ENERGY AUDIT FINAL POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Fort Yukon

For EECBG and VEEP Grants City of Fort Yukon, Alaska

July 17, 2012

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Prepared For: Alaska Energy Authority
City of Fort Yukon
## TABLE OF CONTENTS

**EXECUTIVE SUMMARY AND PREFACE** .................................................................................................................. 1

1.0 **BUILDING DESCRIPTIONS** ............................................................................................................................. 3
   1.1 **ADDIE SHEWFELT BUILDING** ..................................................................................................................... 3
   1.2 **FORT YUKON CITY HALL** ........................................................................................................................ 5
   1.3 **FORT YUKON POWER HOUSE** ................................................................................................................. 9
   1.4 **GWANDAK PUBLIC BROADCASTING AND COUNCIL OF ATHABASCAN TRIBAL GOVERNMENTS (CATG) BUILDING** ....................................................................................... 13
   1.5 **FORT YUKON TRIBAL HALL** ................................................................................................................... 16
   1.6 **OTHER BUILDINGS VISITED** ................................................................................................................... 18

2.0 **UTILITIES** ......................................................................................................................................................... 19
   2.1 **ELECTRICITY** ............................................................................................................................................... 19
      2.1.1 **Electricity Usage Profiles** .................................................................................................................. 19
   2.2 **FUEL** .......................................................................................................................................................... 21
      2.2.1 **Fuel Usage Profiles** ............................................................................................................................ 21

3.0 **OPERATIONS/MAINTENANCE PRACTICES** .................................................................................................... 23

4.0 **WHOLE VILLAGE AUDIT INITIATIVES** ......................................................................................................... 24
   4.1 **LIGHTING EXCHANGE PROGRAM** .......................................................................................................... 24
   4.2 **STREET LIGHTING UPGRADE** .................................................................................................................. 24

5.0 **ENERGY CONSERVATION OPPORTUNITIES** .................................................................................................. 25
   5.1 **ECO DESCRIPTIONS** ................................................................................................................................... 26
      5.1.1 **Building Envelope Opportunities** ..................................................................................................... 26
      5.1.2 **Controls Opportunities** .................................................................................................................... 27
      5.1.3 **Electrical Opportunities** ................................................................................................................... 27
      5.1.4 **Mechanical Opportunities** ................................................................................................................. 27
      5.1.5 **Renewable Opportunities** .................................................................................................................. 28

6.0 **FINAL COSTING AND CHANGES FROM INITIAL REPORTING** ................................................................. 29
   6.1 **GRANT CHANGES FROM INITIAL REPORTING** ....................................................................................... 29
   6.2 **ECO CHANGES FROM INITIAL REPORTING** ........................................................................................... 29
   6.2.1 **FUNDING ALLOCATION SUMMARY TABLES** .................................................................................... 31
APPENDICES

APPENDIX A – VEEP & WHOLE VILLAGE PROJECT COSTS & EXPECTED SAVINGS….. A-1
APPENDIX B – EECBG PROJECT COSTS & EXPECTED SAVINGS ........................................ B-1
APPENDIX C – ECO CALCULATION RESULTS – NOT FUNDED ......................................... C-1
APPENDIX D – EQUATIONS USED IN CALCULATIONS ...................................................... D-1
APPENDIX E – POST INSTALLATION PHOTOS ................................................................... E-1
EXECUTIVE SUMMARY AND PREFACE

This Final Post Installation Report summarizes the results of an Ameresco Energy Audit of the Village of Fort Yukon, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Fort Yukon is a recipient of an Alaska Energy Authority (AEA) Whole Village Energy Efficient Retrofit of $400,000 as well as an Energy Efficiency and Conservation Block Grant (EECBG) of $33,700.

Ameresco engineers conducted an energy audit of the City of Fort Yukon on December 29-30, 2010. The table below shows the buildings audited and their respective square footages.

<table>
<thead>
<tr>
<th>Building</th>
<th>Category</th>
<th>Square Footage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addie Shewfelt</td>
<td>Public Building</td>
<td>2,059</td>
</tr>
<tr>
<td>City Hall</td>
<td>Public Building</td>
<td>3,120</td>
</tr>
<tr>
<td>Power House</td>
<td>Public Facility</td>
<td>5,076</td>
</tr>
<tr>
<td>Gwandak Public Broadcasting and CATG</td>
<td>Public Building</td>
<td>2,188</td>
</tr>
<tr>
<td>Tribal Hall</td>
<td>Public Building</td>
<td>4,740</td>
</tr>
<tr>
<td>Richard C Carroll Community Center</td>
<td>Public Building</td>
<td>1,800</td>
</tr>
<tr>
<td>Tribal Office</td>
<td>Public Building</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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 table below shows 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.

