Comprehensive Energy Audit
For
Klawock Wastewater Treatment Plant

Prepared For

City of Klawock

August 5, 2016

Prepared By:

ANTHC
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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 and Cooperative Association of Klawock 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 and Cooperative Association of Klawock, Alaska. The authors of this report are Bailey Gamble, Mechanical Engineer I; Gavin Dixon, Senior Project Manager and Certified Energy Manager (CEM), and Cody Uhlig, Utility Support Engineer.

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 Rural Energy Initiative of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of the Wastewater Treatment Plant Operator Harry Jackson, Sr., City of Klawock Special Projects Advisor Phil Downing and City of Klawock Administrator Leslie Isaacs, and Klawock Cooperative Association President Archie W. Demmert, III.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Klawock. The scope of the audit focused on the Klawock Wastewater Treatment Plant (WWTP), and the two lift stations pumping sewage into the facility; the lift stations are locally known as the Bayview Lift Station and the East Side Lift Station. Fuel and electricity analysis includes electricity and fuel use at all three facilities. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, Heating and Ventilation systems, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $18,349 per year. Electricity represents the largest portion with an annual cost of approximately $16,188 for Electricity. This includes about $14,690 paid for by the City of Klawock and $1,498 paid for by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel represents the remaining portion, with an annual cost of $2,161.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the cost of electricity and make energy in rural Alaska more affordable. In Klawock, the cost of electricity without PCE is $$0.22/kWh, and the cost of electricity with PCE is $0.20 /kWh.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	74,918 kWh	59,236 kWh
#1 Oil	777 gallons	0 gallons
Spruce Wood	0.00 cords	4.10 cords

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 1.2: Building Benchmarks for the Waste Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	74.8	10.09	$3.83
With Proposed Retrofits	57.7	7.78	$2.99
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.			

It should be noted that the Klawock wastewater treatment plant has recently received a Preliminary Engineering Report (PER) aimed at identifying and addressing multiple sanitation deficiencies, specifically: Improvement of the grit screening removal process, repair and replacement of damaged structural components and piping, improvement of ventilation system and controls to reduce exposure to corrosive gases, replacement of end of life equipment, and effluent pumping improvements. More detail on these improvements can be found in the PER Appendix C.

Table 1.3 below summarizes the energy efficiency measures analyzed for the Klawock Wastewater 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	Other Electrical - Controls Retrofit: Blower Pump Room Fan	Shut off blower pump room fan when the room is unoccupied.	$66	$100	4.08	1.5	549.3
2	Air Tightening:	Keep doors, windows closed that are located within conditioned air space (Documents impact of gas control and ability to close doors/windows)	$209	$500	3.88	2.4	1,595.3
3	Ventilation	Implement occupancy sensors for the control room, blower room, and sludge pump room so fans can run with operator occupancy	$463	$2,500	2.43	5.4	3,567.5
4	Lighting - Controls Retrofit: Sludge Dewatering, Sludge Loading Lighting	Replace with direct wire LED replacements and occupancy sensors	$56 + $25 Maint. Savings	$500	1.91	6.2	201.8
5	Lighting - Power Retrofit: Entrance, Upstairs Hallway, Office, Pump Room	Replace with direct wire LED replacements and occupancy sensors	$132 + $50 Maint. Savings	$1,360	1.54	7.5	1,008.5
6	Lighting - Power Retrofit: Clarifier, Screen Filter Room	Replace with direct wire LED replacements and occupancy sensors.	$120 + $50 Maint. Savings	$1,360	1.47	8.0	938.3
7	Other Electrical - Power Retrofit: Blower Pumps	Replace with 2 Premium Efficiency Pumps/Motors running alternately to agitate sludge	$734	$5,000	1.24	6.8	6,126.7

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
8	Other Electrical - Combined Retrofit: East Lift Station Pumps	Replace with two smaller pumps in order to reduce surges of sewage into wastewater plant, improve reliability, and reduce energy consumption. Also includes installation of manhole liners on manholes serving the East Lift Station in order to reduce infiltration from rain.	$1,299 + $2,500 Maint. Savings	$40,000	1.19	10.5	10,842.1
9	Other Electrical - Controls Retrofit: Bayview Lift Station Pumps	Install manhole liners on manholes serving the Bayview Lift Station in order to reduce infiltration from rain.	$764 + $2,500 Maint. Savings	$25,000	1.11	7.7	6,379.9
10	Lighting - Controls Retrofit: Entrance, Upstairs Hallway, Office, Pump Room	Replace with direct wire LED replacements and occupancy sensors	$120 + $25 Maint. Savings	$1,500	1.10	10.4	893.1
11	Setback Thermostat: Office	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Office space.	$74	$1,000	1.00	13.5	564.8
	TOTAL, cost-effective measures		**$4,036 + $5,150 Maint. Savings**	**$78,820**	**1.24**	**8.6**	**32,667.2**
The following measures were *not* found to be cost-effective:							
12	Lighting - Power Retrofit: Mechanical Room Lighting, Bathroom Lighting, Storage Room, Blower Room	Replace with direct wire LED replacements	$22 + $40 Maint. Savings	$1,200	0.60	19.3	193.7
13	Lighting - Power Retrofit: Sludge Dewatering, Sludge Loading Lighting	Replace with direct wire LED replacements	$16 + $25 Maint. Savings	$960	0.51	23.2	59.1

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
14	Other Electrical - Power Retrofit: Clarifier Room Fans	Replace with fans with premium efficiency motors, and shut down usage of the Screen room fan except when room is occupied or gas levels are exceeded. Cost represent marginal cost of installing premium efficiency motors.	$50	$2,500	0.29	49.6	421.0
15	HVAC And DHW	Replace boiler With pellet boiler, replace hot water heater with smaller on demand hot water heater	$424	$16,500	0.25	999.9	12,598.1
16	Ceiling w/ Attic: House	Add R-11 fiberglass batts to attic with Standard Truss.	$13	$3,682	0.07	276.0	5.9
17	Other Electrical - Controls Retrofit: Effluent Pumps	This represents the impact of installing functional effluent pumps that can force sewage throw the ocean outfall when gravity will not suffice.	-$378	$15,000	-0.21	999.9	-3,156.0
18	Lighting - Combined Retrofit: Exterior Lights	Exterior Lights currently not in use, shut off at the breaker. This represents the energy impact of installing LED lights and operating on photocell controls.	-$153 + $50 Maint. Savings	$3,005	-0.40	999.9	-1,278.2
	TOTAL, all measures		**$4,031 + $4,765 Maint. Savings**	**$121,667**	**0.82**	**13.8**	**41,510.8**

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 $4,031 per year, or 22.0% of the buildings' total energy costs. These measures are estimated to cost $121,667, for an overall simple payback period of 13.8 years. If only the cost-effective measures are implemented, the annual utility cost can be reduced by $4,036 per year, or 22.0% of the buildings' total energy costs. These measures are estimated to cost $78,820, for an overall simple payback period of 8.6 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.

Annual Energy Cost Estimate

Description	Space Heating	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$2,237	$434	$114	$1,105	$40	$13,291	$1,128	**$18,349**
With Proposed Retrofits	$1,287	$387	$11	$785	$40	$10,680	$1,128	**$14,318**
Savings	$950	$47	$103	$320	$0	$2,611	$0	**$4,031**

Bayview Lift Station

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Klawock Wastewater 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 Klawock Wastewater 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.

Klawock Wastewater Treatment Plant is made up of the following activity areas:

1) Sewage Pump Room: 663 square feet
2) Office: 370 square feet
3) Sludge Process Treatment: 437 square feet
4) Other Facility Space: 2,214 square feet
5) Clarifying Room: 1,107 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.

East Side Lift Station

3. Klawock Wastewater Treatment Plant

3.1. Building Description

The 5,900 square foot Klawock Wastewater Treatment Plant was constructed in 1998, with a normal occupancy of one person. The number of hours of operation for this building average 5.6 hours per day, considering all seven days of the week. The facility consists of a two story facility which houses primary screening facilities, 2 primary clarifiers, effluent pumping, a sludge holding/aeration tank, sludge dewatering equipment, a dry sludge truck loading bay, a laboratory and an office. The facility is classified by the Alaska Department of Environmental Conservation as a Class 1 Wastewater system.

The two lift stations are located at low elevation points within the Klawock sewer system. Sewage collects in these two lift stations and is pumped to the wastewater treatment plant. Pumps operate on float level control.

Sewage enters the wastewater treatment plant and is run through a filter screen which removes grit and non-sewage solids from the influent from the lift stations. This screen operates automatically upon receipt of sewage from the lift stations. Sewage then enters a single clarifier. One of the two clarifiers is not in use and is scheduled for repair as part of the WWTP renovation project funded by EPA. Sludge settles in the clarifier which uses gravity and mechanical sifting to separate fluids and solids. Once settlement has occurred, fluid flows by gravity to an 8" ocean outfall.

Solids are transferred using a pair of sludge pumps to an aerated sludge tank. For about two days every two weeks sludge is removed from the sludge tank and ran through a sludge dewatering process, which involves a sludge press, polymer feed system and lime feeder. Once sludge has been dried and processed it is discharged through a chute to a dump truck parked in the sludge truck loading area. Processed and dried sludge is then transferred to the local landfill for disposal. Water from sludge dewatering process enters a sump for the facility which transfers fluids back to the clarifiers for retreatment.

The Klawock Wastewater Treatment Plant is powered by the Craig electricity power plant, and the two lift stations serving the facility are powered by the Klawock power plant. In rare cases of a Craig power outage, this results in sewage from the lift station being pumped into the WWTP while the facility is not powered or functioning. There is no backup generator at the WWTP, and this is highly recommended to prevent overflows and non-treatment of sewage during the rare instances of power outages.

Description of Building Shell

The lower floor walls are concrete, with a 2x4 metal stud wall with R-15 insulation. The second floor is a 2x6 metal stud wall with 6" with R-21 insulation.

The (WWTP has a cold roof with 12" of R-38 batt insulation with minor water damage. The roof itself has an additional 3.5" of R-11 batt insulation.

The floor/foundation of the building is a concrete slab.

Typical windows throughout the building are double paned glass operable aluminum frame windows.
There are three double metal doors with a fiberglass core, five standard metal doors with a fiberglass core, and a 120 square foot garage door.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLain Gold Oil

Fuel Type:	#1 Oil
Input Rating:	198,000 BTU/hr
Steady State Efficiency:	77 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - May

Electric Storage Tank Water Heater

Fuel Type:	Electricity
Input Rating:	1.65 KW
Steady State Efficiency:	100 %
Idle Loss:	0.25 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

Boilers are well maintained and in good condition.

Space Heating Distribution Systems

The facility is heated by a series of unit heaters and baseboard heaters. The oil fired boiler operates a single small grundfos pump which moves heat through a glycol/water mix of heating fluid to each of the unit heaters. Unit heaters are controlled locally on non-programmable thermostats.

Due to the presence of excessive corrosive gases, the majority of spaces in the facility regularly are kept ventilated through open windows and doors with the unit heaters shut off. The heating system is shut down for almost six months of the year during the warm months.

Domestic Hot Water System

An electric hot water heater with a 19 gallon storage tank supplies hot water to the facility. Hot water is only used for hand washing and equipment cleaning, with an estimated 20 gallons of hot water used per day.

Description of Building Ventilation System

The wastewater treatment plant utilizes extensive ventilation.

The clarifying room operates with multiple fans brining in and dispersing outside air. This space is unheated, the venting is to control for corrosive gases and improve the sewage treatment process.
There are multiple spaces in the building that operate ventilation manually based upon operator occupancy, both for comfort and safety. The sludge pump room, sludge dewatering room, rotary screen room, blower pump room, and bathroom are all supposed to be operated this way. Due to failure of portions of the ventilation system in the clarifying room and screen room however, the screen room effluent fan operates 100% of the time, the blower room effluent fan is also operated 100% of the time.

A listing of mechanical ventilation equipment, motors size and flow rates is identified in the Major Equipment section.

Due to failures of portions of the ventilation system in the clarifying room, much of the facility is exposed to corrosive gases. As a result the operator maintains significant outside air ventilation through opening all windows and doors.

Lighting

Interior lighting in the facility is consists of 122 individual T8 32 watt fluorescent bulbs in two or three bulb fixtures. All interior lights are operated manually. Interior lighting is responsible for approximately 5,500 kwh of electrical load per year.

