Comprehensive Energy Audit
For

Noatak Water Treatment Plant

Prepared For

Native Village of Noatak

April 14, 2016

Prepared By:

ANTHC-DEHE
4500 Diplomacy Dr.,
Anchorage, AK 99508

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PREFACE

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

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The Native Village of Noatak, Alaska. The authors of this report are Kevin Ulrich, Energy Manager-in-Training (EMIT); and Simon Evans, Certified Energy Manager (CEM).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in February of 2016 by the Rural Energy Initiative 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 Rural Energy Initiative gratefully acknowledges the assistance of Water Treatment Plant Operators Paul Walton, John Williams, and Leonard Eestal; and Noatak Tribal Administrator Herbert Walton Sr.

1. EXECUTIVE SUMMARY

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

In the near future, a representative of ANTHC will be contacting both the Native Village of Noatak and the water treatment plant operators to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

The total predicted energy cost for the Noatak Water Treatment Plant is $138,612 per year. Electricity represents the largest portion with an annual cost of $100,098. This includes $29,516 paid by the village and $70,581 paid by the Power Cost Equalization program through the State of Alaska. Fuel oil represents a large portion with an annual cost of $28,338. Heat recovery represents the remaining portion of the energy cost with an annual cost of approximately $10,176.

There are solar photovoltaic (PV) panels on the building that are used to produce electricity for consumption in the water treatment plant building. These panels were installed in October 2013 and produce approximately 7,798 kWh annually.

There is an existing heat recovery system that transfers heat from the cooling loops of the generators at the Alaska Village Electric Cooperative (AVEC) power plant to the glycol circulation loop in the heating system of the water treatment plant. The system was first installed with the construction of the water treatment plant in 1994 and was later renovated in 2009.

The table below lists the total usage of electricity, #1 heating oil, and the heat recovery system before and after the proposed retrofits.

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	129,030 kWh	103,864 kWh
#1 Oil	2,837 gallons	1,400 gallons
Heat Recovery	969.16 million Btu	872.29 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	688.3	41.07	$53.48

With Proposed Retrofits	544.6	32.50	$40.08
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 Noatak 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 - Water Storage Tank Heat Tape	Shut off heat tape between the water treatment plant building and the water storage tank. Use the heat tape only for emergency thaw purposes.	$3,302	$2,000	19.39	0.6	7,731.5
2	Lighting - WTP Room Lights	Replace with new energy-efficient LED lighting and add a new occupancy sensor to the room.	$2,101	$1,860	13.10	0.9	4,760.7
3	Lighting - Garage Lights	Replace with new energy-efficient LED lighting and add a new occupancy sensor to the room.	$1,732	$1,700	11.81	1.0	3,918.0
4	Water Heating Controls	On the North Loop, repair controls on actuator and solenoid and lower the temperature set point to 40 degrees F.	$2,514	$4,000	10.79	1.6	7,837.4
5	Water Heating Controls	Lower set point to 40 degrees F on the South Loop.	$873	$1,500	9.99	1.7	2,720.3
6	Lighting - Office Lights	Replace with new energy-efficient LED lighting.	$111	$160	8.05	1.4	251.5
7	Other Electrical - North Loop Circulation Pump	Shut off circulation pumps during the summer months	$1,586	$3,500	6.62	2.2	3,698.5
8	Other Electrical - West Loop Circulation Pump	Shut off the circulation pumps during the summer months.	$1,457	$3,500	6.08	2.4	3,397.1
9	Other Electrical - Far West Loop Circulation Pump	Shut off the circulation pumps during the summer months.	$1,068	$3,500	4.56	3.3	2,605.7
10	Water Heating Controls	Lower Temperature set point to 40 degrees F on the West Loop.	$393	$1,500	4.50	3.8	1,224.6
11	Other Electrical - South Loop Circulation Pump	Shut off the circulation pumps during the summer months.	$1,005	$3,500	4.19	3.5	2,340.9
12	Lighting - Side Entry Lights	Replace with new energy-efficient LED lighting.	$28	$80	4.01	2.9	62.6

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]**	**CO_2 Savings**
13	Other Electrical - Far West/North Loops Pump 7	Shut off the circulation pumps during the summer months.	$865	$3,500	3.61	4.0	2,014.2
14	Air Tightening	Perform air sealing by tightening the seals around the doors and windows.	$3,323	$10,000	2.88	3.0	8,668.9
15	Water Heating Controls	On the Far West Loop, repair controls on actuator and solenoid and lower the temperature set point to 40 degrees F.	$659	$4,000	2.83	6.1	2,051.8
16	Water Heating Controls	Add controls to lower the temperature to 40 degrees F for the Raw Water Heat Add.	$1,048	$5,000	2.81	4.8	3,264.5
17	Lighting - Mezzanine Lights	Replace with new energy-efficient LED lighting and add a new occupancy sensor to the room.	$224	$1,220	2.14	5.4	508.7
18	Lighting - Restroom Lights	Replace with new energy-efficient LED.	$11	$80	1.64	7.1	25.6
19	Heating, Ventilation, and Domestic Hot Water	Insulate heat recovery pipes and heat exchanger to reduce heat loss to the atmosphere. Convert the heating system to a primary/secondary system so that the heated glycol does not pass through the unused boilers. Also, the primary/secondary system will allow for the most efficient boiler to be used for most operations. Replace the heat recovery pump with a Grundfos Magna 3 smart pump. Replace Boiler guns with new, properly-sized, more efficient models.	$11,596	$150,000	1.30	12.9	21,441.8
20	Exterior Door: Shop Entrance	Remove existing doors and install standard insulated doors with proper air sealing.	$75	$1,731	0.87	23.0	203.6
21	Window/Skylight: WTP Room Windows	Replace existing broken windows in the process room with triple pane windows.	$280	$4,979	0.85	17.8	755.9

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
22	Water Heating Controls	Lower the water storage tank temperature set point to 38 degrees F. Add tank mixer to the water storage tank.	$467	$11,000	0.56	23.5	1,775.9
	TOTAL, all measures		**$34,717**	**$218,310**	**2.29**	**6.3**	**81,259.7**

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 $34,717 per year, or 25.0% of the buildings' total energy costs. These measures are estimated to cost $218,310, for an overall simple payback period of 6.3 years.

