Comprehensive Energy Audit For Sand Point Water Treatment Plant and Intake Facility

Prepared For

City of Sand Point

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PREFACE

This energy audit was conducted using funds provided by the Department of Energy as part of the Rural Alaskan Communities Energy Efficiency (RACEE) Competition. Coordination with the City of Sand Point 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 City of Sand Point, Alaska. The author of this report is Gavin Dixon, Rural Energy Initiative Senior Project Manager.

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

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operator Allen Hill, Water Treatment Plant Operator Allen Young, City Administrator Andy Varner, and State of Alaska Remote Maintenance Worker Steve Evavold.

1. EXECUTIVE SUMMARY

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

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $54,929 per year and the breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are $38,034 for Electricity and $16,895 for #1 Oil.

Table 1.1

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	87,163 kWh	77,019 kWh
#1 Oil	3,929 gallons	1,372 gallons

The Sand Point Water Plant and Intake Facility both receive the power cost equalization (PCE) subsidy for electricity from the State of Alaska. The City of Sand Point pays $17,433 for electricity for the two facilities, with the PCE program paying for $20,601 of the cost of electricity.

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 Sand Point the cost of electricity without PCE is $0.44/kWh and the cost of electricity with PCE is $0.20/kWh. For the purposes of this report, all costs and savings are calculated using the full unsubsidized electrical rate.

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.

Table 2.2

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	283.4	31.97	$19.07
With Proposed Retrofits	154.1	17.39	$13.72
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 Sand Point Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3 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	HVAC And DHW	Reprogram Tekmar, remove hot water heater, re-plumb hot water heating system and install smaller indirect hot water heater. Install check valves on boiler circulation pumps.	$11,220	$20,000	9.73	1.8	54,827.3
2	Air Tightening	Perform air sealing to reduce air leakage by 250 cfm within the two doghouses.	$131	$500	2.43	3.8	638.4
3	Other Electrical - Controls Retrofit: Intake Building Electric Heater	Install programmable thermostat and reduce heating set point in the Intake facility to 50 degrees.	$416	$1,500	2.33	3.6	1,623.8
4	Setback Thermostat: Office	Install a programmable thermostat and reduce heating set point in the Office to 50 degrees when unoccupied.	$252	$1,500	2.27	6.0	1,230.5
5	Lighting - Combined Retrofit: Office Lights	Replace with direct wired 17 watt LED replacement bulbs.	$229 + $10 Maint. Savings	$1,200	2.23	5.0	824.2
6	Setback Thermostat: Water Treatment Plant Process	Install a programmable thermostat and reduce heating set point in the Filter Room to 50 degrees when unoccupied.	$579	$3,600	2.17	6.2	2,828.0
7	Setback Thermostat: Chlorine Room	Install a programmable thermostat and reduce heating set point in the Chlorine Room to 50 degrees when unoccupied.	$158	$1,200	1.78	7.6	771.2
8	Setback Thermostat: Polymer Room	Install a programmable thermostat and reduce heating set point in the Polymer to 50 degrees when unoccupied.	$152	$1,200	1.71	7.9	742.8
9	Lighting - Power Retrofit: Other T8 Lighting	Replace with direct wired 17 watt LED replacement bulbs.	$170 + $20 Maint. Savings	$1,530	1.40	8.1	615.1
10	Other Electrical - Combined Retrofit: Pump 3-4	Identify and repair small leaks in the water distribution system to reduce run time on pumps. Replace the VFD for the 15 Horsepower, 150 GPM pump and use this pump as the primary water source pump.	$3,229	$20,500	1.21	6.3	12,605.0

Table 1.3 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**
11	Lighting - Combined Retrofit: Intake Exterior Lighting	Replace Exterior Lighting at intake facility with LED replacements.	$63	$350	1.12	5.5	246.6
12	Other Electrical - Controls Retrofit: Polymer Pump	Identify and fix leaks in the water distribution system to reduce polymer usage and pumping energy.	$128 + $500 Maint. Savings	$5,000	1.06	8.0	459.0
	TOTAL, cost-effective measures		**$16,726 + $530 Maint. Savings**	**$58,080**	**4.31**	**3.4**	**77,412.0**
The following measures were *not* found to be cost-effective:							
13	Lighting - Power Retrofit: High Bay Lighting	Replace with LED High Bay lighting fixtures.	$269 + $50 Maint. Savings	$5,000	0.72	15.7	963.4
14	Lighting - Power Retrofit: Intake Building Lights	Replace with direct wired 17 watt LED replacement bulbs.	$24 + $5 Maint. Savings	$550	0.61	19.2	92.5
15	Ventilation	This retrofit models the energy impact of operating the current shut down Air Handler to reduce humidity in the facility.	-$1,604	$500	-41.12	999.9	-7,210.3
	TOTAL, all measures		**$15,414 + $585 Maint. Savings**	**$64,130**	**3.64**	**4.0**	**71,257.6**