Exterior lights are made up of six 70 watt high pressure sodium fixtures. Exterior lighting is shut off at the breaker and is never used.

The facility also features emergency egress lighting dual halogen heads and a battery pack.

Plug Loads

Plug loads in the facility are made up primarily of a variety of small appliances such as tool and equipment battery chargers, two computers with monitors, a microwave, a mini refrigerator, a fan. This makes up only a small portion of the electric load of the facility, approximately 613 kwh per year.

Bayside Lift Station

The Bayside lift station features no heated structure. The facility operates an electric control panel operating two submersible pumps, alternating in use on sewage levels within the wet well. The two pumps are 8 horsepower pumps that run for 2 minutes every 7 minutes on average, moving about 150-180 gpm of sewage. Pump one is suspected to not completely seal. Run time on the pumps increases significantly during rain events, primarily in the fall. It is suspected that there is significant infiltration into the sewer system of rain water through manholes.

Eastside Lift Station

The Eastside lift station features no heated structure. The facility operates an electric control panel operating a single submersible pumps, operating on sewage levels within the wet well. The pump is an 18 horsepower pump that runs about twice per hour for about 3 minutes at a time. Run time on the pump increases significantly during rain events, primarily in the fall. It is suspected that there is significant infiltration into the sewer system of rain water through manholes. The rail system to remove the pump is busted.

Other Lift Stations

There are two private lift stations that serve individual facilities and operate very rarely. The tribe/cannery lift station is currently operated manually and discharges to the City sewer system. The clinic sewer system operates automatically and has very low usage, and discharges to the City of Klawock sewer system.

WWTP Major Equipment

Table 3.1 Ventilation Fans

Ventilation Fans	Motor Size	CFM Rating	Operating Schedule	Annual kWh
Clarifying Room Supply	1/8 HP	1200	24/7/365	600
Clarifying Room Exhaust	1/4 HP	1200	24/7/365	1200
Clarifying Room Supply	1/16 HP	2000	24/7/365	400
Rotary Screen Exhaust	1/12 HP	800	24/7/365	900
Blower Pump Exhaust	1/20 HP	400	24/7/365	350
Sludge Pump Exhaust	1/12 HP	400	6 hours/day	175
Control Room Exhaust	1/10 HP	100	6 hours/day	175
Bathroom Exhaust	1/10 HP	100	Rarely	5
Sludge Loading Exhaust	1/4 HP	1100	36 hours every 10 days	290
Sludge Press Exhaust	1/12 HP	650	12 hours every 10 days	20

Table 3.2 Motors and Pumps

Major Pumps + Motors	**Purpose**	**Motor Size**	**Operating Schedule**	**Annual kWh**
Sump Pump 2x	Dewatering and Sludge Fluid transfer	2 HP	On Demand based upon water levels (~1.5 minutes/hr)	1,104
Clarifier Skimmer	Sludge Transfer/ Sewer Treatment	.5 HP	24/7/365	3,106
Rotary Screen	Grit removal from sewage	.5 HP	~10% of the time Lift Station Pumping Schedule	327
Blower Pumps 2x	Aeration of sludge tank	4 HP	24/7/365	22,595
Sludge Press	Dewatering of Sludge	3 HP	About 12 hours every 10 days	600
Lime Mixers 3x	Sludge Treatment	.5 HP	About 12 hours every 10 days	500
Polymer Injection Pump	Sludge Binding	1 HP	About 12 hours every 10 days	215
Sludge Pumps 2x	Sludge Transfer to Sludge Tank	3 HP	On demand, ~1.5 minutes/hr	817
Outfall Effluent Pumps	Pumping through Ocean outfall during high tide	7 HP	Never	0

Sludge Pumps

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.

–Alaska Power and Telephone provides electricity to the residents of Klawock as well as all commercial and public facilities.

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

Table 3.3 Energy Cost Per Unit

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.2161/kWh
#1 Oil	$ 2.78/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the City of Klawock pays approximately $18,349 annually for electricity and other fuel costs for the Klawock Wastewater Treatment Plant.

Table 1.6 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.

Table 3.4 Annual Energy Costs by End Use

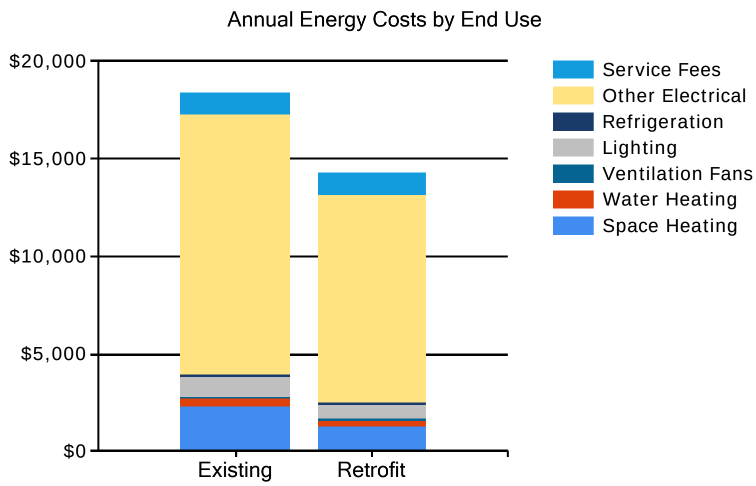


Table 1.7 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Table 3.5 Annual Energy Use by Fuel Type

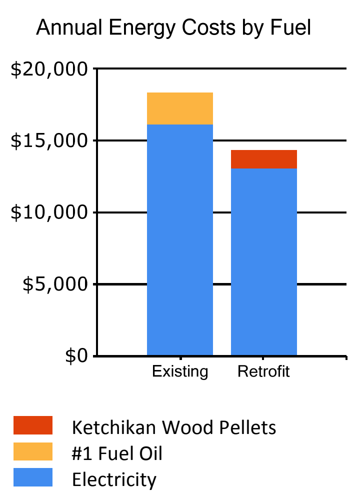
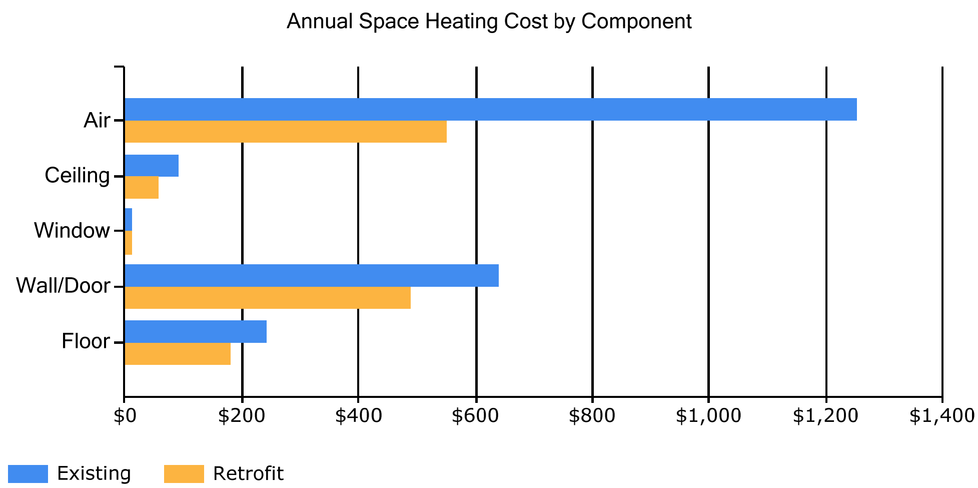


Table 1.8 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

Table 3.6 Annual Space Heating Costs by Component



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

Table 3.7 Monthly Energy Use by End use

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	103	66	53	16	0	0	0	0	0	3	49	85
DHW	183	167	183	177	183	177	183	183	177	183	177	183
Ventilation Fans	48	44	48	47	48	47	48	48	47	48	47	48
Lighting	467	425	467	451	467	451	467	467	451	467	451	467
Refrigeration	17	15	17	16	17	16	17	17	16	17	16	17
Other Electrical	5612	5114	5612	5431	5612	5431	5612	5612	5431	5612	5431	5612

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	198	132	110	45	0	0	0	0	0	23	102	166

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 3.8
Klawock Wastewater 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	74,918 kWh	255,697	3.340	854,026
#1 Oil	777 gallons	102,621	1.010	103,647
Total		**358,317**		**957,673**
BUILDING AREA		4,791	Square Feet	
BUILDING SITE EUI		75	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		200	**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 3.9

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**74.8**	**10.09**	**$3.83**
With Proposed Retrofits	**57.7**	**7.78**	**$2.99**
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 systems and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

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

For the purposes of this study, the Klawock Wastewater Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Klawock was used for analysis. From this, the model was be calibrated to predict the impact of theoretical energy savings measures.   Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

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

• The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in 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 Klawock Wastewater Treatment Plant, Klawock, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Other Electrical - Controls Retrofit: Blower Pump Room Fan	Shut off blower pump room fan when the room is unoccupied.	$66	$100	4.08	1.5	549.3

Table 4.1 Klawock Wastewater Treatment Plant, Klawock, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
2	Air Tightening: Keep doors, windows closed that are located within conditioned air space	Perform air sealing to reduce air leakage by 2500 cfm at 50 Pascals. (Documents impact of gas control and ability to close doors/windows)	$209	$500	3.88	2.4	1,595.3
3	Ventilation	Implement Occupancy Sensors for the Control room, blower room, and sludge pump room so fans can run with operator occupancy	$463	$2,500	2.43	5.4	3,567.5
4	Lighting - Controls Retrofit: Sludge Dewatering, Sludge Loading Lighting	Replace with direct wire LED replacements and occupancy sensors	$56 + $25 Maint. Savings	$500	1.91	6.2	201.8
5	Lighting - Power Retrofit: Entrance, Upstairs Hallway, Office, Pump Room	Replace with direct wire LED replacements and occupancy sensors	$132 + $50 Maint. Savings	$1,360	1.54	7.5	1,008.5
6	Lighting - Power Retrofit: Clarifier, Screen Filter Room	Replace with direct wire LED replacements and occupancy sensors.	$120 + $50 Maint. Savings	$1,360	1.47	8.0	938.3
7	Other Electrical - Power Retrofit: Blower Pumps	Replace with 2 Premium Efficiency Pumps/Motors running alternately to agitate sludge	$734	$5,000	1.24	6.8	6,126.7

Table 4.1 Klawock Wastewater Treatment Plant, Klawock, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
8	Other Electrical - Combined Retrofit: East Lift Station Pumps	Replace with two smaller pumps in order to reduce surges of sewage into wastewater plant, improve reliability, and reduce energy consumption. Also includes installation of manhole liners on manholes serving the East Lift Station in order to reduce infiltration from rain.	$1,299 + $2,500 Maint. Savings	$40,000	1.19	10.5	10,842.1
9	Other Electrical - Controls Retrofit: Bayview Lift Station Pumps	Install manhole liners on manholes serving the Bayview Lift Station in order to reduce infiltration from rain.	$764 + $2,500 Maint. Savings	$25,000	1.11	7.7	6,379.9
10	Lighting - Controls Retrofit: Entrance, Upstairs Hallway, Office, Pump Room	Replace with direct wire LED replacements and occupancy sensors	$120 + $25 Maint. Savings	$1,500	1.10	10.4	893.1
11	Setback Thermostat: Office	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Office space.	$74	$1,000	1.00	13.5	564.8
12	Lighting - Power Retrofit: Mechanical Room Lighting, Bathroom Lighting, Storage Room, Blower Room	Replace with direct wire LED replacements	$22 + $40 Maint. Savings	$1,200	0.60	19.3	193.7
13	Lighting - Power Retrofit: Sludge Dewatering, Sludge Loading Lighting	Replace with direct wire LED replacements	$16 + $25 Maint. Savings	$960	0.51	23.2	59.1

Table 4.1 Klawock Wastewater Treatment Plant, Klawock, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
14	Other Electrical - Power Retrofit: Clarifier Room Fans	Replace with fans with premium efficiency motors, and shut down usage of the Screen room fan except when room is occupied or gas levels are exceeded. Cost represent marginal cost of installing premium efficiency motors.	$50	$2,500	0.29	49.6	421.0
15	HVAC And DHW	Replace Boiler With Pellet Boiler, replace hot water heater with smaller on demand hot water heater	$424	$16,500	0.25	999.9	12,598.1
16	Ceiling w/ Attic: House	Add R-11 fiberglass batts to attic with Standard Truss.	$13	$3,682	0.07	276.0	5.9
17	Other Electrical - Controls Retrofit: Effluent Pumps	This represents the impact of installing functional effluent pumps that can force sewage throw the ocean outfall when gravity will not suffice.	-$378	$15,000	-0.21	999.9	-3,156.0
18	Lighting - Combined Retrofit: Exterior Lights	Exterior Lights currently not in use, shut off at the breaker. This represents the energy impact of installing LED lights and operating on photocell controls.	-$153 + $50 Maint. Savings	$3,005	-0.40	999.9	-1,278.2
	TOTAL, all measures		**$4,031 + $4,765 Maint. Savings**	**$121,667**	**0.82**	**13.8**	**41,510.8**

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 Insulation Measures

Rank	Location		Existing Type/R-Value		Recommendation Type/R-Value	
16	Ceiling w/ Attic: House		Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: None Bottom Insulation Layer: R-38 Batt:FG or RW, 12 inches Top Insulation Layer: R-11 Batt:FG or RW, 3.5 inches Insulation Quality: Damaged Modeled R-Value: 41.8		Add R-11 fiberglass batts to attic with Standard Truss.	
Installation Cost		$3,682	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$13
Breakeven Cost		$261	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	276
Auditors Notes: There is sufficient space in the attic to add additional insulation above the existing bottom layer. Based on low heating needs, this is not economical.						