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

Table 1.2

Annual Energy Cost Estimate							
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$27,191	$8,775	$68,708	$8,858	$22,276	$2,744	**$138,612**
With Proposed Retrofits	$22,278	$3,333	$59,607	$5,622	$11,664	$1,331	**$103,895**
Savings	$4,913	$5,442	$9,101	$3,236	$10,611	$1,413	**$34,717**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

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

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

1) Water Treatment Plant: 2,592 square feet

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

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

2.3. Method of Analysis

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

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

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

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

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

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

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

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

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

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

2.4 Limitations of Study

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

3. Noatak Water Treatment Plant

3.1. Building Description

The 2,592 square foot Noatak Water Treatment Plant was constructed in 1994and has a typical occupancy of one person. The number of hours of operation for this building average 8 hours per day, considering all seven days of the week.

The Noatak Water Treatment Plant serves as the water distribution center for the residents of the community. It houses all water intake processes, filters, and distribution networks. The building is owned and maintained by the Native Village of Noatak.

The Noatak Water Treatment Plant has four distribution loops that are used to provide water service to the community. All four loops use 3-inch copper piping in buried arctic pipe insulation to distribute the water. The North Loop serves the northern part of town and has a length of approximately 3000 feet. The South Loop serves the southern part of town and has a length of approximately 5100 feet. The West Loop serves the western part of town and has a length of approximately 5350 feet. The Far West Loop serves the recently developed subdivision and school on the western side of town beyond the central location of the community and has a length of approximately 12,000 feet.

Water is pumped into the water treatment plant from a well on an island in the nearby Noatak River approximately 1,250 feet from the building. The water is pumped through one of two greensand filters in the water treatment plant before being injected with chlorine and pumped to the 97,000 gallon water storage tank. The water stays in the water storage tank to allow for proper contact time with the chlorine before it gets distributed through the four distribution loops to the residents in the community.

There are three wet wells across town that are used to collect sewage and transport it to the sewage lagoon. Wet Wells 1 and 3 are both completely outdoors while Wet Well 2 has a lift station building to house the operations.

Description of Building Shell

The exterior walls are stressed skin panel construction with 5.5 inches of polyurethane foam insulation. The insulation is slightly damaged and there is approximately 3,096 square feet of wall space in the building.

The building has a cathedral ceiling with panelized roof construction and standard 24—inch spacing between the panel framing. The roof has 6 inches of R-19 fiberglass batt insulation that is in fair condition and there is approximately 2,672 square feet of roof space in the building.

The building has a concrete slab foundation on an elevated gravel bed with rigid foam insulation beneath the slab. The floor has heavy damage from frost heaving stemming from the former location of the heat recovery intake pipe directly beneath the gravel pad. There is approximately 2,592 square feet of floor space in the building.

There are eight total windows in the Noatak Water Treatment Plant building. There are five windows that are each 41.5" x 41.5" in dimensions with triple-paned glass wood framing. Four of these windows are in the shop area and one window is in the office. There are three windows in the process room that are each 29.5" x 41.5" in dimension with broken triple-paned glass and wood framing.

The building has four total entrances with only two of them in active use. The primary entrance is through a single metal door on the side of the shop area. The door has no permanent latch and is very leaky around the edges. There is a single metal door in the hallway next to the office that is of the same construction as the shop door but with better insulation around the edges. This door is not commonly used. The shop also has two large garage doors. One garage door is a large metal door with dimensions of approximately 12 x 14 feet. This door is not used and has batt insulation covering the area of the door. There is also a set of wooden garage double doors that together occupy approximately 74" x 90". These doors are built into what was formerly a large conventional wooden garage door and there are prominent air leaks through these doors.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler 1

Nameplate Information:	Weil Mclain P 668V-WT
Fuel Type:	#1 Oil
Input Rating:	190,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Boiler 1 is not in operation and some parts have been salvaged for repairs on boilers 2 and 3.

Boiler 2

Nameplate Information:	Weil Mclain Gold P-WGTO-5
Fuel Type:	#1 Oil
Input Rating:	158,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Boiler 3

Nameplate Information:	Weil Mclain P 668V-WT
Fuel Type:	#1 Oil
Input Rating:	190,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Heat Recovery

Fuel Type:	Heat Recovery
Input Rating:	100,000 BTU/hr
Steady State Efficiency:	95 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Space Heating Distribution Systems

There are five unit heaters associated with the building that are used for space heating purposes. The process room has three unit heaters and the shop has two unit heaters. Two of the process room unit heaters and both of the shop unit heaters are all Dunham Bush M-400-C models with 1/8 HP fans that produce approximately 5000 BTU/hr each. The third unit heater in the process room is a Dunham-Bush M-175-C model that produces approximately 2,400 BTU/hr. There are also three cabinet unit heaters in the building. One cabinet heater is in the restroom and produces approximately 5000 BTU/hr. Two cabinet heaters are in the office and produce approximately 300 BTU/hr each.

Domestic Hot Water System

The building had no hot water heaters installed. There is a sink in the restroom, a sink in the office, and a shower that can all use a domestic hot water heater if installed.

