Comprehensive Energy Audit
For
Grayling WTP

Prepared For
City Of Grayling

July 29, 2014

Prepared By:

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Grayling, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon. Kevin Ulrich and Martin Wortman also participated in the onsite portion of this audit.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in April of 2014 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 energy conservation action plan are also included in this report.

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 RMW Program and associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

In the near future, a representative of ANTHC will be contacting both the City of Grayling and the water treatment plant operator to follow up on the recommendations made in this audit report. A Rural Alaska Village Grant has funded ANTHC to provide the City with assistance in understanding the report and in implementing the recommendations. Funding for implementation of the recommended retrofits is being partially provided for by the above listed funding agencies, as well as the State of Alaska.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Joshua Koyukuk and Kyle Anthony, Mayor Shirley Clark, City Administrator Ann Short, and Remote Maintenance Worker Bruce Werba.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Grayling. The scope of the audit focused on Grayling WTP. 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, water treatment energy use, and plug loads.

The total predicted energy cost for the WTP is $79,026 per year. This total compares favorably with the $68,810 actual cost. Electricity represents the largest piece with an annual cost of $50,841 per year. This includes $16,639 paid by the end-users and $34,202 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The WTP including the circulation loops and water storage tank was modeled to spend $28,083 for #1 heating oil. These predictions are based on the electricity and fuel prices at the time of the audit.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy in rural Alaska affordable. In Grayling, the cost of electricity without PCE is $0.55/KWH, and the cost of electricity with PCE is $0.18/KWH.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Grayling WTP. 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]
1	Thermostat – Reprogram existing thermostat	Reset Thermostat in South Lift Station #1 to 50 Degrees	$998	$200	58.59	0.2
2	Lighting – Reduce lighting cost in North Lift Station	Teach operators that lift station lighting should only be on when lift station is occupied.	$420	$110	23.62	0.3
3	Thermostat – Install new thermostat in WTP and set to 50 degrees.	Add remote thermostat in the North Lift Station and set it at 50 degrees	$1,540	$1,000	18.09	0.6

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]**
4	Lighting – Reduce lighting cost in South Lift Station.	Relocate light switch for south lift station from outside building to inside and train to only use lights when building is occupied.	$420	$200	12.99	0.5
5	Thermostat – Combined Retrofit: Intake Gallery Space Heating	Add remote thermostat in the Intake Gallery and set at 50 degrees	$1,748	$2,000	10.27	1.1
6	Other Electrical – Identify and repair leaks in distribution piping to reduce pumping electrical usage	Find and repair leaks to reduce water treatment and pumping needs.	$7,112	$6,000	9.98	0.8
7	Lighting - Replace the Gallery exterior metal halide light fixture with LED wall pack.	Replace with energy-efficient LED lighting and a photocell light sensor.	$170	$500	4.96	2.9
8	Lighting – Replace WTP interior fluorescent lighting with LED replacement bulbs.	Replace with energy-efficient LED lighting and eliminate ballasts.	$1,521 Plus $200 Maintenance Savings	$6,000	4.07	3.5
9	Setback Thermostat: Water Treatment Plant	Install programmable thermostat that can reset the temperature the building is heated to when unoccupied to 60 degrees, such as at nights and on weekends.	$897	$4,000	3.03	4.5
10	Walls: Broken window	Eliminate the broken window by installing rigid foam board insulation with additional siding.	$36	$365	2.31	10.2
11	Lighting - Replace interior fluorescent lighting in WTP with LED replacement bulbs.	Replace with energy-efficient LED lighting and remove ballasts.	$66	$250	1.62	3.8
12	Lighting – Replace exterior fluorescent lighting at WTP with LED wall packs.	Replace with energy-efficient LED wall pack and a photocell light sensor.	$11 plus $10 Maintenance Savings	$200	1.53	9.7
13	Window: WTP Single Pane Window	Replace existing window with new vinyl window	$89	$1,334	1.16	15.0
14	HVAC And DHW	Add a Recovered Heat System from the AVEC Power Plant to the WTP	$16,394 plus $1,000 Maintenance Savings	$375,000	1.10	21.6
	TOTAL, all measures		**$31,422 plus $1,210 Maintenance Savings**	**$397,160**	**1.44**	**12.2**

