Comprehensive Energy Audit
For
Toksook Bay Water Treatment Plant

Prepared For

City of Toksook Bay

August 15, 2011

Prepared By:

ANTHC-DEHE
Energy Projects Group
1901 Bragaw, Suite 200
Anchorage, Alaska 99508

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PREFACE

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

The purpose of this report is to provide a comprehensive document that summarizes the findings and analysis that resulted from an energy audit conducted over the past couple months by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy efficiency measures. Discussions of site specific concerns and an Energy Efficiency Action Plan are also included in this report.

ACKNOWLEDGMENTS

The Energy Projects Group gratefully acknowledges the assistance of water plant operators Richard and Jeff Curtis, John Nichols of the Alaska Rural Utility Collaborative and Marcie Sherer, AVCP.

1. EXECUTIVE SUMMARY

This report was prepared for the city of Toksook Bay and the Alaska Rural Utility Collaborative. The scope of the audit focused on Toksook Bay 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 annual predicted energy costs for the buildings analyzed were $29,642 for Electricity, $8,379 for #1 Oil, and $296 for Recovered Heat with total energy costs of $38,317 per year.

For valuing the recovered heat, the AVEC standard rate of $7.50/million BTU was used. Additionally it should be noted that the lift station and well houses received the power cost equalization subsidy (PCE) from the state of Alaska last year. The water plant itself did not receive PCE because the facility is receiving power indirectly through the school, so that they can use the school generator in an emergency. Schools are not eligible for power cost equalization. If none of the facilities had received PCE the electricity costs would be $53,795, Fuel would be $8,379, and total energy costs would be $62,174.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Toksook Bay Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
1	Other Electrical: Well house #2 Electrical Heat	Improve Other Controls	$2,666	$200	85.14	0.1
2	Other Electrical: Well house Electric Heat	Improve Other Controls	$2,310	$200	73.79	0.1
3	Other Electrical: Well house #1 Heat Tape	Improve Manual Switching	$2,367	$500	30.24	0.2
4	HVAC And DHW	Repair wiring, programming and electrical panel for recovered heat to maximize recovered heat usage	$1,474	$3,000	8.87	2.0
5	Circulation Loops	The loops are currently being heat to 44 degrees on return temperature. By reducing the return temperature to 40 degrees, significant energy savings can be realized. Also involves the replacement of current aquastats to ensure accuracy. Control based on return temperature.	$873	$2,000	6.80	2.3

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]**
6	Setback Thermostat: Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant space.	$59	$200	4.00	3.4
7	Lighting: Exterior Lights	Replace with 2 LED 17W Module Electronic	$178	$500	3.11	2.8
8	Water Storage Tank	The Tank is currently being heated to 46 degrees, by turning the tank down to 40 degrees; significant savings can be realized, while maintaining a safe buffer against freeze ups. Also involves the replacement of current aquastats to ensure accuracy. Control based on return temperature.	$171	$2,000	1.29	11.7
	TOTAL, cost-effective measures		**$10,097**	**$8,600**	**10.70**	**0.9**
	The following measures were *not* found to be cost-effective:					
9	Lighting: Water Plant Lighting	Replace with 11 LED Replacement Bulbs	$150	$1,320	0.99	8.8
10	Other Electrical: Loop 2 Circulation Pumps	Replace with 2 Circulation Pumps	$168	$2,300	0.53	13.7
11	Other Electrical: Loop One Circulation Pumps	Replace with 2 Circulation Pumps	$110	$2,100	0.33	19.1
	TOTAL, all measures		**$10,526**	**$14,320**	**6.65**	**1.4**

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 $10,526 per year, or 27.5% of the buildings' total energy costs. These measures are estimated to cost $14,320, for an overall simple payback period of 1.4 years. If only the cost-effective measures are implemented, the annual utility cost can be reduced by $10,097 per year, or

26.4% of the buildings' total energy costs. These measures are estimated to cost $8,600, for an overall simple payback period of 0.9 years.