Heat Recovery Information

There is a heat recovery system that was installed when the water treatment plant was first constructed. The system was renovated in 2009 to replace the pipes and change the routing to minimize effects on permafrost. The heat recovery system transports heat from the AVEC power plant generator cooling loops to the water treatment plant to heat the circulating glycol loop prior to the traditional boilers. The power plant has two CAT 3456 generators with marine jackets installed that are used for the winter loads. These generators are the primary source of heat for the heat recovery system. The power plant is approximately 300 feet away from the water treatment plant. It was estimated that the heat recovery system delivers approximately 100,000 BTU/hr to the water treatment plant.

Lighting

The process room has 17 fixtures with two T12 4ft. fluorescent light bulbs in each fixture. The lights are on during common work hours as well as when necessary during evening duties for approximately 11 hours per day all year long and consume approximately 5,019 kWh annually.

The garage and shop area has 15 fixtures with two T12 4ft. fluorescent light bulbs in each fixture. The lights are on during common work hours as well as when necessary during evening duties for approximately 11 hours per day all year long and consume approximately 4,428 kWh annually.

The mezzanine has 6 fixtures with two T12 4ft. fluorescent light bulbs in each fixture. The lights operate approximately 50% of the time during the eight-hour work day all year long and consume approximately 633 kWh annually.

The office has 2 fixtures with two T12 4ft. fluorescent light bulbs in each fixture. The lights are on approximately eight hours per day all year long and consume approximately 422 kWh annually.

There is a single fixture in the side entry hallway with two T12 4ft. fluorescent light bulbs in each fixture. The lights are on approximately 50% of the time during the eight-hour work day all year long and consume approximately 105 kWh annually.

The restroom has a single fixture with two T12 4ft. fluorescent light bulbs that consume approximately 42 kWh annually.

Lift Station 2 has one fixture with two T8 4ft. fluorescent light bulbs, two fixtures with a single incandescent 60 W light bulb in each fixture, and an exterior 150 W metal halide light. The lights consume approximately 669 kWh annually.

Plug Loads

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

Major Equipment

There are two well pumps that are used to pump water from the well to the water treatment plant building. One pump is running constantly throughout the year and both pumps will run during high demand times. The two pumps are each rated for 3 HP. The primary well pump consumes approximately 18,146 kWh annually. The secondary well pump consumes approximately 4,536 kWh annually.

There are six circulation pumps that are used to circulate water through the four distribution loops constantly throughout the year. Three circulation pumps (numbers 2, 3, and 4) control the circulation for the South Loop and West Loop while three other circulation pumps (numbers 5, 6, and 7) control the circulation for the North Loop and Far West Loop. All circulation pumps except for Pump 7 are rated for 1.5 HP and their actual consumption was measured on site with a power meter. Pump 7 is rated for 3 HP and the energy consumption was measured by a power meter. Pumps 2, 4, 5, and 6 were operating during the site visit. The West Loop circulation pump consumes approximately 5,847 kWh annually. The South Loop consumes approximately 4,138 kWh annually. The North Loop consumes approximately 6,312 kWh annually. The Far West Loop circulation pump consumes approximately 7,863 kWh annually. Pump 7 operates for both the North Loop and Far West Loop and consumes approximately 3,592 kWh annually.

There are three pressure pumps that maintain pressure in the water treatment and distribution systems. The pumps are rated for 5 HP and one of the pumps will run approximately 25% of the time. The pressure pumps consume approximately 6,575 kWh annually.

There is a heat tape that runs from the water treatment plant to the water storage tank that is used to prevent the water from freezing in the pipes. The heat tape runs constantly all year long and consumes approximately 4,383 kWh annually.

There is a heat tape on the well line that is used to prevent the water freezing. This heat is only used for emergency thaw purposes and consumes approximately 872 kWh annually.

There is a backwash pump that is used to backwash the filters for maintenance purposes. The pump is rated for 5 HP. The backwash process occurs once per week for approximately 30 minutes and the pump consumes approximately 85 kWh annually for the process.

There is an air scour blower that is used to remove air from the water. The blower operates periodically and consumes approximately 77 kWh annually. This was not functioning during the site visit.

There are some chemical pumps that inject chemicals into the water during the treatment process. These pumps consume approximately 279 kWh annually.

There is a chiller unit that is used to actively cool the foundation of the building during the summer months to prevent permafrost damage. This is a relatively new installation that circulates chilled glycol beneath the building in order to absorb heat in the foundation to prevent shifting from the thawing of frozen ground. The unit runs constantly during the summer months from April through October and consumes approximately 6,958 kWh annually.

There is a washer and dryer unit that reportedly is used for one load per day. The unit consumes approximately 348 kWh annually.

There is a coffee pot that is plugged in constantly and consumes approximately 438 kWh annually.

There are three wet wells that are used to collect sewage from the community and pump it to the sewage lagoon. Wet Well 1 services the north part of town and is estimated to handle approximately 4000 gallons per day. Wet Well 1 has a 3 HP pump that consumes approximately 1,987 kWh annually. Wet Well 2 has a lift station building to service the wet well. Lift Station 2 collects the sewage from Wet Well 1 and it also services the southern part of town. It is estimated that Lift Station 2 handles approximately 10,000 gallons per day. The lift station has a 5 HP pump that consumes approximately 4,383 kWh annually. The electric heater in the Lift Station 2 building operates approximately 33% of the time during the winter heating months from September to May and consumes approximately 7,116 kWh annually. Wet Well 3 services the far west part of town and handles an estimated 5000 gallons per day. It has a 3 HP pump and consumes approximately 4,675 kWh annually.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

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

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

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

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.78/kWh
#1 Oil	$ 9.99/gallons
Heat Recovery	$ 10.50/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Noatak pays approximately $138,612 annually for electricity and other fuel costs for the Noatak Water Treatment Plant.

