ENERGY AUDIT FINAL POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Alakanuk

For EECBG and Whole Village Grants

City of Alakanuk, Alaska

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EXECUTIVE SUMMARY

This Final Post Installation Report summarizes the results of an Ameresco Energy Audit of the City of Alakanuk, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Alakanuk is a recipient of an Alaska Energy Authority (AEA) Whole Village Energy Efficiency Retrofit audit of $400,000 as well as an Energy Efficiency and Conservation Block Grant (EECBG) of $62,400.

Ameresco engineers conducted an energy audit of the City of Alakanuk on October 20, 2010. The table below shows the buildings audited and their respective square footages.

City of Alakanuk - Building Summary		
Building	**Category**	**Square Footage**
City Hall	Public Building	1,250
Police Department	Public Building	1,200
Washeteria	Public Building	9,000
Water Treatment Plant	Public Facility	4,200
Alakanuk School	School	20,000

The audit identified existing types, conditions, operating modes, and energy consumption profiles for a variety of buildings, facilities and systems. The audit also identified all cost-effective system and facility modifications, adjustments, alterations, additions, and retrofits. Systems investigated during the audit included heating, ventilation, interior and exterior lighting, process exhaust, domestic hot water, motors, building envelopes, utility metering systems, and energy management control systems (EMCS).

The following tables show the results of Ameresco's audit and potential calculation savings, allocated by grant. See *Appendix A* and *Appendix B* for more detailed calculation results. Project costs include costs incurred from the site visit, engineering time, materials cost, and labor cost, as well as Ameresco's markup. It is important to note that the simple paybacks (SPBs) have been determined according to ECO type. For example, the SPB for an electrical ECO is calculated using only the annual kWh savings, even though the equivalent annual fuel gallon monetary savings is reported.

WHOLE VILLAGE/VEEP – PROJECT COSTS & EXPECTED SAVINGS – ALAKANUK					
ECO		**Cost**		**Savings**	**SPB**
B01 - WEATHER-STRIPPING UPGRADE	$	4,184.02	$	444.10	9.42
B02 - THERMAL INSULATION UPGRADE	$	23,794.32	$	303.92	78.29
B03 - ENERGY EFFICIENT WINDOW UPGRADE	$	45,435.15	$	440.30	103.19
B04 - ENERGY EFFICIENT DOOR UPGRADE	$	14,439.80	$	137.56	104.97
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	$	2,014.39	$	7,317.95	0.28
E01 - T8 LIGHTING UPGRADE	$	20,744.67	$	1,004.64	20.65
E02 - T5 LIGHTING UPGRADE	$	7,050.36		*N/A*	*N/A*
E03 - INSTALL OCCUPANCY SENSORS	$	4,773.19	$	1,677.39	2.85
E05 - CFL LIGHTING UPGRADE	$	2,855.41	$	245.99	11.61
E06 - LED LIGHTING UPGRADE	$	41,127.93	$	1,253.59	32.81
E07 - STREET LIGHTING UPGRADE	$	41,127.93	$	2,298.32	17.89
E08 - LED EXTERIOR LIGHTING UPGRADE	$	31,317.72	$	1,374.89	22.78
M02 - BOILER REBUILD	$	59,946.30	$	1,986.67	30.17
M03 - INDIRECT WATER HEATER UPGRADE	$	41,408.07	$	2,727.90	7.30**
M04 - DOMESTIC WATER HEATER UPGRADE	$	19,626.59	$	349.24	56.20
M05 - HEAT TRACE CONTROLS UPGRADE	$	29,400.19	$	690.35	42.59
AVAILABLE FUNDING	$	10,753.95			
** Available funding allocated to Kotlik.*					
*** SPB takes into account cost of required upgrade*					
GRANT TOTAL	**$**	**400,000.00**			
VILLAGE TOTAL	**$**	**389,246.05**	**$**	**22,252.83**	**16.53****

EECBG - PROJECT COSTS & EXPECTED SAVINGS - ALAKANUK					
ECO		**Cost**		**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$	2,437.08	$	110.25	22.11
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$	56,038.91	$	629.38	89.04
M01 - BOILER TUNE-UP	$	9,758.86	$	21,084.76	0.46
TOTAL PROJECT COST	**$**	**68,234.85**	**$**	**21,824.38**	**3.13**
TOTAL EECBG GRANT	**$**	**62,400.00**			
BUDGET EXCEEDED	**$**	**(5,834.85)**			

1.0 BUILDING DESCRIPTIONS

1.1 ALAKANUK WASHETERIA

Description: The Alakanuk Washeteria is a bit run down, but is still serving its purpose. The building itself is in good condition, but some of the equipment inside no long functions. The washeteria operates Thursdays through Sundays. At 8:00 pm, tokens are no longer available, and the sauna is turned off. Typically, 6 to 7 loads of laundry are done each day at the facility.

General Conditions: The building exterior is in good condition, but the interior is fair. Much of the laundry equipment has been poorly cared for, is run down, or is not functional. One of the bathrooms/saunas is currently being used for storage and is not operational. The boilers are also in poor condition, and one was not operational at the time of the audit.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The standing seam metal exterior of the building appears to be in good condition, with no cracks or major defects. The standing seam metal roof of the building also appears to be in good condition, but there is very little insulation in the ceiling. The aluminum doors are in good condition and appear to seal well. There are no exterior windows in the building.

Air Distribution: A PACE air handling unit (AHU) provides the building with 8612 cubic feet per minute (cfm) of air distribution. This unit is equipped with preheat and heating coils. At the time of the audit, the unit did not appear to be operational. One of the exhaust fan motors is currently missing a belt; it appears, however, that this is the exhaust fan for the men's bathroom and sauna, which is currently not operational.

Heating: Two Weil-McLain fuel oil model 86 boilers (sizes 786 and 886) provide heating to the building in conjunction with the PACE AHU. These boilers are discontinued models and were about 82% efficient at time of manufacture. The 786 model boiler was not operational at the time of the audit and needed many parts for repairs.

Controls: The building does not currently have a direct digital control (DDC) energy management control system (EMCS). Building zones are controlled by mechanical thermostats.

Lighting: Interior lighting consists primarily of T12 fluorescent lamps with magnetic ballasts. Several 75 watt and 100 watt incandescent fixtures are also used for interior light. Exterior lighting is provided by 100 watt high pressure sodium (HPS) fixtures.

Domestic Water: Ameresco engineers were unable to gather information on the domestic water heater(s) at the time of the audit. The faucet in the women’s bathroom and sauna is rated for 2.0 gallons per minute (gpm), but currently flows at 1.0 gpm. There are 3 showers that flow at 2.5 gpm, and there are 2 toilets that are 1.6 gallons per flush (gpf). The men’s room is identical to the women’s, but is not currently operational. Instead, the sauna-use rotates between men’s and women’s nights.

Laundry Equipment: The laundry equipment in the Alakanuk Washeteria is a mixture of several manufacturers, and the equipment ages vary considerably. There are a total of 5 Wascomat Senior washers, mostly Model W124. There are also two Bock Engineered Product (BEP, today North Star Engineered Products) laundry centrifuges from 1997. There are a total of 8 American Dryer Corp dryers in the facility of varying ages and models, but only 3 of these are currently functional. The functional dryers all date near 1992.

Building Photos: Alakanuk Washeteria

Wascomat Washers

American Dryer Corp Dryers

BEP Centrifuges

Dryer Tubing

Exhaust Fan Motor Missing Belt

Weil-McLain Boilers

1.2 ALAKANUK WATER TREATMENT PLANT

Description: The Alakanuk Water Treatment Plant handles all of the village's water conditioning. There is a single full time operator on site. The building is also houses the sewage treatment system for the village.

General Conditions: The facility as a whole is in good condition although there is some equipment that could be cleaned up or needs to be repaired. There are no obvious major structural defects. Interior spaces are comfortable. The boiler room of the building is in need of the most work. One section of the heat trace system is leaking badly and is in need of repair or replacement.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The structure of the facility appears to be in good condition with no major flaws. Weather-stripping for all exterior doors, including the large bay door, is in good condition. Windows are in good condition. The walls and ceiling of the warehouse/vehicle bay appear to be well insulated, and insulation is in good condition.