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 $31,422 per year, or 39.8% of the buildings' total energy costs. These measures are estimated to cost $397,160, for an overall simple payback period of 12.2 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**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$14,986	$0	$0	$0	$4,641	$33,825	$1,772	$16,874	$6,869	**$79,026**
With Proposed Retrofits	$8,399	$0	$0	$0	$1,698	$26,774	$743	$7,081	$2,850	**$47,605**
Savings	$6,587	$0	$0	$0	$2,944	$7,051	$1,028	$9,793	$4,019	**$31,422**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Grayling WTP, Intake Gallery, and both the North and South Lift Stations. The scope of this project included evaluating building shell, lighting and other electrical systems, water process loads, heating and ventilating 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, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment & disposal

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

Details collected from Grayling WTP and associated facilities 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.

Grayling WTP is classified as being made up of the following activity areas:

1) Water Treatment Plant: 1,536 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 ventilating; lighting, plug load, water treatment process loads, 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. Grayling WTP

3.1. Building Description

The 1,536 square foot Grayling WTP was constructed in 1977, with a normal occupancy of one person, the operator. The building is occupied approximately four hours per day, seven days per week.

The Grayling WTP houses a circulating water system with three loops that provide water to the residents of the community as well as a supply line that provides water to the school. One loop services the north end of town and is approximately 1850 feet long. Another loop serves the south side of town and is approximately 2000 feet long. A third loop serves the Hill Street area and is approximately 1800 feet long. There is also a supply line that feeds water to the school, which is approximately 125 ft.

The raw water is treated with two pressure sand filters. A boost pump is used to maintain system pressure . Two additional water filters treat the water after they are through the pressure sand filters. The water is injected with chlorine prior to making a run up a hill to the 60,000 gallon water storage tank.

The water system also has an intake gallery. The intake gallery has two pumps to move the water from the feeder creek to the WTP. One of the two pumps is constantly running, though for about a month both pumps were operating. This was necessary due to system leaks.

The sewer system has a force main pipe that goes through two lift stations and is forced to the sewage lagoon about a half-mile away.

Description of Building Shell

The exterior walls are four inch panel construction with 3.5” polyurethane insulation. There is 1504 square feet of wall space and the insulation has some damage due to water and ice formation.

The 1,619 square foot roof of the building is a cathedral style ceiling. The roof is standard 24 inch panel construction and 3.5” of polyurethane insulation.

The floor and foundation of the building are 4 inch concrete slab with no insulation. There is 1536 square feet of floor space.

There are multiple windows in various conditions throughout the building. There are two window spaces with plywood covering the opening and no insulation. This totals about 14 square feet. There are four window spaces with a single pane of Lexan or glass present that total about 21 square feet. There are four window spaces with two panes of either glass or Lexan that total about 23 square feet. All of the windows are damaged.

There is only one entrance into the water plant with a metal door with no insulation or windows. The door has worn its hinges down and hangs slightly off center from the door frame.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLean

Nameplate Information:	BL 676-WS
Fuel Type:	#1 Oil
Input Rating:	300,000 BTU/Hour
Steady State Efficiency:	75 %
Idle Loss:	2 %
Heat Distribution Type:	Glycol
Boiler Operation:	Sep - Jun
Notes:	Boilers are very old

Weil McLean

Fuel Type:	#1 Oil
Input Rating:	300,000 BTU/Hour
Steady State Efficiency:	75 %
Idle Loss:	2 %
Heat Distribution Type:	Glycol
Boiler Operation:	Sep – Jun

Gallery Electric Heater

Nameplate Information:	5000 watts made by Markel
Fuel Type:	Electricity

Input Rating:	17,000 BTU/Hour
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	No remote thermostat room temp was 70

