Comprehensive Energy Audit
For
Newhalen Water Plant

Prepared For
City of Newhalen

April 20, 2017

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PREFACE

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

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Newhalen, Alaska. The authors of this report are Bailey Gamble, Mechanical Engineer I, Maxwell Goggin-Kehm, Senior Engineering Project Manager and Shawn Takak, Engineering Project Manager I.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in November of 2016 by the Rural Energy Initiative and Alaska Rural Utility Collaborative of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Nick Johnson and Arthur Andreanoff, City of Newhalen Mayor Susanna Wassillie and City Clerk Cathleen Gust.

1. EXECUTIVE SUMMARY

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

Based on electricity prices in effect at the time of the audit, the total predicted energy costs are $21,581 per year. This includes about $10,791 paid by the village and about $10,790 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The plant does not currently use any fuel oil.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Newhalen, the cost of electricity without PCE is about $0.56/kWh and the cost of electricity with PCE is about $0.28/kWh, saving the village over $10,000 a year on electricity for the water plant.

Table 1.1 lists the total usage of electricity and #1 heating oil in the Newhalen water plant before and after the proposed retrofits.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	38,537 kWh	13,594 kWh
#1 Oil	0 gallons	715 gallons

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

Table 1.2: Building Benchmarks for the Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	117.4	10.55	$19.27
With Proposed Retrofits	125.7	11.29	$9.78
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

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

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
1	Heating System	Install protective equipment to prevent fuel oil theft so that the Monitor oil heater may be utilized rather than the electric heaters.	$8,375	$1,000	112.90	0.1
2	Other Electrical - Controls Retrofit: Well Heat Tapes	Wire heat tapes along intake lines to turn on only during the winter when intake pumps are not running.	$1,232	$1,200	6.35	1.0
3	Other Electrical - Controls Retrofit: Well Pump	Install floats in water tank. Use to control intake pumps.	$380	$600	5.25	1.6
4	Air Tightening	Air seal doors and seal old vent in ceiling to reduce air leakage by 20%.	$174	$400	4.02	2.3
5	Lighting - Power Retrofit: WTP Lighting	Replace with energy efficient LED bulbs	$110	$1,040	0.87	9.5
6	Other Electrical - Controls Retrofit: Pressure Pump	Replace improperly functioning and oversized pressure tanks with new ones. Replace pressure switches and rebuild pressure pump control panel to reduce run time and frequency of starts.	$427 + $200 Maint. Savings	$14,000	0.37	22.3
7	Lighting - Combined Retrofit: WTP Exterior Lighting	Install an LED light fixture with built in daylight sensor	-$66	$250	-2.23	999.9
	TOTAL, all measures		**$10,631 + $200 Maint. Savings**	**$18,490**	**7.08**	**1.7**

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] 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

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With all of these energy efficiency measures in place, the annual utility cost can be reduced by $10,631 per year, or 49.3% of the buildings' total energy costs. These measures are estimated to cost $18,490, for an overall simple payback period of 1.7 years.

Table 1.4 below is a breakdown of the annual energy cost across various energy end use types, such as Space Heating and Water Heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate					
Description	**Space Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Total Cost**
Existing Building	$11,853	$180	$433	$9,115	**$21,581**
With Proposed Retrofits	$3,449	$180	$372	$6,949	**$10,950**
Savings	$8,405	$0	$61	$2,166	**$10,631**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

- Building envelope (roof, windows, etc.)
- Heating and ventilation equipment
- Lighting systems and controls
- Building-specific equipment
- Water treatment process and distribution

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

Details collected from Newhalen water 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. Newhalen Water Plant is classified as being made up of a single 1,120 square foot activity area.

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:

- Occupancy hours
- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

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

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

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

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

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

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

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

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

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

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

2.4 Limitations of Study

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

3. NEWHALEN WATER PLANT

3.1. Building Description

The 1,120 square foot Newhalen Water Plant was constructed in 1980, with a normal occupancy of zero or one person. The number of hours of operation for this building average 1.7 hours per day, considering all seven days of the week, with the operator passing in and out of the plant as he tends to various components of the system.

Raw groundwater is pumped from two wells to a storage tank inside of the water plant building. The submersible well pumps are controlled manually by the operator.

After exiting the water storage tank, pressure pumps send water to hydropneumatic tanks. The tanks do not function as intended and the pressure pumps cycle on for about 20 seconds per minute.

After pressurization, the water is delivered to homes and community facilities through a piped distribution system.

