Pre-Feasibility Assessment for Integration of Wood-Fired Heating Systems Final Report

July 24, 2012

City of Aleknagik
Aleknagik, Alaska

Presented by
CTA Architects Engineers
Jesse Vigil & Nathan Ratz

Lars Construction Management Services
Rex Goolsby

For
City of Aleknagik

In partnership with
Fairbanks Economic Development Corporation
Alaska Wood Energy Development Task Group

Funded by
Alaska Energy Authority and U.S. Forest Service

306 W. Railroad, Suite 104
Missoula, MT 59802
406.728.9522
www.ctagroup.com
CTA Project: FEDC_ALEKNAGIK

TABLE OF CONTENTS

<u>Appendixes</u>

1.0 Executive Summary

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system at the Aleknagik City Hall Building located in Aleknagik, Alaska. During the field visit the Health Clinic and Fire Department Garage, Maintenance Garage, and Future Washeteria were also reviewed and discussed.

The following tables summarize the current fuel use and the potential wood fuel use:

Table 1.1 - Fuel Use Summary

Building	Fuel Type	Avg. Use (Gallons)	Average Annual Cost	Average Cost/Gal.
City Hall	Fuel Oil	1,300	$7,371	$5.67
Health Clinic / Fire Depart. Garage	Fuel Oil	2,350	$13,325	$5.67
Maintenance Garage	Fuel Oil	1,127	$6,390	$5.67

Table 1.2 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)
City Hall (C)	1,300	11.4	10.4
Heath Clinic (H)	2,650	23.2	21.1
Future Washeteria (W)	1,000	8.7	8.0
C + H	3,950	34.5	31.5
C + H + W	4,950	43.3	39.4

Note: Wood fuel use assumes offsetting 85% of the current energy use.

Based on the potential wood use the cord wood boiler option was investigated and results are as follows:

Cord Wood Boiler Options:

- C.1: City Hall and Health Clinic.
- C.2: City Hall, Health Clinic, and Future Washeteria.

The table on the following page summarizes the economic evaluation for each option:

	Table 1.3 - Economic Evaluation Summary Aleknagik Biomass Heating System								
	Project Cost	Year 1 Operating Savings	NPV 30 yr at 3%	NPV 20 yr at 3%	20 Yr B/C Ratio	30 Yr B/C Ratio	ACF YR 20	ACF YR 30	YR ACF=PC
C.1	$346,000	$797	$264,465	$125,334	0.36	0.76	$186,695	$486,354	27
C.2	$439,000	$4,173	$416,227	$212,664	0.48	0.95	$310,839	$748,746	24

A small district heating system connecting city buildings appears to be a poor candidate for the use of a wood biomass heating system. With the current economic assumptions, the economic viability of all the options is poor and none of the options meet the minimum requirement of the 20 year B/C ratio exceeding 1.0. Each building individually does not spend enough on heating fuel to be able to pay for a project through potential savings. Combining multiple buildings increases the project costs without substantially increasing the annual fossil fuel use.

2.0 Introduction

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system at the Aleknagik City Hall Building located in Aleknagik, Alaska. During the field visit the Health Clinic and Fire Department Garage, Maintenance Garage, and Future Washeteria were also reviewed and discussed.

3.0 Existing Building Systems

Aleknagik City Hall

The Aleknagik City Hall is a single story wood framed building constructed in 1980 that is approximately 3,315 square feet. The space is divided 5 separate uses: the City Hall, Post Office, Rental Office Space, Village Public Safety Officer Program (VSPO) Office, and a Garage / Storage Space. Each space is heated by a single Toyo Stove. In the City Hall Offices plug-in personal electric heaters are used to provide supplemental heat. The table below indicates the current system outputs:

Table 3.1 - Existing Heating System Summary

Building	Heat System	BTU/hr Output	Condition
City Hall	Toyo Stove	40,000	Good
Rental Office	Toyo Stove	40,000	Good
Post Office	Toyo Stove	40,000	Good
VSPO	Toyo Stove	14,800	Good
Garage / Storage	Toyo Stove	22,000	Poor / Inoperable

There is also an existing fuel oil furnace located in the central mechanical room. The system has been decommissioned; however the ductwork and furnace are still in place.

Domestic hot water is provided by one electric water heater rated at 4.5 KW input and 30 gallons of storage.

Facilities Added to Feasibility Study

Health Clinic and Fire Department Garage

The Aleknagik Health Clinic and Fire Department Garage were designed in 2006 and were added to the feasibility study during the field visit. The Health Clinic is approximately 2,563 square feet and the Fire Department Garage is approximately 952 square feet. The facilities share a common 159,000 Btu/hr output hot water boiler.

Domestic hot water is provided by a 148,000 Btu/hr fuel oil fired hot water heater with 5.1 gallon storage tank. The existing boiler and heating system infrastructure is original to the building and is in good condition but in need of commissioning to improve performance. During the visit one of the zone valves appeared to be stuck open, causing the boiler to run continuously, causing the temperature in the Health Clinic to be higher than desired.