South Lift Station #1 Electric Heater

Fuel Type:	Electricity
Input Rating:	6,100 BTU/Hour
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air

North Lift Station #2

Fuel Type:	Electricity
Input Rating:	5,100 BTU/Hour
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air

Space Heating Distribution Systems

The building is heated with three unit heaters with an output of approximately 10,000 BTU/Hour. The heaters had thermostats attached to them but only one was operational. This was set to 70 deg. F. There are electric heaters present in the gallery and each lift station. The gallery heater has been left running during unoccupied periods, and each heater is also run when the space is occupied.

Lighting

There are 23 fixtures with four T-12 fluorescent light bulbs in each fixture and 2 fixtures with two T-12 fluorescent light bulbs in each fixture present in the interior of the WTP. Of all the total light bulbs, approximately 50% of the bulbs were in operation and 50% of the bulbs had burned out past their useful lives. The WTP has a fluorescent 20W CFL light bulb on the exterior of the building. Additionally, there are MH 70W lights in each of the three additional buildings apart from the WTP.

Plug Loads

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

Major Equipment

There are two raw water pumps that use approximately 2,984 watts each while in operation. These pumps are located in the gallery. One of these pumps is constantly running.

Each loop has two circulation pumps that use approximately 1,119 watts each while in operation. One circulation pump is constantly running from January through July and October through December for a total of ten months per year. With three loops, there are six pumps total with three in constant operation during these ten months.

The line to the water storage tank has a circulation pump that uses approximately 179 watts while in operation and runs constantly for ten months per year. It is not used in August or September.

Chlorine is injected into the system by a 60 watt LMI pump that runs whenever the raw water pump runs.

The South Lift Station has a pump that consumes approximately 1,650 watts. This runs constantly throughout the year. This pump forces the sewage to the sewage lagoon outside of town.

The North Lift Station has a pump that consumes approximately 2,300 watts. This runs constantly throughout the year. The pump forces sewage too move through the force main to the South Lift Station and on to the sewage lagoon.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the four facilities. The model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (KWH). One KWH of usage is equivalent to 1,000 watts running for one hour. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

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

The following is a list of the utility companies providing energy to the building and the class of service provided:

Electricity: AVEC-Grayling - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.55/kWh
#1 Oil	$ 4.10/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the unsubsidized cost of energy for the WTP and associated facilities is $79,026 for electricity and fuel costs.