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 $15,414 per year, or 28.1% of the buildings' total energy costs. These measures are estimated to cost $64,130, for an overall simple payback period of 4.0 years. If only the cost-effective measures are implemented, the annual utility cost can be reduced by $16,726 per year, or

30.5% of the buildings' total energy costs. These measures are estimated to cost $58,080, for an overall simple payback period of 3.4 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

Annual Energy Cost Estimate									
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$5,909	$0	$11,647	$24	$46	$2,232	$34,990	$80	**$54,929**
With Proposed Retrofits	$5,890	$0	$391	$660	$46	$1,273	$31,175	$80	**$39,515**
Savings	$19	$0	$11,256	-$636	$0	$960	$3,815	$0	**$15,414**

Sand Point Water Intake Facility

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment (optional) & 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 Sand Point 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.

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

1) Water Treatment Plant Process: 2,051 square feet
2) Chlorine Room: 143 square feet
3) Polymer Room: 140 square feet
4) Office: 273 square feet
5) Restroom: 104 square feet
6) Mechanical Room: 169 square feet

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

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

2.3. Method of Analysis

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

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

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

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

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

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

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money).

Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

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

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

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

2.4 Limitations of Study

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

3. Sand Point Water Treatment Plant

3.1. Building Description

The 2,880 square foot Sand Point Water Treatment Plant was constructed in 2001, with a normal occupancy of 2 people. The number of hours of operation for this building average 6.5 hours per day, considering all seven days of the week.

The intake facility is a 400 square foot building with a normal occupancy of one person for about half an hour per day.

Sand Point collects its water from a small lake. The intake facility uses four vertical axis turbine pumps to pump water from the lake to the water treatment plant. The raw water is treated with polymer coagulant and run through three green sand filters with 10' diameters each. The water is then treated with chlorine before being stored in a 500,000 gallon water storage tank. A small pressure booster pump station is built near the school and water plant that provides additional pressure for homes and the school. The remainder of the community uses gravity to maintain pressure and flow through the water distribution system.

Water is pumped on average 19 hours a day at a rate of on average 120 gallons per minute using primarily one of the 25 horsepower, 250 gpm capacity vertical axis turbine pumps in the intake facility. Pumping is controlled by water storage tank level. The water plant uses about 10 gpm for treatment, with approximately110 gpm of water treated for storage. The following table displays treated water production rates by month for 2015 in Sand Point.

2015	
Month	Gallons
January	3,445,456
February	4,109,668
March	3,608,841
April	3,990,721
May	3,579,115
June	3,480,556
July	4,507,088
August	4,589,769
September	4,044,010
October	4,492,026
November	4,729,404
December	4,543,896
Total gallons	49,120,550
Daily Average	134,577

Of this production, about 120,000 gallons per month is used for backwash and the remainder for domestic and commercial use in the community. This amounts to approximately125 gallons of water per person per day. It is estimated that about 5 to 10% of water use in Sand Point can be attributed to running taps to reduce freeze ups in the winter on water service lines. An additional 10-15% is estimated to be lost through small leaks in the water distribution system. The City of Sand Point fixes leaks consistently and regularly, and performed significant leaks repairs in 2012 and 2013 that reduced water usage by nearly 50%.

The three filters are cleaned using gravity backflow from the water storage tank about once per week. During this period, raw water pumps are shut off. The filters are partially drained, then provided with about 15 minutes of air scour, and finally are backwashed for 5-10 minutes each using 900 gpm of treated water. About 30,000 gallons of treated water are used in each backwash cycle.

Description of Building Shell

The exterior walls are 2x8 wood frame construction with R-30 batt insulation.

The roof of the building is a cold roof with 12 inches of R-38 batt insulation.

The floor of the facility is slab on grade with no insulation.

Typical windows throughout the building are double paned glass windows with insulated fiberglass frames.

There are seven exterior metal doors with fiberglass cores.

