Comprehensive Energy Audit
For

Ambler Water Treatment Plant

Prepared For
City of Ambler

December 22, 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 Ambler, Alaska and the Alaska Rural Utility Collaborative (ARUC). The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in November of 2013 as well as more recent visits 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.

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 Ambler 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 Tony Tickett and Roy Ramoth, Ambler Mayor Conrad Douglas, and Ambler City Administrator Crystal Tickett.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Ambler and the ARUC. The scope of the audit focused on Ambler 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, HVAC systems, and plug loads.

The total predicted energy cost for the WTP is $97,662 per year. Electricity represents the largest piece with an annual cost of $68,904 per year. This includes $22,292 paid by the end-users and $46,612 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The WTP is predicted to spend $28,758 for 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 Ambler, the cost of electricity without PCE is $0.68/KWH, and the cost of electricity with PCE is $0.22/KWH.

The solar array added to the water treatment plant (WTP) has generated approximately 7,500 KWHs of electricity over the past year, almost all of which was consumed by the WTP.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	101,635 kWh	75,893 kWh
#1 Oil	3,595 gallons	300 gallons
Hot Wtr District Ht	0.00 million Btu	342.78 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	475.3	30.32	$56.52
With Proposed Retrofits	371.2	23.68	$33.28
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 Ambler 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	Other Electrical - Controls Retrofit: Lift Station #1 Sewer Pump	Replace float system that controls the sewer pump.	$14,253	$5,000	24.00	0.4	38,342.3
2	Other Electrical - Controls Retrofit: Lift Station # 1 Electric Heat	Remove manual controls and add automated control system to improve efficiency.	$1,154	$1,500	6.48	1.3	3,104.1
3	Setback Thermostat: Ambler Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 60.0 deg. F for the Ambler Water Treatment Plant space.	$948	$2,000	6.42	2.1	2,503.3
4	Other Electrical - Power Retrofit: Tank Line Electric Heat Tape	Rewire electric heat tape to only heat the junction box rather than the whole glycol line.	$586	$1,000	4.93	1.7	1,576.3
5	Other Electrical - Power Retrofit: Mechanical Room Exhaust Fan	Replace exhaust fan to reduce the size.	$507	$1,000	4.27	2.0	1,364.8
6	Lighting - Power Retrofit: Exterior Lighting	Replace with energy-efficient LED lighting and a photocell light sensor.	$225	$1,400	2.35	6.2	604.6
7	HVAC And DHW	Add a heat recovery system that recovers heat from the AVEC owned local power plant and utilize the heat at the water plant to reduce the use of oil. In order to reduce peaking heat loads, the raw water heat exchanger and the tank add heat exchanger should be switched at the same time the heat recovery is added.	$22,219	$300,000	1.77	13.5	47,856.1
8	Lighting - Power Retrofit: Plant Lighting	Replace with energy-efficient LED lighting.	$157	$1,690	1.35	10.8	410.6
9	Lighting - Power Retrofit: Office Lighting	Replace with energy-efficient LED lighting.	$55	$612	1.31	11.1	144.0

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
10	Lighting - Power Retrofit: Chemical Room	Replace with energy-efficient LED lighting.	$10	$136	1.08	13.5	26.4
11	Lighting - Power Retrofit: Mechanical Room Lighting	Replace with energy-efficient LED lighting.	$40	$544	1.08	13.5	105.3
	TOTAL, all measures		**$40,154**	**$314,882**	**2.19**	**7.8**	**96,037.7**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

[2] Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $40,154 per year, or 41.1% of the buildings' total energy costs. These measures are estimated to cost $314,882, for an overall simple payback period of 7.8 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	Service Fees	Total Cost
Existing Building	$7,531	$0	$418	$0	$1,294	$64,997	$8,465	$9,203	$5,694	$60	**$97,662**
With Proposed Retrofits	$5,286	$0	$40	$0	$797	$48,491	$1,019	$1,129	$686	$60	**$57,508**

Savings	$2,245	$0	$378	$0	$496	$16,506	$7,445	$8,074	$5,008	$0	**$40,154**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Ambler Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, 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 and 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 Ambler 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.

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

1) Ambler Water Treatment Plant: 1,728 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; HVAC; 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. Ambler Water Treatment Plant

3.1. Building Description

The 1,728 square foot Ambler Water Treatment Plant was constructed in 2012 and has a occupied by one operator during working hours. The number of hours of operation for this building average 3 hours per day, considering all seven days of the week.