4.3.2 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
2	Keep doors, windows closed that are located within conditioned air space		Air Tightness from Blower Door Test: 10000 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 2500 cfm at 50 Pascals.	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$209
Breakeven Cost		$1,940	**Savings-to-Investment Ratio**	3.9	**Simple Payback yrs**	2
Auditors Notes: This retrofit is not possible unless gas detector controls, ventilation, sludge disposal, and rotary screen disposal are improved. This is included only to represent the energy impact of the planned renovations to the facility.						

4.4 Mechanical Equipment Measures

4.4.1 Heating/ Domestic Hot Water Measure

Rank	Recommendation				
15	Replace Boiler With Pellet Boiler, replace hot water heater with smaller on demand hot water heater				
Installation Cost	$16,500	**Estimated Life of Measure (yrs)**	25	**Energy Savings (/yr)**	$424
Breakeven Cost	$4,084	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	1000
Auditors Notes: Nearby Ketchikan produces wood pellets. Adding a pellet boiler in series with the existing fuel oil heated system would provide an alternative to diesel fuel. Wood pellets acquired locally are slightly more cost effective than fuel, though the primary benefit is in providing local economic stimulus from locally produced heating fuel. A smaller on demand hot water heater would be sufficient for the facility hot water usage and would save a small amount of electricity.					

4.4.2 Ventilation System Measures

Rank	Description			Recommendation	
3				Implement Occupancy Sensors for the Control room, blower room, and sludge pump room so fans can run with operator occupancy a	
Installation Cost	$2,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$463
Breakeven Cost	$6,069	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5
Auditors Notes: Currently the control room, blower room, sludge pump room all operate fans run by manual switching and connected to the lights. These fans are intended to be operated for comfort and safety purposes. Occupancy sensors attached to the fans/lights would allow for usage during occupied times and minimizes unnecessary excessive run time.					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
11	Office			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Office space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$74
Breakeven Cost	$1,001	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	13
Auditors Notes: The office space is the primary occupied space that is heated. Implement nighttime setback temperatures of 50 degrees after installing a programmable thermostat for the space would reduce heating costs significantly.					

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	Entrance, Upstairs Hallway, Office, Pump Room	17 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 17 LED (2) 17W Module StdElectronic	
Installation Cost	$1,360	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$132
				Maintenance Savings (/yr)	$50
Breakeven Cost	$2,091	**Savings-to-Investment Ratio**	1.5	**Simple Payback yrs**	7
Auditors Notes: Replacing interior lighting with direct wired LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
6	Clarifier, Screen Filter Room	17 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 17 LED (2) 17W Module StdElectronic	
Installation Cost	$1,360	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$120
				Maintenance Savings (/yr)	$50
Breakeven Cost	$2,003	**Savings-to-Investment Ratio**	1.5	**Simple Payback yrs**	8
Auditors Notes: Replacing interior lighting with direct wired LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
12	Mechanical Room Lighting, Bathroom Lighting, Storage Room, Blower Room	15 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 15 LED (2) 17W Module StdElectronic	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$22
				Maintenance Savings (/yr)	$40
Breakeven Cost	$725	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	19
Auditors Notes: Replacing interior lighting with direct wired LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs.					

Rank	Location		Existing Condition		Recommendation	
13	Sludge Dewatering, Sludge Loading Lighting		12 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 12 LED (2) 17W Module StdElectronic	
Installation Cost		$960	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$16
					Maintenance Savings (/yr)	$25
Breakeven Cost		$490	**Savings-to-Investment Ratio**	0.5	**Simple Payback yrs**	23
Auditors Notes: Replacing interior lighting with direct wired LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs.						

Rank	Location		Existing Condition		Recommendation	
18	Exterior Lights		6 HPS 70 Watt Magnetic with Manual Switching		Replace with 6 LED 25W Module StdElectronic and Improve Manual Switching	
Installation Cost		$3,005	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	-$153
					Maintenance Savings (/yr)	$50
Breakeven Cost		-$1,201	**Savings-to-Investment Ratio**	-0.4	**Simple Payback yrs**	1000
Auditors Notes: Replacing exterior lighting with LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs. The lights should be controlled by photocell. While exterior lighting is not currently utilized, this retrofit represent the energy impact of installing LED lights and using them for safety and security purposes.						

4.5.1b Lighting Measures – Lighting Controls

Rank	Location		Existing Condition		Recommendation	
4	Sludge Dewatering, Sludge Loading Lighting		12 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Improve Manual Switching	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$56
					Maintenance Savings (/yr)	$25
Breakeven Cost		$954	**Savings-to-Investment Ratio**	1.9	**Simple Payback yrs**	6
Auditors Notes: Replacing interior lighting with direct wired LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs.						

Rank	Location		Existing Condition		Recommendation	
10	Entrance, Upstairs Hallway, Office, Pump Room		17 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Improve Manual Switching	
Installation Cost		$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$120
					Maintenance Savings (/yr)	$25
Breakeven Cost		$1,649	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	10
Auditors Notes: Replacing interior lighting with direct wired LED replacements will reduce energy consumption and extend the lift of the bulbs, reducing the need for replacement bulbs						

4.5.2 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Blower Pump Room Fan		1/20 HP Pump with Manual Switching		Improve Manual Switching	
Installation Cost		$100	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$66
Breakeven Cost		$408	**Savings-to-Investment Ratio**	4.1	**Simple Payback yrs**	2
Auditors Notes: The Blower room fan is sealed from the clarifying room and only needs to operate when the operator is in the room. This can be shut off manually the rest of the year.						

Rank	Location		Description of Existing		Efficiency Recommendation	
7	Blower Pumps		2 2 Pumps running alternately to agitate sludge with Manual Switching		Replace with 2 2 Pumps running alternately to agitate sludge	
Installation Cost		$5,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$734
Breakeven Cost		$6,179	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	7
Auditors Notes: This retrofit includes marginal cost and beneift or repalcing pumps with premium efficiency pumps and motors.						

Rank	Location		Description of Existing		Efficiency Recommendation	
8	East Lift Station Pumps		18 HP Pump with Manual Switching		Replace with 10 HP Pump and Improve Manual Switching	
Installation Cost		$40,000	**Estimated Life of Measure (yrs)**	16	**Energy Savings (/yr)**	$1,299
					Maintenance Savings (/yr)	$2,500
Breakeven Cost		$47,449	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	11
Auditors Notes: Replace large pump with two smaller pumps. This should increase run time, but provide for steadier loads, reduced maintenance, improved reliability, and additionally reduce the large batches of sewage that overwhelm existing clarifiers at the WWTP and potentially cause DEC violations of fecal coliform effluent to the ocean. Additionally manholes on the sewage system feeding into the East Lift Station should install liners to reduce infiltration during rain events and reduce runtimes on pumps. Reduced rainwater influent should also substantially increase useful lifespan of pumps from reduced grit, and thus reduced replacement cost. Additionally would reduce runtime of rotary screen and sump pumps in the waste water treatment plant.						

Rank	Location		Description of Existing		Efficiency Recommendation	
9	Bayview Lift Station Pumps		8 HP Pumps with Manual Switching		Improve Manual Switching	
Installation Cost		$25,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$764
					Maintenance Savings (/yr)	$2,500
Breakeven Cost		$27,760	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	8
Auditors Notes: Install rain liners for manholes on sewer system to reduce infiltration and excessive run time on Bayview lift station pumps, increasing life span of pumps and reducing replacement costs. Additionally would reduce runtime of rotary screen and sump pumps in the waste water treatment plant.						

Rank	Location		Description of Existing		Efficiency Recommendation	
14	Clarifier Room Fans		4 Fans: 1/20 HP, 1/16 HP, 1/8 HP, 1/4 HP with Manual Switching		Replace with 4 Fans: 1/20 HP, 1/16 HP, 1/8 HP, 1/4 HP	
Installation Cost		$2,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$50
Breakeven Cost		$737	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	50

Auditors Notes: This retrofit requires implementation of gas detector controls in the screen room that will allow the vent fan to be shut off in that room except for when occupied by the operator, as well as increased ventilation to the clarifier rooms. This retrofit also includes the marginal efficiency improvement and cost of premium efficiency motors and fans replacing existing clarifier room fans.

Rank	Location		Description of Existing		Efficiency Recommendation	
17	Effluent Pumps		7 HP Effluent Pumps with Manual Switching		Improve Manual Switching	
Installation Cost		$15,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	-$378
Breakeven Cost		-$3,183	**Savings-to-Investment Ratio**	-0.2	**Simple Payback yrs**	1000
Auditors Notes: Installation of new effluent pumps to pump effluent water from clarifiers out to ocean through existing outfall. Currently pumps are shut off and not operating, this represents the energy cost to restore operator of this equipment.						

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 Klawock and Klawock Cooperative Association in the development of a proposal based on the retrofits identified in this report as part of the RACEE competition. The City of Klawock and ANTHC are funded by the Environmental Protection agency to renovate and improve the existing wastewater treatment plant. See Appendix D for details on this scope. The findings of this report will be integrated into the design and construction of this system as appropriate. Construction is expected complete during 2018. Regardless of the results of the RACEE competition, ANTHC will continue to work with Klawock 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: Klawock Wastewater Treatment Plant	**Auditor Company:** ANTHC
Address: N/A	**Auditor Name:** Gavin Dixon, Cody Uhlig
City: Klawock	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: City of Klawock	
Client Address:	**Auditor Phone:** (907) 729-3600
	Auditor FAX:
Client Phone: (907) -	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 4,791 square feet	**Design Space Heating Load:** Design Loss at Space: 86,736 Btu/hour with Distribution Losses: 86,736 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 132,220 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 50.1 deg F (building average)
Actual City: Klawock	**Design Outdoor Temperature:** 15.1 deg F
Weather/Fuel City: Klawock	**Heating Degree Days:** 7,413 deg F-days
Utility Information	
Electric Utility: –Alaska Power and Telephone	**Average Annual Cost/kWh:** $0.22/kWh

Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$2,237	$434	$114	$1,105	$40	$13,291	$1,128	**$18,349**
With Proposed Retrofits	$1,287	$387	$11	$785	$40	$10,680	$1,128	**$14,318**
Savings	$950	$47	$103	$320	$0	$2,611	$0	**$4,031**