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

Table 1.2
Annual Energy Cost Estimate

Description	Space Heating	Space Cooling	Water Heating	Lighting	Other Electrical	Circulation Loops	Water Storage Tank	Ventilation Fans	Service Fees	Total Cost
Existing Building	$3,007	$0	$0	$559	$27,027	$4,724	$3,000	$0	$0	**$38,317**
With All Proposed Retrofits	$1,485	$0	$0	$230	$19,397	$3,851	$2,829	$0	$0	**$27,792**
SAVINGS	$1,522	$0	$0	$329	$7,631	$873	$171	$0	$0	**$10,526**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Toksook Bay 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

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 Toksook Bay 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.

Toksook Bay Water Treatment Plant is classified as being made up of 354 square feet of water treatment space.

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. Toksook Bay Water Treatment Plant

3.1. Building Description

The 354 square foot Toksook Bay Water Treatment Plant was constructed in 1986, with a normal occupancy of 1 people. The building is in operation four hours a day, seven days a week on average.

Description of Building Shell

The exterior walls are constructed 2x6 construction, though one wall is 2x4 construction. All walls are filled with batt insulation.

The roof of the building is a warm roof with 6 inches of damaged batt insulation.

The floor of the building is a concrete slab.

Typical windows throughout the building are double paned glass windows with wood/vinyl siding.

Doors are metal urethane with no thermal break.

Description of Heating and Cooling Plants

The Heating Plants used in the building are:

Recovered Heat from AVEC

Fuel Type:	Recovered Heat
Input Rating:	44,000 BTU/hr
Steady State Efficiency:	95 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - Jun
Notes:	Recovered heat is currently not functioning properly,

and far less recovered heat is being used than is available.

Weil McClain BL-76-WS

Nameplate Information:	BL-76-WS, EH Type SS
Fuel Type:	#1 Oil
Input Rating:	376,200 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - Jun
Notes:	2.85 gph, burner found with extreme oil and soot

buildup. Electrodes were burnt and not serviceable, nozzle was fouled and transformer was very weak. Electrodes and nozzle were replaced, air band set & operator trained @ time of audit. Igniter/transformer needed. Temperature was set as lead boiler, set point needs to be lowered to take advantage of additional waste heat. Boiler #1 was set as the lead boiler.

Weil McClain BL-76-WS

Fuel Type:	#1 Oil
Input Rating:	376,200 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - Jun
Notes:	Boiler #2 is set as the lag boiler.

Space Heating Distribution Systems

A series of unit heaters supply the building with heat, though in practice the jacket losses off the boiler and the electrical heat supplied to the building by the pumps make up the vast majority of the space heating demand.

Waste Heat Recovery Information

Waste heat is available from the AVEC Plant. Currently the heat recovery control panel is not configured to be compatible with the existing heat exchanger circulation pump. Trials conducted at the time of the energy audit indicate that the available heat could be approximately twice of what is currently being utilized.

Lighting

Typical lighting throughout the building is made up of T8 electronic fixtures with three 25watt bulbs. ABSN recently came through the facility and replaced the lighting.

Plug Loads

The building has essentially no plug loads, though there are several battery chargers for power tools and other equipment.

Major Equipment

The building has two sets of circ pumps operating the two water circulation loops. There is one pressure pump, various LMI treatment pumps, and lots of control panels, including VFD drives for the pressure pumps. Well pumps are located in the well houses, and are 1.5 horsepower.

Lift Station

The lift station has a pair of submersible pumps, and some fixtures for lighting.

The building is heated electrically with two electric wall heaters set to 65 degrees.

Well House #1

Well pumps are located in the well house #1, and are 1.5 horsepower.

The well house additionally has a long heat tape for the well line that is controlled manually. Currently it is left on the majority of the time, including when water is being pumped.

The building is heated electrically using a wall mounted electric heater that is currently set to 65 degrees.

Well house #2

Well house #2 is not currently in use due to broken lines. These lines were possibly broken during the construction of the AVEC water plant.