The Ambler WTP houses a circulating water system with two loops that provide water to the residents of the community. One loop services the east side of town and the other loop services the west side of town.

The raw water is treated with injected with chlorine prior to entering the 210,000 gallon storage tank. A booster pump is used to keep the pressure up and increase the circulation rate of the system.

The sewer system has two operational lift stations (labeled LS-1 and LS-3) and one lift station that is no longer in service (LS-2). A force main pipe runs through town and LS-1 before being forced to a sewage lagoon beyond LS-3.

The new lift station (LS-3) is heated with two Weil McLean Gold P-WGO-4 hydronic boilers. These boilers are also used to heat the force main to the lagoon.

Description of Building Shell

The exterior walls are of panel construction with 6" of polyurethane insulation. There are 1788 square feet of wall space and the insulation has no significant damage.

The roof of the building is a "hot roof" with cathedral ceilings. It is 1752 square feet. The roof is also of panel construction.

The Floor/Foundation of the building is constructed with a 4" concrete slab. 608 square feet of the perimeter of the floor has 4" of rigid foam board insulation while the remaining 1180 square feet of the building has no insulation.

Typical windows throughout the building are double-paned glass with wood frames. There is a total of 48 square feet of window space in the building.

There are two exterior doors in the building, each made of metal with a polyurethane core and a window. There are two doors with a combined total of 42 square feet. There is also a large metal insulated garage door that is 2" thick. This door is a total of 64 square feet.

Description of Heating Plants

The Heating Plants used in the building are:

Hydronic Boiler # 1

Nameplate Information:	Burnham Model V903
Fuel Type:	#1 Oil
Input Rating:	302,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Sep - Jun

Hydronic Boiler #2

Fuel Type:	#1 Oil
Input Rating:	302,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	Sep - Jun

Space Heating Distribution Systems

The building is heated with two unit heaters that each put out 10,000 BTU/hr. There are electric heaters utilized to for heat in in LS-1. These heaters run excessively during the winter months due to a lack of control.

Heat Recovery

A heat recovery system is being added that takes heat from the AVEC power plant and transports it to the water treatment plant to heat the glycol. This system will be in series with (before) the existing boilers. The heat recovery line is approximately 850 ft. long and is buried beneath the roadways of the community.

Lighting

The water plant main room has 13 fixtures with two T8 fluorescent light bulbs in each fixture. The mechanical room has four fixtures with two T8 fluorescent light bulbs in each fixture. The chemical room has one fixture with two T8 fluorescent light bulbs in the fixture. The office has three fixtures with three T8 fluorescent light bulbs in each fixture. The exterior of the building has four standard 35W metal halide fixtures.

Plug Loads

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

Major Equipment

There are two water circulation pumps for the water circulation loops that use 4554 watts each. The two pumps run constantly for approximately 10 months per year.

There are pressure pumps in the water plant that consume approximately 2200 watts when operating. These pumps run approximately 20% of the time for the entire year.

There is a well pump that consumes approximately 2100 watts when operating. This pump operates approximately 60 hours of every week.

There are two glycol pumps in operation for the heat recovery system. One glycol pump is on the AVEC side of the heat recovery loop and uses 7889 watts and will run constantly. The other glycol pump is on the water plant side and uses 2178 watts while constantly running for 8 months per year.

There is an exhaust fan for the mechanical room that helps to ventilate the building as needed to keep the building from over-heating. The exhaust fan consumes approximately 746 watts and operates approximately 25% of the time. The exhaust fan is estimated to be approximately twice the size necessary.

The controls for the water system operation consume approximately 300 watts and run continuously.

The water line to the water storage tank uses electric heat tape for freeze protection. The heat tape consumes 300 watts when on and uses approximately 1751 KWHs per year. It is off in the summer.

There is a variety of miscellaneous pumps and equipment that operate throughout the heating season that combine to consume approximately 300 watts when operating. Annual consumption is approximately 3240 KWHs per year. The equipment runs constantly for 8 months per year.

Lift Station #1 has a sewer pump and electric heater located in the building. The sewer pump runs constantly for the entire year because the float system is not working, which prevents the sewer pump from shutting off. This pump consumes approximately 3240 watts and uses approximately 28,402 KWHs per year. The electric heater consumes approximately 3000 watts when operating. Annual consumption is approximately 17,514 KWHs per year.

Lift Station #3 has a sewer pump and a number of glycol pumps. The sewer pump consumes approximately 2226 watts when operating. The pump runs approximately 50% of time which results in annual consumption of approximately 9,757 KWHs. The glycol pumps consumes approximately 376 watts when operating. These pumps are off in the summer but consume approximately 2,466 KWHs per year.