Sand Point Mechanical Room

Description of Heating Plants

The heating plants used in the building are:

Burnam PV8H84WC

Fuel Type:	#1 Oil
Input Rating:	178,200 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Burnam PV8H84WC

Fuel Type:	#1 Oil
Input Rating:	178,200 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	20 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

The boilers in the facility are controlled by a Tekmar intended to setback boiler operating temperature based upon outside air temperature. The Tekmar is not operating according to its designed programming. The boilers are in excellent condition. Small boiler primary circulation pumps run with a short lag every time the boilers fire. The boilers both operate Beckett AFG Burners.

Space Heating Distribution Systems

Space heating to the facility is distributed by two circulation pumps piped in parallel labeled HP1A and HP1B. Space heating is then provided to the polymer room, and filter room via three unit heaters controlled by non-programmable thermostats. There are additionally short runs of hydronic baseboard heating in the office and bathroom controlled by non-programmable thermostats.

The intake facility uses a single Chromalox electric unit heater set with a non-programmable thermostat at approximately60 degrees Fahrenheit. This consumes about 3,820 kWh annually.

Domestic Hot Water System

An indirect 119 gallon hot water heater provides hot water to the facility. A small circulation pump injects heat to the hot water heater from the primary loop, though currently the pump is ineffective at this task. This results in excessive run time of the boilers attempting to satisfy a call for heat to the hot water heater, resulting in excessive boiler cycling and stack losses. At the time of the audit the hot water heater was set to 140 degrees. Hot water is only used for occasional washer loads and for hand washing in the facility, averaging about 5 gallons per day.

Description of Building Ventilation System

There is a Greenheck air handler intended to provide dehumidification to the facility. The air handler has a ¾ horsepower motor, and can move 600 CFM. The design operation calls for a maintenance of 30% humidity inside the facility. At the time of the audit the air handler had been shut down by the operators of the facility to reduce energy consumption, and the humidistat was set to 80% humidity. Operators state the facility rarely experiences humidity issues and sweating of pipes is limited due to maintenance of low temperatures in the facility.

Lighting

The majority of lighting in the facility is made up of fluorescent T8 wraparound fixtures with two to four 32 watt bulbs each. Lights are kept off most of the time. These lights use approximately3,000 kWh annually.

There are an additional six 250 Watt Metal Halide high bay lighting fixtures for use during backwashing and filter maintenance. These lights are kept off most of the time. These lights are estimated to use ~`1200 kWh annually.

Exterior lighting has recently been replaced with motion sensor and photo cell controlled LED 20 watt lighting fixtures. ~365 kWh annually.

Lighting in the intake facility is also made up of T8 wraparound fixtures with two 32 watt bulbs each. Exterior lighting in the intake facility consists of a single 50 watt high pressure sodium light. Lights at the intake facility are estimated to use ~450 kWh annually.

Plug Loads

A variety of plug loads operate in the facility, including several computers, monitors, cell phone chargers, a printer, fax machine, phone, battery chargers for power tools and a variety of household appliances. These loads are estimated to use ~1300 kWh annually.

A small electric washing machine and an electric dryer operate in the facility. These loads are estimated to use ~250 kWh annually.

Major Equipment

Major Equipment	Purpose	Motor Size	Operating Schedule	Annual kWh
Polymer Injection Pump	Inject polymer to coagulate with organics from raw water for water treatment	1 HP	19 hours per day during raw water treatment	4,381
Chlorine Injection Pump	Injection chlorine for disinfection during water treatment	½ HP	19 hours per day during treatment process	1,634
Air Scour Blower	Air scour of filters during backwashing filter process	20 HP	15 minutes per week	150 kWh
250 GPM Raw Water Pump 3,4	Pump raw water through treatment plant to water storage tank	25 HP	19 hours per day	59,462 kWh
150 GPM Raw Water Pump 2	Pump raw water through treatment plant to water storage tank	15 HP	Never	0 kWh
50 GPM Raw Water Pump 1	Pump raw water through treatment plant to water	7.5 HP	One hour per week	~600 kWh

	storage tank			
UPS Power supply	Backup power	300 watt	24/7/365	2,629 kWh
Water Treatment Controls	Variety of controls including streaming current detector, turbidimeters, tekmar, chlorine analyzer, etc.	250 watts	24/7/365	2,191 kWh
Intake Building Controls and Controls Cooling	A series of VFD's with cooling fans and telemetry/radio control	350 watts	24/7/365	3,068 kWh

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.

–TDX Power owns and operates a power plant that provides electricity to the community of Sand Point.