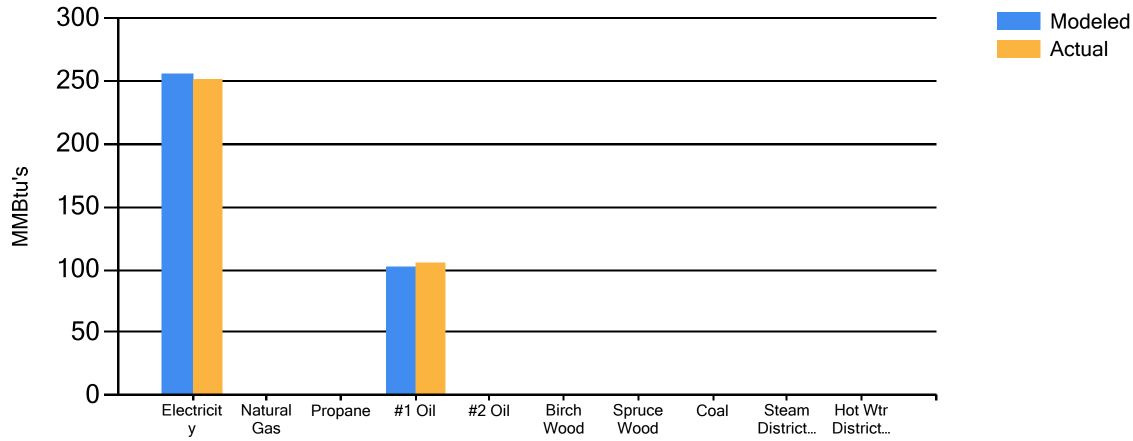
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	74.8	10.09	$3.83
With Proposed Retrofits	57.7	7.78	$2.99

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

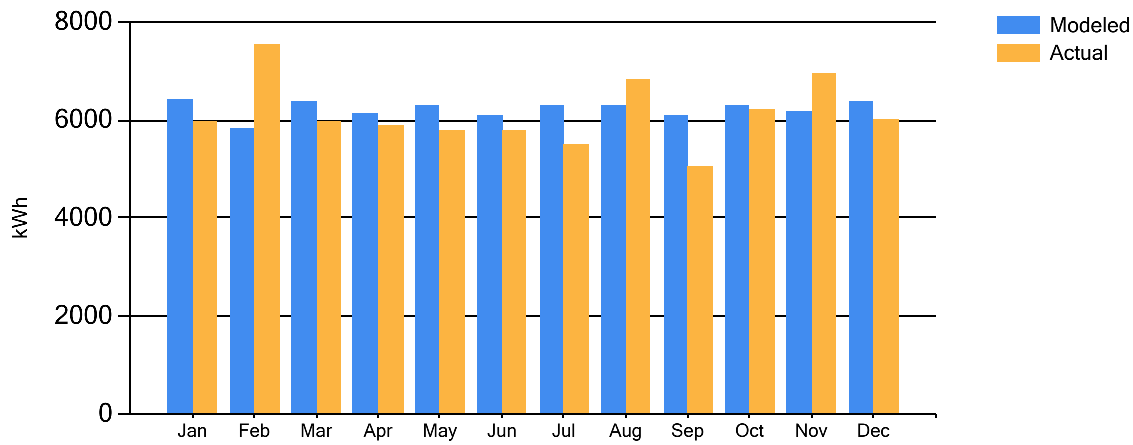
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

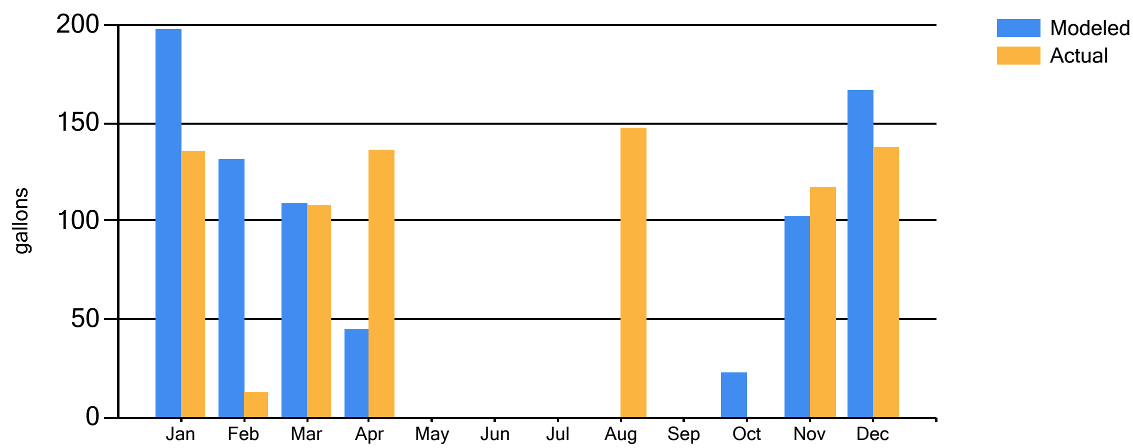
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix C: Klawock Wastewater Treatment PER

Klawock Wastewater Treatment Plant Renovation Preliminary Engineering Report

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Department of Environmental Health and Engineering, ANTHC

August 2016

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1.0 Introduction

The City of Klawock operates a wastewater treatment plant (WWTP) that provides primary treatment of sewage prior to discharge of effluent into the Klawock Inlet via an ocean outfall line. The facility consists of a 5,900 square foot, 2-story facility which houses primary screening facilities, 2 primary clarifiers, effluent pumping, a sludge holding/aeration tank, sludge dewatering equipment, a dry sludge truck loading bay, a lab and an office.

Two primary deficiencies have been identified as needing improvement. First, the existing layout of the facility does not provide for efficient handling and disposal of grit screenings from the headworks of the plant and thus the original grit management plan has been abandoned. The operator now manually shovels grit from collection hoppers into garbage cans lined with heavy duty plastic bags. The trash can are dragged to an outside second floor stair landing from which the plastic bags are shoved through the stair rails into a truck parked below.

Second, the headworks piping in the screening room has been exposed to corrosive gases. The 8-inch ductile iron inlet pipe and fittings are corroded to a point of disrepair and need to be replaced. The same corrosive gases have damaged the concrete inlet structure which is also in need of repair. Neglecting to repair and/or replace the corrosion damaged elements will ultimately lead to a pipe failure that would most likely result in a direct discharge of untreated wastewater into the Klawock Inlet. The corrosive gas exposure has also done damage to doors and windows and lighting fixtures throughout the facility.

The Alaska Native Tribal Health Consortium (ANTHC), Division of Environmental Health and Engineering (DEHE) developed this report to identify and evaluate appropriate solutions for these deficiencies. The proposed solutions include the construction of a vacuum grit transport/dump system, and the replacement of all corroded ductile iron pipe and fittings with new pipe.

In addition to these primary project elements, additional ancillary repair and replacement items have been identified to eliminate the conditions that lead to initial corrosion damage; to replace and/or upgrade aging equipment, to improve the operation of the facility, and/or to extend the life of the wastewater treatment plant.

A third-party construction cost estimate has been prepared for this project and is attached to this report in **Appendix H**. The estimated cost for this project is $1.98 million.

2.0 Project Planning

2.1 Location

Klawock is located on the western side of Prince of Wales Island on the Klawock Inlet. It is 60 air miles west of the City of Ketchikan. The community lies at approximately 55.55222° North Latitude and 133.0958° West Longitude. (T073S, R081 E, Seward Meridian.) It is located in the Ketchikan Recording District.

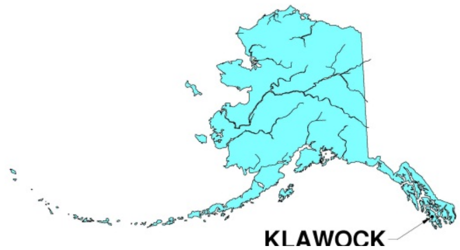


Figure 1: Klawock Location

The climate of the Kodiak Islands is dominated by a strong marine influence. Summer temperatures range from 49 to 63 °F and winter temperatures range from 32 to 42 °F. Average annual precipitation is 120 inches with 40 inches of snowfall.

The Wastewater Treatment Plant is located outside of the city limits of Klawock about ½ mile west of the Craig Klawock Highway on Klawock Island. Project location maps can be found in **Appendix A**.

2.2 Environmental Resources Present

The ANTHC uses the Indian Health Service (IHS) environmental review procedures for conducting environmental analyses of all health and sanitation facilities projects, as outlined in the Environmental Review Manual, issued January 2007. All actions involving the proposed project have been reviewed in the attached National Environmental Policy Act (NEPA) Environmental Review Draft found in **Appendix G.** No extraordinary or exceptional circumstances were found to exist. It is therefore recommended that the IHS approve a determination of eligibility for categorical exclusions from the requirement to conduct further NEPA evaluation for this project upon receipt of the final environmental review document, which will be submitted after the 65% design drawings are complete.

Fish and wildlife have historically been important to the economy and lifestyle in Klawock. The waters around Klawock are abundant in salmon and other fish, and these resources are sought after by commercial fishermen. Wild game, including brown bear and deer are prevalent around the community. Bird populations are also extensive.

2.3 Population Trends

Based on a 2013 Department of Commerce, Community and Economic Development (DCCED) certified estimates, Klawock' s populations in 2013 and 2014 were 786 and 802, respectively. According to Census 2010, there are 363 housing units in the community of which 297 are occupied.

Table 1: U.S. Census Population History

Census Year	Population
2014	802
2013	786
2010	755
2000	854
1990	722
1980	318
1970	213

Population characteristics were taken from the DCED, Community and Regional Affairs, Alaska Community Database available at: http://commerce.alaska.gov/cra/DCRAExternal/community

Population has grown at an average annual rate of about 3% from 1970 until 2013. However over the last 20 years, population growth has been relatively flat.

Indian Health Service (IHS) Housing Inventory Tracking System (HITS) reports a total of 321 residential units in the community. The breakdown between various housing categories is delineated in **Table 2**.

Table 2: HITS Housing Inventory

Category	Description	Count
E-1	Native Homes	189
E-2	Non Residential Units	73
E-3	Non-Indian Units	125
H-1	HUD Units.	7

2.4 Community Engagement

In May 2014, ANTHC Engineers travelled to Klawock for an inspection of the WWTP with the operator. Together, the team developed a list of repair and replacement scope of work. This list is documented in a trip report of the site visit which is included in **Appendix B**. ANTHC engineers have continued to work directly with the WWTP personnel over the ensuing weeks in order to refine the scope of work and define appropriate recommendations.

The community employs both primary and backup operators for the wastewater collection and treatment systems. Both the primary and backup operators hold Class 1 Wastewater Collection and Wastewater Treatment Certificates according to the Alaska Certified Water/Wastewater Operator database.

Over the last several years, the City of Klawock has endeavored to improve water/wastewater system collection rates. Impressive gains have been made. In 2010, collection rates were approximately 60%. In fiscal year 2012, collection rates improved to 92%. In 2013 and through the first half of 2014, collection rates exceeded 100%. *(RUBA Assessment, February 2014)*

3.0 Existing Facilities

3.1 Location Map

Project maps are included in **Appendix A**.

3.2 Background

Klawock operates a wastewater system with 2 collection zones. Each of the 2 zones terminates in a lift station which pumps to the wastewater treatment plant. The collection system serves over 90% of the residences and businesses in the community, including approximately 330 residential connections, the school, and cannery. The current service population is approximately 790.

The facility consists of a 5,900 square foot, 2-story facility which houses primary screening facilities, 2 primary clarifiers, effluent pumping, a sludge holding/aeration tank, sludge dewatering equipment, a dry sludge truck loading bay, a lab and an office. A system schematic is provided in **Appendix C**. The treatment plant was designed for an average dry weather flow of 295,000 gallons per day and a peak day wet weather flow of 623,000 gallons per day. It has been classified by the State of Alaska Department of Conservation as a Class 1 wastewater system.

The wastewater treatment system was put into service in 1999. The facility provides primary treatment of wastewater prior to discharge of effluent into the Klawock Inlet via an ocean outfall line.

3.3 Condition of Existing Facilities

In general, the WWTP is in functional working order. However, it is in need of repair and renovation in order to address specific corrosion damage, to improve operation efficiency, and to replace aging equipment. These issues are delineated below.

3.3A Headworks and Other Corrosion Repair:

A ventilation failure occurred at some time in the past. This failure allowed high concentrations of corrosive gases (hydrogen sulfide) from the natural decay of wastewater to accumulate in the process rooms. Extended exposure to these gases causes extensive corrosion and deterioration of concrete structures and metal fixtures. In the Klawock WWTP, metal doors and door frames, windows, lighting fixtures, ventilation and exhaust fans, ductile iron pipe and fittings, and concrete basins have been damaged due to exposure to hydrogen sulfide gas. Photos documenting corrosion damage can be found in **Appendix F**.