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. Since 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). 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-Ambler - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.68/kWh
#1 Oil	$ 8.00/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, ARUC pays approximately $97,662 annually for electricity and fuel costs for the Ambler Water Treatment Plant and associated lift stations.

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

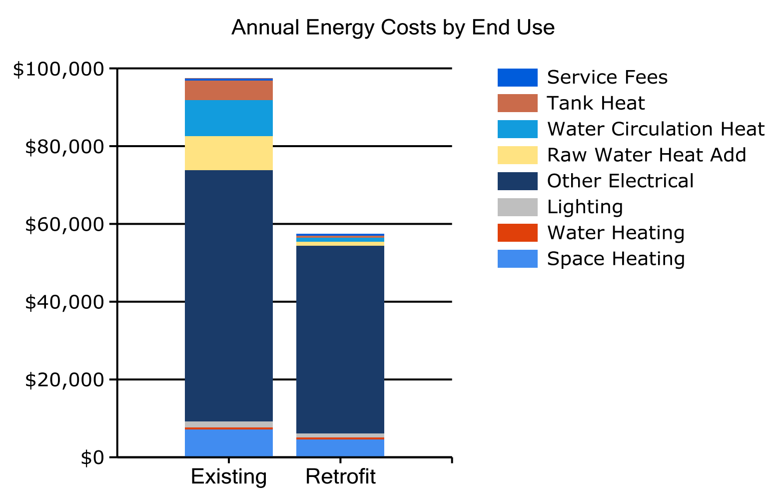


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

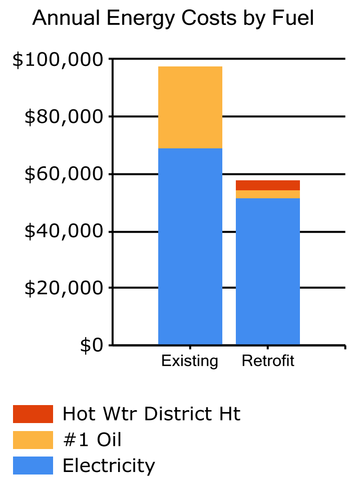
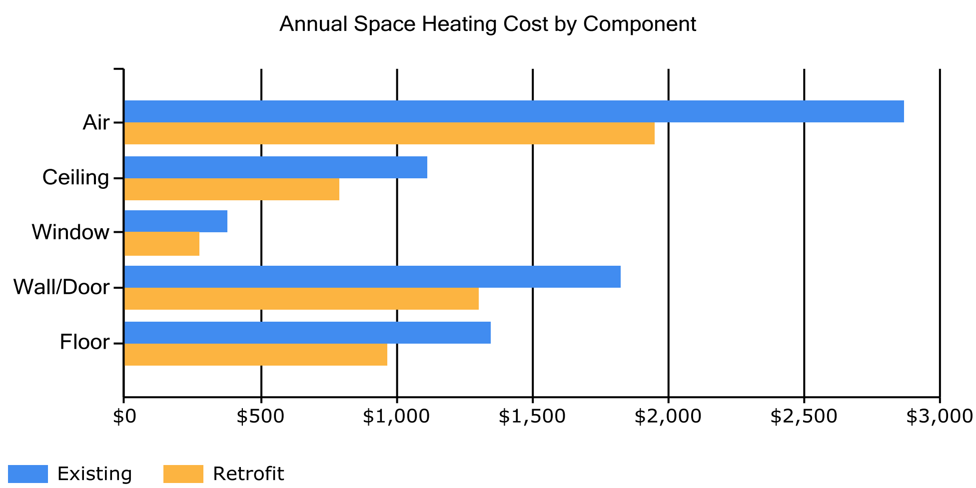


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	444	402	436	413	431	5	5	5	6	428	424	443
DHW	0	0	0	0	2	0	0	0	1	0	0	0
Lighting	177	162	177	172	177	113	116	116	172	177	172	177
Other_Electrical	9321	8494	9321	9021	8169	5630	5193	5826	7312	9321	9021	9321
Raw_Water_Heat_Add	21	18	16	10	0	0	0	0	5	10	17	21
Water_Circulation_Heat	23	20	18	12	1	0	0	0	0	12	19	23
Tank_Heat	14	12	11	7	3	0	0	0	0	8	11	14

