit: Exterior Lights	Replace with new energy-efficient LED lighting.	$474	$2,000	2.79	4.2	1,707.4
9	Temperature Controls	Reset main well temperature controller from 50 degrees to 40 degrees.	$69	$1,000	0.90	14.4	523.5
10	Temperature Controls	Reset arts and crafts well heat add from 50 degrees to 40.	$69	$1,000	0.90	14.4	523.5
11	Controls Retrofit: Well Circulation Pump	Use Grundfos Alpha pumps to reduce run time of well circulation lines.	$78	$1,000	0.65	12.8	262.8
12	Air Tightening	Seal cracks around doors, windows, and vents to reduce air leakage,	$45	$600	0.65	13.4	241.8
13	Temperature Controls	Reset Heat Add Temperature controller from 50 degrees to 40 degrees.	$112	$3,000	0.48	26.9	842.9
	TOTAL, all measures		**$4,443**	**$19,100**	**2.82**	**4.3**	**16,423.9**

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 $4,443 per year, or 14.3% of the buildings' total energy costs. These measures are estimated to cost $19,100, for an overall simple payback period of 4.3 years.

Table 1.2 below is a breakdown of the annual energy cost across various energy end use types, such as Space Heating and Water Heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.2

Annual Energy Cost Estimate							
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$4,480	$3,105	$20,214	$1,540	$1,244	$327	**$30,971**
With Proposed Retrofits	$3,289	$1,560	$18,767	$1,398	$1,127	$328	**$26,528**
Savings	$1,191	$1,546	$1,447	$142	$117	-$1	**$4,443**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Minto Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, and heating and ventilation equipment, motors and pumps. Measures were analyzed based on life-cycle-cost techniques, which include the initial cost of the equipment, life of the equipment, annual energy cost, annual maintenance cost, and a discount rate of 3.0%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information was gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is used and what opportunities exist within a building. The entire site was surveyed to inventory the following to gain an understanding of how each building operates:

• Building envelope (roof, windows, etc.)
• Heating and ventilation equipment
• Lighting systems and controls
• Building-specific equipment

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

Details collected from Minto 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.

The Minto Water Treatment Plant has a total area of 1,808 square feet.

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:
• Occupancy hours
• Local climate conditions
• Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; heating and ventilation; lighting, plug load, and other electrical improvements; and motor and pump systems that will reduce annual energy consumption.

EEMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. Energy savings are calculated based on industry standard methods and engineering estimations.

Our analysis provides a number of tools for assessing the cost effectiveness of various improvement options. These tools utilize **Life-Cycle Costing**, which is defined in this context as a method of cost analysis that estimates the total cost of a project over the period of time that includes both the construction cost and ongoing maintenance and operating costs.

Savings to Investment Ratio (SIR) = **Savings** divided by **Investment**

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the Department of Energy are included. Future savings are discounted to the present to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation includes the labor and materials required to install the measure. An SIR value of at least 1.0 indicates that the project is cost-effective—total savings exceed the investment costs.

Simple payback is a cost analysis method whereby the investment cost of a project is divided by the first year's savings of the project to give the number of years required to recover the cost of the investment. This may be compared to the expected time before replacement of the system or component will be required. For example, if a boiler costs $12,000 and results in a savings of $1,000 in the first year, the payback time is 12 years. If the boiler has an expected life to replacement of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the project life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money). Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

Measures are implemented in order of cost-effectiveness. The program first calculates individual SIRs, and ranks all measures by SIR, higher SIRs at the top of the list. An individual measure must have an individual SIR>=1 to make the cut. Next the building is modified and re-simulated with the highest ranked measure included. Now all remaining measures are re-evaluated and ranked, and the next most cost-effective measure is implemented. AkWarm goes through this iterative process until all appropriate measures have been evaluated and installed.