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	$ 0.44/kWh
#1 Oil	$ 4.30/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Sand Point pays approximately $54,929 annually for electricity and other fuel costs for the Sand Point 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

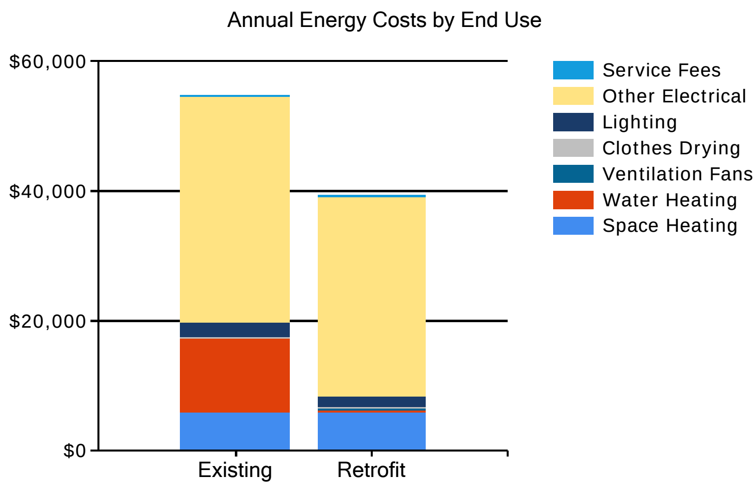


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

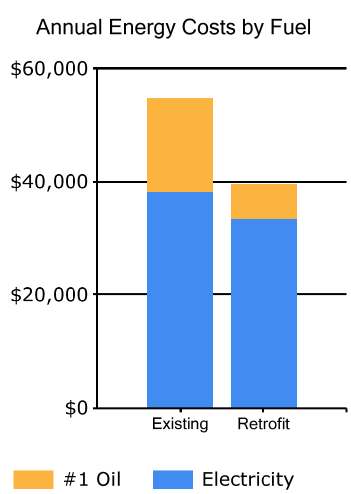
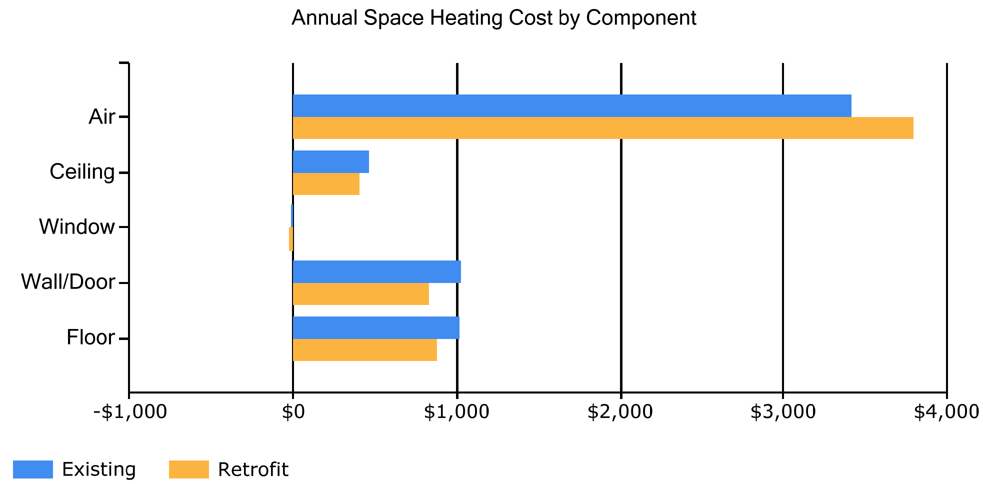


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused

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.

Table 3.2

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	138	127	134	118	104	87	86	86	86	106	117	134
DHW	17	15	17	16	17	16	17	17	16	17	16	17
Ventilation_Fans	5	4	5	5	5	5	5	5	5	5	5	5
Clothes_Drying	9	8	9	9	9	9	9	9	9	9	9	9
Lighting	435	397	435	421	435	421	435	435	421	435	421	435
Other_Electrical	7054	6428	7054	6826	6496	6286	6496	6496	6286	7054	6826	7054

Table 3.3

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	191	180	180	135	77	30	15	15	24	84	130	180
DHW	228	208	228	221	228	221	228	228	221	228	221	228

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
Sand Point 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	87,163 kWh	297,488	3.340	993,609
#1 Oil	3,929 gallons	518,650	1.010	523,837
Total		**816,138**		**1,517,445**
BUILDING AREA		2,880	Square Feet	
BUILDING SITE EUI		283	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		527	**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	**283.4**	**31.97**	**$19.07**
With Proposed Retrofits	**154.1**	**17.39**	**$13.72**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. **EUI/HDD: Energy Use Intensity per Heating Degree Day.** **ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.**			

3.3 AkWarm© Building Simulation

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

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

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

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Sand Point. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.