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	113	88	66	11	42	29	30	30	37	19	76	109
DHW	3	3	3	3	13	3	3	3	9	3	3	3
Raw_Water_Heat_Add	190	159	146	86	0	0	0	0	40	90	150	187
Water_Circulation_Heat	210	176	164	102	6	0	0	0	0	106	168	207
Tank_Heat	126	105	99	63	21	0	0	0	0	66	101	124

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 and Table 3.5 for details):

Building Site EUI = *(Electric Usage in kBtu + Fuel Oil Usage in kBtu)* / *Building Square Footage*

Building Source EUI = *(Electric Usage in kBtu X SS Ratio + Fuel Oil Usage in kBtu X SS Ratio)* / *Building Square Footage*

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

Table 3.4
Ambler 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	101,635 kWh	346,881	3.340	1,158,583
#1 Oil	3,595 gallons	474,499	1.010	479,244
Total		**821,380**		**1,637,827**
BUILDING AREA		1,728	Square Feet	
BUILDING SITE EUI		475	$kBTU/Ft^2/Yr$	
BUILDING SOURCE EUI		948	**$kBTU/Ft^2/Yr$**	
* 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	**475.3**	**30.32**	**$56.52**
With Proposed Retrofits	**371.2**	**23.68**	**$33.28**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

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

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

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

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Ambler. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.
• The model does not model HVAC systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 1.1 PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Other Electrical - Controls Retrofit: Lift Station #1 Sewer Pump	Replace float system that controls the sewer pump.	$14,253	$5,000	24.00	0.4	38,342.3
2	Other Electrical - Controls Retrofit: Lift Station # 1 Electric Heat	Remove manual controls and add automated control system to improve efficiency.	$1,154	$1,500	6.48	1.3	3,104.1
3	Setback Thermostat: Ambler Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 60.0 deg. F for the Ambler Water Treatment Plant space.	$948	$2,000	6.42	2.1	2,503.3
4	Other Electrical - Power Retrofit: Tank Line Electric Heat Tape	Rewire electric heat tape to only heat the junction box rather than the whole glycol line.	$586	$1,000	4.93	1.7	1,576.3
5	Other Electrical - Power Retrofit: Mechanical Room Exhaust Fan	Replace exhaust fan to reduce the size.	$507	$1,000	4.27	2.0	1,364.8

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**
6	Lighting - Power Retrofit: Exterior Lighting	Replace with energy-efficient LED lighting and a photocell light sensor.	$225	$1,400	2.35	6.2	604.6
7	HVAC And DHW	Add a heat recovery system that recovers heat from the AVEC owned local power plant and utilize the heat at the water plant to reduce the use of oil. In order to reduce peaking heat loads, the raw water heat exchanger and the tank add heat exchanger should be switched at the same time the heat recovery is added.	$22,219	$300,000	1.77	13.5	47,856.1
8	Lighting - Power Retrofit: Plant Lighting	Replace with energy-efficient LED lighting.	$157	$1,690	1.35	10.8	410.6
9	Lighting - Power Retrofit: Office Lighting	Replace with energy-efficient LED lighting.	$55	$612	1.31	11.1	144.0
10	Lighting - Power Retrofit: Chemical Room	Replace with energy-efficient LED lighting.	$10	$136	1.08	13.5	26.4
11	Lighting - Power Retrofit: Mechanical Room Lighting	Replace with energy-efficient LED lighting.	$40	$544	1.08	13.5	105.3
	TOTAL, all measures		**$40,154**	**$314,882**	**2.19**	**7.8**	**96,037.7**

4.2 Interactive Effects of Projects

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

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

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. When the building is in cooling mode, these items contribute to the overall cooling demands of the building; therefore, lighting efficiency improvements will reduce cooling requirements in air-conditioned buildings. Conversely, lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties and cooling benefits were included in the lighting project analysis.

4.3 Mechanical Equipment Measures

4.3.1 Heating /Domestic Hot Water Measure

Rank	**Recommendation**				
7	Add a heat recovery system from the AVEC power plant to the water treatment plant.				
Installation Cost	$300,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$22,219
Breakeven Cost	$530,270	**Savings-to-Investment Ratio**	1.8	**Simple Payback yrs**	14
Auditors Notes: Add a heat recovery system that recovers heat from the AVEC owned local power plant and utilize the heat at the water plant to reduce the use of oil. In order to reduce peaking heat loads, the raw water heat exchanger and the tank add heat exchanger should be switched at the same time the heat recovery is added. This recommendation was implemented by ANTHC in 2011.					