<table>
<thead>
<tr>
<th>WHOLE VILLAGE/VEEP ECOS – FORT YUKON</th>
<th>ECO</th>
<th>Cost</th>
<th>Savings</th>
<th>SPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>B01 - WEATHERSTRIPPING</td>
<td>$2,368.57</td>
<td>$161.55</td>
<td>14.66</td>
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</tr>
<tr>
<td>B02 - THERMAL INSULATION UPGRADE</td>
<td>$61,270.98</td>
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<tr>
<td>B03 - NEW MAINTENANCE BAY DOORS</td>
<td>$119,350.09</td>
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<td></td>
</tr>
<tr>
<td>E01 - STREET LIGHTING UPGRADE</td>
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<td>$31,978.39</td>
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<tr>
<td>E02 - INSTALL OCCUPANCY SENSORS</td>
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<td>N/A</td>
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<tr>
<td>E03 - LED LIGHTING UPGRADE</td>
<td>$23,876.30</td>
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<tr>
<td>M01 - FURNACE UPGRADE</td>
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<tr>
<td>M02 - DOMESTIC WATER HEATER UPGRADE</td>
<td>$43,702.56</td>
<td>$2,173.68</td>
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<tr>
<td>AVAILABLE FUNDING</td>
<td>$ 5,455.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Available funding allocated to Kotlik</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL GRANT</td>
<td>$ 400,000.00</td>
<td></td>
<td></td>
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<tr>
<td>FORT YUKON PROJECT TOTAL</td>
<td>$ 394,544.87</td>
<td>$52,368.83</td>
<td>7.53</td>
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<table>
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<tr>
<th>EECBG - PROJECT COSTS &amp; EXPECTED SAVINGS - FORT YUKON</th>
<th>ECO</th>
<th>Cost</th>
<th>Savings</th>
<th>SPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>B01 - WEATHERSTRIPPING</td>
<td>$13,036.96</td>
<td>$4,409.70</td>
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<tr>
<td>C01 - PROGRAMMABLE THERMOSTAT UPGRADE</td>
<td>$ 1,680.23</td>
<td>$ 2,519.13</td>
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<tr>
<td>E02 - INSTALL OCCUPANCY SENSORS</td>
<td>$ 9,690.23</td>
<td>$ 2,248.06</td>
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<td>E04 - INSTALL NEW AIR COMPRESSOR SYSTEM</td>
<td>$ 9,065.38</td>
<td>$ 1,737.17</td>
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<tr>
<td>AVAILABLE FUNDING</td>
<td>$ 227.20</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>* Available funding allocated to Kotlik</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL GRANT</td>
<td>$ 33,700.00</td>
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</tr>
<tr>
<td>FORT YUKON PROJECT TOTAL</td>
<td>$ 33,472.80</td>
<td>$10,914.06</td>
<td>3.07</td>
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</tbody>
</table>
1.0 BUILDING DESCRIPTIONS

1.1 ADDIE SHEWFELT BUILDING

Description: The Addie Shewfelt Building functions as a youth center for the city of Fort Yukon. The building is open 7 days a week from 1600 to 2000 hours.

General Conditions: The building was constructed in 1974, but is holding up relatively well for its age. The building also has a photovoltaic system with solar panels on the roof. At the time of the audit, these panels were snow-covered and could not be closely inspected. These panels appear to be connected to the main electrical panel and the domestic hot water system, but no batteries were found at the time of the audit.

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

Building Envelope: The building is in good condition overall, although the exterior is showing signs of weathering and age. There is no evidence of this facility being overheated as seen by the condition of the metal roof. Many of the windows have been boarded up with plywood to prevent break-ins because the building is closed for the majority of the day. There are four exterior doors, but three have been sealed to control the building traffic. Interior surfaces are in fair condition; a few drop tiles have been removed, as well as a few plastic floor tiles. The biggest concerns for the condition of the building envelope are several penetrations that have been covered by fiberglass insulation only and are leaking cold air into the building.

Heating: Two Monitor oil stoves provide the building with space heating, models 441 and 442. At the time of the audit, one of the oil heaters had been shut down for an unknown reason.

Controls: There are no additional building controls.
**Lighting:** Interior lighting consists primarily of T8 fluorescent lamps with electronic ballasts as well as several CFL fixtures.

**Domestic Water:** The building water pipes are currently not connected to a heat trace system. Because of this, the pipes freeze and remain frozen during the colder months in Fort Yukon. This was the case at the time of the audit. Also because of this, water to the building is turned off once the pipes freeze, and the domestic water heater is turned off as well. This water heater is a General Electric 38 gallon electric water heater.
1.2 **Fort Yukon City Hall**

**Description:** The City Hall building in Fort Yukon is a multi-functional building that is divided into two sections. The first building section is the Fort Yukon City Hall. The second section consists of the Garage, Police Department, and Washeteria. Construction on the building was finished in 1981. Building operational hours are 0800 to 1700, Monday through Friday.

![Fort Yukon City Hall](image)

**General Conditions:** The building is in good condition overall, with no major faults or defects. At the time of the audit, the heating system was not fully functional, leaving only one working furnace.

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

**Building Envelope:** The structure appears to be in good condition overall with no noticeable concerns. The roof is in good condition, as are the exterior windows and doors. The walls are in good condition, though there is a cosmetic flaw in one of the exterior walls.

**Heating:** There are a total of 4 fuel oil furnaces that provide the building with space heating. Two Luxaire 126 MBH oil furnaces provide the City Hall area of the building with space heating. At the time of the audit, only one of these furnaces was operational and was running at 73.2% combustion efficiency. Both of these furnaces are old and run down, and two new replacements have already been ordered by the City. Two more warm air furnaces are housed in the Garage section of the building and provide heat to the Garage, Police Station, and Washeteria. A combustion analysis showed these two furnaces to be functioning at 70.3% and 70.9% combustion efficiency at the time of the audit.