• The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.

The 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 Sand Point Water Treatment Plant, Sand Point, Alaska 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	HVAC And DHW	Reprogram tekmar, remove hot water heater, re-plumb hot water heating system and install smaller indirect hot water heater. Install check valves on boiler circulation pumps.	$11,220	$20,000	9.73	1.8	54,827.3
2	Air Tightening	Perform air sealing to reduce air leakage by 250 cfm within the two doghouses.	$131	$500	2.43	3.8	638.4
3	Other Electrical - Controls Retrofit: Intake Building Electric Heater	Install programmable thermostat and reduce heating set point in the Intake facility to 50 degrees.	$416	$1,500	2.33	3.6	1,623.8
4	Setback Thermostat: Office	Install a programmable thermostat and reduce heating set point in the Office to 50 degrees when unoccupied.	$252	$1,500	2.27	6.0	1,230.5
5	Lighting - Combined Retrofit: Office Lights	Replace with direct wired 17 watt LED replacement bulbs.	$229 + $10 Maint. Savings	$1,200	2.23	5.0	824.2
6	Setback Thermostat: Water Treatment Plant Process	Install a programmable thermostat and reduce heating set point in the Filter Room to 50 degrees when unoccupied.	$579	$3,600	2.17	6.2	2,828.0
7	Setback Thermostat: Chlorine Room	Install a programmable thermostat and reduce heating set point in the Chlorine Room to 50 degrees when unoccupied.	$158	$1,200	1.78	7.6	771.2
8	Setback Thermostat: Polymer Room	Install a programmable thermostat and reduce heating set point in the Polymer to 50 degrees when unoccupied.	$152	$1,200	1.71	7.9	742.8
9	Lighting - Power Retrofit: Other T8 Lighting	Replace with direct wired 17 watt LED replacement bulbs.	$170 + $20 Maint. Savings	$1,530	1.40	8.1	615.1
10	Other Electrical - Combined Retrofit: Pump 3-4	Identify and repair small leaks in the water distribution system to reduce run time on pumps. Replace the VFD for the 15 Horsepower, 150 GPM pump and use this pump as the primary water source pump.	$3,229	$20,500	1.21	6.3	12,605.0

Table 4.1 Sand Point Water Treatment Plant, Sand Point, Alaska 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**
11	Lighting - Combined Retrofit: Intake Exterior Lighting	Replace Exterior Lighting at intake facility with LED replacements.	$63	$350	1.12	5.5	246.6
12	Other Electrical - Controls Retrofit: Polymer Pump	Identify and fix leaks in the water distribution system to reduce polymer usage and pumping energy.	$128 + $500 Maint. Savings	$5,000	1.06	8.0	459.0
	TOTAL, cost-effective measures		**$16,726 + $530 Maint. Savings**	**$58,080**	**4.31**	**3.4**	**77,412.0**
The following measures were *not* found to be cost-effective:							
13	Lighting - Power Retrofit: High Bay Lighting	Replace with LED High Bay lighting fixtures.	$269 + $50 Maint. Savings	$5,000	0.72	15.7	963.4
14	Lighting - Power Retrofit: Intake Building Lights	Replace with direct wired 17 watt LED replacement bulbs.	$24 + $5 Maint. Savings	$550	0.61	19.2	92.5
15	Ventilation	This retrofit models the energy impact of operating the current shut down Air Handler to reduce humidity in the facility.	-$1,604	$500	-41.12	999.9	-7,210.3
	TOTAL, all measures		**$15,414 + $585 Maint. Savings**	**$64,130**	**3.64**	**4.0**	**71,257.6**

4.2 Interactive Effects of Projects

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

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

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

4.3 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)	
2			Air Tightness estimated as: 6950 cfm at 50 Pascals		Insulate and install weather stripping around access doors of the dog house structures.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$131	
Breakeven Cost	$1,213	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	4	
Auditors Notes: Reduce infiltration into doghouse structures using foam sealant and latching improvements to the access doors.						