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

Figure 3.1
Annual Energy Costs by End Use

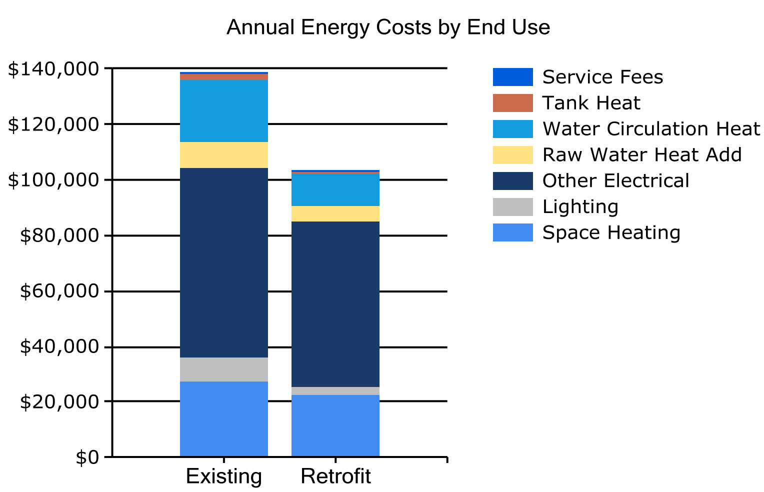


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

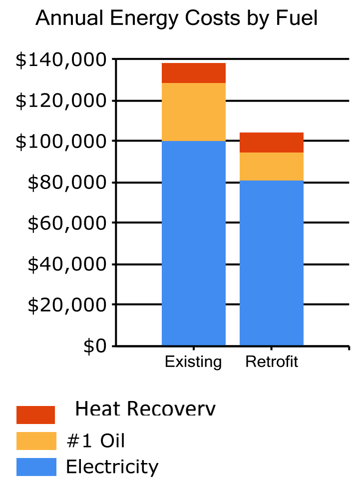
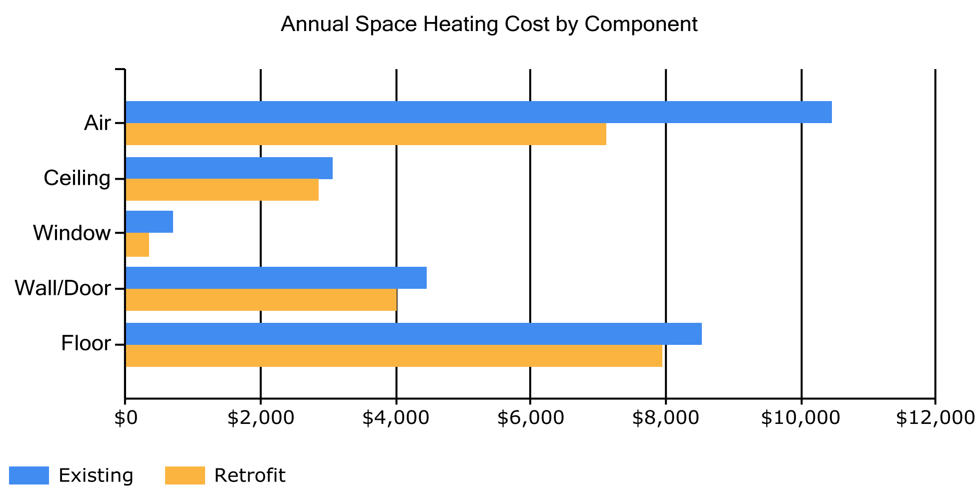


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. 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	3961	3737	3579	2198	1112	900	930	930	910	1857	3013	4000
Lighting	989	902	989	957	945	875	904	904	916	989	957	989
Other Electrical	7286	6640	7286	8105	7829	7082	7318	7318	7593	7813	7051	7286
Raw Water Heat Add	223	203	223	216	108	0	0	0	108	223	216	223
Water Circulation Heat	30	27	30	29	14	0	0	0	14	30	29	30

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	75	72	64	24	16	16	16	16	16	16	49	76
Raw Water Heat Add	88	85	85	62	16	0	0	0	6	46	68	90
Water Circulation Heat	172	157	173	171	121	65	67	67	121	180	169	172
Tank Heat	33	31	31	22	6	0	0	0	2	16	25	33

Recovered Heat Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	30	29	26	11	0	0	0	0	0	7	20	31
Raw Water Heat Add	32	31	31	22	5	0	0	0	2	16	24	33
Water Circulation Heat	62	57	62	60	38	15	15	15	38	62	60	62
Tank Heat	12	11	11	8	2	0	0	0	1	6	9	12

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
Noatak 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	129,030 kWh	440,379	3.340	1,470,866
#1 Oil	2,837 gallons	374,436	1.010	378,181
Heat Recovery	969.16 million Btu	969,157	1.280	1,240,521
Total		**1,783,972**		**3,089,567**
BUILDING AREA		2,592	Square Feet	
BUILDING SITE EUI		688	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,192	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**688.3**	**41.07**	**$53.48**
With Proposed Retrofits	**544.6**	**32.50**	**$40.08**
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.			

