Comprehensive Energy Audit
For
Water Treatment Plant & Washeteria

Prepared For

City of Huslia

November 11, 2014

Prepared By:

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Huslia, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in January of 2014 by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

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

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

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Darrell Vent and Emil Sam, and Huslia Mayor Lorraine Pavlick.

1. EXECUTIVE SUMMARY

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

The total predicted energy cost for the WTP is $51,254 per year. Electricity accounted for half of the total energy cost with an annual cost of $25,394 per year. This includes $9,461 paid by the end-users and $15,933 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The WTP is predicted to spend $25,860 for #1 heating oil. These predictions are based on the electricity and fuel prices at the time of the audit.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy in rural Alaska affordable. In Huslia, the cost of electricity without PCE is $0.51/kWh, and the cost of electricity with PCE is $0.19/kWh. The figures used in this report represent the unsubsidized cost of electricity.
Table 1.1 below summarizes the energy efficiency measures analyzed for the Water Treatment Plant & Washeteria. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
1	Other – Pump Controls	Connect well pump and raw water heat add controls; shut off heat add when pumping	$2,855	$2,500	15.45	0.9
2	Other – Reprogram existing generator thermostat	Lower unit heater set point from 60 to 45 degrees	$373	$350	14.42	0.9
3	Lighting - Tank Hallway	Replace lighting with new energy-efficient LED bulbs	$19	$40	6.88	2.1
4	Lighting - Exterior Lighting	Replace lighting with new energy-efficient LED fixtures	$308	$700	6.42	2.3
5	Lighting - Washeteria Lighting	Replace lighting with new energy-efficient LED bulbs	$354	$1,560	3.32	4.4
6	Lighting – Water Treatment Plant	Replace lighting with new energy-efficient LED bulbs	$357	$3,120	1.67	8.7
7	Lighting - Office	Replace lighting with new energy-efficient LED bulbs	$59	$520	1.67	8.8
8	Lighting - Restroom Lighting	Replace lighting with new energy-efficient LED bulbs	$30	$390	1.11	13.2

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]
9	Lighting - Mechanical Room Lighting	Replace lighting with new energy-efficient LED bulbs	$36	$500	1.04	14.1
	TOTAL, all measures		**$4,390**	**$9,680**	**6.27**	**2.2**
The following measures were *not* found to be cost-effective:						
10	HVAC and Circulating Water Heating	Add a Garn 2000 biomass boiler, Tekmar 256 controller, and shut off the boilers in the summer except when the washeteria is open.	$10,358 + $1,000 Maint. Savings	$276,000	10	HVAC And DHW
	TOTAL, all measures		**$14,748 + $1,000 Maint. Savings**	**$285,680**		**TOTAL, all measures**

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 $4,390 per year, or 8.6% of the buildings' total energy costs. These measures are estimated to cost $9,680, for an overall simple payback period of 2.2 years. The City of Huslia will see $663 of electricity savings after PCE while the State of Alaska PCE program will see $1,116 of electricity savings.

It should be noted that the biomass boiler, while not cost effective for installation at the water plant alone, will also serve the nearby Huslia clinic. With the additional economy of scale, the biomass boiler can be a cost effective energy option for the community of Huslia. Even if the project should prove to be ineffective at reducing costs, replacing fuel oil consumption with local jobs and income from spruce wood harvesting is an appealing alternative.

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

Table 1.2

Annual Energy Cost Estimate												
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Other**		**Total Cost**
Existing Building	$529	$0	$3,899	$0	$3,486	$20,809	$9,650	$7,377	$4,201	$1,243		**$51,254**
With Proposed Retrofits	$771	$0	$2,246	$0	$2,281	$20,871	$3,507	$4,019	$2,292	$458		**$36,506**
Savings	-$242	$0	$1,653	$0	$1,205	-$62	$6,142	$3,358	$1,909	$785	$0	**$14,748**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

- Building envelope (roof, windows, etc.)
- Heating 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 Water Treatment Plant & Washeteria 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.