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first, and then cycling through the list to find the next most cost effective measure. Implementation of more than one EEM often affects the savings of other EEMs. The savings may in some cases be relatively higher if an individual EEM is implemented in lieu of multiple recommended EEMs. For example implementing a reduced operating schedule for inefficient lighting will result in relatively high savings. Implementing a reduced operating schedule for newly installed efficient lighting will result in lower relative savings, because the efficient lighting system uses less energy during each hour of operation. If multiple EEM's are recommended to be implemented, AkWarm calculates the combined savings appropriately.

Cost savings are calculated based on estimated initial costs for each measure. Installation costs include labor and equipment to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers.

2.4 Limitations of Study

All results are dependent on the quality of input data provided, and can only act as an approximation. In some instances, several methods may achieve the identified savings. This report is not intended as a final design document. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

3. Minto Water Treatment Plant

3.1. Building Description

The 1,808 square foot Minto Water Treatment Plant was constructed in 1970 with a normal occupancy of 1 people. The number of hours of operation for this building average 5 hours per day, considering all seven days of the week.

The Minto Water Treatment Plant serves as the water distribution center for the residents of the community. There are three distribution loops that are used to circulate water throughout the town. One loop serves the west part of town and is approximately 2650 ft. long. A second loop serves the north part of town and is approximately 5900 ft. long. A third loop serves the south part of town and is approximately 5775 ft. long.

Water is pumped into the water treatment plant from a well that is under the influence of surface water. The water is piped through two pressure filters and injected with chlorine before getting sent to the water storage tank. Pressure pumps are used to keep the pressure up in the water distribution system.

Description of Building Shell

The exterior walls of the water treatment plant are of single stud construction with 2X6 framing. The walls have 5.5 inches of R21 batt insulation in slightly damaged condition and there is approximately 1,450 square feet of wall space in the building. The utilidor walls leading to the water storage tank are constructed with stressed skin panels with 5.5 inches of polyurethane foam insulation that is slightly damaged. There is approximately 273 square feet of utilidor wall space.

The roof of the water treatment plant building has a cathedral ceiling with standard 16-inch spacing. The roof of the water treatment plant has 5.5 inches of R21 batt insulation that is slightly damaged and there is approximately 1,833 square feet of roof space. The roof of the utilidor has a cathedral ceiling with standard 16-inch spacing. The roof of the water treatment plant has 5.5 inches of R21 batt insulation that is slightly damaged and there is approximately 106 square feet of roof space.

The building is constructed on a concrete slab on grade with no insulation on the perimeter of the building. The water treatment plant building and the utilidor combine to have 1,906 square feet of floor space.

There are no windows in the Minto Water Treatment Plant.

There is one set of two doors in the water treatment plant. The doors are metal with an insulated core and combine to have approximately 42 square feet of space.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLain Gold 1

Nameplate Information:	WTGO-8
Fuel Type:	#1 Oil
Input Rating:	231,000 BTU/hr
Steady State Efficiency:	85 %
Idle Loss:	0.25 %
Heat Distribution Type:	Glycol
Boiler Operation:	Nov - Apr

Weil McLain Gold 2

Nameplate Information:	WTGO-8
Fuel Type:	#1 Oil
Input Rating:	231,000 BTU/hr
Steady State Efficiency:	85 %
Idle Loss:	0.25 %
Heat Distribution Type:	Glycol
Boiler Operation:	Nov - Apr

Heat Recovery System

Fuel Type:	Hot Wtr District Ht
Input Rating:	306,000 BTU/hr
Steady State Efficiency:	99 %
Idle Loss:	0.25 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Space Heating Distribution Systems

There are four unit heaters that distribute space heat from the hydronic system throughout the building. The four unit heaters are controlled by two thermostats and combine to distribute approximately 40,000 BTU/hr.

Heat Recovery Information

The Minto Water Treatment Plant completed a heat recovery project in 2012. The heat recovery system captures heat from the generators from the power plant, co-located in the same building as the water treatment plant, and transfers that heat to the water treatment plant hydronic system prior to the fuel oil boilers. The heat recovery system completely covers all heating loads for the building. The power plant is an AVEC facility.

Lighting

The main room of the water treatment plant has nine fixtures with two T12 fluorescent light bulbs in each fixture.