Figure 2: Inlet Piping and Concrete Damage

The worst corrosion damage occurred in the inlet screening room. In the inlet screening room, raw wastewater is discharged from pressure mains into a screening vessel which it is exposed to atmospheric conditions. From this point wastewater flows by gravity into the primary clarifiers. It is at this location that most hydrogen sulfide gas would be released and therefore where most of the corrosion damage would occur. The 8-inch ductile iron inlet pipe and fittings in the screening room are severely corroded. The bolts holding the pipe and fittings together cannot be tightened or removed. Failure to address this corrosion will ultimately lead to a failure in the inlet piping which would lead to a direct discharge of raw sewage into Klawock Inlet. In addition, the concrete surfaces in the inlet screening chamber have deteriorated due to exposure to corrosive gases. The concrete structure is generally sound but the surfaces are in need of repair in order to curtail any further deterioration. Corrosion damage in the inlet screening room is illustrated in **Figure 2**.

3.3B Grit Removal, Transfer, and Disposal:

Over time, the removal and disposal of screenings from the inlet screening room has proved to be operationally difficult. The screening room is located on the second floor of the WWTP. Refer to **Figure 3** for the floor plan of the WWTP upper level. Screenings (grit, fat, grease and other solids) are automatically removed by a rotary drum screen (cover photo) and are discharged into a steel hopper on wheels. Per the original operational plan, these hoppers would be maneuvered out into the clarifier room to be dumped through an access hole in the floor. Screening would fall by gravity through the access into a secondary container located in a first floor storage room with exterior access via a pair of double doors. Refer to **Figure 4** for a photo of the east view of the WWTP. The secondary container would then be removed from the storage closet via some type of lift truck and be hauled to the landfill for final disposal.

This procedure has proved to be unsuccessful for a number of reasons. First, it is difficult to maneuver the hoppers from the screenings room to the disposal chute. The hoppers must cross over grating which is not compatible with the wheeled hoppers. Second, disposal through the chute typically resulted in some quantity of screenings being splattered on the walls and floor of the storage closet. This resulted in excessive odors and added an additional cleaning task to the routine Operation and Maintenance (O&M) list for the operator. Finally, removal of the secondary storage containers from the first floor closet required a special piece of equipment (garbage truck with front mount lifting equipment). The truck used for collecting and hauling dewatered biosolids could not simultaneously be used for the removal of screenings and transportation to the final disposal site.

In lieu of the operational procedure described above, the operator currently shovels screenings from the hopper into plastic bag-lined storage bins (kitchen trash cans). These storage bins are collected in the clarifier room for 7-10 days and then transported to the disposal site along with dewatered biosolids. The dump truck with biosolids is driven to the east side of the building and backed up just below the exterior stair landing. The operator drags the storage bins to the stair landing and shoves the plastic bags through the stair rails down to the truck bed below. The procedure is marginally functional. It effectively provides for removal of grit but it is a labor intensive and strenuous activity requiring more operator time than necessary. It creates safety and health issues in that it requires more operator contact with wastewater biosolids (shoveling), and demands that the operator works on a narrow stair landing to either lift heavy loads over the railing or shove them through the railing to the truck below.

Figure 3: Screenings Removal Traverse through Upper Level

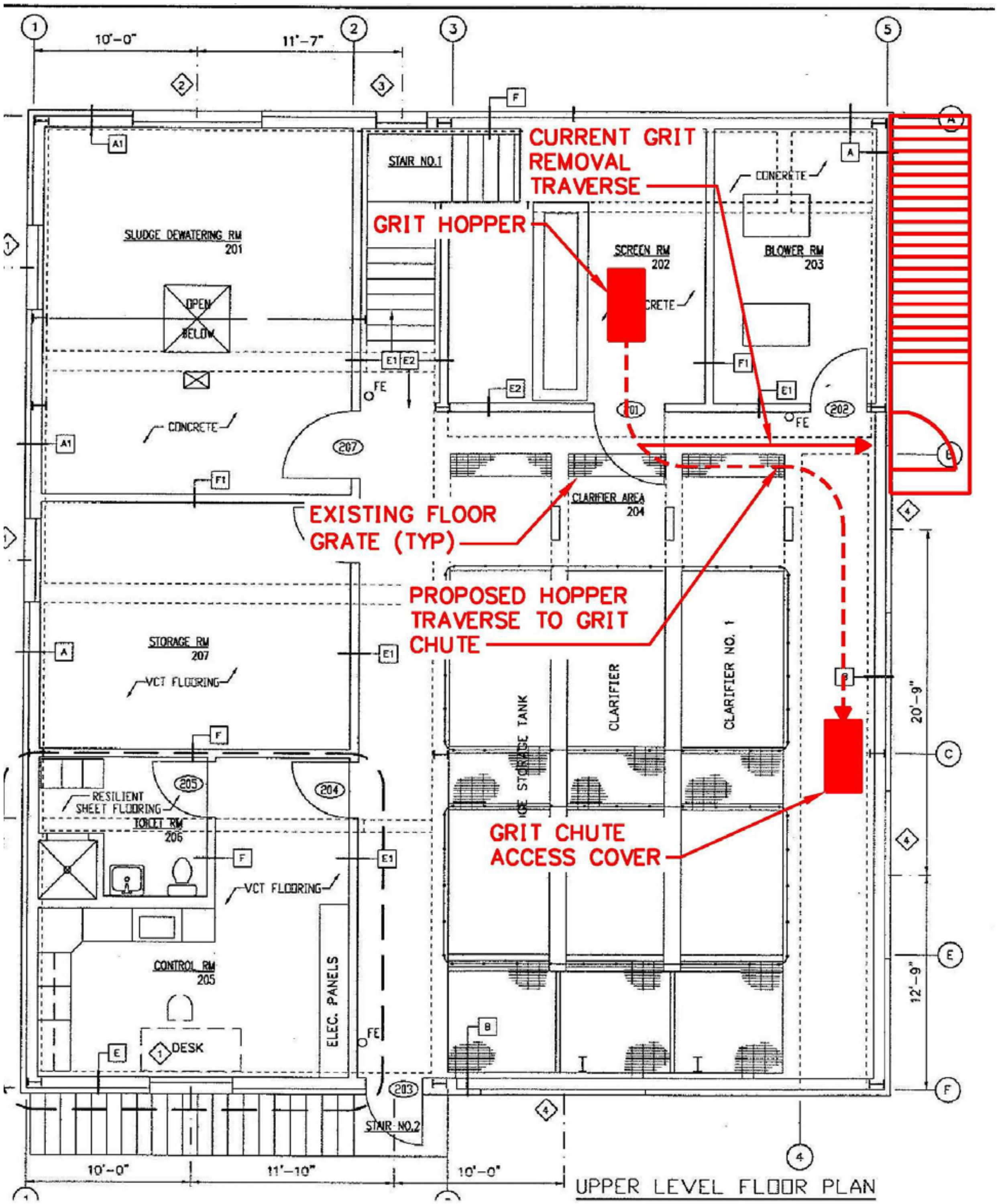


Figure 4: East View of WWTP

3.3C Capital Equipment

1. Sludge Dewatering:

   The facility is equipped with a vertical screw press for dewatering of primary sludge taken from the clarifiers and stored in the aerated sludge tank. The dewatering system includes a polymer feed system and a lime feeder. This equipment is located on the second floor of the facility directly over a truck bay (See Figure 5). Processed sludge is discharged through a chute directly into a dump truck parked in the bay below.

   Operators process sludge once every 7-10 days depending on sludge accumulation in the holding tank. Utilizing the existing equipment, operators are currently struggling to sufficiently dry sludge. Very wet sludge is being discharged into the collection vehicles. Insufficiently dry sludge results in splashing and spreading of sludge in the truck bay, leaking from the truck, and potentially eliminates the ability to dispose of the sludge in the landfill due to maximum moisture content requirements. The system of polymer feed, dewatering press, and lime mixing needs to be renovated and/or replaced in order to consistently produce acceptably dewatered biosolids.

Figure 5: Sludge Dewatering Press

2. Effluent Pumping:

   Effluent from the WWTP flows by gravity through an 8-inch diameter outfall line into Klawock Inlet. In an event of both extreme high tide and high wastewater flows into the WWTP, it is necessary to pump treated effluent from the plant. The facility is equipped with duplex 7.5 HP, 1000 gpm effluent pumps for these events. These pumps are not currently functional and are in need of repair and/or replacement.

3. Sludge and Scum Baffles:

   The primary clarifiers are equipped with baffles that rotate through the length of the tanks (Figure 6). These devices move settled sludge along the bottom of the tank to a sludge trough from which it can be removed from the tank and push scum along the surface of the wastewater in the tank to skimmers devices that remove scum and move it to the sludge tank. The baffles and drive system are made from polyethylene chains, sprockets, and gears driven by a low horsepower motor. These are all wear items that need to be repaired or replaced over time in order to maintain the system in working order.

Figure 6: Primary Clarifier Skimmers and Scrappers

4. Power Supply and Emergency Power Backup:

   The WWTP receives its power from Alaska Power and Telephone (APT). The facility currently has no backup power. Primary generation for APT is a hydro-electric facility with back-up diesel generation located in Craig. The power system is reliable and most outages are addressed within minutes. However, in unusual circumstances, it is possible for power to be provided to one or both of the 2 lift stations when simultaneously there is no power being provided to the WWTP. Such an event results in wastewater being pumped into the WWTP without a means to process it through the facility leading to overflows and spillage within the facility, primarily out of the open top clarifiers. This situation can be alleviated via the provision of an emergency backup power supply.

3.3D Delineated Repair and Renovation Scope

In May 2014, ANTHC engineers travelled to Klawock for an inspection of the WWTP. A copy of the trip report is included in this report as **Appendix B**. Based on the inspection and subsequent discussion with operators, a detailed list of recommended repair and renovation items has been developed. The final list is presented in this section. The list includes all of the specific scope items necessary to correct the issues discussed above as well as other ancillary elements necessary to improve the functionality of the facility and/or extend its useful like. It is organized in priority order with primary project scope items (headworks repair and grit handling) at the top of the list. This list was provided to a consultant and is the basis for development of the 3rd party cost estimate included in **Appendix H**.

Appendix E contains a copy of the WWTP record drawings. The list below includes a reference to pages of the record drawing that illustrate the specific scope item. The drawings themselves have also been annotated with a reference to the recommended repair and renovations scope items below. Appendix F contains photos of the same elements.

1. Headworks:
   a. Obtain permits from ADEC for temporary bypass of wastewater treatment plant for repair of headworks.
   b. Temporarily remove drum screen. (Sheet M2)
   c. Repair damaged concrete structure supporting the screen. Assume that 100 sq-ft of the structures facing (50%) will need to be repaired. (Sheet S10 & S13)
      - Remove damaged concrete.
      - Apply bonding agent.
      - Apply concrete/grout patch to restore structure.

   d. Service or replace existing rotary drum screen per manufacturer's recommendation.
   e. Install the optional automatic screen wash system
      - Provide new hot water generator (Approximately 50 gallon electric heater).
      - Provide hot water piping to drum screen.
      - Provide electrical controls.

f. Remove and replace wastewater inlet piping per original drawings up to and including 8-inch through-floor pipe spool (Sheet M-6)
g. Remove and replace existing “utility station” (Sheet M4 & M17)
h. Remove and replace inlet flow meter (Sheet M6)
i. Remove and Replace 2 each floor drain covers (Sheet M10/17)

2. <u>Grit Transfer</u>

a. Replace existing grating with close mesh aluminum bar grating suitable for wheeled hoppers: 3 each 6 foot x 1.25 foot sections. (Sheet M2)
b. Provide new light weight hoppers for collecting screenings (See photos)
c. Replace 2 doors with new 4’-0” doors and low-profile threshold to provide for easier navigation of hoppers: Screen Room and East Exterior Door. (Sheet A1, A4, M2)
d. Install vacuum grit handling equipment.

3. <u>Primary Clarify Room</u>

a. Demolish and replace 2 clarifier sludge scrapers and drives. (Sheet M4)
b. Demolish and replace sludge skimmers. (Sheet M2 & M4)
c. Add air scour to sludge sumps to eliminate manual scraping/cleaning.
d. Replace all windows in the clarify room (3 each). Use roll up type devices as per original plans. (Sheet A1, A4, A5)
e. Remove and replace exhaust and supply fans (7 each). Install automatic control with gas detection system. (Sheet M14 & M15)
f. Remove and replace unit heaters (3 each). (Sheet M14 & M16)
g. Replace 2 doors: secondary external doors/frames and blower room door. (Sheet A1, A4, A5, M2)
h. Replace all area lighting. Assume LED fixtures and bulbs. Assume replacement of wiring, conduit, and switching. (Sheet E6)

4. <u>Sludge Holding Tank</u>

a. Remove and replace diffusers to improve DO levels in sludge tank. (Sheet M5)
b. Remove and replace corroded diffuser mounting stands.