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

1) Water Treatment Plant: 1,606 square feet
2) Washeteria: 561 square feet

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

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

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; heating and ventilating; lighting, plug load, 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. Water Treatment Plant & Washeteria

3.1. Building Description

The 2,167 square foot Water Treatment Plant & Washeteria was constructed in 2008, with a normal occupancy of 2 people. The number of hours of operation for this building average 10 hours per day, considering all seven days of the week.

The Huslia Water Treatment Plant houses a circulating water system with two loops that provide water to residents of the community. The system consists of approximately 13,300 feet of pipe. One loop extends approximately 2800 feet to residents near the airport while the second loop is approximately 10,500 feet long and serves the rest of the residents while also being circulated through the old water treatment plant building. There is no additional heating provided at the old water treatment plant building. The water treatment plant also circulates hot water to the washeteria located in the same building. The washeteria contains four washers and four dryers that are hydronically heated.

The raw water is treated with 2 vertical pressure filters. A boost pump is used to keep the pressure up and increase the circulation rate of the system. The water is injected with chlorine prior to entering the 150,000 gallon water storage tank.

The sewer system is gravity fed with a sewage lagoon located approximately 2000 feet from the water treatment plant. A force main section is located on the western end of town.

Description of Building Shell

The exterior walls are of 2X6 constructed of frames with 5.5” polyurethane insulation. There is 1920 square feet of wall space.

The 2284 square foot roof of the building is a cathedral ceiling (hot roof). The roof has standard 24” framing with 2x6 construction and 5.5” of polyurethane insulation.

The floor/foundation of the building is constructed with 2x6 lumber and 5.5” polyurethane insulation. There is 2167 square feet of floor space.

The windows in the building are double-paned glass with wood frames. The combined window space area is 32 square feet.

There are two entrances with one for the water treatment plant and one for the washeteria. The water treatment plant entrance has a single metal door with a polyurethane core. The washeteria has a single metal door in an arctic entry configuration. The arctic entry has another door on the exterior. The total area of the doors is 42 square feet.

Description of Heating Plants

The Heating Plants used in the building are:

Burnham Boiler #1

Nameplate Information:	Burnham Model PV89WT-GBWF25
Fuel Type:	#1 Oil
Input Rating:	234,500 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Boilers were new in 2008

Burnham Boiler #2

Nameplate Information:	Burnham Model PV89WTGBWF2S
Fuel Type:	#1 Oil
Input Rating:	234,500 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Boilers were new in 2008

Space Heating Distribution Systems

The water treatment plant is heated with three unit heaters and some baseboard. The unit heaters can each produce 10000 BTU/hr and had operational thermostats. The washeteria is heated with baseboard.

Lighting

The water treatment plant is lighted with 12 fixtures with four T8 light bulbs in each fixture. The mechanical room is lighted with three fixtures with four T8 light bulbs in each fixture. The restroom is lighted with two fixtures with four T8 light bulbs in each fixture. The office is lighted with two fixtures with four T8 light bulbs in each fixture. The washeteria is lighted with six fixtures with four T8 light bulbs in each fixture. The chemical room is lighted with two 150W incandescent lights. The tank hallway is lighted with two 26W fluorescent CFL lights. The exterior of the building is lighted with two 70W magnetic lights.

Plug Loads

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

Major Equipment

The airport loop has a water circulation pump that uses 1880 watts. This pump is located in the water treatment plant and is constantly running from approximately November through May.

The downtown loop has a water circulation pump that uses 3320 watts. This pump is located in the water treatment plant and is constantly running from approximately November through May.

There are two well pumps that are both operated at the same time. They use approximately 2100 watts combined and operate approximately two days per week.

There are two pressure pumps that combine to use 2984 watts. They are located in the water treatment plant and run 20% of the time.

The generator building is heated with a temperature controlled block heater that uses 1500 watts when operating. The heater has a setpoint of 60 degrees F. The heater is in operation 50% of the time from November through May.

The washeteria has two electric washer units that combine to use 500 watts. They operate approximately 15% of the time during a 10-hour day.

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). One KWH usage is equivalent to 1,000 watts running for one hour. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

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

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

Electricity: AVEC-Huslia - Commercial - Sm

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges and utility customer charges but does not reflect the PCE subsidy:

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.51/kWh
#1 Oil	$ 3.91/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Huslia pays approximately $51,254 annually for electricity and other fuel costs for the Water Treatment Plant & Washeteria.