The additional space in the building has nine fixtures with two T12 fluorescent light bulbs in each fixture.

The exterior of the building has three fixtures with a single HPS 70 Watt light bulb in each fixture.

Plug Loads

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

Major Equipment

There is a well pump that is used to pump water from the well into the water treatment plant building. The pump consumes approximately 15,363 KWH annually.

There is a circulation pump that is used to circulate water through a distribution loop to the community. The pump consumes approximately 2,762 KWH annually.

There is a second circulation pump that is used to circulate water through a second distribution loop to the community. The pump consumes approximately 5,358 KWH annually.

There is a third circulation pump that is used to circulate water through a third distribution loop to the community. The pump consumes approximately 8,194 KWH annually.

There is a pressure pump that is used to maintain pressure in the water distribution system. The pump consumes approximately 1,594 KWH annually.

There is a well circulation pump that is used to circulate water between the water treatment plant and the well for freeze protection purposes. The pump consumes approximately 1,792 KWH annually.

There is a heat recovery pump that is used to transport the heated glycol from the power plant to the water treatment plant. The pump consumes approximately 1,534 KWH annually.

There are a variety of controls and electrical equipment that is used during normal operations of the water treatment plant. These items consume approximately 2,630 KWH annually.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One KW of electric demand is equivalent to 1,000 watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

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

The Alaska Village Electric Cooperative (AVEC) provides electricity to the residents of Minto as well as all the commercial and public facilities.

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.52/kWh
#1 Oil	$ 5.10/gallons
Hot Wtr District Ht	$ 7.35/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Minto pays approximately $30,971 annually for electricity and other fuel costs for the Minto Water Treatment Plant.

Figure 3.1 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the “Retrofit” bar in the figure to the “Existing” bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