**Controls:** Building heating is controlled by mechanical thermostats. Two mechanical thermostats control the zones of the City Hall section of the building. The thermostat controls for the two zones, however, are placed next to each other in one central location in the City Clerk’s office. One mechanical thermostat located in the Garage section of the building controls both furnaces that heat the Garage, Police Station, and Washeteria. Programmable thermostats have been ordered to replace the mechanical thermostats that serve the City Office portion of the building.
**Lighting:** Interior lighting fixtures are mostly T8 fluorescent with electronic ballasts.

**Domestic Water:** A 32 gallon Bock fuel oil fired domestic water heater provides hot water to the building. This size domestic water heater is a residential model with an energy factor of 0.63 and a recovery efficiency of 85%. Occupants state that this current water heater does not have enough capacity to serve washers and bathroom fixtures.
Building Photos: Fort Yukon City Hall

- Minor Damage to Exterior Façade
- Exterior Lighting Fixture
- Defunct Furnace
- Side-By-Side Zone Controls
- Bock Domestic Water Heater
- Attic Insulation
Building Photos: Fort Yukon City Hall

Washeteria Area

Garage Lighting System

Heating System in Garage
1.3 **Fort Yukon Power House**

**Description:** The Fort Yukon Power House building contains the village’s generators and serves as a maintenance storage facility. The building was first constructed in the 1940’s and has been patched and augmented over the years. It was originally owned by a private company, which then sold the facility to the city. Typical operating hours are 0800 to 1700, Monday through Friday, though the operator is on call during non-working hours.

![Picture of Fort Yukon Power House]

**General Conditions:** Overall, the building is in poor condition due to age and weathering. Many parts of the building are falling apart and are in desperate need of repair. This building is not charged for electric use, so any monetary savings will come from fuel use reduction. The operator believes that his load has grown considerably faster than the other villages over the years and most likely will continue to do so. Since the time of the audit, Ameresco has been informed that a renovation project has already been planned for this facility. No ECOs have been identified for this building because of this.

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

**Building Envelope:** The building is in extremely poor condition. The roof has a plethora of holes through which the sky is visible. There is no insulation either, so when the excess generator heat escapes, this causes the snow to melt and ice to form around the perimeter of the building and create a safety hazard. The walls are in poor condition and have many holes as well. Windows are in poor condition, and many of the single pane fixtures are broken. Exterior door weather-stripping has deteriorated to the point that it no longer functional.

**Heating:** When the temperature drops, extra heating is provided by electric and hydronic unit heaters. If the building were repaired and insulated more adequately, the waste heat from the generators could be captured and used to heat the facility.

**Controls:** Three mechanical thermostats control space heating to the building. One thermostat controls heating to the workshop, while the other two control heating to the garage area.
**Lighting:** Interior lighting is primarily T8 fluorescent with electronic ballasts as well as several CFL fixtures. There are no occupancy sensors or lighting timers.

**Domestic Water:** There is not a domestic water system at the Fort Yukon Power House.

**Power Equipment and Loading:** The Power House holds 4 Caterpillar diesel generators ranging from 500 to 700 kW. These generators are in fair condition, and all 4 were operational at the time of the audit, though only 2 were running. At the time of the audit, Generators 1 and 4 carried no load, Generator 2 had a 290 kW load, and Generator 3 had a 209 kW load. A new generator was being housed in the garage as well. The operator informed Ameresco engineers that one of the older generators will be replaced with this new 445 kW generator, even though it cannot carry as large of a load as the 700 kW generator.
Building Photos: Fort Yukon Power House

Power Lines

Ice Melting From Generator Heat

Electric Unit Heater

Hydronic Unit Heater

Generator Panels

Dilapidated Door
Building Photos: Fort Yukon Power House

- Non-insulated Penetrations
- Gaps in Structure to Outside Conditions
- Deteriorating Insulation
- Lighting System
- New Generator
1.4 **GWANDAK PUBLIC BROADCASTING AND COUNCIL OF ATHABASCAN TRIBAL GOVERNMENTS (CATG) BUILDING**

**Description:** The Gwandak Public Broadcasting building is a multi-functional building that also houses the Council of Athabascan Tribal Governments (CATG). The CATG section is on the ground floor and is used by the city as an income property. The radio station is housed on the upper level of the building. Typical operating hours for the radio station are 0800 to 1900, seven days a week.

![Building Image](image.jpg)

**General Conditions:** The building is an old building and is in relatively poor condition. A single mechanical thermostat controls building heating to both the radio station and the CATG section. There is an equipment room on the top floor of the building that remains warm because of all the transmitters and broadcasting equipment. A window is kept open to keep this room cool because the thermostat is located downstairs.

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

**Building Envelope:** The building is in poor condition due to weathering and its age. The roof is in poor condition and has a large patch to keep water from leaking in, but the patch is no longer effective. One area of the roof is leaking water near the electrical board, which raises a safety concern. Walls are in fair condition. Most of the windows are in good condition, but one needs to be resealed. Weather-stripping is in poor condition and is no longer adequate.

**Heating:** A recently replaced Lennox furnace provides the building with space heating. A combustion analysis showed this furnace to be operating at 81.2% combustion efficiency at the time of the audit. There are also several electrical heaters scattered around that tenants and employees use when the temperature drops. Occupants most often use these extra heaters when the temperature drops below zero. Several penetrations remain in the furnace room that have not been adequately insulated and still allow warm air to escape the building.
**Controls:** One mechanical thermostat controls heating to the whole building.

**Lighting:** The building is primarily lit by T8 fluorescent fixtures with electronic ballasts as well as several CFL fixtures.