Figure 1: Aerial view of Newhalen Water Plant.

<u>Description of Building Shell</u>

The exterior walls of the water treatment plant are constructed with single stud 2x6 lumber construction with a 16-inch offset. The average wall height is approximately 12 ft. The walls have approximately 5.5 inches of batt insulation damaged due to age. There is approximately 1,360 square feet of wall space in the WTP.

The WTP has a cathedral ceiling with 2x6 lumber construction. The roof has standard framing and a 24-inch offset. The peak ceiling height is approximately 14 ft. The ceiling has approximately 5.5 inches of batt insulation with significant damage due to age and moisture. There is approximately 1,349 square feet of roof space in the building.

The WTP is built on grade on a gravel pad. The concrete floor is uninsulated. There is approximately 1,120 feet of floor space in the building.

There are three windows located throughout the building. All windows are double-pane glass with wooden frames. The north facing window measures 36” x 33”, the east facing window measures 32” x 28” and the south facing window measures 36” x 36”.

There is a single set of double wooden doors measuring 74” x 82” on the front side of the building.

<u>Description of Heating and Cooling Plants</u>

The Heating Plants used in the building are:

MPI Monitor 2400

Fuel Type:	#1 Oil
Input Rating:	32,000 BTU/hr
Steady State Efficiency:	93 %
Idle Loss:	0.2 %
Heat Distribution Type:	Air
Boiler Operation:	October - April

Electric Heaters

Fuel Type:	Electricity
Input Rating:	25,575 BTU/hr
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Boiler Operation:	October - April

Heating demand in the water plant is seasonal and includes only space heating during colder months. The water in Newhalen is not heated. Due to issues with fuel theft, the MPI Monitor 2400 fuel oil heater was not in use at the time of the audit visit. The building heating demand is met by three electric unit heaters each operating at the 2500 W setting.

Figure 2: MPI Monitor 2400 fuel oil heater and electric heater in Newhalen water plant.

Space Heating Distribution System

Heat in the water plant is distributed by fans in the three electric unit heaters.

Description of Building Ventilation System

Condensation on exposed plumbing and the water storage tank located inside the building lead to high levels of humidity in the Newhalen water plant, especially during the summer months. The operator runs the bathroom vent fan during the summer in an attempt to mitigate the associated accumulation of mold/mildew. Air exchange is also achieved through an open hole from a former boiler stack in the ceiling.

Figure 3: Mildew visible on the water plant ceiling.

Lighting

Lighting in the water plant consists of 13 light fixtures each containing two 4 foot long, 32 W T8 fluorescent bulbs for a total of 26 bulbs. There is an exterior fixture with no bulb in place. Lighting consumes approximately 773 kWh annually or about 2% of the facility's total electrical consumption.

Major Equipment

Table 3.2 contains the details on each of the major electricity consuming mechanical components found in the water treatment plant. Major equipment consumes approximately 6,280 kWh annually constituting about 16% of the facility's total electrical consumption.

Table 3.2: Major Equipment List

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Pressure Pump x 2	Pressurize water before distribution	1.5 HP	Runs about 20 seconds each minute or 33% of the time.	3,335
Well Pump x 2	Draw groundwater into water system	0.75 HP	Runs about 60% of the time.	2,945
			Total Energy Consumption	6,280

Heat Tape

There are two heat tapes running from the water plant along the well intake lines. Each heat tape is an estimated 200 feet long. The heat tapes are run from early October until late April and consume approximately 9,997 kWh annually or about 26% of the facility's total electrical consumption.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

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

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

Iliamna-Newhalen-Nondalton Electric Cooperative, Inc. (INNEC) runs the Tazima Hydroelectric Plant that provides electricity to the residents, commercial and public facilities of Newhalen.

The average cost for each type of fuel used in this building is shown below in Table 3.3. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.3: Energy Rates by Fuel Type in Newhalen

Table 3.3 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.56/kWh
#1 Oil	$ 4.67/gallon

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Newhalen pays approximately $22,204 annually for electricity and other fuel costs for the Newhalen Water Plant.

Figure 4 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.

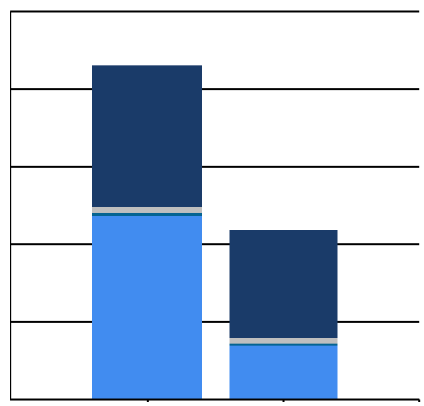

Figure 4: Annual energy costs by end use.