4.3.2 Night Setback Thermostat Measures

Rank	**Building Space**			**Recommendation**	
3	Ambler Water Treatment Plant			Reduce temperature when unoccupied to 60 deg. F.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$948
Breakeven Cost	$12,839	**Savings-to-Investment Ratio**	6.4	**Simple Payback yrs**	2
Auditors Notes: Implement a heating temperature unoccupied setback to 60.0 deg F for the Ambler Water Treatment Plant space.					

4.4 Electrical & Appliance Measures

4.4.1 Lighting Measures

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

4.4.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	**Location**	**Existing Condition**		**Recommendation**	
6	Exterior Lighting	4 HPS 35 Watt Standard electronic with Manual Switching		Replace fluorescent bulbs with energy-efficient LED light bulbs.	
Installation Cost	$1,400	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$225
Breakeven Cost	$3,284	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	6
Auditors Notes: Replace with 4 LED 12W Module Standard electronic. Replace the metal halide wall packs used for exterior lighting with LED.					

Rank	Location		Existing Condition		Recommendation	
8	Plant Lighting		13 FLUOR (2) T8 4' F32T8 32W Standard Instant Standard electronic with Manual Switching		Replace fluorescent bulbs with energy-efficient LED light bulbs.	
Installation Cost		$1,690	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$157
Breakeven Cost		$2,285	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	11
Auditors Notes: Convert the fluorescent lighting to LED. Replace with 13 LED (2) 17W Module Standard electronic.						

Rank	Location		Existing Condition		Recommendation	
9	Office Lighting		3 FLUOR (3) T8 4' F32T8 32W Standard (2) Instant Standard electronic with Manual Switching		Replace fluorescent bulbs with energy-efficient LED light bulbs.	
Installation Cost		$612	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$55
Breakeven Cost		$802	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	11
Auditors Notes: Convert the fluorescent lighting to LED. Replace with 3 LED (3) 17W Module (2) Standard electronic.						

Rank	Location		Existing Condition		Recommendation	
10	Chemical Room		FLUOR (2) T8 4' F32T8 32W Standard Instant Standard electronic with Manual Switching		Replace fluorescent bulbs with energy-efficient LED light bulbs.	
Installation Cost		$136	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$10
Breakeven Cost		$147	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	14
Auditors Notes: Convert the fluorescent lighitng to LED. Replace with LED (2) 17W Module Standard electronic.						

Rank	Location		Existing Condition		Recommendation	
11	Mechanical Room Lighting		4 FLUOR (2) T8 4' F32T8 32W Standard Instant Standard electronic with Manual Switching		Replace fluorescent bulbs with energy-efficient LED light bulbs.	
Installation Cost		$544	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$40
Breakeven Cost		$586	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	14
Auditors Notes: Convert the fluorescent lighting to LED. Replace with 4 LED (2) 17W Module Standard electronic.						

4.4.2 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Lift Station #1 Sewer Pump		Lift Station Pump with Manual Switching		Replace float system that controls the sewer pump.	
Installation Cost		$5,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$14,253
Breakeven Cost		$120,024	**Savings-to-Investment Ratio**	24.0	**Simple Payback yrs**	0
Auditors Notes: Repair or replace the float system used to control the sewer pumps in Lift Station #1. The float system is presently not operating correctly and is resulting in the pump running continuously.						

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Lift Station # 1 Electric Heat	Lift Station # 1 Electric Heat with Manual Switching		Remove manual controls and add automated control system to improve efficiency.	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$1,154
Breakeven Cost	$9,717	**Savings-to-Investment Ratio**	6.5	**Simple Payback yrs**	1
Auditors Notes: Add thermostats to the two electric heaters in Lift Station # 1 and set the temperature at 40 degrees.					

Rank	Location	Description of Existing		Efficiency Recommendation	
4	Tank Line Electric Heat Tape	Electric Heat Tape with Manual Switching		Rewire electric heat tape for more efficient use.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$586
Breakeven Cost	$4,934	**Savings-to-Investment Ratio**	4.9	**Simple Payback yrs**	2
Auditors Notes: Rewire the electric heat tape between the water plant and the water storage tank such that it only heats the junction box not the entire line.					

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Mechanical Room Exhaust Fan	Exhaust Fan with Manual Switching		Replace mechanical exhaust fan	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$507
Breakeven Cost	$4,272	**Savings-to-Investment Ratio**	4.3	**Simple Payback yrs**	2
Auditors Notes: Down size the motor or add a VFD to reduce CFM by 50%.					