**Domestic Water:** A 30-gallon American water heater provides the building with domestic hot water.
Building Photos: Gwandak Broadcasting

Exterior Windows in Good Condition

Patched Roof

Lennox Furnace

Sealed Penetration

Thermostat for Entire Building

Electric Heater
1.5 **Fort Yukon Tribal Hall**

**Description:** The Fort Yukon Tribal Hall was originally constructed in 1982 and is the main meeting area for many of the villagers. This building is where major ceremonies are held such as weddings, traditional dances, and funerals.

![Fort Yukon Tribal Hall](image)

**General Conditions:** The log cabin-style building is in good condition overall, except for two penetrations through the rear wall. No major faults or defects were found during the audit walkthrough.

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

**Building Envelope:** The structure is in good condition overall. The exterior and interior walls are also in good condition. The roof is in good condition and shows no signs of damage or poor insulation. Windows are in fair condition; several are broken and others have been boarded up for unknown reasons. Weather-stripping is in poor condition and needs to be replaced. Doors are in fair condition and could be upgraded.

**Heating:** Two Monitor-2400 fuel oil forced air heaters as well as a wood-burning heater supply the building with space heating.

**Controls:** There are no separate building controls.

**Lighting:** The building is primarily lit by T8 fluorescent fixtures with electronic ballasts.

**Domestic Water:** There is not a domestic water heating system in the Tribal Hall.
Building Photos: Fort Yukon Tribal Hall

Wood Stove Vent and Storage Tank

Partially-Boarded Window

Sealed Penetrations

Non-Weather-stripped Door

Wood-Burning Stove

Monitor-2400 Fuel Oil Heater
1.5 **Other Buildings Visited**

**Richard C Carroll Community Hall:** At the time of the audit, the Richard C Carroll Community Hall had been shut down by the city to save money. The building appears to be in good condition overall, without any major faults or defects. Ameresco engineers could not fully assess the condition of the mechanical equipment at this facility because it is no longer operational. Lighting is provided by T8 fluorescent fixtures with electronic ballasts.

![Richard C Carroll Community Hall](image)

**Tribal Council Office:** The Tribal Office is a separate building from the Tribal Council and is in good condition overall. The building is well kept up, but the domestic water heater at this facility is outdated and uses a great deal of electricity.

![Tribal Council Office](image)
2.0 UTILITIES

2.1 ELECTRICITY

The City of Fort Yukon produces its own electricity via the Gwitchyaa Zhee Utility Company.

Utility Fuel Charge Per kWh $0.1900
Rate Per kWh, Fuel Cost Included $0.6034
State Assistance Rate Per kWh $0.3211

The Fort Yukon City Hall is the only building audited to receive state assistance at this time. The street lighting bill, however, receives state assistance as well.

2.1.1 Electricity Usage Profiles

Note: The City Shop is the Garage section of the Fort Yukon City Hall building.
2.2 Fuel

The City of Fort Yukon purchases its fuel from Crowley Petroleum Distribution, Inc. The majority of City buildings paid an average of $4.449/gallon in 2010. The Gwandak Public Broadcasting building has a separate account and paid an average of $5.074/gallon in 2010.

2.2.1 Fuel Usage Profiles
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 training or experience 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 within 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

Section 4 details opportunities for the City of Fort Yukon’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 buildings. Since there are a large number of existing incandescent fixtures, Ameresco proposes to send a pre-determined number of 7-watt LED lights to be exchanged for incandescent bulbs from village buildings. This program, if instituted, will decrease energy usage and costs for lighting for all buildings that take advantage of this program.

4.2 STREET LIGHTING UPGRADE

This ECO proposes replaced the existing 150W high pressure sodium (HPS) fixtures with 40W LED fixtures. The City of Fort Yukon has 110 street light fixtures, and this retrofit will lower nighttime demand and electricity consumption considerably.
5.0 ENERGY CONSERVATION OPPORTUNITIES

The ECO matrix below summarizes the energy conservation opportunities identified during the site survey and baseline analysis. A description of each energy conservation opportunity follows the matrix. It is important to note the matrix below does not display Ameresco’s recommendations, but only the opportunities analyzed. For Ameresco’s implementation recommendations, see the funding table in the Executive Summary.

<table>
<thead>
<tr>
<th>ECO No.</th>
<th>ECO Description</th>
<th>ECO MATRIX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable</td>
<td>FORT YUKON</td>
</tr>
<tr>
<td>Building Envelope</td>
<td>Addie Shewfelt</td>
<td>City Hall</td>
</tr>
<tr>
<td>B01</td>
<td>Door Weather-stripping Upgrade</td>
<td>X</td>
</tr>
<tr>
<td>B02</td>
<td>Insulation Upgrade</td>
<td>X</td>
</tr>
<tr>
<td>B03</td>
<td>Install New Maintenance Bay Doors</td>
<td>X</td>
</tr>
<tr>
<td>Controls</td>
<td>Thermostat Upgrade</td>
<td>X</td>
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<tr>
<td>Electrical</td>
<td>Street Lighting Upgrade</td>
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<tr>
<td>E02</td>
<td>Occupancy Sensors</td>
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<tr>
<td>E03</td>
<td>Residential Lighting Upgrade</td>
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<tr>
<td>E04</td>
<td>Install New Air Compressor System</td>
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<td>Mechanical</td>
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<td>M02</td>
<td>DHW Upgrade</td>
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<tr>
<td>Renewable</td>
<td>Solar Domestic Hot Water</td>
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Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Fort Yukon in the Final Audit Report. These include Ameresco’s initial project recommendations for the village.