Figure 5 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.

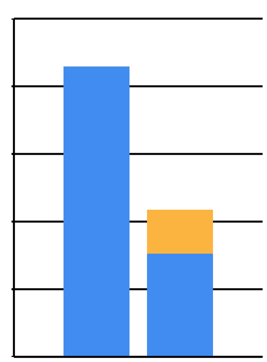

Figure 5: Annual energy costs by fuel type.

Figure 6 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.

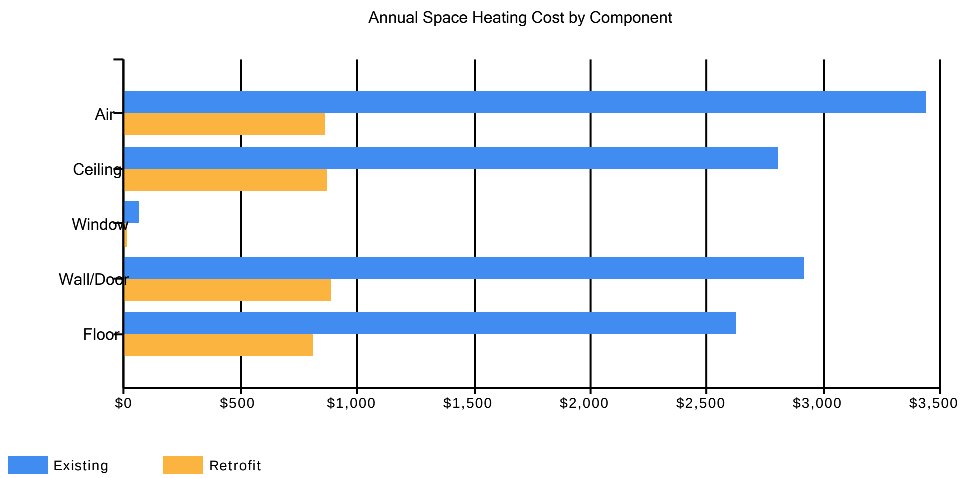

Figure6: Annual space heating costs by component.

The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note that total annual electrical consumption for space heating modeled by AkWarm aligns with the actual annual total, however, the distribution of modeled space heating electrical consumption differs from the actual distribution. In reality the space heaters operate at a constant rate from late September/early October to late April/early May regardless of actual heating demand.

Table 3.4: Electrical Consumption Records by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	3766	3191	2922	1602	694	213	220	220	346	1572	2577	3844
Ventilation_Fans	0	0	0	0	49	67	69	69	67	0	0	0
Lighting	66	60	66	63	66	63	66	66	63	66	63	66
Other_Electrical	2021	1842	2021	1860	533	516	533	533	516	1973	1956	1973

3.2.2 Energy Use Index (EUI)

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

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

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

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

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

Table 3.7: Newhalen Water 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	38,537 kWh	131,528	3.340	439,304
#1 Oil	0 gallons	0	1.010	0
Total		**131,528**		**439,304**
BUILDING AREA		1,120	Square Feet	
BUILDING SITE EUI		117	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		392	kBTU/Ft²/Yr	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.8: Newhalen Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	117.4	10.55	$19.27
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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 Newhalen Water Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Newhalen was used for analysis. From this, the model will 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 Newhalen. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

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	Heating System	Install protective equipment to prevent fuel oil theft so that the Monitor oil heater may be utilized rather than the electric heaters.	$8,375	$1,000	112.90	0.1
2	Other Electrical - Controls Retrofit: Well Heat Tapes	Wire heat tapes along intake lines to turn on only during the winter when intake pumps are not running.	$1,232	$1,200	6.35	1.0
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5	Lighting - Power Retrofit: WTP Lighting	Replace with energy efficient LED bulbs	$110	$1,040	0.87	9.5
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7	Lighting - Combined Retrofit: WTP Exterior Lighting	Install an LED light fixture with built in daylight sensor	-$66	$250	-2.23	999.9
	TOTAL, all measures		**$10,631 + $200 Maint. Savings**	**$18,490**	**7.08**	**1.7**

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. Lighting efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Air Sealing Measures

Rank	**Location**		**Existing Air Leakage Level (cfm@50/75 Pa)**		**Recommended Air Leakage Reduction (cfm@50/75 Pa)**	
4			Air Tightness estimated as: 1680 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 20%.	
Installation Cost	$400		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$174
Breakeven Cost	$1,609		**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	4.8 MMBTU
			Savings-to-Investment Ratio	4.0		
Auditors Notes: Air seal from entry doors and seal former vent in ceiling to reduce air leakage by an estimated 20%.						