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

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

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

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1 Noatak Water Treatment Plant, Noatak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Other Electrical - Water Storage Tank Heat Tape	Shut off heat tape between the water treatment plant building and the water storage tank. Use the heat tape only for emergency thaw purposes.	$3,302	$2,000	19.39	0.6	7,731.5
2	Lighting - WTP Room Lights	Replace with new energy-efficient LED lighting and add a new occupancy sensor to the room.	$2,101	$1,860	13.10	0.9	4,760.7
3	Lighting - Garage Lights	Replace with new energy-efficient LED lighting and add a new occupancy sensor to the room.	$1,732	$1,700	11.81	1.0	3,918.0
4	Water Heating Controls	On the North Loop, repair controls on actuator and solenoid and lower the temperature set point to 40 degrees F.	$2,514	$4,000	10.79	1.6	7,837.4
5	Water Heating Controls	Lower set point to 40 degrees F on the South Loop.	$873	$1,500	9.99	1.7	2,720.3

Table 4.1 Noatak Water Treatment Plant, Noatak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
6	Lighting - Office Lights	Replace with new energy-efficient LED lighting.	$111	$160	8.05	1.4	251.5
7	Other Electrical - North Loop Circulation Pump	Shut off circulation pumps during the summer months	$1,586	$3,500	6.62	2.2	3,698.5
8	Other Electrical - West Loop Circulation Pump	Shut off the circulation pumps during the summer months.	$1,457	$3,500	6.08	2.4	3,397.1
9	Other Electrical - Far West Loop Circulation Pump	Shut off the circulation pumps during the summer months.	$1,068	$3,500	4.56	3.3	2,605.7
10	Water Heating Controls	Lower Temperature set point to 40 degrees F on the West Loop.	$393	$1,500	4.50	3.8	1,224.6
11	Other Electrical - South Loop Circulation Pump	Shut off the circulation pumps during the summer months.	$1,005	$3,500	4.19	3.5	2,340.9
12	Lighting - Side Entry Lights	Replace with new energy-efficient LED lighting.	$28	$80	4.01	2.9	62.6
13	Other Electrical - Far West/North Loops Pump 7	Shut off the circulation pumps during the summer months.	$865	$3,500	3.61	4.0	2,014.2
14	Air Tightening	Perform air sealing by tightening the seals around the doors and windows.	$3,323	$10,000	2.88	3.0	8,668.9
15	Water Heating Controls	On the Far West Loop, repair controls on actuator and solenoid and lower the temperature set point to 40 degrees F.	$659	$4,000	2.83	6.1	2,051.8
16	Water Heating Controls	Add controls to lower the temperature to 40 degrees F for the Raw Water Heat Add.	$1,048	$5,000	2.81	4.8	3,264.5
17	Lighting - Mezzanine Lights	Replace with new energy-efficient LED lighting and add a new occupancy sensor to the room.	$224	$1,220	2.14	5.4	508.7
18	Lighting - Restroom Lights	Replace with new energy-efficient LED.	$11	$80	1.64	7.1	25.6

Table 4.1 Noatak Water Treatment Plant, Noatak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
19	Heating, Ventilation, and Domestic Hot Water	Insulate heat recovery pipes and heat exchanger to reduce heat loss to the atmosphere. Convert the heating system to a primary/secondary system so that the heated glycol does not pass through the unused boilers. Also, the primary/secondary system will allow for the most efficient boiler to be used for most operations. Replace the heat recovery pump with a Grundfos Magna 3 smart pump. Replace Boiler guns with new, properly-sized, more efficient models.	$11,596	$150,000	1.30	12.9	21,441.8
20	Exterior Door: Shop Entrance	Remove existing doors and install standard insulated doors with proper air sealing.	$75	$1,731	0.87	23.0	203.6
21	Window/Skylight: WTP Room Windows	Replace existing broken windows in the process room with triple pane windows.	$280	$4,979	0.85	17.8	755.9
22	Water Heating Controls	Lower the water storage tank temperature set point to 38 degrees F. Add tank mixer to the water storage tank.	$467	$11,000	0.56	23.5	1,775.9
	TOTAL, all measures		**$34,717**	**$218,310**	**2.29**	**6.3**	**81,259.7**

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 Window Measures

Rank	Location		Size/Type, Condition		Recommendation	
21	Window/Skylight: WTP Room Windows		Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11		Replace existing window with triple pane window.	
Installation Cost		$4,979	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$280
Breakeven Cost		$4,231	**Savings-to-Investment Ratio**	0.8	**Simple Payback yrs**	18
Auditors Notes: These windows had been smashed and broken such that the windows were effectively down to one single pane. Replace these windows for better insulation and to prevent air leakage.						

4.3.2 Door Measures

Rank	Location		Size/Type, Condition		Recommendation	
20	Exterior Door: Shop Entrance		Door Type: Entrance, Metal, EPS core, metal edge, no glass Modeled R-Value: 2.7		Remove existing door and install standard pre-hung insulated metal door.	
Installation Cost		$1,731	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$75
Breakeven Cost		$1,513	**Savings-to-Investment Ratio**	0.9	**Simple Payback yrs**	23
Auditors Notes: This door had no latch or weather stripping and was not hung evenly on its hinges. Replace this door with a better constructed door to prevent air leakage and to improve the insulation.						

4.3.3 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
14			Air Tightness estimated as: 5200 cfm at 50 Pascals		Perform air sealing by tightening the seals around the doors and windows.	
Installation Cost		$10,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$3,323
Breakeven Cost		$28,794	**Savings-to-Investment Ratio**	2.9	**Simple Payback yrs**	3
Auditors Notes: Sealing the areas around the main entrance, garage entrance, and broken windows and reduce the air leakage by 1400 cfm and lower the heating demand.						

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
19	Insulate Heat recovery pipes and heat exchanger to reduce heat loss to the atmosphere. Convert the heating system to a primary/secondary system so that the heated glycol does not pass through the unused boilers. Also, the primary/secondary system will allow for the most efficient boiler to be used for most operations. Replace the heat recovery pump with a Grundfos Magna 3 smart pump. Replace Boiler guns with new, properly-sized, more efficient models.				
Installation Cost	$150,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$11,596
Breakeven Cost	$194,408	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	13
Auditors Notes:					

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	WTP Room Lights	17 FLUOR (2) T12 4' F40T12 40W Standard Electronic		Replace with new energy-efficient LED lighting and install an occupancy sensor.	
Installation Cost	$1,860	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,101
Breakeven Cost	$24,373	**Savings-to-Investment Ratio**	13.1	**Simple Payback yrs**	1
Auditors Notes: The room has 17 fixtures with two bulbs per fixture for a total of 34 light bulbs to be replaced. The occupancy sensor will limit the lighting operation to approximately 75% of the occupied time.					