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

Figure 3.1
Annual Energy Costs by End Use

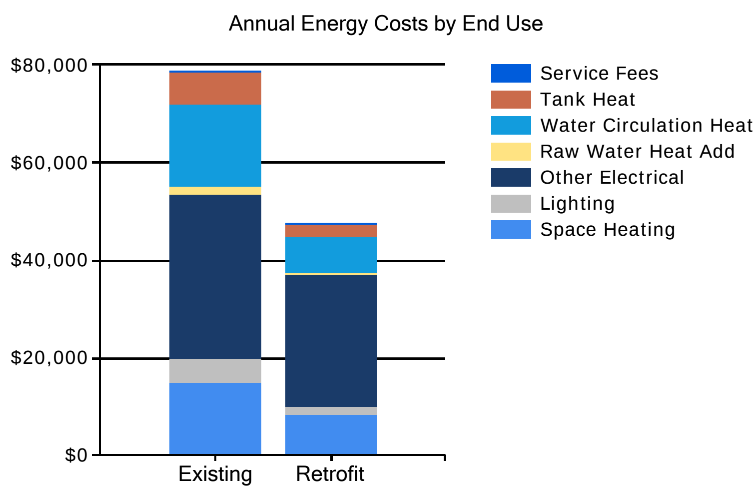


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

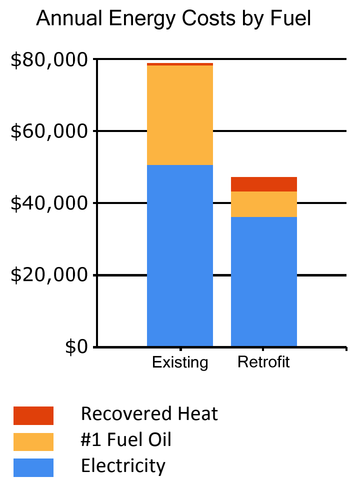
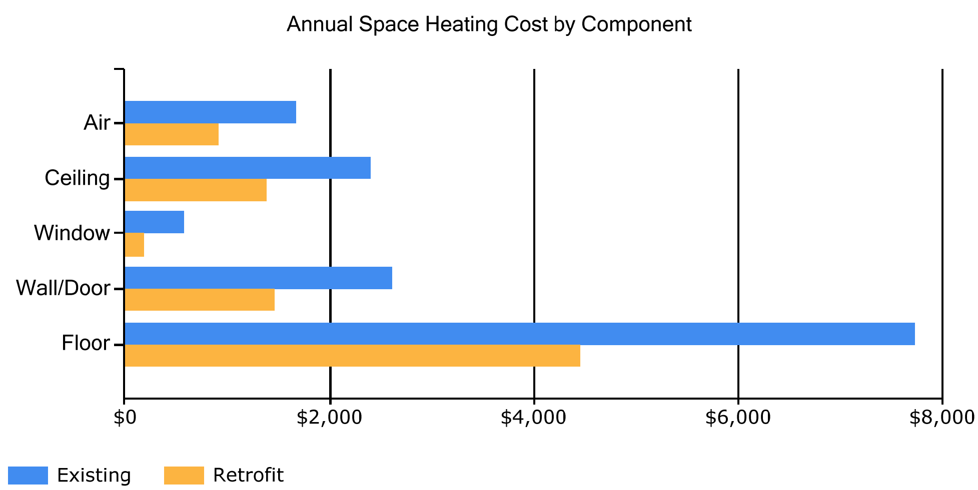


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Electrical Consumption (KWH)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	4163	3190	2744	1774	1052	2	2	7	28	1909	2817	4094
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	725	661	725	702	725	647	669	669	702	725	702	725
Other_Electrical	5650	5149	5650	5468	5650	5468	5650	2882	2789	5650	5468	5650
Raw_Water_Heat_Add	5	4	5	5	5	0	0	0	0	5	5	5
Water_Circulation_Heat	45	41	46	47	51	0	0	0	0	48	44	45
Tank_Heat	31	24	21	9	0	0	0	0	0	11	21	30

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	146	103	67	7	0	8	8	28	95	16	80	143
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Raw_Water_Heat_Add	53	49	54	54	56	0	0	0	0	55	52	53
Water_Circulation_Heat	508	465	516	510	536	0	0	0	0	525	498	508
Tank_Heat	349	273	230	103	0	0	0	0	0	118	239	344

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
Grayling 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	91,836 KWH	313,437	3.340	1,046,880
#1 Oil	6,850 gallons	904,144	1.010	913,186
Hot Water Dist Heat	13.15 million Btu	13,149	1.280	16,831
Total		**1,230,730**		**1,976,896**
BUILDING AREA		1,536	Square Feet	
BUILDING SITE EUI		801	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,287	**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.				

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.

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 Grayling WTP and associated facilities were modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Grayling 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 Grayling. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating and ventilation load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1
Grayling WTP, Grayling, Alaska
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4	Lighting – Reduce lighting cost in South Lift Station.	Relocate light switch for south lift station from outside building to inside and train to only use lights when building is occupied.	$420	$200	12.99	0.5
5	Thermostat – Combined Retrofit: Intake Gallery Space Heating	Add remote thermostat in the Intake Gallery and set at 50 degrees	$1,748	$2,000	10.27	1.1
6	Other Electrical – Identify and repair leaks in distribution piping to reduce pumping electrical usage	Find and repair leaks to reduce water treatment and pumping needs.	$7,112	$6,000	9.98	0.8
7	Lighting - Replace the Gallery exterior metal halide light fixture with LED wall pack.	Replace with energy-efficient LED lighting and a photocell light sensor.	$170	$500	4.96	2.9
8	Lighting – Replace WTP interior fluorescent lighting with LED replacement bulbs.	Replace with energy-efficient LED lighting and eliminate ballasts.	$1,521 Plus $200 Maintenance Savings	$6,000	4.07	3.5