Figure 3.1
Annual Energy Costs by End Use

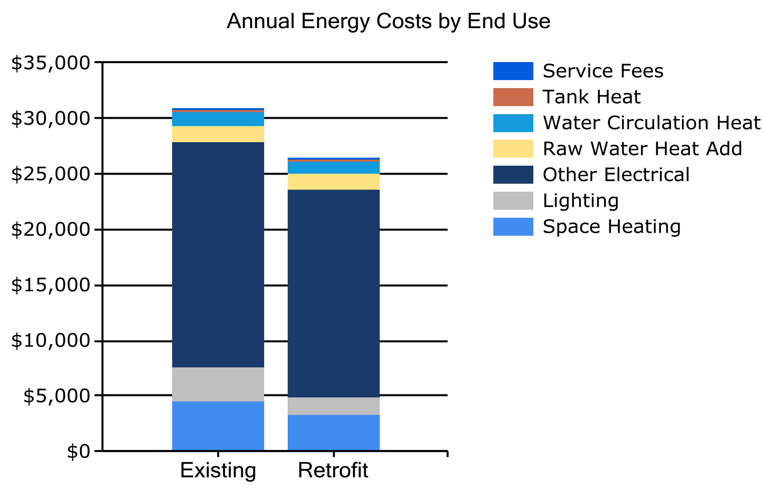


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

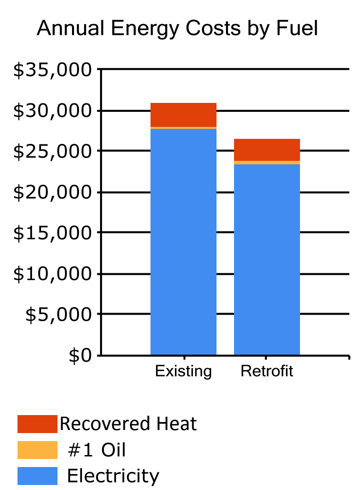
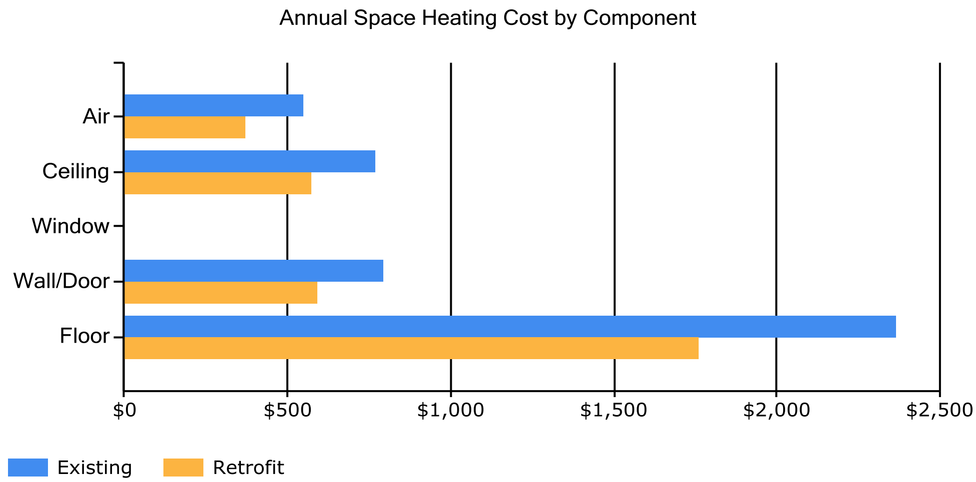


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses.

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	933	788	769	585	486	43	32	64	131	648	781	913
Lighting	572	521	572	553	451	380	393	393	473	572	553	572
Other_Electrical	4139	3772	4139	4006	2583	1731	1788	1788	2944	4139	4006	4139
Raw_Water_Heat_Add	298	272	298	288	2	2	2	2	288	298	289	298
Water_Circulation_Heat	17	14	12	4	0	0	0	0	1	6	12	16
Tank_Heat	4	4	3	1	0	0	0	0	0	2	3	4

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	6	5	5	1	0	0	0	0	1	1	5	6
Raw_Water_Heat_Add	1	0	1	0	0	0	0	0	0	0	1	1
Water_Circulation_Heat	4	4	4	1	0	0	0	0	0	1	4	4
Tank_Heat	1	1	1	0	0	0	0	0	0	0	1	1

Hot Water District Ht Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	28	22	19	10	5	2	1	3	7	13	21	27
Raw_Water_Heat_Add	4	3	4	3	4	4	4	4	4	4	3	4
Water_Circulation_Heat	31	24	20	9	1	0	0	0	2	11	22	30
Tank_Heat	8	6	5	2	0	0	0	0	0	3	6	8

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.
The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

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

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

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

Table 3.4
Minto Water Treatment Plant 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	53,790 kWh	183,586	3.340	613,179
#1 Oil	61 gallons	8,096	1.010	8,177
Hot Wtr District Ht	388.73 million Btu	388,733	1.280	497,579
Total		**580,416**		**1,118,934**
BUILDING AREA		1,808	Square Feet	
BUILDING SITE EUI		321	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		619	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**321.0**	**20.67**	**$17.13**
With Proposed Retrofits	**297.0**	**19.13**	**$14.67**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The heating and ventilation systems and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Minto Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Minto was used for analysis. From this, the model was be calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Minto. 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 model does not model heating and ventilation systems that simultaneously provide both heating to the same building space (typically done as a means of providing temperature control in the space).

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1
Minto Water Treatment Plant, Minto, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Controls Retrofit: Circulation Pump Loop 3	Shut off circulation pump from April 30th to October 1st.	$410	$500	9.63	1.2	1,475.0
2	Controls Retrofit: Circulation Pump Loop 2	Shut off circulation pump from April 30th to October 1st.	$268	$500	6.29	1.9	964.4
3	Lighting - Power Retrofit: WTP Lighting - Work Area	Replace with new energy-efficient LED lighting.	$527	$1,000	6.15	1.9	1,781.8
4	Lighting - Power Retrofit: WTP Lighting Non Work Area	Replace with new energy-efficient LED lighting.	$394	$1,000	4.60	2.5	1,329.2
5	Other Electrical - Power Retrofit: Well Circulation Pump	Replace existing circulation pumps with Grundfos Alpha pumps	$539	$1,000	4.52	1.9	1,818.3
6	Controls Retrofit: Circulation Pump Loop 1	Shut off circulation pump from April 30th to October 1st.	$138	$500	3.24	3.6	497.1
7	Heating, Ventilation, and Domestic Hot Water	Replace existing glycol circulation pumps with Grundfos Magna pumps.	$1,320	$6,000	3.19	4.5	4,456.3