Heating: Two Weil-McLain Model 88 boilers provide the facility with heating. The boilers appear to be in good condition and are rated at 84% efficient.

Controls: Building zone heating is controlled by a series of mechanical thermostats placed throughout the building.

Lighting: Interior lighting fixtures are mostly T12 fluorescent with magnetic ballasts. There are a few small exterior wall pack HPS fixtures ranging from 50 to 100 watts.

Domestic Water: The water treatment plant houses many pumps and motors of varying ages and efficiencies. Opportunities exist here for more efficient replacements. According to the plant operator, usually only one of the smaller treated water pumps runs, but occasionally other pumps will kick on to carry the rest of the load.

Vacuum System: There are a total of 4 vacuum pumps (15 hp) between two AIRVAC systems at the water treatment plant. The upper level system handles the plant's treated water, while the sewage system is housed below. Vacuum sewage systems are installed in bush Alaska due to permafrost and lack of available pitch. The system originates at the treatment facility and is in good operational condition. The vacuum pump motor runs 24/7 to meet village requirements. A higher efficiency motor will result in measurable savings for this system.

Heat Trace: To prevent system freeze ups, hot water heat trace pumps that run throughout the water and sewer distribution system originate from this facility. The system is manually controlled and runs at all times or at operators' discretion. Limiting the operation of the heat trace based on outside air or ground temperatures will provide significant savings to the village. According to the plant operator, some of the heat trace pumps are running continuously. The system pumps hot water from the boilers through out the village water and sewer distribution system to minimize freeze ups in below freezing weather. When the outside temperatures are above freezing the system should be shut down. Automatically controlling the pumps to run only when temperatures drop in a range where freeze ups of the distribution system are possible will decrease overall energy usage by reducing pump operation as well as hot water generation

Building Photos: Alakanuk Water Treatment Plant

Treated Water Pump System

AIRVAC System – Treated Water

Weil-McLain Model 788 Boilers

Leaky Heat Trace System

Leaky Heat Trace System

Insulated Bay Door and Weather-stripping

1.3 ALAKANUK SCHOOL

Description: The Alakanuk School houses elementary through high school age students. The elementary and middle school students are in one wing of the building, while the high school classrooms are in the other wing near the gym/cafeteria and office area.

General Conditions: The building is in good condition and is probably the best maintained facility in the village. Structurally, the building appears to have no major defects, and the standing seam exterior and roof and in good condition. The HVAC and other mechanical equipment are in good condition and appear to be well-maintained.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The building appears to be structurally in good condition. The exterior shows some signs of weathering, but there are no major faults. Windows are a mixture of clear single-pane glass or plexi-glass and are in fair condition due to some scratches and cracks. Insulation appears sufficient in most places. Doors and weather-stripping are in good condition.

Heating: Two Burnham boilers work in conjunction with two Trane air handling units (AHUs) to heat the school. The boilers are fairly new and in good condition and are listed at 84.6% efficient. Each of the AHUs provides the school with 3000 cubic feet per minute (cfm) of air; these AHUs are in good condition as well.

Controls: Building zones are controlled by a series of mechanical thermostats.

Lighting: Interior lighting consists of mainly T12 fluorescent fixtures with magnetic ballasts, as well as a handful of incandescent fixtures.

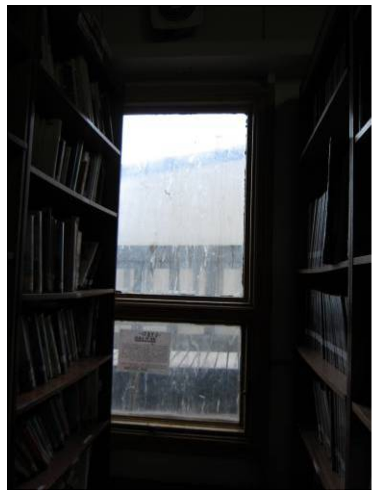
Domestic Water: An 80 gallon Amtrol Boilermate indirect-fired water heater supplies the building with heated domestic water. The water heater appears to be relatively new and in good condition.

Building Photos: Alakanuk School

Burnham Boilers

Trane Air Handling Unit (AHU-2)

Circulating Pumps



Typical Window

Amtrol Indirect-Fired Water Heater

Trane Air Handling Unit and Ductwork (AHU-1)

1.4 OTHER ALAKANUK BUILDINGS SURVEYED

City Hall: The Alakanuk City Hall building is in poor condition structurally. The exterior of the building has been damaged, and insulation is beginning to deteriorate or fall out. Many of the windows have been boarded up. Doors are in good condition, although they have poor weather-stripping. The roof appears to be in good condition. Interior lights are T12 fluorescent fixtures with magnetic ballasts. Interior spaces are in fair condition overall.

Housing Unit: The housing unit audited by Ameresco is in fair condition. Several of the windows have been boarded up, and the ones that remain are in fair condition due to cracks or other damage. Doors are in good condition, but their weather-stripping is in poor condition. A single room heater heats the building. Although the building appears to be unoccupied, Ameresco engineers found running water in the bathroom tub upon entering the building. Interior lighting consists of T12 fluorescent fixtures with magnetic ballasts.

Alakanuk Police Department: The Police Department building is in fair condition; the wood exterior is showing many signs of age and weathering, as is the standing seam metal roof. Several of the windows have been boarded up, usually due to broken glass. Some of the remaining double paned windows have cracked or broken glass. The hatch to the attic does not have any sort of cover, and the roof has no insulation. There is some insulation above the ceiling of the building, but there are still many opportunities for heat to escape through the attic and roof. A single electric room heater provides the building with heat.

Maintenance Shop: The Alakanuk maintenance facility is in good condition. The exterior standing seam siding and roof show little signs of weather or damage. Windows are in good condition. Doors are insulated and have adequate weather-stripping. Interior lights have been retrofit to T5 high bay fixtures. An Energy Logic waste oil burner heats the facility.

Building Photos: Other Alakanuk Buildings Surveyed

Exterior Damage to City Hall Building

Water Running in Vacant Housing Unit

Police Department – No Door to Attic Access

Police Department - Existing Attic Insulation

Oil Burner in Maintenance Shop

2.0 UTILITIES

2.1 ELECTRICITY

The City of Alakanuk purchases its electricity from the Alaskan Village Electric Cooperative (AVEC). Village facilities are billed on an electric use and fuel use to provide the electricity. Some facilities may also qualify for a Power Cost Equalization (PCE) incentive. The AVEC rates for the City of Alakanuk are listed below.

AVEC Cost of Fuel (Added to Customer Electric Bill)	$	0.2558
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$	0.5558
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$	0.4558
PCE Rate (1-700 kWh)	$	0.3392
PCE Rate (Over 700 kWh)	$	0.3119

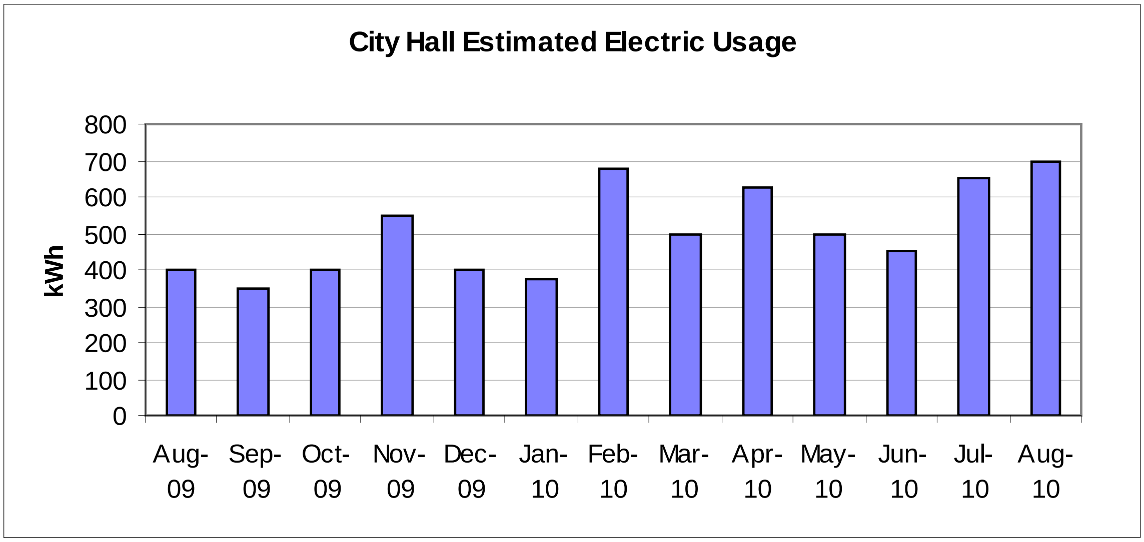
The following buildings currently receive PCE funding:

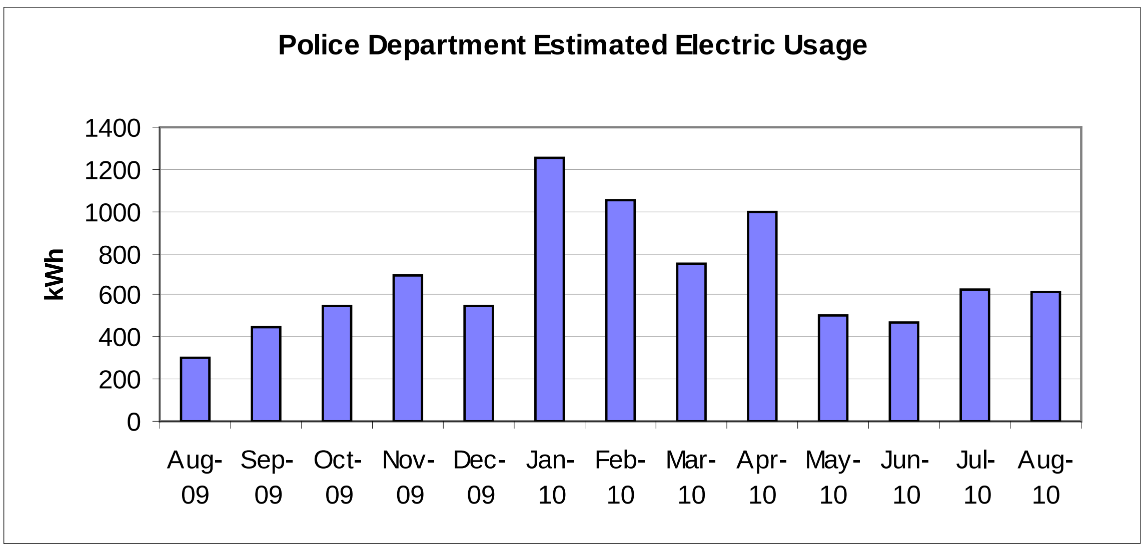
- Alakanuk City Hall
- Alakanuk Police Department
- Maintenance Shop
- Housing Unit
- Alakanuk Water Treatment Plant
- Alakanuk Washeteria

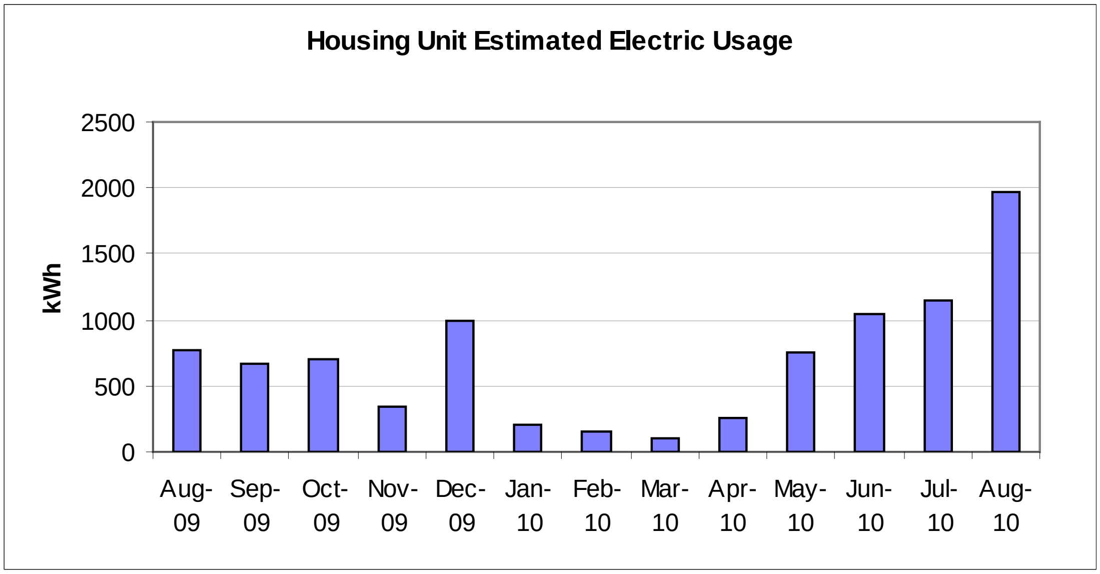
The Lower Yukon School District has its own agreement with AVEC and does not receive PCE funding. The AVEC rates for the Alakanuk School are listed below.

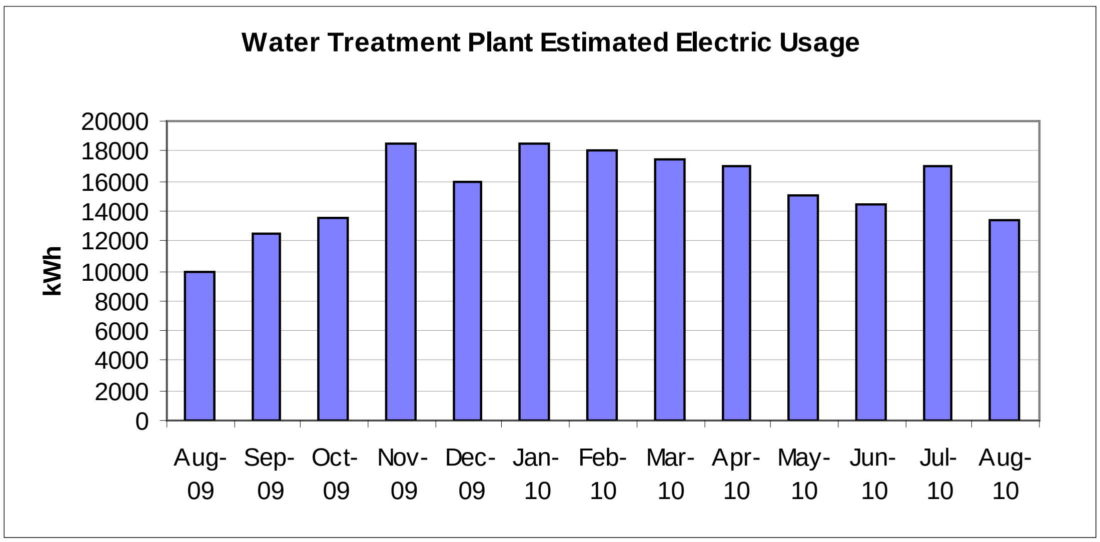
AVEC Average Cost of Fuel	$	0.22613
Rate Per kW	$	45.00
Rate Per kWh, Fuel Cost Included (1-1,500 kWh)	$	0.34613
Rate Per kWh, Fuel Cost Included (Over 1,500 kWh)	$	0.26613