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

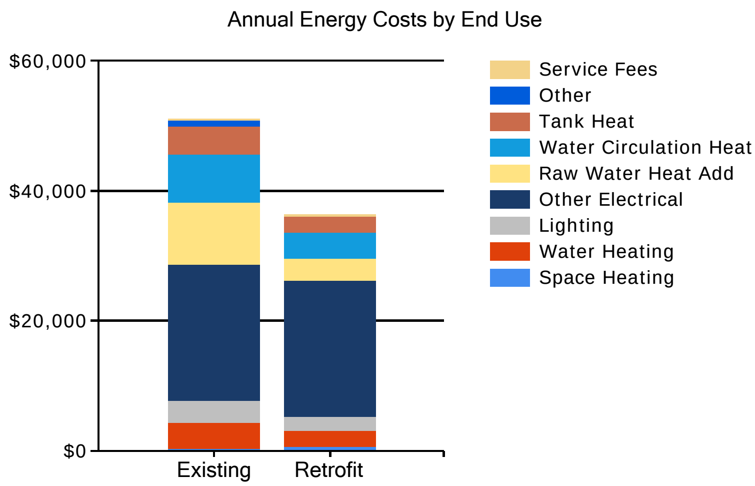


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

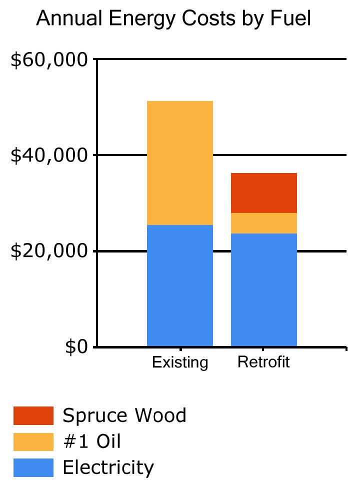
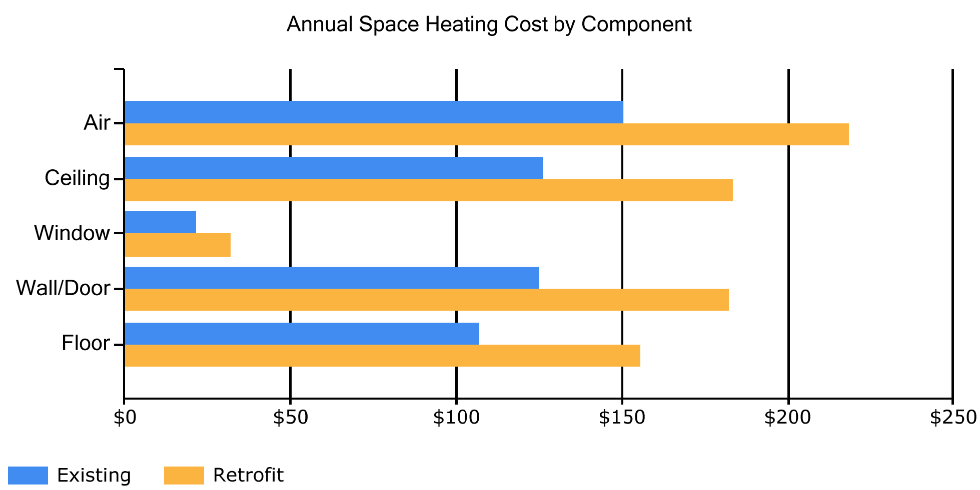


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	24	22	25	24	25	24	25	25	24	35	24	24
DHW	64	59	65	63	65	64	66	66	64	65	62	64
Lighting	573	522	573	554	573	554	573	573	554	573	554	573
Other_Electrical	5340	4867	5340	5168	5340	884	914	914	884	914	5168	5340
Raw_Water_Heat_Add	33	31	34	33	34	36	37	37	35	35	32	33
Water_Circulation_Heat	45	41	46	45	47	0	0	0	0	0	44	45
Tank_Heat	34	28	26	13	0	0	0	0	2	15	26	34
Other	9	7	7	4	1	0	0	1	2	5	7	9