Rank	Location	Existing Condition		Recommendation	
3	Garage Lights	15 FLUOR (2) T12 4' F40T12 40W Standard Electronic		Replace with new energy-efficient LED lighting and install an occupancy sensor.	
Installation Cost	$1,700	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,732
Breakeven Cost	$20,083	**Savings-to-Investment Ratio**	11.8	**Simple Payback yrs**	1
Auditors Notes: The room has 15 fixtures with two bulbs per fixture for a total of 30 light bulbs to be replaced. The occupancy sensor will limit the lighting operation to approximately 75% of the occupied time.					

Rank	Location	Existing Condition		Recommendation	
6	Office Lights	2 FLUOR (2) T12 4' F40T12 40W Standard Electronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$111
Breakeven Cost	$1,287	**Savings-to-Investment Ratio**	8.0	**Simple Payback yrs**	1
Auditors Notes: The room has 2 fixtures with two bulbs per fixture for a total of 4 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
12	Side Entry Lights	FLUOR (2) T12 4' F40T12 40W Standard Electronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$28
Breakeven Cost	$321	**Savings-to-Investment Ratio**	4.0	**Simple Payback yrs**	3
Auditors Notes: The room has a single fixture with two bulbs for a total of 2 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
17	Mezzanine Lights	6 FLUOR (2) T12 4' F40T12 40W Standard Electronic		Replace with new energy-efficient LED lighting and install an occupancy sensor.	
Installation Cost	$1,220	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$224
Breakeven Cost	$2,607	**Savings-to-Investment Ratio**	2.1	**Simple Payback yrs**	5
Auditors Notes: The room has 6 fixtures with two bulbs per fixture for a total of 12 light bulbs to be replaced. The occupancy sensor will limit the lighting operation to approximately 75% of the occupied time.					

Rank	Location	Existing Condition		Recommendation	
18	Restroom Lights	FLUOR (2) T12 4' F40T12 40W Standard Electronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$11
Breakeven Cost	$131	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	7
Auditors Notes: The room has a single fixture with two bulbs for a total of 2 light bulbs to be replaced.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Water Storage Tank Heat Tape	Water Storage Tank Heat Tape		Shut off heat tape and use only for emergency thaw purposes.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3,302
Breakeven Cost	$38,790	**Savings-to-Investment Ratio**	19.4	**Simple Payback yrs**	1
Auditors Notes: This heat tape was on constantly for freeze protection but the existing glycol heat-add system should be sufficient. Shut off the heat tape and use only for emergency thaw purposes to save on electricity consumption.					

Rank	Location		Description of Existing		Efficiency Recommendation	
7	North Loop Circulation Pump		Circulation Pump		Shut off circulation pumps during the summer months.	
Installation Cost		$3,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,586
Breakeven Cost		$23,158	**Savings-to-Investment Ratio**	6.6	**Simple Payback yrs**	2
Auditors Notes: The circulation pumps should be primarily used to keep the water moving for freeze protection during the winter months. Shut off the pumps during the summer time as this is unnecessary work being done by the system.						

Rank	Location		Description of Existing		Efficiency Recommendation	
8	West Loop Circulation Pump		Circulation Pump		Shut off circulation pumps during the summer months.	
Installation Cost		$3,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,457
Breakeven Cost		$21,278	**Savings-to-Investment Ratio**	6.1	**Simple Payback yrs**	2
Auditors Notes: The circulation pumps should be primarily used to keep the water moving for freeze protection during the winter months. Shut off the pumps during the summer time as this is unnecessary work being done by the system.						

Rank	Location		Description of Existing		Efficiency Recommendation	
9	Far West Loop Circulation Pump		Circulation Pump		Shut off circulation pumps during the summer months.	
Installation Cost		$3,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,068
Breakeven Cost		$15,959	**Savings-to-Investment Ratio**	4.6	**Simple Payback yrs**	3
Auditors Notes: The circulation pumps should be primarily used to keep the water moving for freeze protection during the winter months. Shut off the pumps during the summer time as this is unnecessary work being done by the system.						

Rank	Location		Description of Existing		Efficiency Recommendation	
11	South Loop Circulation Pump		Circulation Pump		Shut off circulation pumps during the summer months.	
Installation Cost		$3,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,005
Breakeven Cost		$14,673	**Savings-to-Investment Ratio**	4.2	**Simple Payback yrs**	3
Auditors Notes: The circulation pumps should be primarily used to keep the water moving for freeze protection during the winter months. Shut off the pumps during the summer time as this is unnecessary work being done by the system.						

Rank	Location		Description of Existing		Efficiency Recommendation	
13	Far West/North Loops Pump 7		Circulation Pump		Shut off circulation pumps during the summer months.	
Installation Cost		$3,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$865
Breakeven Cost		$12,629	**Savings-to-Investment Ratio**	3.6	**Simple Payback yrs**	4
Auditors Notes: The circulation pumps should be primarily used to keep the water moving for freeze protection during the winter months. Shut off the pumps during the summer time as this is unnecessary work being done by the system.						

4.5.3 Other Measures

Rank	Location	Description of Existing			Efficiency Recommendation
4		North Circulation Loop			Repair controls on actuator and solenoid and lower the temperature set point to 40 degrees F. Replace circulation pumps with new energy efficient model.
Installation Cost	$4,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$2,514
Breakeven Cost	$43,167	**Savings-to-Investment Ratio**	10.8	**Simple Payback yrs**	2

Auditors Notes: The loop actuator on the heat-add system did not open or close all the way when activated, leaving the line partly open or closed. Also, the loop temperature was 49 degrees during the site visit. This can be lowered to 40 degrees to limit unnecessary heating. The circulation pump can be replaced to a more efficient model, which should improve the pump efficiency by approximately 8-10%.