The building is heated electrically using a wall mounted electric heater that is currently set to 65 degrees.

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.

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-Toksook Bay - Commercial – Sm

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

Table 3.1 – Average Energy Cost

Description	Average Energy Cost
Electricity*	$ 0.27/kWh
#1 Oil	$ 3.11/gallons
Recovered Heat	$ 7.50/million Btu

*This number represents a weighted average of the electrical costs of the Toksook Bay Water Treatment System

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, ARUC pays approximately $38,317 annually for electricity and other fuel costs for the Toksook Bay Water Treatment Plant.

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

Figure 3.1
Annual Energy Costs by End Use

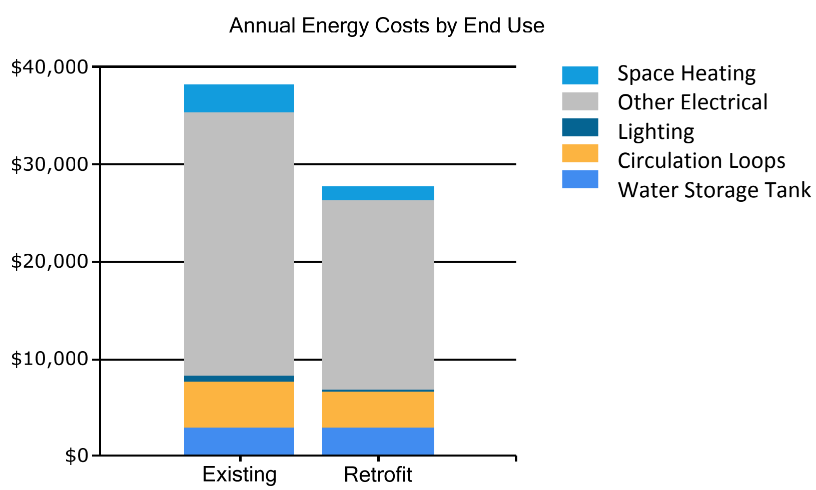


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

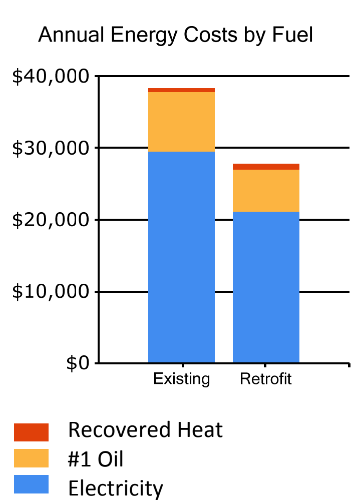
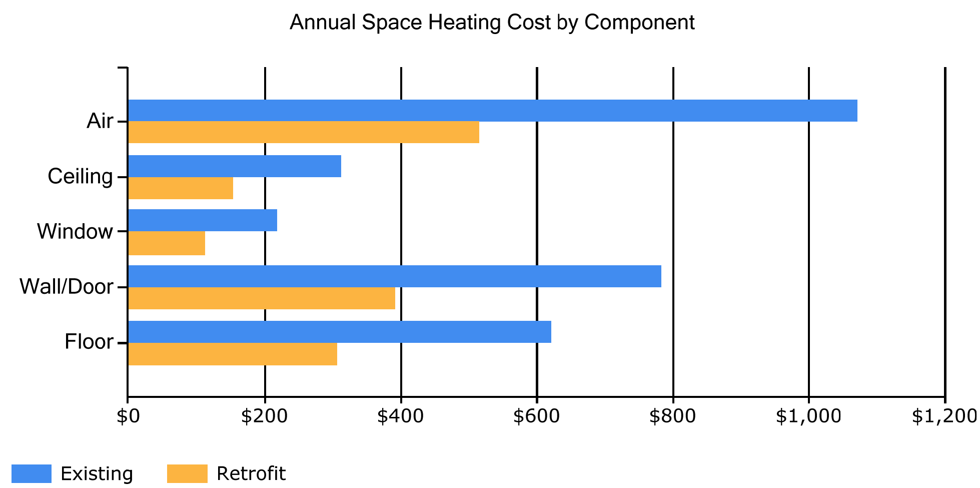