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	7	6	7	7	8	8	9	9	8	13	7	7
DHW	73	67	74	72	75	78	80	80	77	77	71	73
Raw_Water_Heat_Add	197	180	198	193	202	209	216	215	207	208	192	197
Water_Circulation_Heat	268	245	269	262	274	0	0	0	0	0	260	268
Tank_Heat	203	168	150	79	0	0	0	0	10	86	156	200
Other	52	44	41	26	8	1	0	4	13	29	42	51

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
Water Treatment Plant & Washeteria 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	49,846 kWh	170,123	3.340	568,212
#1 Oil	6,614 gallons	873,018	1.010	881,748
Total		**1,043,141**		**1,449,960**
BUILDING AREA		2,167	Square Feet	
BUILDING SITE EUI		481	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		669	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The 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 Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Huslia 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 Huslia. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.
• The model does not model HVAC systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1
Water Treatment Plant & Washeteria, Huslia, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
1	Other – Pump Controls	Connect well pump and raw water heat add controls; shut off heat add when pumping	$2,855	$2,500	15.45	0.9
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9	Lighting - Mechanical Room Lighting	Replace lighting with new energy-efficient LED bulbs	$36	$500	1.04	14.1
	TOTAL, cost-effective measures		**$4,390**	**$9,680**	**6.27**	**2.2**
	The following measures were *not* found to be cost-effective:					
10	HVAC and Circulating Water Heating	Add a Garn 2000 biomass boiler, Tekmar 256 controller, and shut off the boilers in the summer except when the washeteria is open.	$10,358 + $1,000 Maint. Savings	$276,000	0.94	24.3
	TOTAL, all measures		**$14,748 + $1,000 Maint. Savings**	**$285,680**	**1.12**	**18.1**

4.2 Interactive Effects of Projects

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

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

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

4.3 Mechanical Equipment Measures

4.3.1 Heating Domestic Hot Water Measure

Rank	Recommendation				
10	Add a Garn 2000 biomass boiler, Tekmar 256 controller, and shut off the boilers in the summer except when the washeteria is open.				
Installation Cost	$276,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings (/yr)**	$10,358
				Maintenance Savings (/yr)	$1,000
Breakeven Cost	$259,655	**Savings-to-Investment Ratio**	0.9	**Simple Payback yrs**	24
Auditor's Notes: The Huslia area is located within a forest that can produce enough wood to operate a cordwood boiler. The Huslia clinic is located next to the water treatment plant/washeteria building that could make a biomass project more feasible.					

4.4 Electrical & Appliance Measures

4.4.1 Lighting Measures

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

4.4.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
3	Tank Hallway	2 FLUOR CFL, Spiral 26 W with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$40	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$19
Breakeven Cost	$275	**Savings-to-Investment Ratio**	6.9	**Simple Payback yrs**	2
Auditor's Notes: Convert tank hallway CFL lamps to LED. Replace with 2 LED 12W module standard electronic lights. LED lights should last longer, use less energy, and perform better in the cold climate than other alternatives.					

Rank	Location	Existing Condition		Recommendation	
4	Exterior Lighting	2 HPS 70 Watt Magnetic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$700	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$308
Breakeven Cost	$4,497	**Savings-to-Investment Ratio**	6.4	**Simple Payback yrs**	2
Auditor's Notes: Replace existing high pressure sodium exterior fixtures with new LED wall packs. Replace with 2 LED 17W module standard electronic lights. . LED lights should last longer, use less energy, and perform better in the cold climate than other alternatives.					

Rank	Location	Existing Condition		Recommendation	
5	Washeteria Lighting	6 FLUOR (4) T8 4' F32T8 32W Standard Instant Standard Electronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$1,560	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$354
Breakeven Cost	$5,173	**Savings-to-Investment Ratio**	3.3	**Simple Payback yrs**	4
Auditor's Notes: Convert fluorescent fixtures in washeteria to LED. Replace with 6 LED (4) 17W module standard electronic lights. These lights can be replaced with LED replacement bulbs that are direct wired. The old fluorescent fixtures can be maintained, with the ballast and lights removed. LED's should last longer between replacements, and use less energy. Additionally, disposal of LED's does not require hazmat recycling as they do not contain mercury like their fluorescent counterparts.					