Table 4.1 Grayling WTP, Grayling, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**
9	Setback Thermostat: Water Treatment Plant	Install programmable thermostat that can reset the temperature the building is heated to when unoccupied to 60 degrees, such as at nights and on weekends.	$897	$4,000	3.03	4.5
10	Walls: Broken window	Eliminate the broken window by installing rigid foam board insulation with additional siding.	$36	$365	2.31	10.2
11	Lighting - Replace interior fluorescent lighting in WTP with LED replacement bulbs.	Replace with energy-efficient LED lighting and remove ballasts.	$66	$250	1.62	3.8
12	Lighting – Replace exterior fluorescent lighting at WTP with LED wall packs.	Replace with energy-efficient LED wall pack and a photocell light sensor.	$11 plus $10 Maintenance Savings	$200	1.53	9.7
13	Window: WTP Single Pane Window	Replace existing window with new vinyl window	$89	$1,334	1.16	15.0
14	HVAC And DHW	Add a Recovered Heat System from the AVEC Power Plant to the WTP	$16,394 plus $1,000 Maintenance Savings	$375,000	1.10	21.6
	TOTAL, all measures		**$31,422 plus $1,210 Maintenance Savings**	**$397,160**	**1.44**	**12.2**

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 and cooling benefits were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Insulation *Measures*

Rank	Location		Existing Type/R-Value		Recommendation Type/R-Value	
10	Windowl: WTP Boarded Window Area		Window Type: Broken, no glass		Install rigid foam board insulation with additional siding to eliminate broken window.	
Installation Cost		$365	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$36
Breakeven Cost		$846	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	10
Auditors Notes: There were window spaces with no window and a sheet of un-insulated plywood covering the space. Consider replacing this with R-25 rigid foam board and T1-11 siding or equivalent.						

4.3.2 Window Measures

Rank	Location		Size/Type, Condition		Recommendation	
13	Window: WTP Single Pane Window		Glass: Single, 1/8" Acrylic/Polycarbonate Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.87 Solar Heat Gain Coefficient including Window Coverings: 0.51		Replace existing window with better double pane vinyl window	
Installation Cost		$1,334	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$89
Breakeven Cost		$1,544	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	15
Auditors Notes: The current windows are damaged, single pane, and some have Lexan sheets in place of glass. Consider replacing all these windows with U-0.22 vinyl window.						

4.4 Mechanical Equipment Measures

4.4.1 Heating Measure

Rank	Recommendation					
14	Add a Recovered Heat System from the AVEC Power Plant to the WTP					
Installation Cost		$375,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$16,394
					Maintenance Savings (/yr)	$1,000
Breakeven Cost		$412,589	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	22
Auditors Notes: The AVEC plant is approximately 200ft. from the WTP building. AVEC uses a Detroit Diesel Series 60 generator that could be outfitted with marine jacket manifold to increase available recovered heat to supply the WTP.						

4.4.3 Night Setback Thermostat Measure

Rank	Building Space			Recommendation	
9	Water Treatment Plant			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant.	
Installation Cost	$4,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$897
Breakeven Cost	$12,116	**Savings-to-Investment Ratio**	3.0	**Simple Payback yrs**	4
Auditors Notes: Most heaters are set to 70 deg. F for all the time. Reducing the heat load by lowering the temperature during unoccupied times can lower the heat demand and the energy costs. This can be done with the installation of a setback thermostat that is programmed to reduce the call for heat on nights and weekends when the facility is unoccupied. Includes the labor hours of an electrician and materials.					