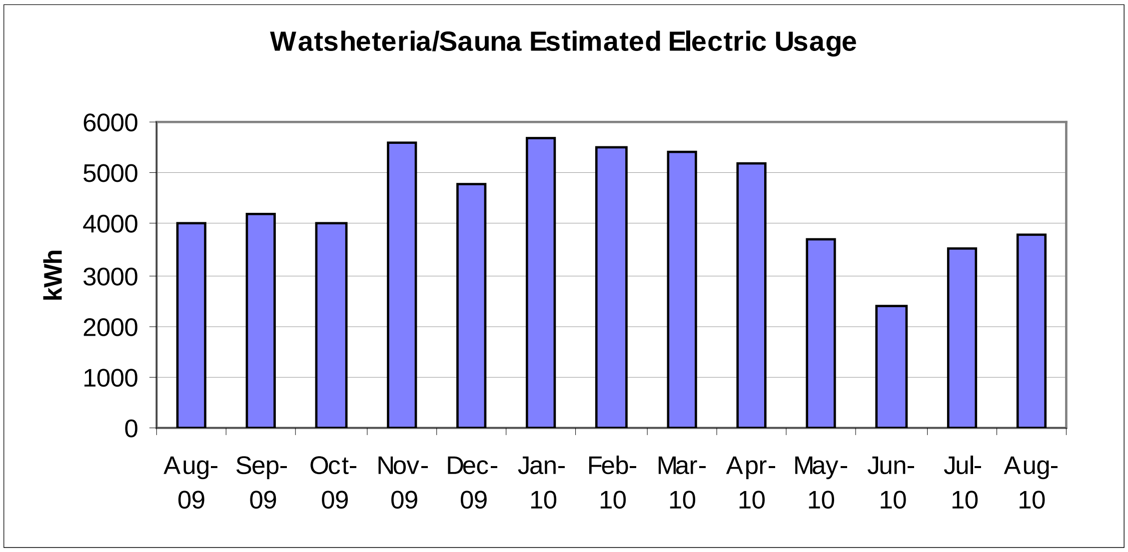
2.1.1 Electricity Usage Profiles

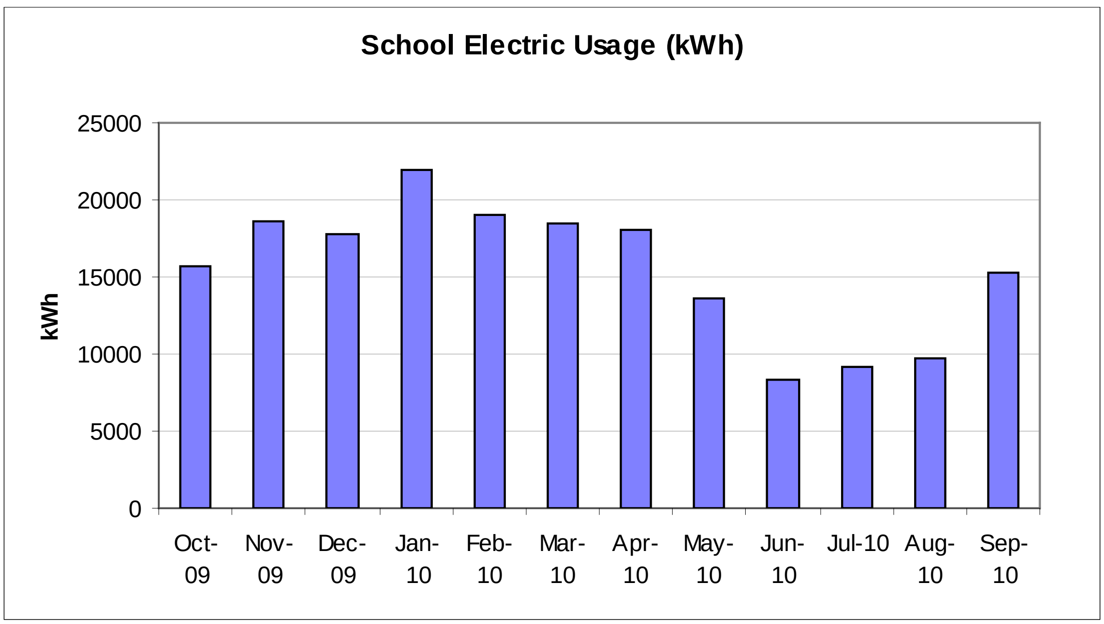


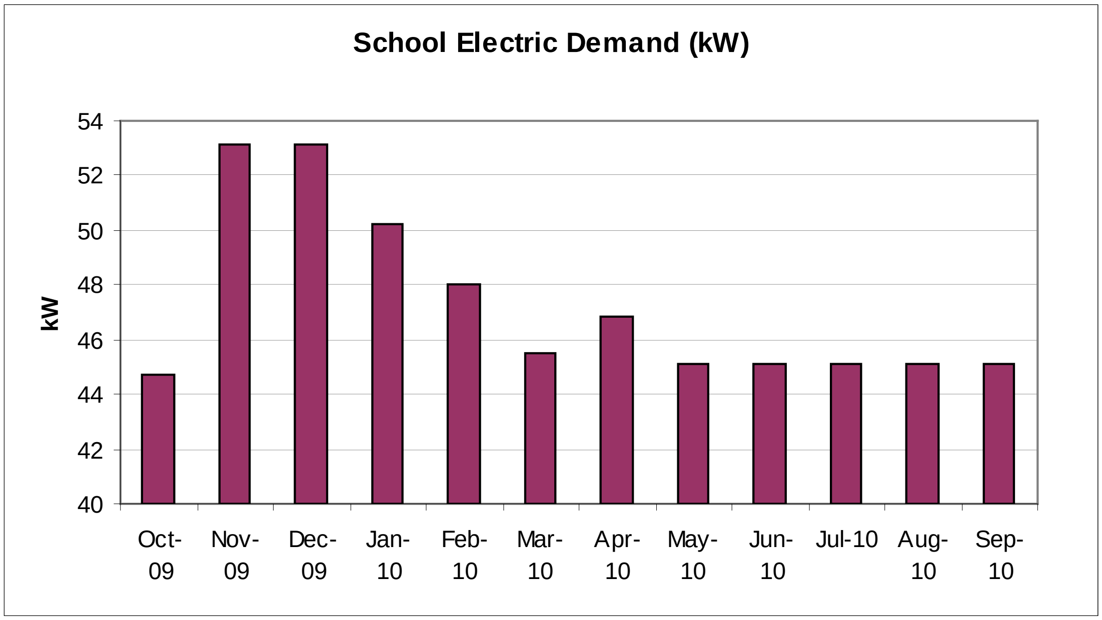



Housing Unit Estimated Electric Usage
kWh
2500
2000
1500
1000
500
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


Water Treatment Plant Estimated Electric Usage
kWh
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


Watsheteria/Sauna Estimated Electric Usage
kWh
6000
5000
4000
3000
2000
1000
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


School Electric Usage (kWh)
kWh
25000
20000
15000
10000
5000
0
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10



2.2 FUEL

The City of Alakanuk purchases its fuel from Ruby Marine, Inc. Ruby Marine provides diesel fuel to the city in two bulk shipments each year. The most current rate is listed below.

Diesel (October 2010)	$ 3.12

The Alakanuk School has its own fuel contract with Crowley Petroleum Distribution, Inc. The school purchases its fuel from Crowley at a rate of $2.9286/gallon.

3.0 OPERATIONS/MAINTENANCE PRACTICES

The village has a number of designated maintenance personnel that seem to possess the basic skills required to clean and maintain selected equipment. From Ameresco's observations, if the equipment should fall into disrepair, the staff does not have the skill to repair the equipment per the manufacturer's requirements and tends to piece together the equipment to maintain operation. Over time, the systems no longer function as required, which currently appears to be the case of most equipment and systems with in the village.

Operations and maintenance is one area in energy services where improvement and training costs are lower than equipment replacement costs, and the energy efficiency return is high. During the site audit, Ameresco found that outside of general cleaning, most of the equipment is not maintained to meet standard manufacturers' recommendations. Dirty filters, boilers in disrepair, systems altered, and control systems disconnected are a result of limited funding and lack of system training. This results in excessive energy use, premature equipment failure, and employee and resident discomfort. An annual system check by a qualified burner service technician to perform services such as boiler cleaning, boiler tune ups, system check out, and control system reviews will not only extend the overall life of the equipment, but improve occupant comfort as well as increase and maintain long term energy efficiency.

4.0 WHOLE VILLAGE AUDIT INITIATIVES - PROPOSED

Section 4 details opportunities for the City of Alakanuk's Whole Village Energy Efficiency Retrofit granted by the Alaska Energy Authority.

4.1 LIGHTING EXCHANGE PROGRAM

Ameresco proposes a lighting exchange program that will encompasses all village residences and buildings. Since the majority of fixtures at the residential level are incandescent, Ameresco proposes to send a pre-determined number of 7-watt LED lights to be exchanged for incandescent bulbs from village residences. This program, if instituted, will decrease energy usage and costs for lighting for all residences that take advantage of this program.