Table 4.1 Minto Water Treatment Plant, Minto, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
8	Lighting - Power Retrofit: Exterior Lights	Replace with new energy-efficient LED lighting.	$474	$2,000	2.79	4.2	1,707.4
9	Temperature Controls	Reset main well temperature controller from 50 degrees to 40 degrees.	$69	$1,000	0.90	14.4	523.5
10	Temperature Controls	Reset arts and crafts well heat add from 50 degrees to 40.	$69	$1,000	0.90	14.4	523.5
11	Controls Retrofit: Well Circulation Pump	Use Grundfos Alpha pumps to reduce run time of well circulation lines.	$78	$1,000	0.65	12.8	262.8
12	Air Tightening	Seal cracks around doors, windows, and vents to reduce air leakage,	$45	$600	0.65	13.4	241.8
13	Temperature Controls	Reset Heat Add Temperature controller from 50 degrees to 40 degrees.	$112	$3,000	0.48	26.9	842.9
	TOTAL, all measures		**$4,443**	**$19,100**	**2.82**	**4.3**	**16,423.9**

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 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
12		Arctic Entry with leaky siding and improperly mounted hinges.		Seal arctic entry gap and insulate to reduce air leakage.	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$45
Breakeven Cost	$389	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	13
Auditors Notes: The arctic entry has been detached from the main building. There is a 3-inch gap between the arctic entry and the building that allows cold outside air to penetrate into the main building. Use plywood to seal the gap and use spray foam insulation to insulate the space. This will reduce air leakage and improve the thermal resistance of the arctic entry.					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
7	Replace existing glycol circulation pumps with Grundfos Magna pumps.				
Installation Cost	$6,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,320
Breakeven Cost	$19,136	**Savings-to-Investment Ratio**	3.2	**Simple Payback yrs**	5
Auditors Notes: Replace the existing glycol circulation pumps with Grundfos Magna pumps. These pumps have a variable speed controller that is used to operate the pump only at the level necessary to meet the present demand. This reduces run times and excess heat loss while improving the efficiency of the glycol circulation.					

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 loads. The building 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	
3	WTP Lighting - Work Area	9 fixtures with 2 fluorescent T12 4' F40T12 34W Energy-Saver EfficMagnetic light bulbs in each fixture.		Replace with new energy-efficient LED lighting.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$527
Breakeven Cost	$6,152	**Savings-to-Investment Ratio**	6.2	**Simple Payback yrs**	2
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast. Replace with 17W LED 4ft. light bulbs.					

Rank	Location	Existing Condition		Recommendation	
4	WTP Lighting Non Work Area	9 fixtures with 2 fluorescent T12 4' F40T12 34W Energy-Saver EfficMagnetic light bulbs in each fixture.		Replace with new energy-efficient Led lighting.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$394
Breakeven Cost	$4,598	**Savings-to-Investment Ratio**	4.6	**Simple Payback yrs**	3
Auditors Notes: Convert fluorescent fixtures to LED and eliminate ballast. Replace with 17W LED 4ft. light bulbs.					

Rank	Location	Existing Condition		Recommendation	
8	Exterior Lights	3 fixtures with one HPS 70 Watt light bulb in each fixture.		Replace with new energy-efficient Led lighting.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$474
Breakeven Cost	$5,572	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	4
Auditors Notes: Convert HPS fixtures to LED. Replace with 20W LED bulbs.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Circulation Pump Loop 3	Circulation Pump		Shut off circulation pump from April 30th to October 1st.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$410
Breakeven Cost	$4,814	**Savings-to-Investment Ratio**	9.6	**Simple Payback yrs**	1
Auditors Notes: Stop using circulation pump April 30th and don't start using until October 1st. . The circulation pumps don’t need to run during seasons with no heating required.					