### 5.1 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 Doors – New Maintenance Bay Doors**

This ECO proposes installing new insulated doors. The installation would improve U-values of the current hollow metal maintenance bay doors. This ECO would also improve the basic maintenance bay door operation, as the currently installed doors do not open and close properly.
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.

5.1.3 Electrical Opportunities

E01 – Street Lighting Upgrade

See Section 4.2.

E02 – 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.

E03 – Residential Lighting Upgrade

See Section 4.1.

E04 – Install New Air Compressor System

The existing air compressor system at the Fort Yukon City Hall building is in need of a replacement due to its age and operational limitations. The unit is also left on, even when use is not required. Savings will be realized by shutting off the system when it is not in use via a relay and timer, fixing any system leaks, and installing a higher efficiency air compressor.

5.1.4 Mechanical Opportunities

M01 – Furnace Upgrade

This ECO proposes replacing existing fuel oil furnaces 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. Furnaces employing modern technology can be installed to reduce energy consumption, improve system operations, and reduce maintenance costs.

M02 – Domestic Hot Water Heater Upgrade

This ECO proposes replacing existing electric or fuel oil tank-type water heaters with fuel oil instantaneous Toyotomi OM-128 models. Standby losses will be eliminated, as there is no need to
continuously heat tanks of water until they are needed. Where electric water heaters are replaced, additional savings will come from the cost of generating electricity.

5.1.5 Renewable Opportunities

R01 – Solar Domestic Hot Water

This ECO proposes installing solar domestic hot-water heating systems that use solar collection panels to capture solar radiated heat to heat domestic water. Such systems can displace the entire domestic water heating load or serve as a pre-heater and supplement the heating load. The total amount of solar heating is dependent upon the domestic hot-water consumption profile, daily weather conditions, and available solar radiation.
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 as 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 for the VEEP projects can be found in Appendix A. Final project costs and expected annual savings for the EECBG projects can be found in Appendix B. ECOs that were categorized as “Not Funded,” whether in the initial stages of the proposal or during VEEP construction, can be found in Appendix C.

6.1 GRANT CHANGES FROM INITIAL REPORTING

In the initial Fort Yukon audit report, the village was documented as receiving a $33,700 additional VEEP grant, but this grant is actually from EECBG funds. Because of this, some of the ECO cost structure was rearranged due to different program requirements between Whole Village, VEEP, and EECBG initiatives. Where necessary, these requirements are explained further in Section 6.2.

6.2 ECO CHANGES FROM INITIAL REPORTING

**B01 – Door Weather-stripping Upgrade**

Installed as planned in the Tribal Hall building under Whole Village funding and in the City Hall and Addie Shewfelt buildings under EECBG funding. EECBG funding does not allow for upgrades on Tribal owned buildings, therefore, this ECO had to be split between funding pools.

**B02 – Thermal Insulation Upgrade**

Installed as planned.

**B02 – Thermal Insulation Upgrade**

Added to scope. This ECO replaced R01 in the Fort Yukon project scope.

**C01 – Programmable Thermostat Upgrade**

Installed as planned with EECBG funding.

**E01 – Street Lighting Upgrade**

Installed as planned.
E02 – Occupancy Sensors
Installed as planned in the City Hall under EECBG funding. Removed from Whole Village scope at Tribal Hall building due to grounding issues; two sensors were purchased in this instance, but could not be installed.

E03 – LED Lighting Upgrade
Distributed as planned. A total of 600 LED light bulbs were dispersed during a Village Energy Efficiency Fair.

E04 – Air Compressor Upgrade
Installed as planned with EECBG funding.

M01 – Furnace Upgrade
Installed as planned.

M02 – Domestic Water Heater Upgrade
Installed as planned in the Addie Shewfelt, Gwandak, and Tribal Office buildings. Removed from scope at the City Hall building.

R01 – Solar Hot Water System
Removed from scope due to funding and time constraints. This ECO would have taken significant engineering and development time that was not available in the Village Audit time frame.
### 6.2 Funding Allocation Summary Tables

#### Whole Village/VEEP ECOS – Fort Yukon

<table>
<thead>
<tr>
<th>ECO</th>
<th>Cost</th>
<th>Savings</th>
<th>SPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>B01 - WEATHERSTRIPPING</td>
<td>$2,368.57</td>
<td>$161.55</td>
<td>14.66</td>
</tr>
<tr>
<td>B02 - THERMAL INSULATION UPGRADE</td>
<td>$61,270.98</td>
<td>$4,346.29</td>
<td>14.10</td>
</tr>
<tr>
<td>B03 - NEW MAINTENANCE BAY DOORS</td>
<td>$119,350.09</td>
<td>$3,549.49</td>
<td>33.62</td>
</tr>
<tr>
<td>E01 - STREET LIGHTING UPGRADE</td>
<td>$99,980.53</td>
<td>$31,978.39</td>
<td>3.13</td>
</tr>
<tr>
<td>E02 - INSTALL OCCUPANCY SENSORS</td>
<td>$1,874.95</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>E03 - LED LIGHTING UPGRADE</td>
<td>$23,876.30</td>
<td>$3,492.17</td>
<td>6.84</td>
</tr>
<tr>
<td>M01 - FURNACE UPGRADE</td>
<td>$42,120.90</td>
<td>$6,667.26</td>
<td>6.32</td>
</tr>
<tr>
<td>M02 - DOMESTIC WATER HEATER UPGRADE</td>
<td>$43,702.56</td>
<td>$2,173.68</td>
<td>20.11</td>
</tr>
</tbody>
</table>