5.0 ENERGY CONSERVATION OPPORTUNITIES

The ECO matrix below summarizes the energy conservation opportunities identified and proposed during the site survey and baseline analysis. A description of each energy conservation opportunity follows the matrix. ***Please Note:*** This matrix applies to the initial proposal and the ECOs identified during that stage of the Alakanuk project. There are some ECOs included in this section that were not performed, or the scope of work may have changed. *Section 5* is for reference only. See *Section 6* for updated project information.

	ECO Description	ECO MATRIX					
		ALAKANUK					
ECO No.	B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	Washeteria	Water Treatment	School	City Hall	Police Department	Whole Village
Building Envelope							
B01	Door Weather-stripping Upgrade	X					
B02	Insulation Upgrade	X			X	X	
B03	Energy Efficient Window Upgrade			X			
B04	Energy Efficient Door Upgrade			X			
B05	Install Access Panel to Attic					X	
Controls							
C01	Thermostat Upgrade	X	X	X			
C02	System Flow Control		X				
Electrical							
E01	T-8 Lighting Upgrade	X	X	X	X	X	
E02	T-5 Lighting Upgrade			X			
E03	Occupancy Sensors	X	X	X	X	X	
E04	Premium Efficiency Motors		X				
E05	CFL Lighting Upgrade	X		X			
E06	Residential Lighting Upgrade						X
Mechanical							
M01	Boiler Tune-Up	X	X				
M02	Boiler Upgrade	X					

EECBG – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 1,570.00	$ 110.25	14.24
B05 - INSTALL ACCESS DOOR TO ATTIC	$ 700.00	$ 32.96	21.24
C02 - SYSTEM FLOW CONTROL	$ 5,460.00	$ 119.53	45.68
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 39,270.00	$ 1,798.22	21.84
M01 - BOILER TUNE-UP	$ 8,400.00	$ 27,908.77	0.30
DESIGN/AUDIT	$ 5,000.00	N/A	N/A
ADDITIONAL LABOR/INSTALL	$ 2,000.00	N/A	N/A
TOTAL	**$ 62,400.00**	**$ 29,969.72**	**2.08**

WHOLE VILLAGE – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
B02 - THERMAL INSULATION UPGRADE	$ 42,300.00	$ 1,131.72	37.38
B03 - ENERGY EFFICIENT WINDOW UPGRADE	$ 24,200.00	$ 340.97	70.97
B04 - ENERGY EFFICIENT DOOR UPGRADE	$ 45,000.00	$ 671.49	67.02
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	$ 800.00	$ 7,317.95	0.11
E01 - T8 LIGHTING UPGRADE	$ 115,000.00	$ 7,295.53	15.76
E02 - T5 LIGHTING UPGRADE	$ 23,000.00	$ 2,294.68	10.02
E03 - INSTALL OCCUPANCY SENSORS	$ 8,500.00	$ 8,921.43	0.95
E05 - CFL LIGHTING UPGRADE	$ 700.00	$ 286.34	2.44
E06 - LED LIGHTING UPGRADE	$ 21,000.00	$ 1,253.59	16.75
M02 - BOILER UPGRADE	$ 41,000.00	$ 3,061.67	13.39
DESIGN/AUDIT	$ 33,000.00	N/A	N/A
ADDITIONAL LABOR/INSTALL	$ 45,500.00		
TOTAL	**$ 400,000.00**	**$ 32,575.38**	**12.28**

5.1 ECO Descriptions - Proposed

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Alakanuk. These include Ameresco's initial project recommendations for the village.

5.1.1 Building Envelope Opportunities

B01 – Door Weather-stripping Upgrade

This ECO proposes applying weather stripping to exterior door perimeters to reduce air infiltration into the buildings. Many building doors have existing weather stripping material which is worn or missing.

B02 – Thermal Insulation Upgrade

This ECO proposes installing blown-in roof insulation on existing building envelopes to reduce energy consumption. Insulation can be added to roofs to increase or renew their insulating ratings (R-value).

B03 – Energy Efficient Windows

This ECO proposes installing new windows with improved heat transfer resistivity. This ECO would improve insulating values of the fenestration and reduce the negative energy effects of insolation.

B04 – Energy Efficient Doors

This ECO proposes installing new insulated doors. The installation would improve U-values of the current hollow metal doors, single pane glass doors, and un-insulated bay doors connected to conditioned spaces.

B05 – Install Access Panel to Attic

This ECO proposes installing an access panel to a building's attic. Without this access panel, building heating is allowed to escape into the attic and is wasted. An access panel to the attic would further insulate heated building spaces and reduce heating costs.

5.1.2 Controls Opportunities

C01 – Thermostat Upgrade

This ECO proposes replacing the outdated mechanical thermostats with 7-day programmable thermostats. The programmable thermostats would allow a building's HVAC system to be scheduled to operate in comfortable conditions while occupied and allow for night set-backs.

C03 – System Flow Control

This ECO proposes redesigning the system flow in various facilities to be more efficient. In Alakanuk, this ECO pertains to the Water Treatment Plant's heat trace system.

5.1.3 Electrical Opportunities

E01 – T8 Lighting Upgrade

This ECO proposes replacing current T-12 fluorescent lighting and magnetic ballast with T-8 lamps and electronic ballasts. Post-light levels will be nearly equal or better to that of the existing lighting systems,

E02 – T5 Lighting Upgrade

This ECO proposes replacing high intensity discharge (HID) lighting systems in the medium and high bay areas such as the water treatment plant, maintenance shops, school, etc., with T5 fluorescent fixtures. HID lighting is often used in areas with high ceilings or roof structures. The fixtures generate high luminous flux, are reasonably energy efficient, and are long lasting. Such systems often remain illuminated continuously since the re-strike times make periodic switching in irregularly occupied spaces a nuisance. Continuous operation of HID fixtures reduces the overall energy efficiency of lighting systems designed around their use. Newer, high output fluorescent sources, characterized by quick warm-up, with instant light output and improved efficiency, are now being used in place of many medium wattage HID fixtures in low and high bay applications. Post-light levels will be nearly equal to that of the existing lighting systems

E03 – Occupancy Sensors

Lighting systems are often left energized in unoccupied areas. This ECO proposes to install sensors to shut off lighting in unoccupied spaces. Common sensing technologies include infrared, ultrasonic, and audible sound, often combining multiple types of sensing in one unit to avoid shutting off lights in an occupied area.

E04 – Premium Efficiency Motors

This ECO proposes installing National Electrical Manufacturers Association (NEMA) premium efficiency motors to replace standard and high efficiency motors. There are various mechanical systems operating with inefficient motors throughout the base. Premium efficiency motors typically increase energy efficiency by 2-3%.

E05 – Residential Lighting Upgrade

See *Section 4.3.*

5.1.4 Mechanical Opportunities

M01 – Boiler Tune-Up

This ECO proposes a comprehensive re-commissioning of the boilers in each building to optimize system operations. Such efforts include:

- Replace, repair, calibrate or install sensors or switches
- Repair air linkages
- Conduct combustion efficiency test services
- Clean combustion chambers and stacks

M02 – Boiler Upgrade

This ECO proposes replacing existing hot-water heating boilers with more energy efficient units. Many of the existing units in the village are original to the buildings they serve and have reached the end of their useful service life. Boilers employing modern technology can be installed to reduce energy consumption, improve system operations, and reduce maintenance costs. In some cases, this ECO proposes adding a storage tank to replace a building's domestic water heater. See *M03* for details.

6.0 FINAL COSTING AND CHANGES FROM INITIAL REPORTING

Due to the brief nature of these contracts and the high cost of travel to and from the villages, audits were conducted a quickly and efficiently as possible. Once engineers have left the villages, communication is strained at best, and gathering additional information is difficult. Because of this, assumptions must be made during the initial ECO assessments and project cost estimates. Occasionally, Ameresco engineers have found that previously identified projects have been externally funded from another source, but this information usually comes too late in the process. As a result of all these factors, some previously identified projects have been modified or abandoned. Final project costs and expected annual savings can be found in *Appendix A* and *Appendix B.* ECOs that were categorized as "Not Funded," whether in the initial stages of the proposal or during construction, can be found in *Appendix C.*

6.1 CHANGES FROM INITIAL REPORTING – WHOLE VILLAGE/VEEP

IMPORTANT NOTE: After the audit and initial recommendations, Ameresco learned that a new Alakanuk School was scheduled to be constructed sometime in 2012. Upon receiving this news, all ECOs tagged for the school were removed, and the scope of work (SOW) was updated to reflect this. Details are explained below.