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	
2	North Lift Station Interior Lighting	MH 70 Watt Magnetic with Manual Switching		Improve controls.	
Installation Cost	$110	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$420
Breakeven Cost	$2,598	**Savings-to-Investment Ratio**	23.6	**Simple Payback yrs**	0
Auditors Notes: Train operators to utilize existing switches to only use North Lift Station #2 interior lighting when the lift station is occupied.					

Rank	Location	Existing Condition		Recommendation	
4	South Lift Station Interior Lighting	MH 70 Watt Magnetic with Manual Switching		Relocate light switch from outside the building to inside and train the operators to only use the light when occupying the building.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$420
Breakeven Cost	$2,598	**Savings-to-Investment Ratio**	13.0	**Simple Payback yrs**	0
Auditors Notes: Train operators to utilize existing switches to only use North Lift Station #2 interior lighting when the lift station is occupied.					

Rank	Location	Existing Condition		Recommendation	
7	Exterior MH Fixture at Gallery	MH 70 Watt Magnetic with Manual Switching		Replace with energy-efficient LED wall pack lighting and a photocell light sensor.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$170
Breakeven Cost	$2,482	**Savings-to-Investment Ratio**	5.0	**Simple Payback yrs**	3
Auditors Notes: Replace with an 17 watt LED wall pack with photocell control.					

Rank	Location	Existing Condition		Recommendation	
8	WTP 4 Lamp Fluorescent	23 FLUOR (4) T12 4' F40T12 40W Standard fixtures with energy efficient magnetic ballasts		Replace with energy-efficient LED lighting and a occupancy sensor	
Installation Cost	$6,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,521
				Maintenance Savings (/yr)	$200
Breakeven Cost	$24,428	**Savings-to-Investment Ratio**	4.1	**Simple Payback yrs**	3
Auditors Notes: Replace fluorescent lighting with direct wired 17 watt replacement LED bulbs. Remove the old fluorescent ballast and light bulbs. This assumes a local installation.					

Rank	Location	Existing Condition		Recommendation	
11	WTP 2 Lamp Fluorescent	2 FLUOR (2) T12 4' F40T12 40W Standard energy efficient magnetic ballasts.		Replace with energy-efficient LED lighting and a occupancy sensor.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$66
Breakeven Cost	$405	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	4
Auditors Notes: Replace fluorescent lighting with direct wired 17 watt replacement LED bulbs. Remove the old fluorescent ballast and light bulbs. This assumes a local installation.					

Rank	Location	Existing Condition		Recommendation	
12	Exterior Fluorescent Fixture on WTP	FLUOR CFL, Spiral 20 W with Manual Switching		Replace with energy-efficient LED wall pack lighting and a photocell light sensor.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$11
				Maintenance Savings (/yr)	$10
Breakeven Cost	$305	**Savings-to-Investment Ratio**	1.5	**Simple Payback yrs**	10
Auditors Notes: Replace with LED 17W exterior wall pack with a photocell. The photocell will automatically cause the light to turn on and off based on the amount of sunlight.					

4.5.6 Other Measures

Rank	Location	Description of Existing	Efficiency Recommendation
1		South Lift Station #1 Electric Heater	Reset Thermostat in South Lift Station #1 to 50 Degrees

Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$998
Breakeven Cost	$11,718	**Savings-to-Investment Ratio**	58.6	**Simple Payback yrs**	0

Auditors Notes: Since the lift station is largely unoccupied, it does not need to be heated to 70 deg. F. Setting the thermostat to 50 deg. F will reduce heating demand and costs.

Rank	Location	Description of Existing	Efficiency Recommendation
3		North Lift Station #2 Electric Heater	Add remote thermostat set at 50 degrees

Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,540
Breakeven Cost	$18,088	**Savings-to-Investment Ratio**	18.1	**Simple Payback yrs**	1

Auditors Notes: Since the lift station is largely unoccupied, it does not need to be heated to 70 deg. F. Adding a remote sensor thermostat and setting the thermostat to 50 deg. F will reduce heating demand and costs.