**AVAILABLE FUNDING** $5,455.13

*Available funding allocated to Kotlik

**TOTAL GRANT** $400,000.00

**FORT YUKON PROJECT TOTAL** $394,544.87 $52,368.83 7.53

#### EECDG - Project Costs & Expected Savings – Fort Yukon

<table>
<thead>
<tr>
<th>ECO</th>
<th>Cost</th>
<th>Savings</th>
<th>SPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>B01 - WEATHERSTRIPPING</td>
<td>$13,036.96</td>
<td>$4,409.70</td>
<td>2.96</td>
</tr>
<tr>
<td>C01 - PROGRAMMABLE THERMOSTAT UPGRADE</td>
<td>$1,680.23</td>
<td>$2,519.13</td>
<td>0.67</td>
</tr>
<tr>
<td>E02 - INSTALL OCCUPANCY SENSORS</td>
<td>$9,690.23</td>
<td>$2,248.06</td>
<td>4.31</td>
</tr>
<tr>
<td>E04 - INSTALL NEW AIR COMPRESSOR SYSTEM</td>
<td>$9,065.38</td>
<td>$1,737.17</td>
<td>5.22</td>
</tr>
</tbody>
</table>

**AVAILABLE FUNDING** $227.20

*Available funding allocated to Kotlik

**TOTAL GRANT** $33,700.00

**FORT YUKON PROJECT TOTAL** $33,472.80 $10,914.06 3.07
APPENDIX A

VEEP & WHOLE VILLAGE PROJECT COSTS & EXPECTED SAVINGS
APPENDIX A - VEEP & WHOLE VILLAGE PROJECT COSTS & EXPECTED SAVINGS - FORT YUKON

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

<table>
<thead>
<tr>
<th>Building</th>
<th># of Doors</th>
<th>Price Per Door</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tribal Hall</td>
<td>2</td>
<td>$1,184.29</td>
<td>$2,368.57</td>
<td>0.00</td>
<td>5.08</td>
<td>5.08</td>
<td>36.31</td>
<td>$0.00</td>
<td>$161.55</td>
<td>$161.55</td>
<td>14.66</td>
</tr>
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</table>

### B02 - THERMAL INSULATION UPGRADE

<table>
<thead>
<tr>
<th>Building</th>
<th>Current Insulation</th>
<th>Proposed Insulation</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addie Shewfelt</td>
<td>R-19</td>
<td>R-38</td>
<td>$10,420.17</td>
<td>0.00</td>
<td>19.17</td>
<td>19.17</td>
<td>136.92</td>
<td>$0.00</td>
<td>$609.10</td>
<td>$609.10</td>
<td>17.11</td>
</tr>
<tr>
<td>City Hall</td>
<td>R-19</td>
<td>R-38</td>
<td>$15,789.66</td>
<td>0.00</td>
<td>33.18</td>
<td>33.18</td>
<td>237.00</td>
<td>$0.00</td>
<td>$1,054.33</td>
<td>$1,054.33</td>
<td>14.98</td>
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<tr>
<td>Gwandak</td>
<td>R-19</td>
<td>R-38</td>
<td>$11,073.01</td>
<td>0.00</td>
<td>34.03</td>
<td>34.03</td>
<td>243.05</td>
<td>$0.00</td>
<td>$1,081.27</td>
<td>$1,081.27</td>
<td>10.24</td>
</tr>
<tr>
<td>Tribal Hall</td>
<td>R-19</td>
<td>R-38</td>
<td>$23,988.14</td>
<td>0.00</td>
<td>50.40</td>
<td>50.40</td>
<td>360.01</td>
<td>$0.00</td>
<td>$1,601.59</td>
<td>$1,601.59</td>
<td>14.98</td>
</tr>
</tbody>
</table>

### B03 - NEW MAINTENANCE BAY DOORS

<table>
<thead>
<tr>
<th>Building</th>
<th># of Doors</th>
<th>Price Per Door</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall</td>
<td>6</td>
<td>Varies w/Size</td>
<td>$119,350.09</td>
<td>-3.00</td>
<td>111.70</td>
<td>111.70</td>
<td>797.86</td>
<td>-$0.97</td>
<td>$3,550.46</td>
<td>$3,549.49</td>
<td>33.62</td>
</tr>
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</table>

### E01 - STREET LIGHTING UPGRADE

<table>
<thead>
<tr>
<th>Number of Fixtures for Retrofit</th>
<th>Existing Fixture</th>
<th>Retrofit Fixture</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Electric kW</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>150W HPS</td>
<td>72W LED</td>
<td>$99,980.53</td>
<td>52,998.00</td>
<td>145.20</td>
<td>180.88</td>
<td>$31,978.39</td>
<td>$17,109.89</td>
<td>$49,088.27</td>
<td>3.13</td>
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</table>

### E02 - INSTALL OCCUPANCY SENSORS

<table>
<thead>
<tr>
<th>Building</th>
<th># of Sensors</th>
<th>Price Per Sensor</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Annual Electric kWh Savings</th>
<th>Equivalent mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tribal Hall</td>
<td>2</td>
<td>$937.48</td>
<td>$1,874.95</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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