B01 – Weather-stripping

Newly added ECO. Installed as planned in the City Hall, Police Department, and Garage/Shop Building.

B02 – Thermal Insulation Upgrade

This ECO was thrown out at the Washeteria as the building was found to have a hot roof under closer examination. Completed as planned at the City Hall and Police Department.

B03 – Energy Efficient Window Upgrade

Installed in the City Hall and Police Station in lieu of the Alakanuk School.

B04 – Energy Efficient Door Upgrade

Installed in the City Hall and Police Station in lieu of the Alakanuk School.

C01 – Programmable Thermostat Upgrade

Installed as planned.

E01 – T8 Lighting Upgrade

Installed as planned in all buildings (City Hall, Police Station, and Washeteria) except for the Alakanuk School.

E02 – T5 Lighting Upgrade

This ECO was removed from the scope of Ameresco's project. Ameresco mobilized for construction before word was received that a T5 upgrade had been paid for by another grant. The lights were handed over to the Alaska Building Science Network per the request of the AEA.

E03 – Occupancy Sensors

Installed as planned in the City Hall, Police Station, Washeteria, and Water Treatment Plant. Not installed at the Alakanuk School.

E05 – CFL Upgrade

Installed as planned.

E06 – LED Lighting Upgrade

The Alaska Housing Craftsman Program successfully distributed 600 LED light bulbs during the Village Energy Efficiency Fair.

E07 – LED Street Lighting Upgrade

Installed as planned.

E08 – Exterior Lighting Upgrade

Installed as planned for 11 of 13 fixtures. The remaining 2 fixtures could not be installed due to code issues.

M02 – Boiler Rebuild

Newly added ECO. This ECO consisted of completely rebuilding the 2 existing boilers in the Alakanuk Washeteria and upgrading their existing burners.

M03 – Indirect Water Heater Upgrade

Newly added ECO. Installed in the Washeteria. **Note:** There is an additional savings in this ECO that affects the SPB calculation. The existing water heater failed its inspection and needed to be replaced no matter what. The cost of installation of a new water heat of the same make has been subtracted from the total project install cost to find the simple payback.

M04 – Domestic Water Heater Upgrade

Newly added ECO. Installed in the City Hall.

M05 – Heat Trace System Upgrade

Newly added ECO. Installed in the Washeteria and Water Treatment Plant. This ECO consisted of a control valve and valve actuator upgrade on the existing heat trace system. Several valves had failed, so operators were controlling the system flow manually by using the ball valves installed in the system intended for service and isolation. Because of this, the heat trace loops were overheating the domestic water and sewer lines for the village. The heat trace loops are now operating correctly and adjusted to provide the correct amount of system heat required for freeze prevention.

6.2 Changes from Initial Reporting – EECBG

B01 – Weather-stripping

Installed as planned.

B05 – Install Access Door to Attic

ECO removed from Ameresco’s scope of work. The access door was found and reinstalled after the initial audit.

C02 – System Flow Control

ECO removed from scope.

E04 – Premium Efficiency Motor Upgrade

Installed as planned.

M01 – Boiler Tune-Up

Completed as planned in the Water Treatment Plant.

6.3 Funding Allocation Summary Tables

WHOLE VILLAGE/VEEP – PROJECT COSTS & EXPECTED SAVINGS – ALAKANUK					
ECO		**Cost**		**Savings**	**SPB**
B01 - WEATHER-STRIPPING UPGRADE	$	4,184.02	$	444.10	9.42
B02 - THERMAL INSULATION UPGRADE	$	23,794.32	$	303.92	78.29
B03 - ENERGY EFFICIENT WINDOW UPGRADE	$	45,435.15	$	440.30	103.19
B04 - ENERGY EFFICIENT DOOR UPGRADE	$	14,439.80	$	137.56	104.97
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	$	2,014.39	$	7,317.95	0.28
E01 - T8 LIGHTING UPGRADE	$	20,744.67	$	1,004.64	20.65
E02 - T5 LIGHTING UPGRADE	$	7,050.36		*N/A*	*N/A*
E03 - INSTALL OCCUPANCY SENSORS	$	4,773.19	$	1,677.39	2.85
E05 - CFL LIGHTING UPGRADE	$	2,855.41	$	245.99	11.61
E06 - LED LIGHTING UPGRADE	$	41,127.93	$	1,253.59	32.81
E07 - STREET LIGHTING UPGRADE	$	41,127.93	$	2,298.32	17.89
E08 - LED EXTERIOR LIGHTING UPGRADE	$	31,317.72	$	1,374.89	22.78
M02 - BOILER REBUILD	$	59,946.30	$	1,986.67	30.17
M03 - INDIRECT WATER HEATER UPGRADE	$	41,408.07	$	2,727.90	7.30**
M04 - DOMESTIC WATER HEATER UPGRADE	$	19,626.59	$	349.24	56.20
M05 - HEAT TRACE CONTROLS UPGRADE	$	29,400.19	$	690.35	42.59
AVAILABLE FUNDING	$	10,753.95			
** Available funding allocated to Kotlik.*					
*** SPB takes into account cost of required upgrade*					
GRANT TOTAL	**$**	**400,000.00**			
VILLAGE TOTAL	**$**	**389,246.05**	**$**	**22,252.83**	**16.53****

EECBG - PROJECT COSTS & EXPECTED SAVINGS - ALAKANUK					
ECO		**Cost**		**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$	2,437.08	$	110.25	22.11
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$	56,038.91	$	629.38	89.04
M01 - BOILER TUNE-UP	$	9,758.86	$	21,084.76	0.46
TOTAL PROJECT COST	**$**	**68,234.85**	**$**	**21,824.38**	**3.13**
TOTAL EECBG GRANT	**$**	**62,400.00**			
BUDGET EXCEEDED	**$**	**(5,834.85)**			

APPENDIX A

WHOLE VILLAGE RETROFIT PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - WHOLE VILLAGE RETROFIT PROJECT COSTS & EXPECTED SAVINGS - ALAKANUK

Note: The reported simple paybacks are based on the type of ECO listed. For example, electrical ECOs only use the Annual kWh Cost Savings column to calculate the SPB, even though the Annual Equivalent Fuel Cost Savings is still reported.

B01 - WEATHER-STRIPPING UPGRADE

Building	# of Doors	Price Per Door	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
City Hall	1	$597.72	$597.72	0.00	2.99	2.99	21.34	$0.00	$66.58	8.98
Garage/Shop	2	$597.72	$1,195.43	0.00	6.02	6.02	42.98	$0.00	$134.11	8.91
Police Department	2	$597.72	$1,195.43	0.00	5.98	5.98	42.68	$0.00	$133.16	8.98
Washeteria	2	$597.72	$1,195.43	0.00	4.95	4.95	35.34	$0.00	$110.25	10.84

B02 - THERMAL INSULATION UPGRADE

Building	Current Insulation	Proposed Insulation	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
City Hall	R-20	R-38	$16,077.25	0.00	9.29	9.29	66.33	$0.00	$206.95	77.69
Police Department	R-5	R-38	$7,717.08	0.00	4.35	4.35	31.08	$0.00	$96.97	79.58

B03 - ENERGY EFFICIENT WINDOW UPGRADE

Building	# of Windows	Price Per Window	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
City Hall	5	$4,543.51	$22,717.57	0.00	15.92	15.92	113.74	$0.00	$354.86	64.02
Police Department	5	$4,543.51	$22,717.57	0.00	3.83	3.83	27.39	$0.00	$85.44	265.88

B04 - ENERGY EFFICIENT DOOR UPGRADE

Building	# of Doors	Price Per Door	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
City Hall	1	$7,219.90	$7,219.90	0.00	3.09	3.09	22.05	$0.00	$68.78	104.97
Police Department	1	$7,219.90	$7,219.90	0.00	3.09	3.09	22.05	$0.00	$68.78	104.97