4.4 Mechanical Equipment Measures

4.4.1 Heating/ Domestic Hot Water Measure

Rank	Recommendation				
1	Reprogram tekmar, remove hot water heater and install smaller indirect hot water heater with new plumbing. Install check valves on boiler circulation pumps.				
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$11,220
Breakeven Cost	$194,646	**Savings-to-Investment Ratio**	9.7	**Simple Payback yrs**	2
Auditors Notes: The oversized hot water heater should be removed and replaced with a smaller indirect hot water heater. This should be re-plumbed and tied to the Tekmar appropriately. The Tekmar should be reprogrammed to design settings, with an outdoor reset setup to lower boiler operating temperature to 140 degrees when the temperature is above 45 degrees outside, and maxing out boiler set points at 180 degrees when the temperature is at or below 0 degrees outside. The Tekmar should also be programmed to only turn on one of the building space heating circulation pumps when there is a call for heat in the facility instead of both pumps. New check valves should be installed on the boiler primary circulation pumps as existing check valves are leaking.					

4.4.2 Ventilation System Measures

Rank	Description			Recommendation	
15				Use Air Handler with Humidistat	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	-$1,604
Breakeven Cost	-$20,558	**Savings-to-Investment Ratio**	-41.1	**Simple Payback yrs**	1000
Auditors Notes: This measure captures the impact of operating the air handler after heating system improvements have been made. This is not recommended for energy efficiency purposes, but is advised to reduce moisture impacts to the facility per the operators discretion.					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
4	Office			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Office space.	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$252
Breakeven Cost	$3,407	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	6
Auditors Notes: Install programmable thermostats with the baseboard heating in the office. Thermostats should be programmed to maintain a temperature of 50 degrees when the space is unoccupied, such as at nights and on weeks.					

Rank	Building Space			Recommendation	
6	Water Treatment Plant Process			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Treatment Plant Process space.	
Installation Cost	$3,600	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$579
Breakeven Cost	$7,829	**Savings-to-Investment Ratio**	2.2	**Simple Payback yrs**	6
Auditors Notes: Install programmable thermostats with the two unit heats in the Filter room. Thermostats should be programmed to maintain a temperature of 50 degrees when the space is unoccupied. Additionally this measure calls for installation of ceiling fans to distribute heating in the facility to ensure operability, freeze protection and comfort throughout the facility.					

Rank	Building Space			Recommendation	
7	Chlorine Room			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Chlorine Room space.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$158
Breakeven Cost	$2,135	**Savings-to-Investment Ratio**	1.8	**Simple Payback yrs**	8
Auditors Notes: Install programmable thermostats with the unit heater in the chlorine room. Thermostat should be programmed to maintain a temperature of 50 degrees when the space is unoccupied.					

Rank	Building Space			Recommendation	
8	Polymer Room			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Polymer Room space.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$152
Breakeven Cost	$2,057	**Savings-to-Investment Ratio**	1.7	**Simple Payback yrs**	8
Auditors Notes: Install programmable thermostats with the unit heater in the polymer room. Thermostat should be programmed to maintain a temperature of 50 degrees when the space is unoccupied.					

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 cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
5	Office Lights	4 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with 4 LED (4) 17W Module StdElectronic and Improve Manual Switching	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$229
				Maintenance Savings (/yr)	$10
Breakeven Cost	$2,681	**Savings-to-Investment Ratio**	2.2	**Simple Payback yrs**	5
Auditors Notes: Install Occupancy Sensor to reduce usage and install direct wire LED lighting replacements in the Water Plant facility. LED lighting will last longer and use less energy.					

Rank	Location	Existing Condition		Recommendation	
9	Other T8 Lighting	17 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with 17 LED (2) 17W Module StdElectronic	
Installation Cost	$1,530	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$170
				Maintenance Savings (/yr)	$20
Breakeven Cost	$2,147	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	8
Auditors Notes: Install direct wire LED lighting replacements in the Water Plant facility. LED lighting will last longer and use less energy.					

Rank	Location	Existing Condition		Recommendation	
11	Intake Exterior Lighting	HPS 50 Watt StdElectronic		Replace with LED 20W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	
Installation Cost	$350	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$63
Breakeven Cost	$391	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	6
Auditors Notes: Install LED replacement lighting for the Exterior of the Intake facility. LED lighting will last longer and use less energy.					

Rank	Location	Existing Condition		Recommendation	
13	High Bay Lighting	6 MH 250 Watt StdElectronic		Replace with 6 LED 80W Module StdElectronic	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$269
				Maintenance Savings (/yr)	$50
Breakeven Cost	$3,598	**Savings-to-Investment Ratio**	0.7	**Simple Payback yrs**	16
Auditors Notes: Install LED Lighting replacements for the high bay replacements.					