5. <u>Effluent Pumps</u>

a. Replace Effluent Pumps and rail system; assume 2 each 7.5-hp pump/motor. (Sheet M4, M6, M9)
b. Remove and replace air vacuum valve. (Sheet M4)

6. <u>Sludge Dewatering:</u>

a. Demolish and replace polymer feed system (Sheet M2, M7, Manufacturer’s estimate)
b. Repair and renovate the sludge dewatering equipment (Sheet M2, M7)
   - Replace wear items per manufacturer’s recommendation.

- Replace mechanical screw speed adjustment with VFD controls and drive ready motors.

c. Repair lime feeder. (Sheet M2, M7)

- Replace wear items per manufacturer's recommendation.

7. Emergency Power:

a. Provide back-up generator and transfer switch for emergency backup power. Assumes 150KW generator set for external installation on gravel pad. (Sheet E7 provides load summary)

8. Fuel tank:

a. Remove and replace existing fuel tank. (Assume 500 gallon double walled tank installed on wood sleepers)

9. Miscellaneous

a. Replace primary plant entrance door on the first floor. (Sheet A1)
b. Provide internet and phone service to the facility.

3.3E Financial Status of Existing Facility

The City operates within a budget adopted on an annual basis by the City Council and reviewed and amended as needed based on the actual operation and maintenance costs for the City's facilities. The State of Alaska, Division of Community and Regional Affairs (DCRA), Rural Utility Business Advisor (RUBA) program, completed an *Assessment of Management Capacity Indicators* report in February of 2014. The report is available online at the following web address: http://commerce.alaska.gov/DNN/Portals/4/pub/RUBA/CityofKlawock-Assessment-2014-02-25.pdf The RUBA report indicates that through December 31, 2013, the water and wastewater utilities are operating within the established annual budget, but is not receiving revenue sufficient to cover repair and replacement costs.

The utility has both metered and unmetered customers. Unmetered customers are charged a flat rate of $117.58 per month. Metered customers pay a monthly rate that averages $91.09. The utility is encouraging the metering of all customers in order to incentivize conservative water use and in order to better monitor loss and leaks.

The City does not have any outstanding debts related to their water and sewer utility.

3.3F Water/Energy/Waste Audits

There have not been any energy audits for the City's water and sewer system.

4.0 Need for Project

4.1A Health, Sanitation, and Security

The objectives of the proposed activities are to prevent a potential corrosion related failure that would lead to a direct discharge of untreated wastewater into the marine environment (headworks repair), to improve the operating efficiency of the WWTP and reduce operating costs (grit handling scope items), and to extend the life of the facility via general capital equipment repair and replacement. The wastewater system in Klawock is vital to the health and economic welfare of the community. The WWTP is a key component of collection and treatment system. If the WWTP is not kept in peak condition, the risk of wastewater spills will increase.

4.1B Aging Infrastructure

Klawock's WWTP was constructed in 1998. Generally, the concrete structure and vessels, the piping, and major capital equipment are all in serviceable order. Some ancillary systems and or components of systems are technologically outdated (sludge dewatering coagulant feed system) and/or have failed and need to be repaired or replaced (inlet rotary grit screen, sludge baffle system, sludge press, effluent pumps, exhaust and vent fans, and doors and windows). Repair and/or replacement of these items will extend the life of the facility for at least 20 years.

4.1C Reasonable Growth

The design population for the original treatment facility appears to be approximately 2950 people. This is based on a dry weather design flow of 295,000 gallons and per capita wastewater production of 100 gallons per day. With a current population of 802, the renovated existing facility will support annual population growth of more than 5% over the next 20 years.

5.0 Alternatives Considered

Due to the nature of the proposed project (primarily a repair and renovation effort), alternative evaluation mainly consists of a determination of whether to repair or to replace a specific piece of equipment. The exception to this is the renovation of the grit handling facilities which does involve the consideration of several technical alternatives. This section presents a general discussion of the considerations made in a determination of whether to repair an existing piece of equipment or to replace it with a new piece of equipment, and a discussion of the technical alternatives considered for addressing existing inefficiencies in the grit removal process.

5.1A Grit Handling Facilities

Potential alternatives for efficient removal of grit from the screenings room include the following:

1. Alternative 1 - Mechanical Conveyance Equipment:

   This option consists of the installation of mechanical conveying equipment to move screenings from the Screening Room on the second floor and transfer them directly to the Sludge Loading Room on the first floor. A conceptual layout for the mechanical conveyance equipment is illustrated in **Figure 7**.

   a. Advantages:

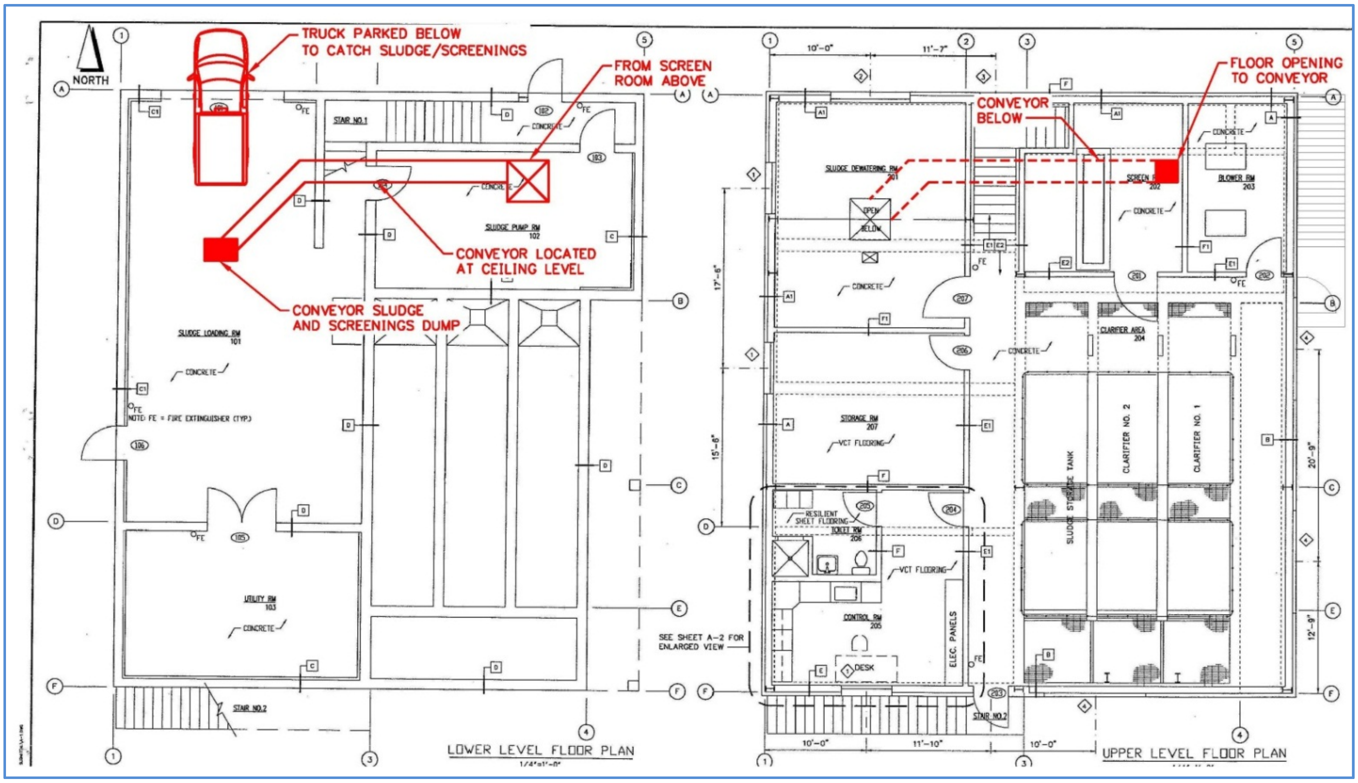
   - Mechanical equipment will reduce the labor requirement for handling of screenings and eliminate routine direct contact with screenings required of the current transfer practice.
   - Although no detail estimate has been obtained, the capital cost of the mechanical equipment installation is believed to be less than the alternative described below.
   - Allows for the co-location of the collection points for dewatered sludge and head works screenings.

   b. Disadvantages

   - Mechanical conveyors carrying wet screenings must pass through several occupancy classifications including the hallway/stairway to the office and lab.
   - There are currently no conveyors in the system. This will be a new piece of equipment that will require routine operation and maintenance to maintain it in functioning order.
   - The screening process is in continuous operation. Sludge is processed once every 7 to 10 days. The haul truck that collects dewatered sludge from the process does not remain idle on site between sludge processing operations. Therefore, conveyed screenings would have to be collected and stored in the sludge loading area between sludge dewatering operations and then somehow transferred into the haul vehicle when it arrives for sludge dewatering

operations. The lack of synchronization of these two processes eliminates any advantages of combining the collection points.

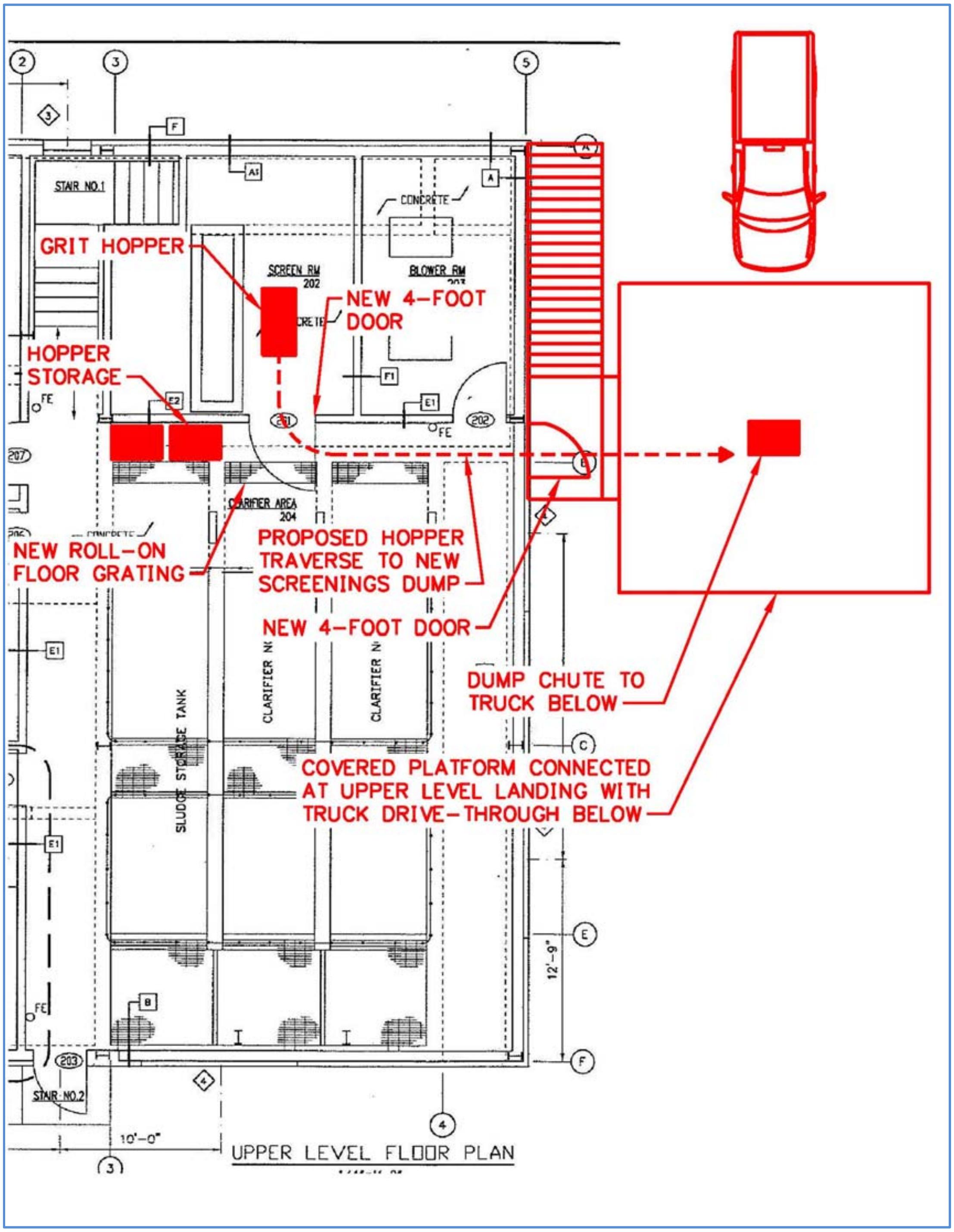
Figure 7: Screenings Conveyor Option



2. Alternative 2 - Construction of Improved Screenings Dump:

   This option consists of the construction of a new 20 x 20 elevated dumping platform on the east side of the existing WWTP. The proposed structure is illustrated in conceptual elevation sketches provided in **Appendix D**. A floor plan of the proposed dump station is included below in **Figure 8**. The objective of the new dump station is to facilitate the movement of wheeled hoppers from the screenings room to a location where they can be directly dumped into a haul vehicle for conveyance to the final disposal location. The implementation of this option consists of providing 2 new 4-foot doors, replacing existing grating with new grating that will accommodate rolling of wheeled hoppers, the provision of new light weight hoppers, and the construction of a drive through dump station located on the east side of the existing structure connected at the upper level landing (see **Figure 8**).