Rank	Location	Description of Existing	Efficiency Recommendation
5		Gallery Space Heating Load	Add remote thermostat set at 50 degrees

Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,748
Breakeven Cost	$20,536	**Savings-to-Investment Ratio**	10.3	**Simple Payback yrs**	1

Auditors Notes: Since the gallery is largely unoccupied, it does not need to be heated to 70 deg. F. Adding a thermostat and setting the thermostat to 50 deg. F will reduce heating demand and costs.

Rank	Location	Description of Existing	Efficiency Recommendation
6	Gallery Pump & Raw Water Booster Pump	Raw Water Booster Pumps with Manual Switching	Find and repair distribution system leaks

Installation Cost	$6,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$7,112
Breakeven Cost	$59,894	**Savings-to-Investment Ratio**	10.0	**Simple Payback yrs**	1

Auditors Notes: System in-ground water leaks are resulting in the need to make water at the rate of 19 GPM 24 hours per day 365 days per year. This is a consumption rate of 148 gallons per person per day based on a population of 188 people. It should be in the range of 30 to 70 gallons per person per day. Find and repair system leaks.

5. ENERGY EFFICIENCY ACTION PLAN

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

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

In the near future, a representative of ANTHC will be contacting both the City of Grayling and the water plant operator to follow-up on the recommendations made in this audit report. A Rural Alaska Village Grant has funded ANTHC to provide the City with assistance in understanding the report and implementing the recommendations.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Grayling WTP	**Auditor Company:** ANTHC-DEHE
Address: PO Box 89	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Grayling	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Joshua Koyukuk & Kyle Anthony	
Client Address: PO Box 89 Grayling, AK 99590	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 453-5131	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,536 square feet	**Design Space Heating Load:** Design Loss at Space: 31,600 Btu/hour with Distribution Losses: 35,111 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 53,523 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: Grayling	**Design Outdoor Temperature:** -47 deg F
Weather/Fuel City: Grayling	**Heating Degree Days:** deg F-days
Utility Information	
Electric Utility: AVEC-Grayling - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.554/kWh	**Average Annual Cost/ccf:** $0.000/ccf

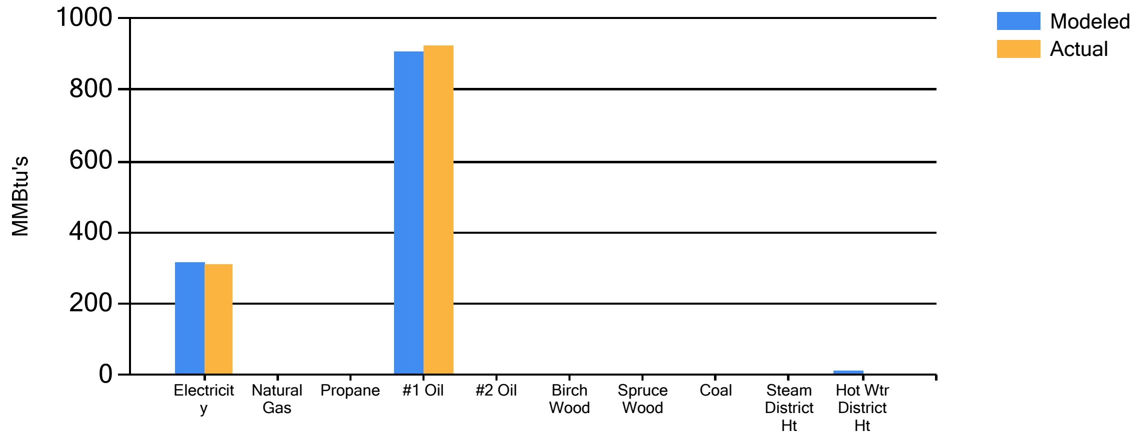
Annual Energy Cost Estimate

Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Tank Heat	Total Cost
Existing Building	$14,986	$0	$0	$0	$4,641	$33,825	$1,772	$16,874	$6,869	**$79,026**
With Proposed Retrofits	$8,399	$0	$0	$0	$1,698	$26,774	$743	$7,081	$2,850	**$47,605**
Savings	$6,587	$0	$0	$0	$2,944	$7,051	$1,028	$9,793	$4,019	**$31,422**