Rank	Location	Existing Condition		Recommendation	
14	Intake Building Lights	6 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with 6 LED (2) 17W Module StdElectronic	
Installation Cost	$550	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$24
				Maintenance Savings (/yr)	$5
Breakeven Cost	$338	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	19
Auditors Notes: Install direct wire LED lighting replacements in the Intake facility. LED lighting will last longer and use less energy.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
3	Intake Building Electric Heater	Chromalox Unit Heater set at 60		Improve Manual Switching	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$416
Breakeven Cost	$3,502	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	4
Auditors Notes: Install programmable thermostat in the Intake facility to maintain temperature at 50 degrees, only to be used when the facility is occupied for maintenance.					

Rank	Location	Description of Existing		Efficiency Recommendation	
10	Pump 3-4	1 25 HP Vertical Axis Pumps		Replace with 15 HP Vertical Axis Pumps and Improve Manual Switching	
Installation Cost	$20,500	**Estimated Life of Measure (yrs)**	9	**Energy Savings (/yr)**	$3,229
Breakeven Cost	$24,858	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	6
Auditors Notes: Replacing the existing VFD on the 15 horsepower 150 GPM pump, with a larger VFD that will allow for operation of the 15 HP pump. This pump should operate more ~4% efficiently more than the lightly loaded 25 HP pumps. Additionally, this retrofit includes identifying and replacing small leaks to reduce water usage by 5% in the community. It is estimated that there is about 10,000 gallons of water lost per day due to leaks in the Sand Point distribution system, about half of which could potentially be reduced through leak detection and repair, most likely to service lines.					

Rank	Location	Description of Existing		Efficiency Recommendation	
12	Polymer Pump	Milton Roy 1 HP , Other Controls		Improve Other Controls	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$128
				Maintenance Savings (/yr)	$500
Breakeven Cost	$5,309	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	8
Auditors Notes: This retrofit represents the energy and chemical savings from finding and identifying minor leaks in the distribution system.					

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 Sand Point in the development of a proposal based on the retrofits identified in this report as part of the RACEE competition. Regardless of the results of the RACEE competition, ANTHC will continue to work with the City of Sand Point to secure project funding and implement the energy efficiency measures identified in this report.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Sand Point Water Treatment Plant	**Auditor Company:** Company
Address: Unknown	**Auditor Name:** Gavin Dixon and Martin Wortman
City: Sand Point	**Auditor Address:** Auditor Address
Client Name: Allen	
Client Address:	**Auditor Phone:** (907) -
	Auditor FAX:
Client Phone: (907) -	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 2,880 square feet	**Design Space Heating Load:** Design Loss at Space: 45,189 Btu/hour with Distribution Losses: 47,567 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 72,511 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 6 people	**Design Indoor Temperature:** 56.7 deg F (building average)
Actual City: Sand Point	**Design Outdoor Temperature:** 14.5 deg F
Weather/Fuel City: Sand Point	**Heating Degree Days:** 8,865 deg F-days
Utility Information	
Electric Utility: Sand Point TDX - Commercial - Sm	**Average Annual Cost/kWh:** $0.44/kWh

Annual Energy Cost Estimate									
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$5,909	$0	$11,647	$24	$46	$2,232	$34,990	$80	**$54,929**
With Proposed Retrofits	$5,890	$0	$391	$660	$46	$1,273	$31,175	$80	**$39,515**
Savings	$19	$0	$11,256	-$636	$0	$960	$3,815	$0	**$15,414**

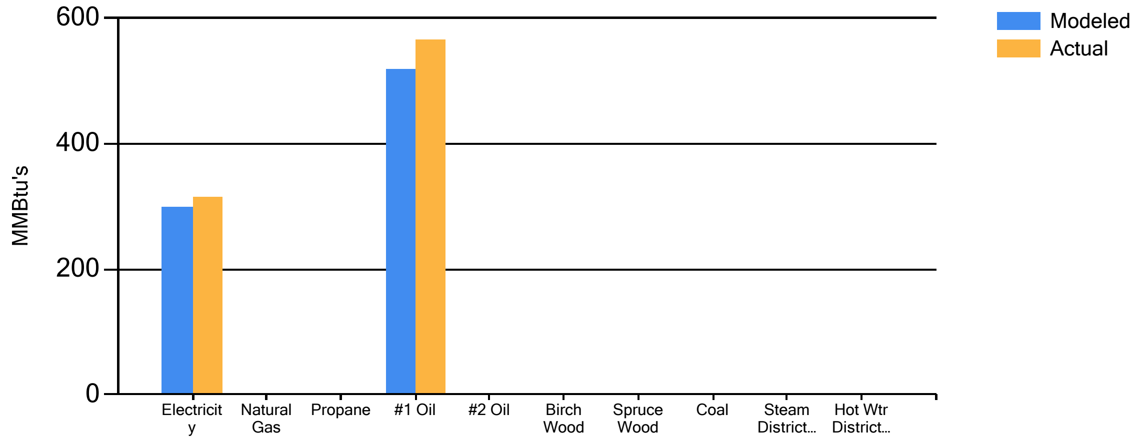
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	283.4	31.97	$19.07
With Proposed Retrofits	154.1	17.39	$13.72

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.