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	**Recommendation**					
1	Install protective equipment to prevent fuel oil being stolen so that the heating may be provided by the Monitor 2400 fuel heater rather than the electric heaters.					
Installation Cost	$1,000		**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$8,375
Breakeven Cost	$112,902		**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	-23.6 MMBTU
			Savings-to-Investment Ratio	112.9		
Auditors Notes: Due to fuel theft, the MPI Monitor 2400 fuel heater in the water plant is not currently in use. Space heating is provided by three 2500 W electric heaters. Install a locking cover for valve and piping on the fuel line and a protective cover surrounding plumbing components to prevent fuel theft so that the Monitor heater may be put back online to meet space heating demand. Set the heating setpoint on the Monitor heater to 60 deg F. Run electric heaters only as emergency back-up. Note: Switching from electricity to fuel for heat generation in the water plant will save the community over $8,000/year on energy costs, however, since all electricity in Newhalen is generated by a renewable source, the Tazima hydroelectric plant, this recommendation actual represents an overall increase in fossil fuel use.						

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

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

4.5.1 Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
5	WTP Lighting	13 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$1,040	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$110
Breakeven Cost	$909	**Simple Payback (yrs)**	9	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	0.9		
Auditors Notes: Replace a total of 26 4’ T8 fluorescent bulbs with their energy efficient LED equivalents.					

Rank	Location	Existing Condition		Recommendation	
7	WTP Exterior Lighting	INCAN A Lamp, Std 100W with Manual Switching		Replace with energy efficienty LED lighting with daylight sensor.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	-$66
Breakeven Cost	-$558	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	-0.4 MMBTU
		Savings-to-Investment Ratio	-2.2		
Auditors Notes: Replace the existing exterior fixture with an LED fixture with built in daylight sensor.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Well Heat Tapes	2 Heat Tape with Manual Switching		Run heat tape only during times when water in intake lines is not moving.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	$1,232
Breakeven Cost	$7,623	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	7.5 MMBTU
		Savings-to-Investment Ratio	6.4		
Auditors Notes: Wire heat tapes that run along intake lines to run only during times when the well pumps are not running to reduce heat tape run time by approximately 30%.					

Rank	Location	Description of Existing		Efficiency Recommendation	
3	Well Pump	2 Pump with Manual Switching		Control well pumps using tank float valve.	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$397
Breakeven Cost	$3,152	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	1.5 MMBTU
		Savings-to-Investment Ratio	5.3		
Auditors Notes: Install float in water storage tank. Control well pumps based upon float position/level of water present in storage tank to reduce tank overflow and pump run time by an estimated 25%.					

Rank	Location		Description of Existing		Efficiency Recommendation	
6	Pressure Pump		Pump with Other Controls		Replace hydropneumatic tanks, pressure switches and pressure pump control panel.	
Installation Cost	$14,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$427	
Breakeven Cost	$5,249	**Simple Payback (yrs)**	22	**Energy Savings (MMBTU/yr)**	1.2 MMBTU	
		Savings-to-Investment Ratio	0.4	**Maintenance Savings ($/yr)**	$200	
Auditors Notes: The two existing pressure tanks in the water plant are full of water and no longer contain the compressed air that allows them to function as intended, absorbing or applying pressure as needed. Replace the non-functional, corroded and oversized pressure tanks with smaller new ones. Replace corroded pressure switches with new ones. The current configuration of the pressure pump control panel poses a safety hazard. Replace with a new control panel. Implementation of these recommendations will reduce pressure pump run time by an estimated 10% and reduce frequency of pump starts. Fewer starts will reduce wear on motors, extending pump/motor life.						