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Circulation Pump Loop 2	Circulation Pump		Shut off circulation pump from April 30th to October 1st.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$268
Breakeven Cost	$3,147	**Savings-to-Investment Ratio**	6.3	**Simple Payback yrs**	2
Auditors Notes: Stop using circulation pump April 30th and don't start using until October 1st. . The circulation pumps don’t need to run during seasons with no heating required.					

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Well Circulation Pump	Well Circulation Pump		Replace with Grundfos Alpha 100W pump	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$539
Breakeven Cost	$4,520	**Savings-to-Investment Ratio**	4.5	**Simple Payback yrs**	2
Auditors Notes: Replace the current pumps with two Grundfos Alpha smart pumps to vary the pump usage based on the demand for water from the well. This will reduce pump run times, increase pump efficiency, and extend the life of the pumps.					

Rank	Location	Description of Existing	Efficiency Recommendation		
6	Circulation Pump Loop 1	Circulation Pump	Shut off circulation pump from April 30th to October 1st.		
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$138
Breakeven Cost	$1,622	**Savings-to-Investment Ratio**	3.2	**Simple Payback yrs**	4
Auditors Notes: Stop using circulation pump April 30th and don't start using it until October 1st. The circulation pumps don't need to run during seasons with no heating required.					

Rank	Location	Description of Existing	Efficiency Recommendation		
11	Well Circulation Pump	Well Circulation Pump	Shut the pump off during non-heating seasons and use variable speed controller to reduce pump run time.		
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$78
Breakeven Cost	$653	**Savings-to-Investment Ratio**	0.7	**Simple Payback yrs**	13
Auditors Notes: The pump currently runs constantly when in operation. Use the Grundfos Alpha pump variable speed controller to run the pump only when there is a demand for water. This will reduce run times, increase efficiency, and extend the life of the pumps.					

4.5.3 Other Measures

Rank	Location	Description of Existing	Efficiency Recommendation		
9		Main Well Heat Add	Reset main well temperature controller from 50 degrees to 40 degrees.		
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$69
Breakeven Cost	$902	**Savings-to-Investment Ratio**	0.9	**Simple Payback yrs**	14
Auditors Notes: Lower the operating temperature of the circulation loop to eliminate unnecessary heat loads.					

Rank	Location	Description of Existing	Efficiency Recommendation		
10		Arts & Craft Raw Water Heat Add	Reset arts and crafts well heat add from 50 degrees to 40.		
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$69
Breakeven Cost	$902	**Savings-to-Investment Ratio**	0.9	**Simple Payback yrs**	14
Auditors Notes: Lower the operating temperature of the circulation loop to eliminate unnecessary heat loads.					

Rank	Location	Description of Existing	Efficiency Recommendation		
13		Water Circulation Heat Load #2	Reset Heat Add Temperature controller from 50 degrees to 40 degrees.		
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$112
Breakeven Cost	$1,452	**Savings-to-Investment Ratio**	0.5	**Simple Payback yrs**	27
Auditors Notes: Lower the operating temperature of the circulation loop to eliminate unnecessary heat loads.					

5. ENERGY EFFICIENCY ACTION PLAN

Through inspection of the energy-using equipment on-site and discussions with site facilities personnel, this energy audit has identified several energy-saving measures. The measures will reduce the amount of fuel burned and electricity used at the site. The projects will not degrade the performance of the building and, in some cases, will improve it.

Several types of EEMs can be implemented immediately by building staff, and others will require various amounts of lead time for engineering and equipment acquisition. In some cases, there are logical advantages to implementing EEMs concurrently. For example, if the same electrical contractor is used to install both lighting equipment and motors, implementation of these measures should be scheduled to occur simultaneously.