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Electrical Consumption (kWh)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Lighting	202	184	202	195	202	195	96	96	97	202	195	202
Other_Electrical	9819	8948	9819	9502	9819	9502	4508	4508	4534	9819	9502	9819
Circulation Loops	372	339	372	360	372	360	0	0	360	372	360	372
Water Storage Tank	65	59	65	63	65	63	0	0	63	65	63	65
Ventilation_Fans	0	0	0	0	0	0	0	0	0	0	0	0
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Space_Heating	298	270	290	272	279	263	273	274	270	279	278	298

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Circulation Loops	114	104	114	110	114	110	0	0	110	114	110	114
Water Storage Tank	93	85	93	90	93	90	0	0	90	93	90	93
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Space_Heating	85	77	85	82	85	0	0	0	4	85	82	85

Hot Water District Ht Consumption (Million Btu)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Circulation Loops	4	3	4	4	4	4	0	0	4	4	4	4
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Space_Heating	1	1	0	0	0	0	0	0	0	0	0	1

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):

Building Site EUI = *(Electric Usage in kBtu + Fuel Usage in kBtu + similar for other fuels)* / *Building Square Footage*

Building Source EUI = *(Electric Usage in kBtu X SS Ratio + Fuel Usage in kBtu X SS Ratio + similar for other fuels)* / *Building Square Footage*

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

Table 3.4
Toksook Bay 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	109,786 kWh	374,701	3.340	1,251,501
#1 Oil	2,694 gallons	355,651	1.010	359,208
Recovered Heat	39.43 million Btu	39,431	1.280	50,471
Total		**769,783**		**1,661,179**
BUILDING AREA		354	Square Feet	
BUILDING SITE EUI		2,175	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		4,693	**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 Toksook Bay Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Toksook Bay 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 Toksook Bay. 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. Calculations and cost estimates for analyzed measures are provided in Appendix C.

Table 4.1 Toksook Bay Water Treatment Plant, Toksook Bay, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**
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	TOTAL, all measures		**$10,526**	**$14,320**	**6.65**	**1.4**

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 Measure

Rank	Recommendation				
4	Repair wiring, programming and electrical panel for recovered heat to maximize recovered heat usage				
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,474
Breakeven Cost	$26,603	**Savings-to-Investment Ratio**	8.9	**Simple Payback yrs**	2
Auditors Notes: building is currently not utilizing the amount of recovered heat available due to a control panel which was improperly wired during installation. The electrical panel wiring and the pump for recovered heat are not compatible, and thus not functioning. The control panel can be easily configured to function properly, or a three phase pump could be installed. Note that boiler set-points should be adjusted at the same time as the waste-heat retro-commission.					

4.3.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
6	Water Treatment Plant			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant space.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$59
Breakeven Cost	$800	**Savings-to-Investment Ratio**	4.0	**Simple Payback yrs**	3
Auditors Notes: Implementing a thermostat for the building to control the heat output of the unit heaters that can be set to lower temperatures for periods when the water plant is unoccupied will reduce the demand for heating in the building and save fuel. Implement					

4.4 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	
9	Water Plant Lighting	11 FLUOR (3) T8 4' F32T8 25W Energy-Saver Program Electronic with Manual Switching		Replace with 11 LED Replacement Bulbs	
Installation Cost	$1,320	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$150
Breakeven Cost	$1,313	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	9
Auditors Notes: This measure is not recommended based upon pure energy savings. However in the construction of the new water plant, these savings represent the lighting potential savings of using LED fluorescent lighting instead of T8 fixtures. This current structure will not be around long enough to justify the cost of installing new lights.					