Rank	Location	Existing Condition		Recommendation	
6	WTP	12 FLUOR (4) T8 4' F32T8 32W Standard Instant StandardElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$3,120	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$357
Breakeven Cost	$5,211	**Savings-to-Investment Ratio**	1.7	**Simple Payback yrs**	9
Auditor's Notes: Convert water treatment plant fluorescent lighting to LED. Replace with 12 LED (4) 17W module standard electronic lights. These lights can be replaced with LED replacement bulbs that are direct wired. The old fluorescent fixtures can be maintained, with the ballast and lights removed. LED's should last longer between replacements, and use less energy. Additionally, disposal of LED's does not require hazmat recycling as they do not contain mercury like their fluorescent counterparts.					

Rank	Location	Existing Condition		Recommendation	
7	Office	2 FLUOR (4) T8 4' F32T8 32W Standard Instant Standard Electronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$520	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$59
Breakeven Cost	$867	**Savings-to-Investment Ratio**	1.7	**Simple Payback yrs**	9
Auditor's Notes: Convert office fluorescent lighting to LED. Replace with 2 LED (4) 17W module standard electronic lights. These lights can be replaced with LED replacement bulbs that are direct wired. The old fluorescent fixtures can be maintained, with the ballast and lights removed. LED's should last longer between replacements, and use less energy. Additionally, disposal of LED's does not require hazmat recycling as they do not contain mercury like their fluorescent counterparts.					

Rank	Location	Existing Condition		Recommendation	
8	Restroom Lighting	2 FLUOR (3) T8 4' F32T8 32W Standard (2) Instant Standard Electronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$390	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$30
Breakeven Cost	$431	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	13
Auditor's Notes: Convert restroom fluorescent lighting to LED. Replace with 2 LED (3) 17W module standard electronic lights. These lights can be replaced with LED replacement bulbs that are direct wired. The old fluorescent fixtures can be maintained, with the ballast and lights removed. LED's should last longer between replacements, and use less energy. Additionally, disposal of LED's does not require hazmat recycling as they do not contain mercury like their fluorescent counterparts.					

Rank	Location	Existing Condition		Recommendation	
9	Mechanical Room Lighitng	3 FLUOR (4) T8 4' F32T8 32W Standard Instant Standard Electronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$36
Breakeven Cost	$520	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	14
Auditor's Notes: Convert mechanical room fluorescent lighting to LED. Replace with 3 LED (4) 17W module standard electronic lights. These lights can be replaced with LED replacement bulbs that are direct wired. The old fluorescent fixtures can be maintained, with the ballast and lights removed. LED's should last longer between replacements, and use less energy. Additionally, disposal of LED's does not require hazmat recycling as they do not contain mercury like their fluorescent counterparts.					

4.4.6 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1		Raw Water Heat Add Load		Connect well pump and raw water heat add controls; shut off heat add when pumping	
Installation Cost	$2,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,855
Breakeven Cost	$38,629	**Savings-to-Investment Ratio**	15.5	**Simple Payback yrs**	1
Auditor's Notes: Interlock well pump to raw water heat add and shut off heat add when pumping.					

Rank	Location	Description of Existing		Efficiency Recommendation	
2		Generator Heat Load		Lower unit heater set point from 60 to 45 degrees	
Installation Cost	$350	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$373
Breakeven Cost	$5,047	**Savings-to-Investment Ratio**	14.4	**Simple Payback yrs**	1
Auditor's Notes: The generator room does not need to be heated beyond 45 degrees F because the primary concern is freezing.					

5. ENERGY EFFICIENCY ACTION PLAN

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

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

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

APPENDICES (Please Attach Documents for Appendixes A through D)

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Water Treatment Plant & Washeteria	**Auditor Company:** ANTHC DEHE
Address: PO Box 10	**Auditor Name:** Carl Remley, Eric Hanssen, Cody Uhlig
City: Huslia	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Darrell Vent & Emil Sam	
Client Address: PO Box 10 Huslia, AK 99746	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 829-2218	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 2,167 square feet	**Design Space Heating Load:** Design Loss at Space: 0 Btu/hour with Distribution Losses: 0 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 0 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 60 deg F (building average)
Actual City: Huslia	**Design Outdoor Temperature:** -39.8 deg F
Weather/Fuel City: Huslia	**Heating Degree Days:** 14,942 deg F-days
Utility Information	
Electric Utility: AVEC-Huslia - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.509/kWh	**Average Annual Cost/ccf:** $0.000/ccf