Rank	Location	Description of Existing			Efficiency Recommendation
5		South Circulation Loop			Lower set point to 40 degrees F. Replace circulation pumps with new energy efficient model.
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$873
Breakeven Cost	$14,982	**Savings-to-Investment Ratio**	10.0	**Simple Payback yrs**	2

Auditors Notes: The loop temperature was at 46 degrees during the site visit. Lower the temperature to 40 degrees to limit unnecessary heating. The circulation pump can be replaced with a more efficient model, which should increase the pump efficiency by approximately 8-10 %.

Rank	Location	Description of Existing			Efficiency Recommendation
10		West Circulation Loop			Lower temperature set point to 40 degrees F. Replace circulation pumps with new energy efficient model.
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$393
Breakeven Cost	$6,745	**Savings-to-Investment Ratio**	4.5	**Simple Payback yrs**	4

Auditors Notes: The loop temperature was at 43 degrees during the site visit. Lower the temperature to 40 degrees to limit unnecessary heating. The circulation pump can be replaced with a more efficient model, which should increase the pump efficiency by approximately 8-10 %.

Rank	Location	Description of Existing			Efficiency Recommendation
15		Far West Circulation Loop			Repair controls on actuator and solenoid and lower the temperature set point to 40 degrees F. Replace circulation pumps with new energy efficient model.
Installation Cost	$4,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$659
Breakeven Cost	$11,311	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	6

Auditors Notes: The actuator on the heat-add system did not function and all heat-add controls had to be completed manually. The loop temperature was at 42 degrees during the site visit. Lower the temperature to 40 degrees to limit unnecessary heating. The circulation pump can be replaced with a more efficient model, which should increase the pump efficiency by approximately 8-10 %.

Rank	Location	Description of Existing		Efficiency Recommendation	
16		Raw Water Heat Add		Add controls to lower the temperature to 40 degrees F.	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,048
Breakeven Cost	$14,044	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	5
Auditors Notes: The raw water temperature was at 46 degrees during the site visit. Lower the temperature to 40 degrees to limit unnecessary heating.					

Rank	Location	Description of Existing		Efficiency Recommendation	
22		Water Storage Tank Heat Add		Lower the water storage tank temperature set point to 34 degrees F. Add tank mixer to the water storage tank.	
Installation Cost	$11,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$467
Breakeven Cost	$6,212	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	24
Auditors Notes: Lower the tank temperature to 34 degrees to prevent unnecessary heating. This temperature can be achieved safely by installing a tank mixer into the tank to allow for evenly heated water throughout all levels of the tank.					

5. ENERGY EFFICIENCY ACTION PLAN

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

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

In the near future, a representative of ANTHC will be contacting both the Native Village of Noatak and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Noatak Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: PO Box 89	**Auditor Name:** Kevin Ulrich and Simon Evans
City: Noatak	**Auditor Address:** 4500 Diplomacy Dr., Anchorage, AK 99508
Client Name: Paul Walton	
Client Address:	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 485-5252	**Auditor Comment:** First number is for Kevin, Second Number is for Simon
Client FAX:	
Design Data	
Building Area: 2,592 square feet	**Design Space Heating Load:** Design Loss at Space: 91,679 Btu/hour with Distribution Losses: 96,504 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 147,110 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 person	**Design Indoor Temperature:** 60 deg F (building average)
Actual City: Noatak	**Design Outdoor Temperature:** -41.4 deg F
Weather/Fuel City: Noatak	**Heating Degree Days:** 16,758 deg F-days
Utility Information	
Electric Utility: AVEC-Noatak - Commercial - Sm	**Average Annual Cost/kWh:** $0.776/kWh

Annual Energy Cost Estimate							
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$27,191	$8,775	$68,708	$8,858	$22,276	$2,744	**$138,612**
With Proposed Retrofits	$22,278	$3,333	$59,607	$5,622	$11,664	$1,331	**$103,895**
Savings	$4,913	$5,442	$9,101	$3,236	$10,611	$1,413	**$34,717**

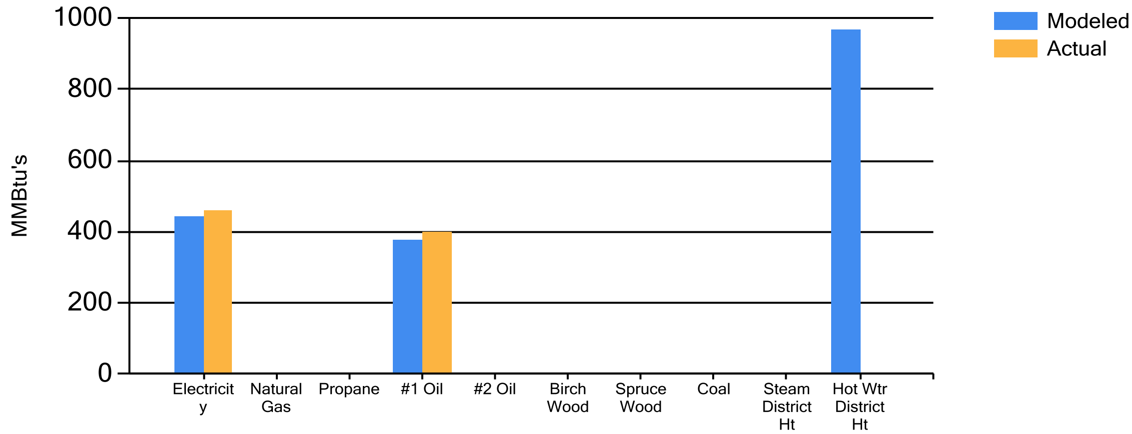
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	688.3	41.07	$53.48
With Proposed Retrofits	544.6	32.50	$40.08