### E03 - LED LIGHTING UPGRADE

<table>
<thead>
<tr>
<th>Number of Bulbs to be Exchanged</th>
<th>Typical Lamp Wattage (kW)</th>
<th>LED Wattage (kW)</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Annual Electric kWh Savings</th>
<th>Equivalent mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>60</td>
<td>7</td>
<td>$23,876.30</td>
<td>5,787.60</td>
<td>31.80</td>
<td>19.75</td>
<td>420.00</td>
<td>$3,492.17</td>
<td>$1,868.47</td>
<td>$5,360.64</td>
<td>6.84</td>
</tr>
</tbody>
</table>

### M01 - FURNACE UPGRADE

<table>
<thead>
<tr>
<th>Building</th>
<th># of Furnaces to Replace</th>
<th>New Furnace Efficiency (AFUE)</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall</td>
<td>2</td>
<td>96.00%</td>
<td>$42,120.90</td>
<td>0.00</td>
<td>209.82</td>
<td>209.82</td>
<td>1,498.69</td>
<td>$0.00</td>
<td>$6,667.26</td>
<td>$2,158.36</td>
<td>6.32</td>
</tr>
</tbody>
</table>

### M02 - DOMESTIC WATER HEATER UPGRADE

<table>
<thead>
<tr>
<th>Building</th>
<th># of Water Heaters to Replace</th>
<th>New Water Heater</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addie Shewfelt</td>
<td>1</td>
<td>Toyotomi O128</td>
<td>$14,567.52</td>
<td>3,363.23</td>
<td>-12.13</td>
<td>-0.65</td>
<td>157.44</td>
<td>$2,029.33</td>
<td>$700.43</td>
<td>$2,729.76</td>
<td>20.80</td>
</tr>
<tr>
<td>Gwandak</td>
<td>1</td>
<td>Toyotomi O128</td>
<td>$14,567.52</td>
<td>3,475.33</td>
<td>-12.13</td>
<td>-0.27</td>
<td>165.58</td>
<td>$2,096.98</td>
<td>$736.62</td>
<td>$2,833.60</td>
<td>19.78</td>
</tr>
<tr>
<td>Tribal Office</td>
<td>1</td>
<td>Toyotomi O128</td>
<td>$14,567.52</td>
<td>3,475.33</td>
<td>-12.13</td>
<td>-0.27</td>
<td>165.58</td>
<td>$2,096.98</td>
<td>$736.62</td>
<td>$2,833.60</td>
<td>19.78</td>
</tr>
</tbody>
</table>
APPENDIX B

EECBG PROJECT
COSTS & EXPECTED SAVINGS
APPENDIX B - EECBG PROJECT COSTS & EXPECTED SAVINGS - FORT YUKON

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

<table>
<thead>
<tr>
<th>Building</th>
<th># of Doors</th>
<th>Price Per Door</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addie Shewfelt</td>
<td>3</td>
<td>Varies w/Size</td>
<td>$3,008.53</td>
<td>8.13</td>
<td>8.13</td>
<td>58.10</td>
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<td>11.64</td>
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</tr>
<tr>
<td>City Hall</td>
<td>10</td>
<td>Varies w/Size</td>
<td>$10,028.43</td>
<td>130.60</td>
<td>130.60</td>
<td>932.86</td>
<td>$0.00</td>
<td>$4,151.23</td>
<td>$4,151.23</td>
<td>2.42</td>
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</tr>
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### C01 - PROGRAMMABLE THERMOSTAT UPGRADE

<table>
<thead>
<tr>
<th>Building</th>
<th># of Thermostats Installed</th>
<th>Cost Per Thermostat</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall</td>
<td>1</td>
<td>$840.12</td>
<td>$840.12</td>
<td>47.74</td>
<td>47.74</td>
<td>341.02</td>
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<td>$1,517.12</td>
<td>$1,517.12</td>
<td>0.55</td>
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</tr>
<tr>
<td>Gwandak</td>
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<td>$840.12</td>
<td>$840.12</td>
<td>31.53</td>
<td>31.53</td>
<td>225.23</td>
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<td>$1,002.01</td>
<td>$1,002.01</td>
<td>0.84</td>
<td></td>
</tr>
</tbody>
</table>

### E02 - INSTALL OCCUPANCY SENSORS

<table>
<thead>
<tr>
<th>Building</th>
<th># of Fixtures</th>
<th>Price Per Fixture</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Annual Electric kWh Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall</td>
<td>14</td>
<td>$692.16</td>
<td>$9,690.23</td>
<td>3,725.72</td>
<td>12.72</td>
<td>270.37</td>
<td>$2,248.06</td>
<td>$1,202.81</td>
<td>$3,450.87</td>
<td>4.31</td>
</tr>
</tbody>
</table>

### E04 - INSTALL NEW AIR COMPRESSOR SYSTEM

<table>
<thead>
<tr>
<th>Building</th>
<th>Air Compressor HP</th>
<th>New Air Compressor Efficiency</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Annual Electric kWh Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall - Shop</td>
<td>3</td>
<td>90%</td>
<td>$9,065.38</td>
<td>5,410.69</td>
<td>18.47</td>
<td>392.65</td>
<td>$1,737.17</td>
<td>$1,747.28</td>
<td>$3,484.45</td>
<td>5.22</td>
</tr>
</tbody>
</table>
APPENDIX C