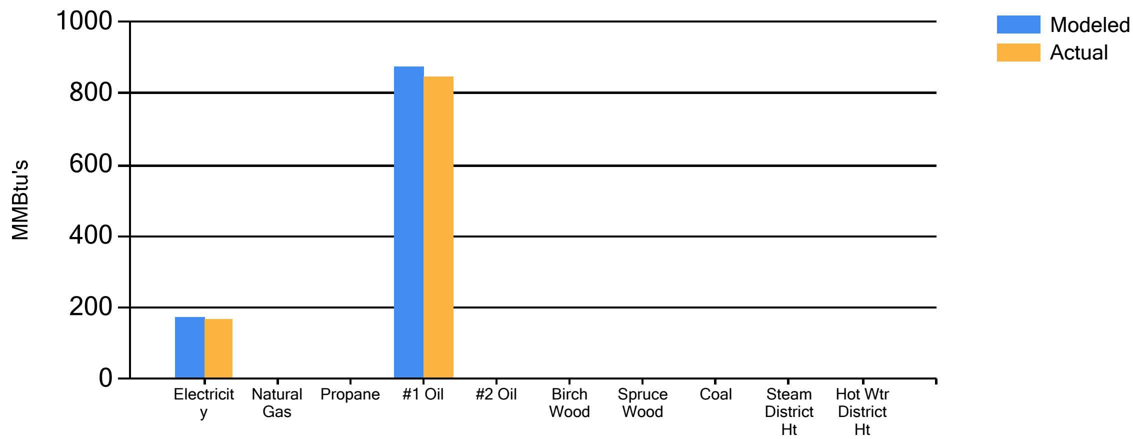
Annual Energy Cost Estimate

Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Tank Heat	Other	Service Fees	Total Cost
Existing Building	$529	$0	$3,899	$0	$3,486	$20,809	$9,650	$7,377	$4,201	$1,243	$60	**$51,254**
With Proposed Retrofits	$771	$0	$2,246	$0	$2,281	$20,871	$3,507	$4,019	$2,292	$458	$60	**$36,506**
Savings	-$242	$0	$1,653	$0	$1,205	-$62	$6,142	$3,358	$1,909	$785	$0	**$14,748**

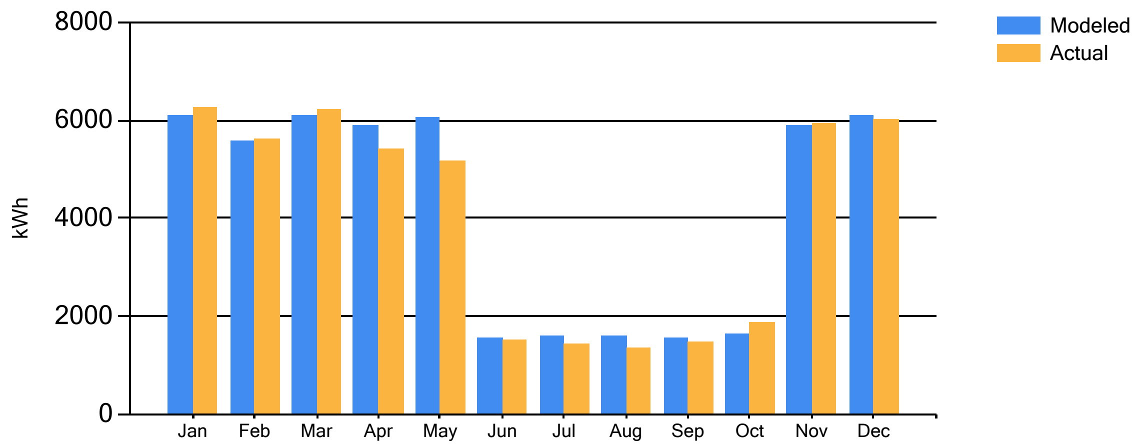
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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