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

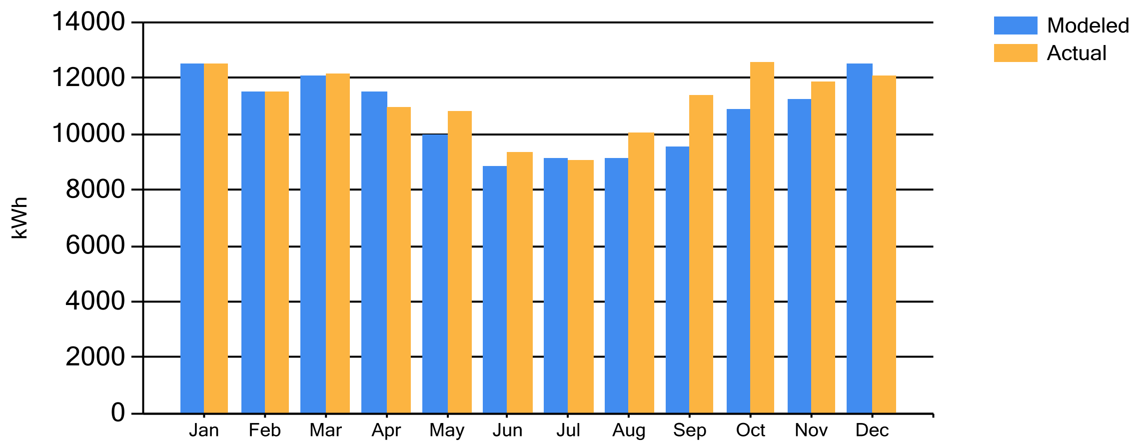
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

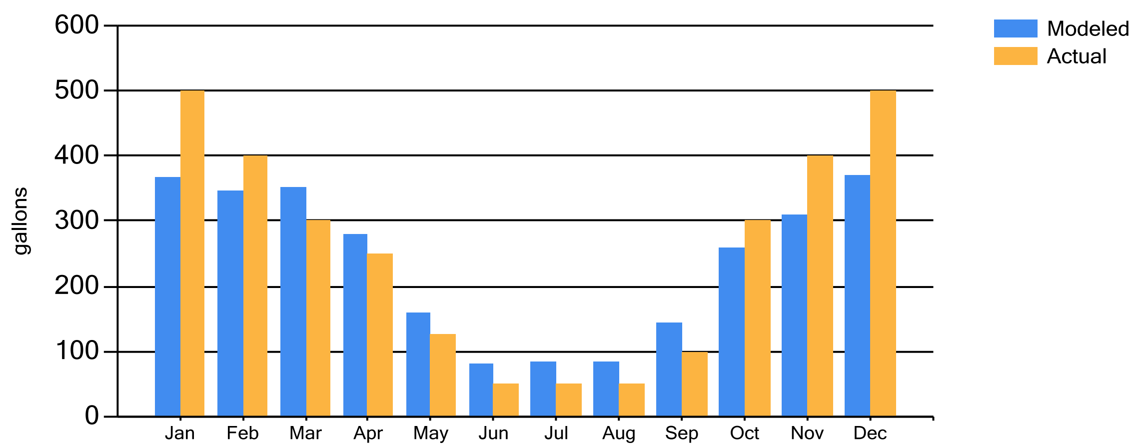
Annual Fuel Use



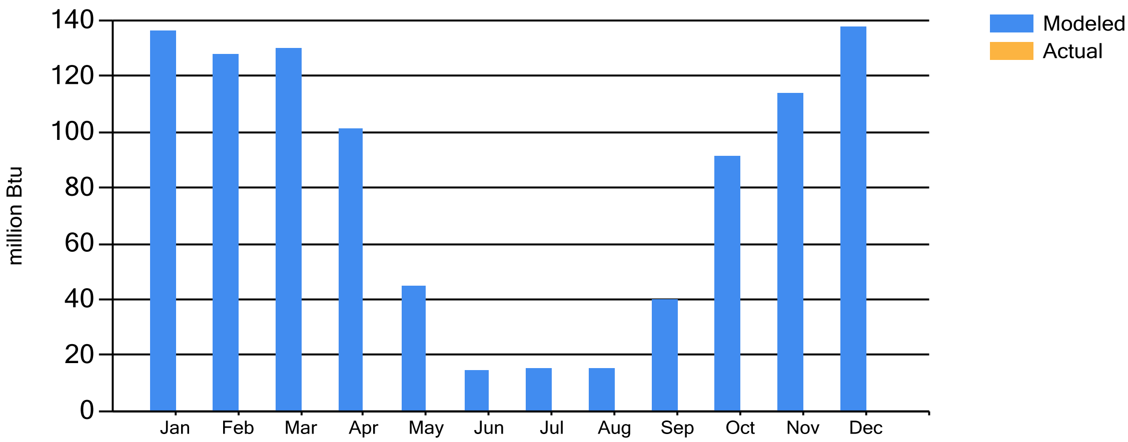
Electricity Fuel Use



#1 Fuel Oil Fuel Use



Heat Recovery Fuel Use



140
120
100
80
60
40
20
0
million Btu
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Modeled
Actual

Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	26.0	26.3	25.3	24.1	20.8	19.5	19.5	19.5	20.5	22.5	24.3	26.1
As Proposed	23.0	23.2	22.3	21.4	17.0	14.0	13.9	13.9	16.6	19.9	21.5	23.0

AkWarmCalc Ver 2.4.1.0, Energy Lib 3/30/2015