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

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Minto Water Treatment Plant	**Auditor Company:** ANTHC
Address: PO Box 58026	**Auditor Name:** Carl Remley
City: Minto	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Dudley Smith & Jeremy Charlie	
Client Address: PO Box 58026 Minto, AK 99758	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 798-7015	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,808 square feet	**Design Space Heating Load:** Design Loss at Space: 62,334 Btu/hour with Distribution Losses: 62,334 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 95,021 Btu/hour Note: Additional Capacity should be added for domestic hot water and other plant loads, if served.
Typical Occupancy: 1 person	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Minto	**Design Outdoor Temperature:** -54.8 deg F
Weather/Fuel City: Minto	**Heating Degree Days:** 15,528 deg F-days
Utility Information	
Electric Utility: AVEC-Minto	**Average Annual Cost/kWh:** $0.52/kWh

Annual Energy Cost Estimate							
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$4,480	$3,105	$20,214	$1,540	$1,244	$327	**$30,971**
With Proposed Retrofits	$3,289	$1,560	$18,767	$1,398	$1,127	$328	**$26,528**
Savings	$1,191	$1,546	$1,447	$142	$117	-$1	**$4,443**

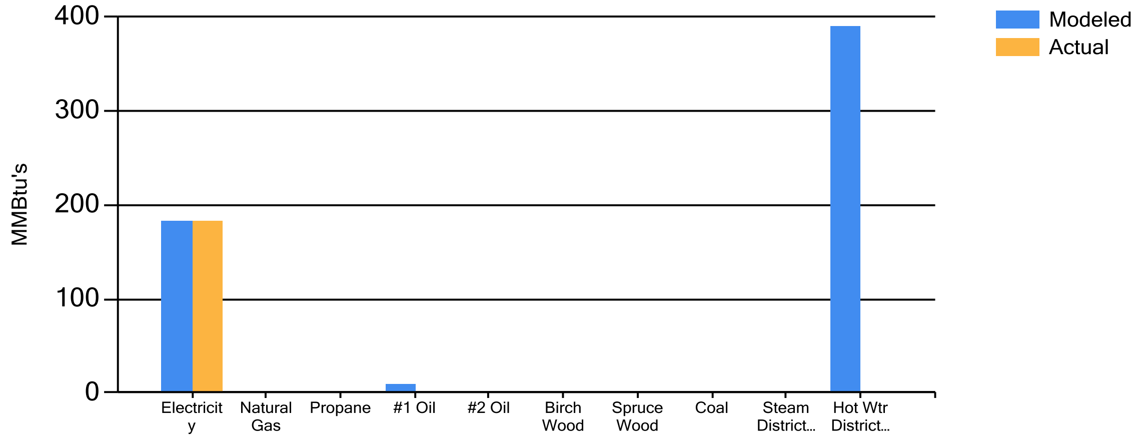
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	321.0	20.67	$17.13
With Proposed Retrofits	297.0	19.13	$14.67

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.

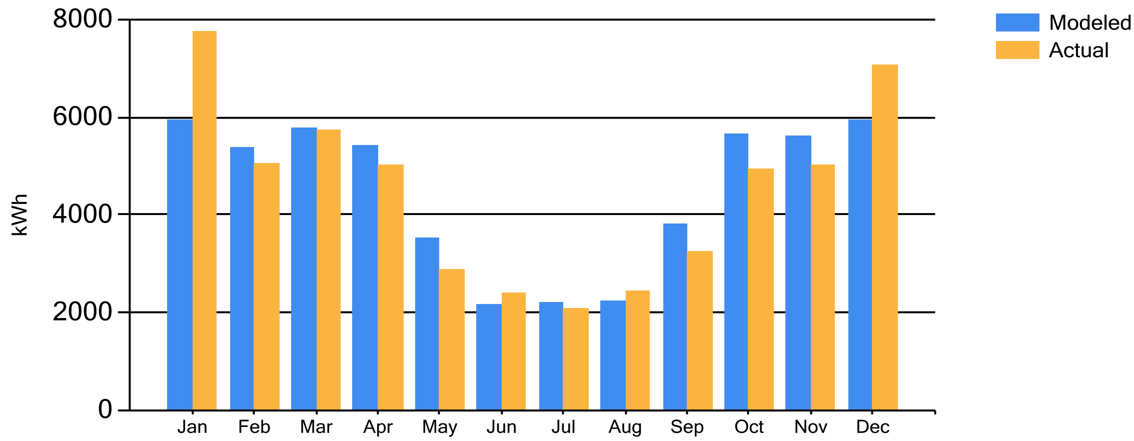
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