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.

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 Ambler 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.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

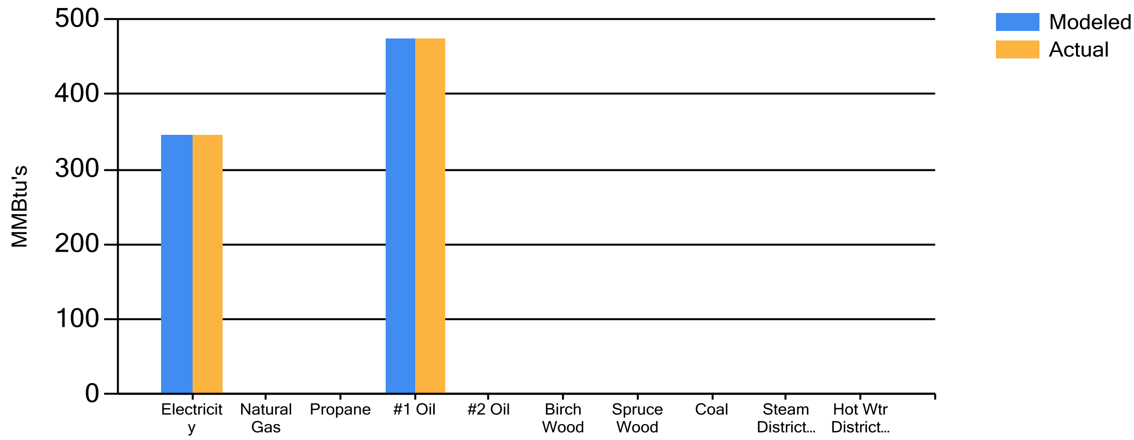
ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Ambler Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: PO Box 9	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Ambler **Client Name:** Tony Tickett & Roy Ramoth	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Address: ARUC 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508	**Auditor Phone:** (907) 729-3543 **Auditor FAX:**
Client Phone: (907) 729-3600 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 1,728 square feet	**Design Space Heating Load:** Design Loss at Space: 26,389 Btu/hour with Distribution Losses: 27,778 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 42,345 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: Ambler	**Design Outdoor Temperature:** -45 deg F
Weather/Fuel City: Ambler	**Heating Degree Days:** 15,675 deg F-days
Utility Information	
Electric Utility: AVEC-Ambler - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.678/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**	**Service Fees**	**Total Cost**
Existing Building	$7,531	$0	$418	$0	$1,294	$64,997	$8,465	$9,203	$5,694	$60	**$97,662**
With Proposed Retrofits	$5,286	$0	$40	$0	$797	$48,491	$1,019	$1,129	$686	$60	**$57,508**
Savings	$2,245	$0	$378	$0	$496	$16,506	$7,445	$8,074	$5,008	$0	**$40,154**

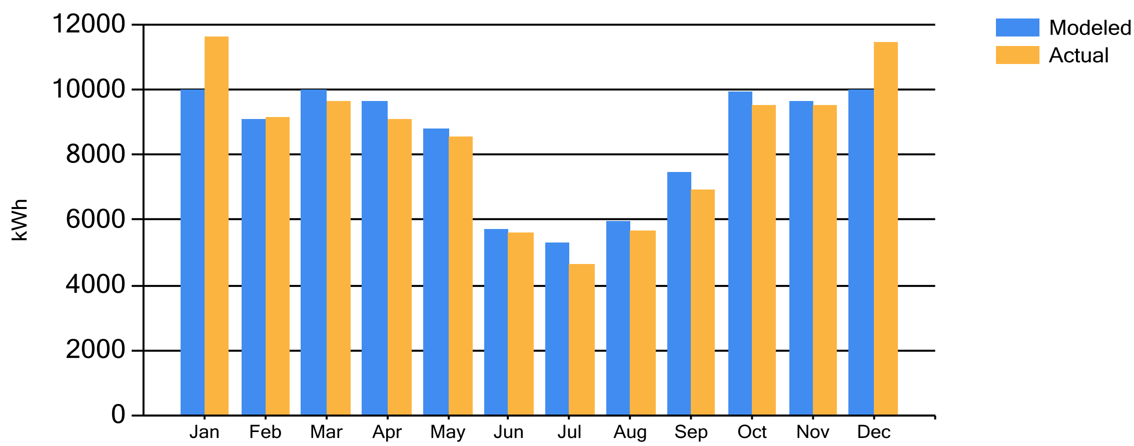
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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