ECO CALCULATION RESULTS – NOT FUNDED
## M02 - DOMESTIC WATER HEATER UPGRADE

<table>
<thead>
<tr>
<th>Building</th>
<th># of Water Heaters to Replace</th>
<th>New Water Heater</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall</td>
<td>1</td>
<td>Toyotomi O128</td>
<td>$12,406.80</td>
<td>0.00</td>
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<td>5.66</td>
<td>40.42</td>
<td>$0.00</td>
<td>$179.83</td>
<td>$179.83</td>
<td>68.99</td>
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</tbody>
</table>

## R01 - SOLAR HOT WATER SYSTEM

<table>
<thead>
<tr>
<th>Building</th>
<th># Solar Collectors Needed</th>
<th>System Size Needed (kW)</th>
<th>Total Cost</th>
<th>Electric kWh Savings</th>
<th>Fuel mmBtu Savings</th>
<th>Total mmBtu Savings</th>
<th>Equivalent Fuel Gallons Savings</th>
<th>Annual kWh Cost Savings</th>
<th>Annual Equivalent Fuel Cost Savings</th>
<th>Total Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Hall</td>
<td>9</td>
<td>14.98</td>
<td>$27,350.40</td>
<td>0.00</td>
<td>33.36</td>
<td>33.36</td>
<td>238.27</td>
<td>$0.00</td>
<td>$1,060.02</td>
<td>$1,060.02</td>
<td>25.80</td>
</tr>
</tbody>
</table>
**ECO Equations**

**B01**
1. Door Leakage Area (in²) = Door Area x Door Leakage Factor
2. Specific Infiltration (CFM/in²) = \[\text{Stack Coefficient} \times \Delta T \] + \[\text{Wind Coefficient} \times \text{Wind Speed}^2\] \(^{1/2}\)
3. \(\Delta T\) = 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 \(\Delta T\)
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 eQuest program.

**B03**
Note: This ECO was completed using the RETscreen program.

Two building models were created and compared using pre- and post-install door upgrade data.

**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.
m mBtu Saved = Baseline Usage - ECM Usage - ECM Usage

**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 (Existing Hours) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) x (Existing Hours) x (Hours Reduced) / (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 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)

**E04**
1. \(W = m \times C_p \times T \times [(P_2/P_1)^{(k-1)/k} - 1]\), \(m\) = mass flow, \(C_p\) = specific heat, \(T\) = temperature, \(P\) = pressure, \(k\) = ratio of specific heats
2. Annual Air Compressor Waste (kWh/yr) = \(W/[(3413 \text{ Btu/hr})/\text{kW}]/(60\text{min/hr})/\text{Annual Hours Equipment Operational Without Need}\)
3. kWh Savings From Higher Efficiency Motor = \((\text{Motor hp})(0.746 \text{kW/hp})(\text{Annual Hours of Operation})/[1/(\text{Old Efficiency}) - 1/(\text{New Efficiency})]\)

**M01**
*Note: This ECO is based on bin data, occupancy, heating peak loads, and furnace efficiency.*

Baseline Usage = (Peak Load x Occupied Load Profile x All Hours) / (Old Heater Efficiency)
ECM Usage = (Peak Load x Occupied Load Profile x All Hours) / (New Heater Efficiency)
m mBtu Saved = Baseline Usage - ECM Usage - ECM Usage

**M02**
1. Annual Energy Usage (mmBtu) = (41,045 Btu/Day) x (Total Days/Yr) x (Total Heaters) / (Energy Factor or Thermal Efficiency)
2. Annual Energy Usage (kWh) = [12.03 kWh/Day] x (Total Days/Yr) x (Total Heaters) / (Energy Factor or Thermal Efficiency)
3. (Commercial Type Heaters) Annual Standby Losses (mmBtu) = (Btu/hr) x (24 Hrs/Day) x (Total Days/Yr) x (Total Heaters) / (1,000,000)
4. (Electric Type Heaters) Annual kW Use = System kW x 12
5. (Commercial Type Heaters) Total Annual Energy Usage (mmBtu) = Annual Energy Usage + Annual Standby Losses
6. Annual Savings = Baseline Conditions - Proposed Conditions

**R01**
1. RETScreen is used for the energy savings estimate.
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
4. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
5. Annual Cost Savings = (Energy Savings) x (Energy Cost)
Savings from installing occupancy sensors are as follows:

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Savings (%):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices (Private)</td>
<td>25-50%</td>
</tr>
<tr>
<td>Offices (Open Spaces)</td>
<td>20-25%</td>
</tr>
<tr>
<td>Rest Rooms</td>
<td>30-75%</td>
</tr>
<tr>
<td>Corridors</td>
<td>30-40%</td>
</tr>
<tr>
<td>Storage Areas</td>
<td>45-65%</td>
</tr>
<tr>
<td>Meeting Rooms</td>
<td>45-65%</td>
</tr>
<tr>
<td>Conference Rooms</td>
<td>45-65%</td>
</tr>
<tr>
<td>Warehouses</td>
<td>50-75%</td>
</tr>
</tbody>
</table>
APPENDIX E – POST INSTALLATION PHOTOS – FORT YUKON

Thermal Insulation Upgrade – Addie Shewfelt Building

New Overhead Shop Doors – City Hall

LED Street Lighting Upgrade

Furnace Upgrade – City Hall