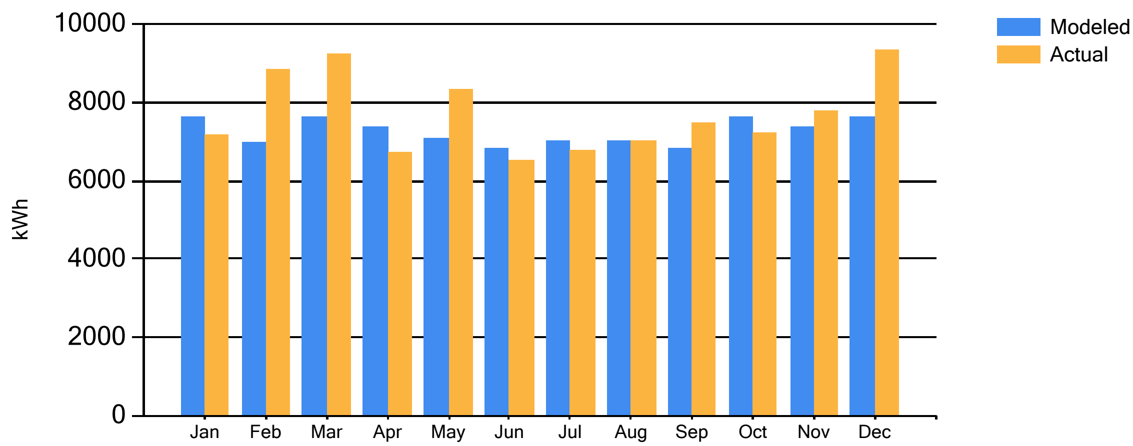
Appendix B– Actual Fuel Use versus Modeled Fuel Use

The graphs below show the modeled energy usage results of the energy audit process compared to the actual energy usage report data. The model was completed using AkWarm modeling software. The orange bars show actual fuel use, and the blue bars are AkWarm's prediction of fuel use.

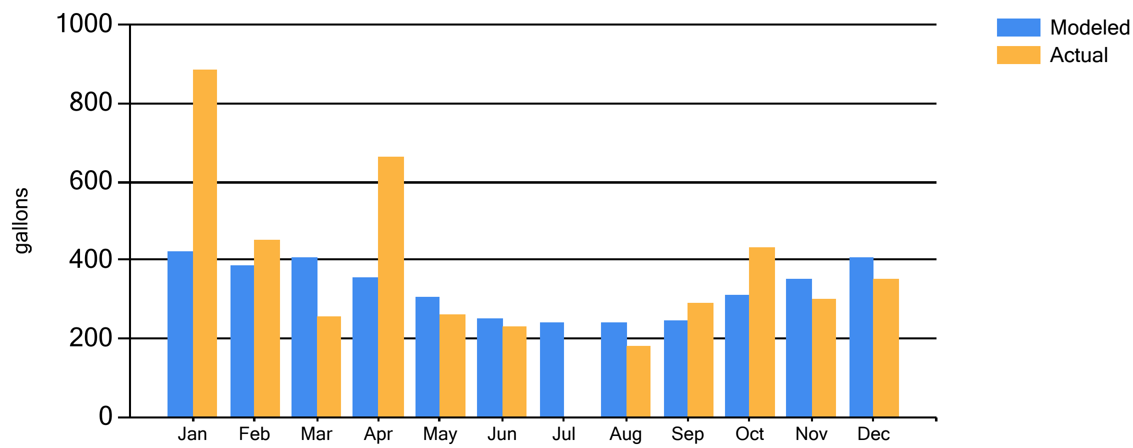
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	15.8	15.8	15.8	15.7	14.2	14.2	14.2	14.2	14.2	15.7	15.7	15.8
As Proposed	14.2	14.2	14.2	14.1	13.0	13.0	13.0	13.0	13.0	14.1	14.1	14.2