C01 - PROGRAMMABLE THERMOSTAT UPGRADE

Building	# of Thermo-stats Installed	Cost Per Thermostat	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
Washeteria	1	$1,007.20	$1,007.20	0.00	75.20	75.20	537.15	$0.00	$1,573.11	0.64
Water Treatment	1	$1,007.20	$1,007.20	0.00	274.63	274.63	1,961.64	$0.00	$5,744.85	0.18

E01 - T8 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Washeteria	27	$227.96	$6,155.01	988.04	8.35	3.37	71.70	$214.01	$223.71	28.76
Water Treatment	36	$227.96	$8,206.68	2,833.38	16.68	9.67	205.62	$613.71	$641.52	13.37
City Hall	18	$227.96	$4,103.34	576.58	4.75	1.97	41.84	$124.89	$130.55	32.86
Police Department	10	$227.96	$2,279.63	240.24	2.64	0.82	17.43	$52.04	$54.39	43.81

E02 - T5 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
School	33	$213.65	$7,050.36	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

E03 - INSTALL OCCUPANCY SENSORS										
Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Washeteria	5	$277.03	$1,385.14	1,767.71	0.00	6.03	128.28	$382.89	$400.24	3.62
Water Treatment	5	$277.03	$1,385.14	5,194.43	0.00	17.73	376.95	$1,125.11	$1,176.10	1.23
City Hall	3	$277.03	$866.67	606.53	0.00	2.07	44.02	$131.37	$137.33	6.60
Police Department	4	$277.03	$1,136.24	175.50	0.00	0.60	12.74	$38.01	$39.74	29.89

E05 - CFL LIGHTING UPGRADE										
Building	# of Lamps to Change	Price Per Lamp	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Washeteria	20	$142.77	$2,855.41	1135.68	9.6	3.88	82.42	$245.99	$257.14	11.61

Note: The following table (E06) is a village-wide energy retrofit initiave. Therefore the savings reported in "Annual kWh Cost Savings" and "Annual Equivalent Fuel Cost Savings" are village-wide savings.

E06 - LED LIGHTING UPGRADE										
Number of Bulbs to be Exchanged	Typical Lamp Wattage (kW)	LED Wattage (kW)	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
600	60	7	$41,127.93	5,787.60	31.80	19.75	420.00	$1,253.59	$1,310.40	32.81

E07 - STREET LIGHTING UPGRADE										
Number of Fixtures for Retrofit	Existing Fixture	Retrofit Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
33	150W HPS	47W LED	$41,127.93	15,971.67	43.76	54.51	1,159.05	$2,298.32	3,616.23	17.89

E08 - LED EXTERIOR LIGHTING UPGRADE										
Number of Fixtures to be Exchanged	# of Lamps Changed	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	2	$2,847.07	$5,694.13	1,298.18	3.70	4.43	94.21	$281.19	$293.93	20.25
Garage/Shop	2	$2,847.07	$5,694.13	1,298.18	3.70	4.43	94.21	$281.19	$293.93	20.25
Water Treatment	5	$2,847.07	$14,235.33	2,453.06	6.98	8.37	178.02	$531.33	$555.41	26.79
Washeteria	2	$2,847.07	$5,694.13	1,298.18	3.70	4.43	94.21	$281.19	$293.93	20.25

M02 - BOILER REBUILD										
Building	# of Boilers to Replace	Increase in Efficiency	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
Washeteria	2	3.00%	$59,946.30	0.00	89.15	89.15	636.75	$0.00	$1,986.67	8.78

M03 - INDIRECT WATER HEATER UPGRADE										
Building	Number of Heaters	Increase in R-Value	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Replacement Water Heater Cost Savings*	Annual Fuel Cost Savings	Simple Payback
Washeteria	2	R-7 to R-16	$41,408.07	0.00	51.65	51.65	712.25	$21,482.00	$2,727.90	7.30

NOTE: This SPB calculation is different because there is a cost savings realized by the necessity of having to replace the existing water heater anyway.

**One-time project cost that affects the simple payback of the project.*

M04 - DOMESTIC WATER HEATER UPGRADE										
Building	**Number of Heaters**	**Special Note**	**Total Cost**	**Electric kWh Savings**	**Required mmBtu**	**New Fuel Gallons Required**	**Annual kWh Cost Savings**	**New Annual Fuel Cost**	**Total Cost Savings**	**Simple Payback**
City Hall	1	Electric to Oil	$19,626.59	2,285.70	5.72	46.74	$495.08	$145.84	$349.24	56.20

M05 - HEAT TRACE CONTROLS UPGRADE										
Building	**Number of Valves**	**Boiler Efficiency**	**Total Cost**	**Electric kWh Savings**	**Fuel mmBtu Savings**	**Total mmBtu Savings**	**Equivalent Fuel Gallons Savings**	**Annual kWh Cost Savings**	**Annual Fuel Cost Savings**	**Simple Payback**
Washeteria	3	82%	$14,700.09	0.00	13.23	13.23	110.63	$0.00	$345.18	42.59
Water Treatment	3	82%	$14,700.09	0.00	13.23	13.23	110.63	$0.00	$345.18	42.59

APPENDIX B

EECBG PROJECT COSTS & EXPECTED SAVINGS

APPENDIX B - EECBG PROJECT COSTS & EXPECTED SAVINGS - ALAKANUK

Note: The reported simple paybacks are based on the type of ECO listed. For example, electrical ECOs only use the Annual kWh Cost Savings column to calculate the SPB, even though the Annual Equivalent Fuel Cost Savings is still reported.

B01 - WEATHERSTRIPPING

Building	# of Doors	Price Per Door	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Washeteria	2	$1,218.54	$2,437.08	0.00	4.95	4.95	35.34	$0.00	$110.25	22.11

E04 - PREMIUM EFFICIENCY MOTORS UPGRADE

Building	# of Motors	Price Per Motor	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Treatment	7	Varies w/HP	$56,038.91	2,905.71	0.91	9.92	210.86	$629.38	$657.90	89.04

M01 - BOILER TUNE-UP

Building	Number of Boilers	Increase in Efficiency	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Treatment	2	3.00%	$9,758.86	0.00	946.11	946.11	6,757.94	$0.00	$21,084.76	0.46

APPENDIX C

EQUATIONS USED IN CALCULATIONS

APPENDIX C - EQUATIONS USED IN CALCULATIONS - ALAKANUK

ECO ***Equations***

B01 1. Door Leakage Area (in2) = Door Area x Door Leakage Factor

2. Specific Infiltration (CFM/in2) = [(Stack Coefficient x ΔT) + (Wind Coefficient x [Wind Speed]2)]1/2
3. ΔT = Heating Setpoint Temp - Bin Temp
4. Air Infiltration (CFM) = Specific Infiltration x Door Leakage Area
5. Heat Loss Rate (Btu/hr) = 1.08 x Air Infiltration x ΔT
6. Heating Load (mmBtu) = Heat Loss Rate x Bin Hours / 1,000,000
7. Energy Savings = Baseline - Proposed

Note: This ECO was completed using the RETscreen program.

B02 *Note: This ECO was completed using the RETscreen program.*
Inputs are R-values reported in the appendices as well as the insulation square footage.

B03 *Note: This ECO was completed using the eQuest program.*
Two building models were created and compared using pre- and post-install window upgrade data.

B04 *Note: This ECO was completed using the eQuest program.*
Two building models were created and compared using pre- and post-install door upgrade data.

B05 *Note: This ECO was completed using the RETscreen program.*
This calculation was completed by varying the air change rate (ac/h) in pre- and post-installation circumstances.