Figure 8: New Screenings Dump Station Option



a. Advantages:

- The operation of the new dump station is consistent with the screenings removal process that has been developed by the operators over the course of managing the facility. It facilitates and simplifies existing procedures without adding additional mechanical equipment.
- Option eliminates the need for the operator to manually shovel screenings from collections and storage hoppers into smaller containers for transport to the haul vehicle.
- It accommodates the different schedules for sludge processing and screenings collection. Screening hoppers can be stored in the clarifier room between scheduled sludge processing periods. Once sludge is processed and collected in the haul vehicle, that same vehicle can maneuver to the dump station and collect grit from the screening hoppers.
- It will add no additional mechanical equipment requiring routine operation and maintenance and/or replacement at the end of its useful life.
- It will not add any electrical power loading.

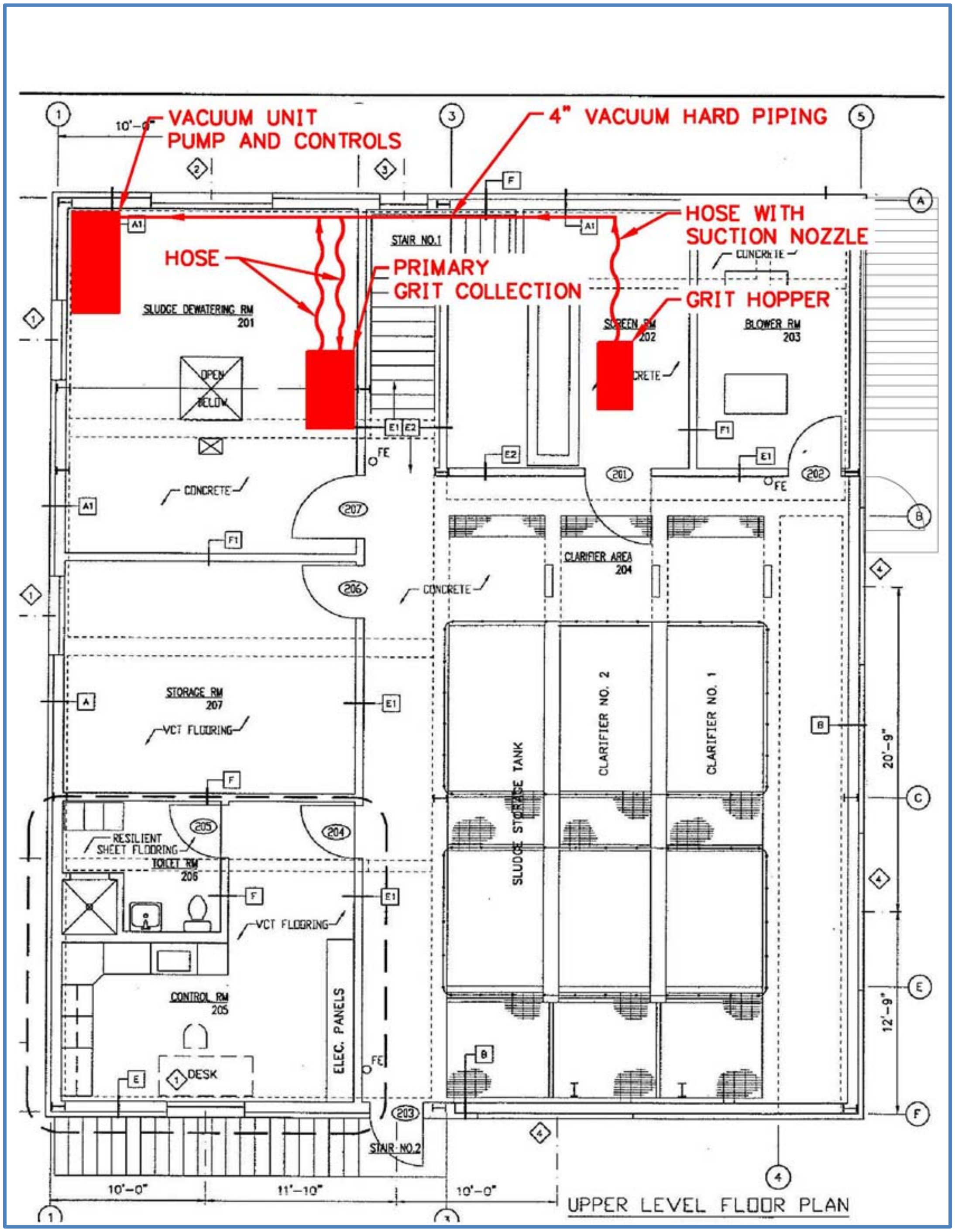
b. Disadvantages:

- This option will have the higher capital cost. Based on the 3rd party cost estimate the new structure and ancillary facilities for the dump station will cost $161,000 plus engineering and administrative costs.
- It will require some additional snow removal as part of routine O&M in order to maintain haul vehicle access to dump station.
- Installation of the additional structure will utilize some of the available “yard” space at the WTP.

3. <u>Alternative 3 – Installation of vacuum grit conveyance system</u>

This option consists of a vacuum system that draws grit from the grit hopper to a storage vessel in the sludge dewatering room. The storage vessel is on large wheels so it can be moved over the existing sludge discharge hatch and dumped into a truck below. The wheelbase of the vessel allows for it to be moved entirely over the hatch, than a valve is operated by hand to discharge the grit. Bumpers would be installed around the floor opening to prevent the storage vessel from falling through the access hole as it is being maneuvered. Flexible hose with cam-lok fittings attaches the storage vessel to the stationary vacuum equipment and also to hard piping that is routed to the screen room. In the screen room, a flexible hose from the hard piping attaches to a hand-operated suction wand that the operator uses to suck out the contents of the grit hopper.

Figure 9: Vacuum Grit Conveyance



a. Advantages:

- This option sharply reduces the labor required to move grit to the receiving truck.
- This option minimizes operator exposure to the grit.
- This option allows grit and sludge to be disposed of in the same location, using existing floor access and truck hauling infrastructure.

- This option requires only one location for the receiving truck, minimizing driver time.
- This option will be consistent with existing occupancy classifications in the building.

b. Disadvantages:

- This option involves an approximately 25-HP vacuum pump and associated equipment that will need some operation and maintenance care.
- This option will likely involve updating the power to the building to accommodate the approximately 25-HP vacuum pump

5.1B Equipment Repair versus Replacement

Section **3.3D** presents a comprehensive list of all items in the plant that need to be repaired or replaced due to age, wear and tear, inefficient performance, and/or general failure. This section addresses considerations that were made in the determination regarding whether a specific deficiency should be addressed via repair or replacement.

1. Design Life:

   The target design life of the WWTP after the completion of renovations is 20 years. If a determination to repair a structure and/or piece of existing equipment is made, then the subsequent repair must extend the life of the equipment or structure for a minimum of 20 years (assuming routine operation and maintenance is provided). If repair cannot extend the life of the individual item for 20 years, then full replacement of the item is the preferred option.

   a. *Header Piping*: The 8-inch ductile iron header piping has visible corrosion of both the pipe and joint fasteners. The corrosion could be removed and new coating applied. However, it is not evident whether the integrity of the pipe has been compromised. It is a relatively small amount of pipe and the potential savings to be had by repair does not warrant the increased risk of failure if the pipe is left in place. Replacement is recommended.

   b. *Concrete Work*: Damage to concrete structures has been identified in the scope of work. The damage is limited to the concrete surface and does not extend into the reinforcing steel and/or impact the integrity of these structures. Concrete surface repair is recommended for these structures.

   c. *Ventilation and Exhaust Fans*: The metal housing of ventilation and exhaust fans has been corroded due to exposure to corrosive gases. The labor involved to patch and repair the housing of these devices would offset the cost savings of not having to purchase new equipment. In addition, purchasing new equipment will provide the opportunity to specify units with new high efficiency motors. Replacement is recommended.

d. *Doors*: Specific metal doors with corrosion issues that are deemed not to be repairable are called out for replacement with like sizes doors and frames. Fiberglass doors and frames will be considered as well as metal for their corrosion resistance.

e. *Unit Heaters*: Similar to ventilation and exhaust fans, the metal cabinets of unit heaters targeted for replacement have corroded due to exposure to corrosive gases. The labor involved to patch and repair the housing of these devices would offset the cost savings of not having to purchase new equipment. In addition, purchasing new equipment will provide the opportunity to specify units with new high efficiency heating elements which may help to reduce operating costs. Replacement is recommended.

f. *Lighting*: Existing fluorescent lighting fixtures that are targeted for replacement are multi-bulb fixtures with a thin steel housing. The housing for the fixtures has corroded to the point that glass covers on the fixture have fallen into the WWTP process vessels and shattered. They are deemed to be un-repairable. Replacement is recommended. The specification of new lights will consider the option to install LED fixtures which will help to reduce electrical utility costs.

g. *Sludge Scrappers and Skimmers*: The scrappers and skimmer system located in the primary clarifiers is assembled out of multiple high density polyethylene chain links, gears, sprockets, and baffles. The existing devices are believed to be those originally purchased during the construction of the WWTP. This system is still supported by manufacturers and individual components can be purchased and installed. However, it is not likely that selective replacement of some parts will catch all of the worn and weathered components and is therefore not likely to provide a 20 year life for the system. It is recommended that the entire system be replaced with all new components.

2. <u>Manufacturer's O&M Support:</u>

In order to consider repair over replacement, it is also important to understand whether the specific equipment is still supported by and will continue to be supported by the manufacturer and/or the after-market parts industry. A piece of equipment may sufficiently sound to meet the 20 design life objective, however, if the operator is not able to obtain replacement parts for the normal wear items, then s for wear items, then this equipment ultimately cannot be maintained in functional order for the life of the facility.

a. *Rotary Screen*: The existing rotary grit screen is manufactured by Parkson Corporation. It is a Hycor RotoStrainer, Model RSA2548. (Contact Name: Venecia at telephone number (847) 837-4958). The main components of the strainer are manufactured of stainless steel. These primary components show little wear and the unit is expected to perform adequately into the future. The manufacturer has been contacted and indicated that the equipment is still supported. The manufacturer markets a repair kit that provides for replacement of all of the normal wear items in the unit. It is recommended that this unit be repaired accordingly per the manufacturer’s recommendations.

This unit is also supplied with an optional hot water wash. The wash system aids in the routine cleaning of the device but was never installed in the unit. It is recommended that the wash system be installed as part of the repair effort. This recommendation includes the installation of a water heater with sufficient capacity to provide warm wash water for the system.

b. *Sludge Dewatering / Screw Press*: Sludge dewatering system consists of a Somat Corporation, Som-a-Press screw press, Model P8-9D, Serial 7607-1. (Contact: SOMAT (800) 237-6628). The body of the press, the screen, and the screw itself are manufactured of stainless steel components. They show little wear and are deemed sufficient to meet the desired 20 year design life.

   Other types of equipment including belt presses and centrifuges are available for sludge dewatering. The existing screw press is believed to be the simplest and most cost effective unit to operate and maintain and it is familiar to the operator. Switching equipment has an additional disadvantage in that it would have to be fit and configured into the existing space along with other appurtenant equipment including the lime feeder and polymer feed system. This is likely to increase the installation cost by much more than the equipment costs alone.