5. ENERGY EFFICIENCY ACTION PLAN

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

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

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

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Newhalen Water Plant	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: City of Newhalen	**Auditor Name:** Bailey Gamble
City: Newhalen	**Auditor Address:** 4500 Diplomacy Dr., Suite 454 Anchorage, AK 99508
Client Name: Nick Johnson	
Client Address: PO Box 165 Newhalen, AK 9960	**Auditor Phone:** (907) 729-4501
	Auditor FAX: ( ) -
Client Phone: (907) 299-5557	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,120 square feet	**Design Space Heating Load:** Design Loss at Space: 27,497 Btu/hour with Distribution Losses: 27,497 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 41,916 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 55 deg F (building average)
Actual City: Newhalen	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Newhalen	**Heating Degree Days:** 11,130 deg F-days
Utility Information	
Electric Utility: I-N-N Electric Cooperative, Inc - Commercial - Sm	**Average Annual Cost/kWh:** $0.506/kWh

Annual Energy Cost Estimate					
Description	**Space Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Total Cost**
Existing Building	$11,853	$180	$433	$9,115	**$21,581**
With Proposed Retrofits	$3,449	$180	$372	$6,949	**$10,950**
Savings	$8,405	$0	$61	$2,166	**$10,631**

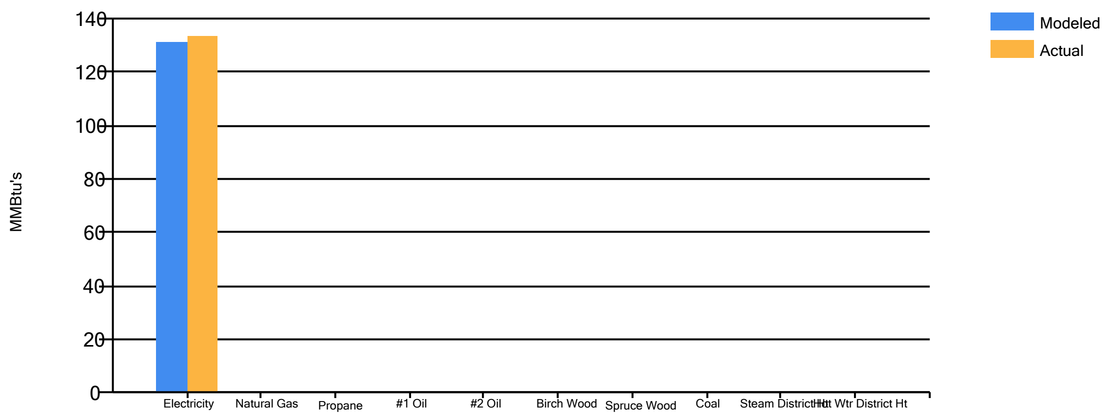
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	117.4	10.55	$19.27
With Proposed Retrofits	125.7	11.29	$9.78

EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

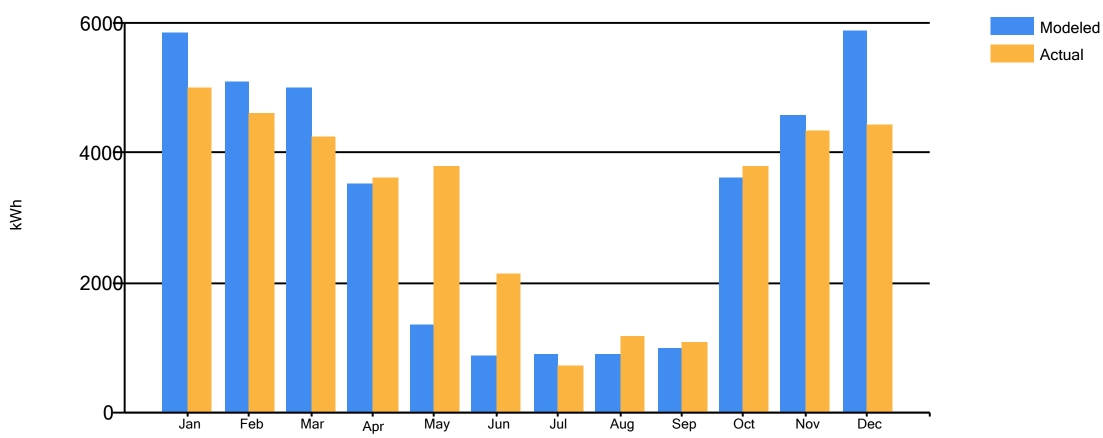
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

Annual Fuel Use



Electricity Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Current	42.1	35.4	29.1	23.8	19.0	17.8	17.4	17.0	16.6	17.8	15.1	10.3
As Proposed	2.7	2.7	2.7	2.6	1.2	1.2	1.2	1.2	1.2	2.6	2.7	2.6

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016