Rank	Location	Existing Condition		Recommendation	
7	Exterior Lights	2 MH 70 Watt Magnetic with Daylight Sensor		Replace with 2 LED 17W Module Electronic	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$178
Breakeven Cost	$1,554	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	3
Auditors Notes: Replacing current metal halide exterior lighting fixtures with LED wall packs will reduce energy use, minimize maintenance and improve exterior lighting functioning in the cold.					

4.5.3 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
11	Loop One Circulation Pumps		2 Circulation Pumps with Manual Switching		Replace with 2 Circulation Pumps	
Installation Cost		$2,100	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$110
Breakeven Cost		$700	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	19
Auditors Notes: Replace Motors with Premium Efficiency Motors. This measure is not recommended unless the motors need to be replaced anyways. The payback period is too long. If motors are to be replaced, these are the savings that could be realized by putting in premium efficiency motors.						

Rank	Location		Description of Existing		Efficiency Recommendation	
10	Loop 2 Circulation Pumps		2 Circulation Pumps with Manual Switching		Replace with 2 Circulation Pumps	
Installation Cost		$2,300	**Estimated Life of Measure (yrs)**	8	**Energy Savings (/yr)**	$168
Breakeven Cost		$1,208	**Savings-to-Investment Ratio**	0.5	**Simple Payback yrs**	14
Auditors Notes: Replace Motors with Premium Efficiency Motors. This measure is not recommended unless the motors need to be replaced anyways. The payback period is too long. If motors are to be replaced, these are the savings that could be realized by putting in premium efficiency motors.						

Rank	Location		Description of Existing		Efficiency Recommendation	
3	Well house #1 Heat Tape		Self Regulating Heat Tape with Manual Switching		Improve Manual Switching	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,367
Breakeven Cost		$15,118	**Savings-to-Investment Ratio**	30.2	**Simple Payback yrs**	0
Auditors Notes: Controls needed to be implemented at the water plant that can control the heat tape in the well house. The heat tape should not be on when water is being pumped, as the movement of the water should prevent freeze ups. Currently the heat tape is heating the water during periods that it would otherwise not be required.						

Rank	Location		Description of Existing		Efficiency Recommendation	
2	Well house Electric Heat		1 Electric Heaters in Well house #1 with Other Controls		Improve Other Controls	
Installation Cost		$200	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,310
Breakeven Cost		$14,757	**Savings-to-Investment Ratio**	73.8	**Simple Payback yrs**	0
Auditors Notes: The well house, though never occupied, is currently being heated to 65 degrees Fahrenheit. The building only needs to be heated enough to prevent freeze ups. Turning down the electric heat to 45 degrees and implementing a thermostat should produce substantial electrical savings.						

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Well house #2 Electrical Heat		5 KW Electric Heater for Well house #2 with Other Controls		Improve Other Controls	
Installation Cost		$200	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,666
Breakeven Cost		$17,027	**Savings-to-Investment Ratio**	85.1	**Simple Payback yrs**	0

Auditors Notes: Well house #2 is currently being heated to 65 degrees, despite never being occupied. The pumps are not used as the line between the well house and the water plant appears to have been damaged by the construction of the AVEC power plant. Reducing electrical heat in the building to 45 degrees would prevent freeze ups and reduce electrical costs.

4.5.4 Circulation Loop Heating Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
5					The loops are currently being heat to 44 degrees on return temperature. By reducing the return temperature to 40 degrees, significant energy savings can be realized. Also involves the replacement of current aquastats to ensure accuracy. Control based on return temperature.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$873
Breakeven Cost		$13,602	**Savings-to-Investment Ratio**	6.8	**Simple Payback yrs**	2
Auditors Notes:						

4.5.5 Water Storage Tank Heating Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
8					The Tank is currently being heated to 46 degrees, by turning the tank down to 40 degrees; significant savings can be realized, while maintaining a safe buffer against freeze ups. Also involves the replacement of current aquastats to ensure accuracy. Control based on return temperature.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$171
Breakeven Cost		$2,574	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	12
Auditors Notes:						

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.