   The manufacturer has been contacted to confirm that the equipment is still supported. A repair kit is available to replace all wear items in the unit. In addition to the repair kit, the manufacture recommends the replacement of speed control system. Speed control is currently accomplished mechanically via the installation or adjustments of pins in the drive system. The existing motor can be replaced with a variable frequency drive rated motor that will provide for speed adjustment via electrical controls. This is a much easier adjustment for the operator. It is recommended that the unit be repaired per manufacturer’s recommendations and fitted with a new motor to provide for electronic speed control.

c. *Lime Feeder*: The lime feeder was configured to be installed along with the existing screw press. The decision to keep and repair the screw press makes it advantageous to keep and maintain the existing lime feeder. The manufacturer has not been contacted. Discussion with the operator and a visual inspection of the machine indicate that it is sufficiently sound to remain in operation for the 20 year design life. Wear items (motors, belts, paddles) are not considered proprietary items and replacements should be readily easy to come by, even if not obtained directly from the manufacturer. It is recommended that this equipment be repaired as required.

3. Technical Obsolescence:

   Due to technical innovation and improvements in accuracy and efficiency of equipment, it may be prudent to replace certain equipment even though it may otherwise be fully functional within its original capabilities.

   a. *Polymer Feed System*: The sludge dewatering process requires the addition of a chemical polymer in order to facilitate the dewatering of sludge. If the polymer feed rate is not set correctly, sludge can pass through the system without being sufficiently dewatered. The existing polymer system has proven to be difficult to adjust and maintain target feed rates. The result is a wet sludge discharge that splatters when it lands in the collection vehicle located one floor below the dewatering process. Polymer feed technology has been improved since the installation of the existing system. New systems include more accurate feed pumps and instrumentation with electronic controls that provide for precise adjustment of the feed rate via the use of user friendly settings. It is recommended that the existing polymer feed system be completely replaced with a new skid mounted feed system.

4. Performance and Functionality:

   Some equipment in WWTP has failed to perform as intended in the original design and/or has simply failed to operate. Other equipment may operate as originally intended but is not adequate to support proposed revisions to the facility operating plan.

   a. *Doors and Windows*: Some doors in the facility have been deemed too narrow to support the operational movement off bins and hoppers through the facility. It is recommended that 2 existing 3’-0” door be replaced with 4’-0” doors.

      There are 3 slider-type aluminum windows in the clarifier room. They aluminum has some corrosion due to exposure to sea air. They are structurally sound but difficult to open. They are not designed to be easily opened and support ventilation of the space. It is recommended that these windows be replaced with roll-up type openings that can be rapidly raised to provide additional passive ventilation for the clarifier room.

   b. *Air Diffusers*: Settled sludge from primary clarifies is moved to a sludge storage tank from which sludge is process on a regular schedule (currently weekly). The storage tank is furnished with an aeration system to prevent the stored sludge from becoming anaerobic and developing odors. Septic sludge is also more difficult to dewater. Based on operator experience, the sludge holding tank is believed to be inadequately aerated. Individual diffusers are in good condition. It is speculated that that the number of and/or the design of the diffusers is not appropriate for sufficient distribution of air throughout the tank. It is recommended that the air system be re-evaluated as part of this effort and that additional diffusers are installed and/or all diffusers are replaced. For budgeting purposes, diffuser replacement has been assumed.

c. *Effluent Pumps*: Primary treated wastewater flows by gravity through an effluent basin and is discharged through an ocean outfall. The effluent basin is equipped with discharge pumps that can force treated wastewater through the outfall line in the event that there is insufficient gravity head to discharge instantaneous flow rates. This is only expected to occur in the event of peak high tides and peak wastewater flow rates into the WWTP. Without the pumps, wastewater could overflow from the effluent basin during these events.

   The current operator of the system is unaware of the effluent pumps having been needed during his tenure. Due to the lack of use, these pumps are non-functional. They are equipped with a rail system for removal of the pumps. However, they are locked onto the rails, likely due to corrosion, and cannot be cannot be removed from the basin.

   Though these pumps have not been needed in the past, they should not be abandoned. As growth in the community occurs incoming flow rates will increase and could exceed the discharge capacity of the outfall line under gravity conditions. It is recommended that the pumps be replaced with new high efficiency pumps and motors, along with new control systems. The control system should be equipped with an automatic exercise function such that the pumps are energized on a regular basis to prevent the freeze-up that has occurred due to lack of use.

6.0 Selected Alternatives

6.1 Grit Handling Facilities

Alternative 3, construction of a vacuum grit handling system is the proposed solution to the deficiencies in the existing grit handling process. This alternative is described in **Section 5.1A *Grit Handling Facilities***. It was selected based on the following considerations:

- This alternative eliminates the need for the operator to manually shovel screenings from collections and storage hoppers into smaller containers for transport to the haul vehicle.
- This alternative consolidates the discharge processes for sludge and grit to one location.
- This alternative sharply reduces the amount of labor and direct operator contact with the grit.
- This alternative is preferred by the community of Klawock. The options were discussed with Public Works Director Mr. Mike Petluska and City Administrator Mr. Leslie Isaacs on December 11, 2015 and the City favored the option to install machinery/conveyances inside the plant for the grit handling option.

7.0 Proposed Project (Recommended Alternative)

The proposed project consists of the scope items outlined in in **Section 3.3D *Delineated Repair and Renovation Scope***. Additional justification for the proposed renovation scope is provided in **Section 5.1B *Equipment Repair vs. Replacement***. The scope includes the recommended alternative for addressing deficiencies in existing grit handling facilities. The selected alternative is described in **Section 6.0 *Selected Alternatives***.

7.1 Preliminary Project Design

The community operates the wastewater treatment plant under an Environmental Protection Agency (EPA) 301(h) waiver that requires only primary treatment for the discharge of wastewater to the ocean outfalls. The discharge of treated wastewater from the facility is governed under an Alaska Pollutant Discharge Elimination System (APDES) general permit No. 2003-DB0096. A copy of the permit is available online at http://dec.alaska.gov/Applications/Water/WaterPermitSearch/Search.aspx.

The proposed project is a repair and renovation project. It will not change the wastewater treatment process. The project will repair and/or replace specific systems and components within the existing WWTP. The objective of the project is to ensure that all system are functional so that the plant can provide peak performance, consistently meet permit requirements, in order to improve operation and maintenance efficiency and to extend the design life of the facility for 20 years.

The estimated change in current O&M expenses associated with the proposed renovations are expected to be negligible. It is expected that the renovations will lessen the operation and maintenance labor burden and slightly reduce power consumption. However, a substantial reduction is not expected.

Conceptual design sketches illustrating proposed renovations were prepared based on existing record drawings for the plant. Existing facility record drawings with annotations illustrating the proposed scope of work are located in **Appendix E**. Concept sketches of the proposed grit dump station are included in **Appendix D**. Additional concept sketches are included in **Section 5** as part of the discussion of alternatives considered.

7.2 Constructability Issues

The primary constructability issue with the proposed scope of work regards the temporary bypass of the inlet screening facility while keeping the remainder of the WWTP operational. At one point it was speculated that significant temporary storage and pumping facilities might be required to accomplish the bypass. However, upon more detailed review, it has been determined that the bypass can be accomplish with relatively simple piping within the Sludge Pump Room on the first floor of the facility. The bypass could be installed as a temporary measure or as a permanent installation that would provide for future bypass simply by opening and closing a couple of valves.

Installation of the bypass line will require the temporary shut-down of the upstream pump station which discharges directly into the plant. The shut-down of the pump station will be required to ensure that the pumps are not energized while the plant inlet piping is disassembled to accommodate the temporary bypass piping. The pumping cycle of the lift station will need to be observed to determine the times of day with sufficiently long time between pumping cycles to accommodate bypass installation.

The proposed bypass line described above will bypass only the inlet screening facilities. All other treatment processes will be functional. Since the primary treatment processes will remain in operation, it may not be necessary to obtain prior approval from ADEC. However, it is recommended that the ADEC be provided a courtesy notice regardless of the permitting requirement.

All remaining scope items can be completed without interrupting the normal function of the WWTP unit processes.

7.3 Project Schedule

The following schedule is proposed assuming funding is made available by November 2014.

November 2016	Begin design
March 2017	Design complete
May 2017	Permitting complete
May 2017	Identify and schedule project equipment and personnel
June 2017	Order materials
August 2017	Mobilize equipment and materials to Klawock
September 2017	Construction start
January 2017	Construction finish
March 2017	Record drawings complete
May 2018	Final Approval to Operate*

*ADEC may require one year of operational data before granting final operational approval

7.4 Permit Requirements

- ADEC Approval to Construct
- ADEC – Certificate to Operate
- Alaska Pollutant Discharge Elimination System (APDES) discharge permit
- U.S. Fish and Wildlife Service (USFWS) Section 7 concurrence
- State Historic Preservation Office (SHPO) Section 106 concurrence

7.5 Sustainability Considerations

The selected alternative for grit handling is believed to be the simplest and most economical to operate and maintain over the life of the facility. Therefore, it is also expected to be the most sustainable solution.

Other scope items are repair and or replacement items. When completed, the facility should be returned to like-new condition. It is expected that the life of the facility will be extended for 20 years.

7.6 Total Project Cost Estimate

A third-party construction cost estimate has been prepared for this project and is attached to this report in **Appendix H**. The total estimated cost for this project is $1.98 million. This report has been updated due to the community's preference (section 6.1) for internal mechanical grit handling. It should be noted that the third party cost estimate in Appendix H was developed with an earlier preference for construction of an improved (external) screenings dump facility. The attached estimate contains over $75,000 for the external structure. The proposed vacuum grit handling system is estimated to cost approximately twice the estimate for the external structure, making the adjusted estimated project cost $2.05 Million.

7.7 Annual Operating Budget

7.7A <u>Income</u>

Klawock's 2014 budget estimates annual income for the Wastewater Department to be $194,955. This includes revenue from wastewater user fees of $167,990 and $26,965 from the general fund. Annual income of the wastewater utility is not expected to be impacted by this project.

7.7B <u>Debt Repayments</u>

The Klawock Wastewater Department reports debt service payments of $25,000 annually for payment on ADEC loans. Funding for this project is expected to be provided by a grant from the Indian Health Service Sanitation Facilities Construction Program. There will be no additional debt service associated with the grant.

7.7C <u>Annual O&M Costs</u>

Estimated annual O&M costs are about $194,955 including the aforementioned debt service. This includes $118,500 for labor, $20,000 for equipment repair, and $15,000 for utilities. It does not include an allowance for reserves. The completion of this project is not expected to have any significant impact on annual operating costs.

8.0 Conclusion and Recommendations

A new vacuum conveyance system has been determined to be the preferred alternative to address the deficiencies in the screenings collection and disposal process at the exiting Klawock WWTP. In addition, a comprehensive renovation scope has been developed consisting of various repair and/or replacement recommendations that will return the facility to like new condition and extend the design life for an additional 20 years. The implementation of these recommendations will improve the operational efficiency of the facility but they are not expected to have a substantial impact on current operation and maintenance costs. These recommendations can be implemented without noteworthy permitting, environmental, or constructability obstacles. The total estimated cost to construct all recommendations is $2.05 million.

9.0 Appendix

9.1 Appendix A: Project Location Map
9.2 Appendix B: Trip Report
9.3 Appendix C: Wastewater Treatment Plant Schematic
9.4 Appendix D: Conceptual Design Sketch of New Screenings Dump Station
9.5 Appendix E: Record Drawings with Scope Item Delineation
9.6 Appendix F: Project Photos
9.7 Appendix G: NEPA Environmental Review Draft
9.8 Appendix H: Third Party Cost Estimate

APPENDIX A

PROJECT LOCATION MAP

APPENDIX B

TRIP REPORTS

APPENDIX C

WASTEWATER TREATMENT PLANT SCHEMATIC

APPENDIX D

CONCEPTUAL DESIGN SKETCH OF NEW SCREENINGS DUMP STATION

APPENDIX E

RECORD DRAWINGS WITH SCOPE ITEM DELINEATION

APPENDIX F

PROJECT PHOTOS

APPENDIX G

DRAFT NEPA ENVIRONMENTAL REVIEW

APPENDIX H

THIRD PARTY COST ESTIMATE FOR SELECTED ALTERNATIVE