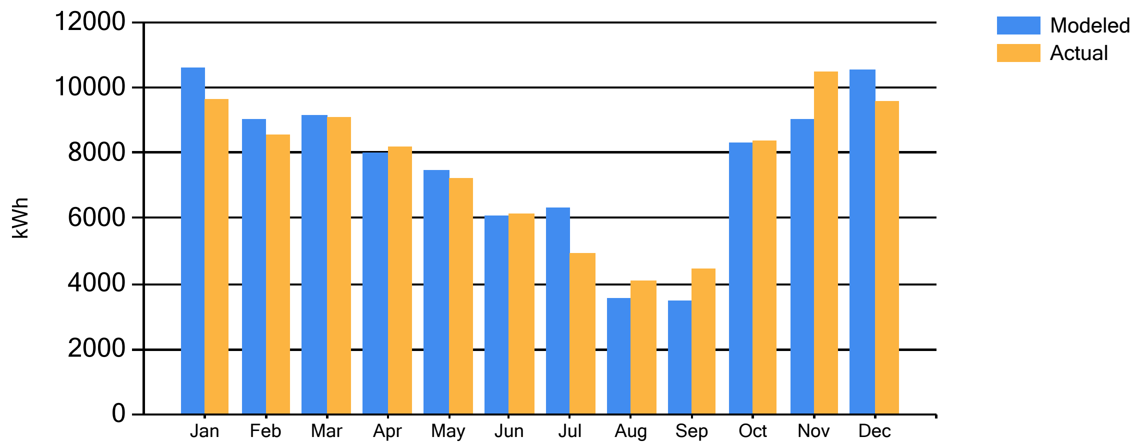
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

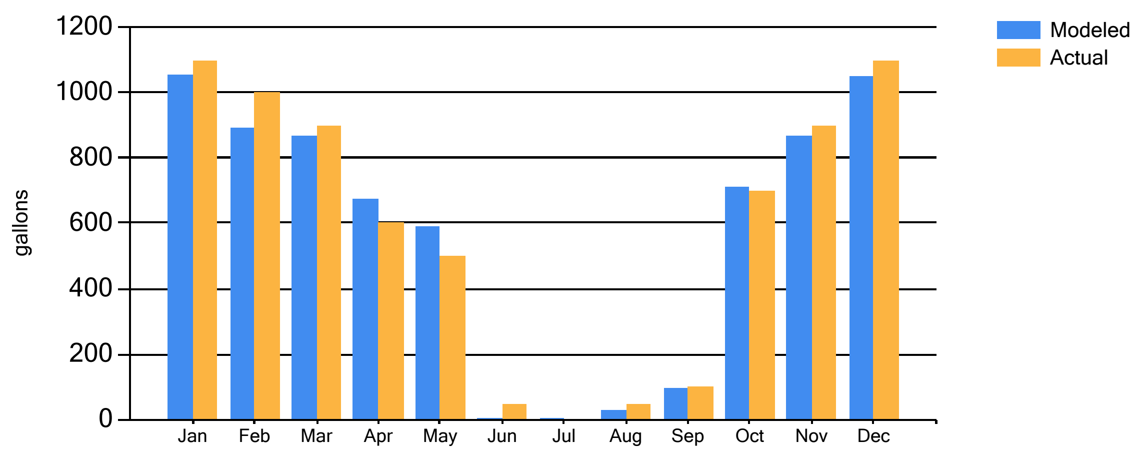
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Recovered Heat