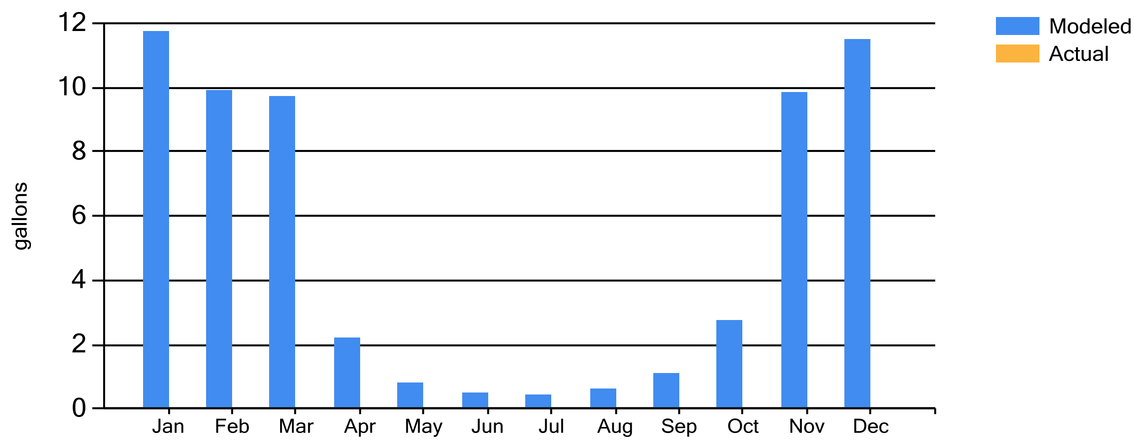
Annual Fuel Use



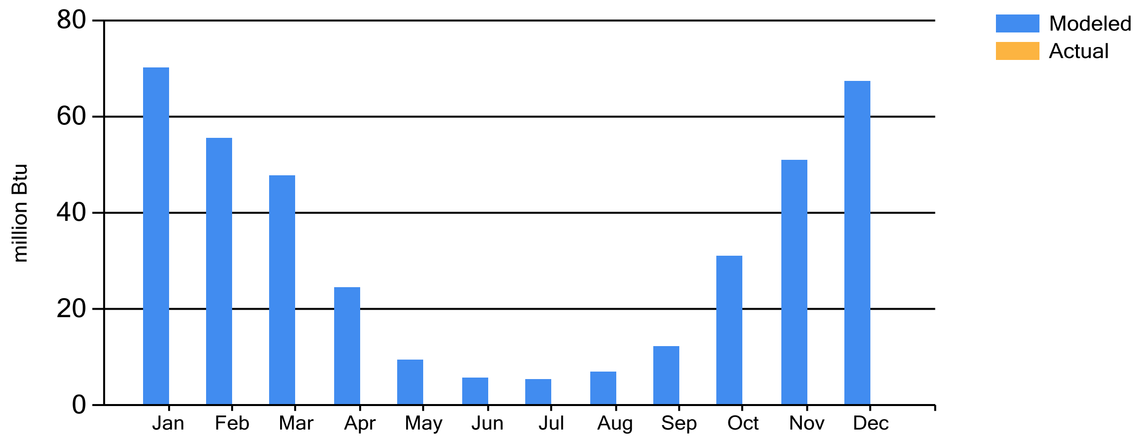
Electricity Fuel Use



#1 Fuel Oil Fuel Use



Recovered Heat Fuel Use


80
60
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million Btu
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Jun
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Modeled
Actual