C01 *Note: This ECO is based on bin data, occupancy, heating peak loads, boiler efficiency, and an assumed night setback.*
Baseline Usage = (Peak Load x Occupied Load Profile x All Hours) / Boiler Eff.
ECM Usage = [(Peak Load x Occupied Load Profile x Occupied Hours)
+ (Peak Load x Unoccupied Load Profile x Unoccupied Hours)] / Boiler Eff.
mmBtu Saved = Baseline Usage - ECM Usage

C02 A conservative savings of 8% was assumed for these calculations.
Baseline Space Heating (MMBtu/yr) = (Energy End-Use) x (Building Area) / 1000
Energy End-Use from Tables 2A and 2B from Chapter 35 of 2003 ASHRAE Applications Handbook were utilized.
Only space heating was taken into consideration.
Space Heating Savings (MMBtu/yr) = (Baseline Space Heating) x [(Occupied Bin Hours)/(Total Bin Hours)] x (8% savings)

E01
1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E02
1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E03
1. Baseline Usage (kWh) = (Existing Fixture Wattage) x (Qty) x (Existing Hours) / (1,000)
2. Proposed Usage (kWh) = (Existing Fixture Wattage) x (Qty) x [(Existing Hours) - (Hours Reduced)] / (1,000)
3. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
4. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E04
1. Existing/Proposed Motor Demand (kW) = (Motor HP) x (Load Factor) x (0.746 kW/HP)/ Motor Efficiency
2. Existing/Proposed Motor Consumption (kWh) = (Motor Demand) x (Diversity Factor) x (Annual Hours)
3. kW Savings = [(Baseline kW) - (Proposed kW)] x (12 Months)
4. kWh Savings = (Baseline kWh) - (Proposed kWh)
5. Energy Cost Savings = Energy Savings (kW or kWh) x (Energy Unit Cost)

E05
1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E06 1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E07 1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E08 1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

M01 Savings (MBtu) = (Boiler Input Rating) x ((1/Tested Efficiency)-(1/Desired Efficiency)) x (Hours per Year)
Savings ($) = (MBtu Savings) x (Energy Cost)

M02 Savings (MBtu) = (Boiler Input Rating) x ((1/Old Boiler Efficiency)-(1/New Boiler Efficiency)) x (Hours per Year)
Savings ($) = (MBtu Savings) x (Energy Cost)

M03 *STANDBY LOSS SAVINGS*
Surface Area of Water Heater, A = 2*PI*r^2 + 2*PI*r*h
Heat Loss (Btu) = U x A x ΔT, where U is 1/R and ΔT
Standby Savings (Btu) = (Existing Standy Losses) - (Proposed Standby Losses)
Standby Cost Savings ($) = (Standby Savings) x (Energy Cost)
WATER HEATER UPGRADE SAVINGS
Annual Water Use = Σ((Appliance or Fixture gpm) x (Minutes of Use Per Use Per Year) x (# of Uses))
Annual Heating (Btu) = (Annual Water Use) x (8.33 lb/gal H20) x (Temp Rise ˚F) x (1 Btu/lb-˚F)
Heating Savings (Btu) = (Existing Annual Heating) - (New Annual Heating)
Note: Existing and New will be different due to the preheat addition with the indirect water heater.
TOTAL SAVINGS
Total Heating Savings (Btu) = (Standby Savings) + (Heating Savings)
Total Heating Cost Savings ($) = (Total Heating Savings) x (Energy Cost)

M04 Surface Area of Water Heater, A = 2*PI*r^2 + 2*PI*r*h
Heat Loss (Btu) = U x A x ΔT, where U is 1/R and ΔT
Standby Loss Savings = (Heat Loss) x (Energy Cost)
Annual Water Use = Σ((Fixture gpm) x (Minutes of Use Per Use Per Year) x (# of Uses))
Annual Heating (Btu) = (Annual Water Use) x (8.33 lb/gal H20) x (Temp Rise ˚F) x (1 Btu/lb-˚F)
Total Existing Heating, kWh = (Annual Heating + Standby Losses) / ((Old Heater Efficiency) x 3413 Btu/kWh)
kWh Cost ($) = Conversion x Energy Cost
Proposed Heating (Btu) = (Annual Heating) / (New Heater Efficiency)
Proposed Heating Cost = (Proposed Heating) x Energy Cost
Savings ($) = (kWh Cost) - (Proposed Heating Cost)

M05 Mass of Water (lbm/gal) = (Weight of Water, 8.33 lb/gallon) / (32.2 ft/s^2)
Mass Flow of Water, mdot (lbm/hr) = (Mass of Water) x (Water gpm) x (60min/hr)
Heat Transfer to Water (Btu/hr) = mdot x cp x Δt = mdot x (1 Btu/lb-˚F) x (Water Out - Water In, ˚F)
Annual Heat Transfer (Btu) = (Heat Transfer to Water) x (Annual Unnecessary Heating Hours)
Cost Savings = (Annual Heat Transfer) x (Energy Cost)

FOR C02

Tables 2A and 2B - 1995 Commercial Building Energy Consumption
2003 ASHRAE Applications Handbook, Chapter 35

	Energy End-Use (1,000 Btu/ft^2-yr)		
Building Characteristics	**Space Heat**	**Cool**	**Ventilation**
Education	32.8	4.8	1.6
Food sales	27.5	13.4	4.4
Food service	30.9	19.5	5.3
Health care	55.2	9.9	7.2
Lodging	22.7	8.1	1.7
Mercantile and service	30.6	5.8	2.5
Office	24.3	9.1	5.2
Public assembly	53.6	6.3	3.5
Public order and safety	27.8	6.1	2.3
Religious worship	23.7	1.9	0.9
Storage/Warehouse	15.7	0.9	0.3
Vacant	11.9	0.6	0.3

FOR E03 - Hours Reduced

From the Energy Management Handbook, Turner, 4th Edition Table 13.8 p361
Savings from installing occupancy sensors are as follows:

Offices (Private)	25-50%
Offices (Open Spaces)	20-25%
Rest Rooms	30-75%
Corridors	30-40%
Storage Areas	45-65%
Meeting Rooms	45-65%
Conference Rooms	45-65%
Warehouses	50-75%

FOR E04

Load factor assumed to be 80% except in some cases. Vacuum pumps assumed 100% load factor.
Diversity factor assumed to be 95%.

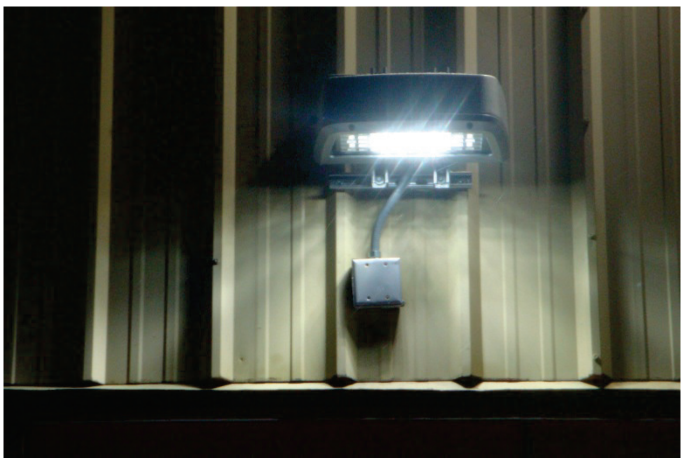
APPENDIX D

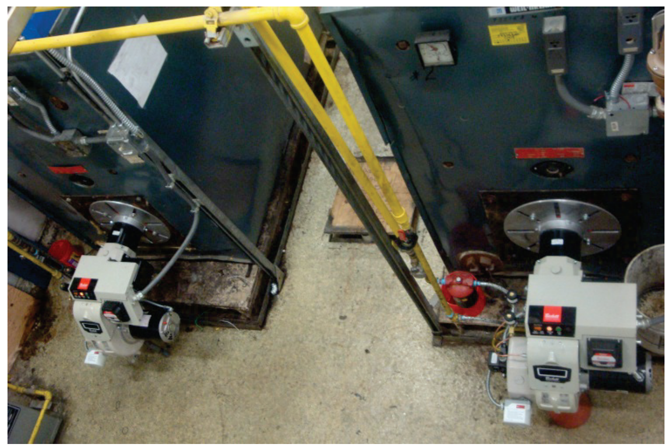
POST INSTALLATION PHOTOS

APPENDIX D – POST INSTALLATION PHOTOS - ALAKANUK


LED Lighting Exchange – Village Energy Efficiency Fair


LED Street Light Installation


Exterior Lighting Upgrade


Boiler Burner Control