Future Washeteria
Although a Washeteria is not currently located at the north village, a desire to construct a new facility adjacent to the Health Clinic and City Hall was discussed. If it could be located in the vicinity of the Health Clinic and City Building it would be a potential candidate for integration into a small district heating system. Since there currently is no plan or schedule for this work an estimated case was included in the assessment. The fuel volumes were calculated based on the typical washeterias constructed in villages of similar size.

Additional Facilities Reviewed but not added to Feasibility Study

Maintenance Garage
The Maintenance Garage that is adjacent to the City Hall building was reviewed as part of the field visit. This facility was constructed during the 1980's and is a manufactured metal building. The existing Garage is heated by 2 fuel oil unit heaters, however only one is currently in operation. A 142,000 btu/hr waste oil heater has also been recently added to the space. Domestic hot water is provided by one electric water heater rated at 4.5 KW input and has 32 gallons of storage. With the relatively small heat demand of the building and the recent addition of the waste oil heater it was determined that the building would not be incorporated into a district system.

4.0 Energy Use

Fuel is delivered to a 10,000 gallon tank located on site. Each individual building has a smaller 500-1000 gallon tank that is refilled from the 10,000 gallon tank. Fuel use summaries for the facilities were provided and the following table summarizes the data:

Table 4.1 - Fuel Use Summary

Building	Fuel Type	Avg. Use (Gallons)	Average Annual Cost	Average Cost/Gal.
City Hall	Fuel Oil	1,300	$7,371	$5.67
Health Clinic / Fire Depart. Garage	Fuel Oil	2,350	$13,325	$5.67
Maintenance Garage	Fuel Oil	1,127	$6,390	$5.67

Electrical energy consumption will increase with the installation of the wood fired boiler system because of the power needed for the biomass boiler components such as draft fans and the additional pumps needed to integrate into the existing heating systems. The cash flow analysis accounts for the additional electrical energy consumption and reduces the annual savings accordingly.

5.0 Biomass Boiler Size

The following table summarized the connected load of fuel fired boilers and domestic water heaters:

Table 5.1 - Connected Boiler Load Summary					
			Output MBH	Peak Load Factor	Likely System Peak MBH
City Hall (C)	Toyo A	Fuel Oil	40	0.66	26
	Toyo B	Fuel Oil	40	0.66	26
	Toyo C	Fuel Oil	40	0.66	26
	Toyo D	Fuel Oil	15	0.66	10
	Toyo E	Fuel Oil	22	0.66	15
Total					103
Heath Clinic (H)	Boiler	Fuel Oil	159	1.00	159
Future Washeteria (W)		Fuel Oil	80	1.00	80
Total Of All Buildings			**396**		**262**

Typically a wood heating system is sized to meet approximately 85% of the typical annual heating energy use of the building. The existing heating boilers would be used for the other 15% of the time during peak heating conditions, during times when the biomass boiler is down for servicing, and during swing months when only a few hours of heating each day are required. Recent energy models have found that a boiler sized at 50% to 60% of the building peak load will typically accommodate 85% of the boiler run hours. Because of the small scale of the heating system, the output will be based on the smallest cordwood boiler size available, or approximately 170,000 Btu/hr.

Table 5.2 - Proposed Biomass Boiler Size			
	Likely System Peak MBH	Biomass Boiler Factor	Biomass Boiler Size MBH
City Hall (C)	103	0.6	62
Heath Clinic (H)	159	0.6	95
Future Washeteria (W)	80	0.6	48
C + H	262	0.6	157
C + H + W	342	0.6	205

6.0 Wood Fuel Use

The fuel source that is available in the area consists entirely of seasoned cord wood cut and gathered locally. At the time of this report there is not an infrastructure in place to transport wood pellets or chipped/ground wood fuel. The estimated amount of wood fuel needed of each wood fuel type for each building was calculated and is listed below:

Table 6.1 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)
City Hall (C)	1,300	11.4	10.4
Heath Clinic (H)	2,650	23.2	21.1
Future Washeteria (W)	1,000	8.7	8.0
C + H	3,950	34.5	31.5
C + H + W	4,950	43.3	39.4

Note: Wood fuel use assumes offsetting 85% of the current energy use.

The moisture content of the wood fuels and the overall wood burning system efficiencies were accounted for in these calculations. The existing fuel oil boilers were assumed to be 80% efficient. Cord wood was assumed to be 20% moisture content (MC) with a system efficiency of 65%. Wood pellets were assumed to be 7% MC with a system efficiency of 70%. Chipped/ground fuel was assumed to be 40% MC with a system efficiency of 65%.

The unit fuel costs for fuel oil and the different fuel types were calculated and equalized to dollars per million Btu ($/MMBtu) to allow for direct comparison. The Delivered $/MMBtu is the cost of the fuel based on what is actually delivered to the heating system, which includes all the inefficiencies of the different systems. The Gross $/MMBtu is the cost of the fuel based on raw fuel, or the higher heating value and does not account for any system inefficiencies. The following table summarizes the equalized fuel costs at different fuel unit costs:

Table 6.2 - Unit Fuel Costs Equalized to $/MMBtu

Fuel Type	Units	Gross Btu/unit	System Efficiency	Net System Btu/unit	$/unit	Delivered $/MMBtu	Gross $/MMBtu
Fuel Oil	gal	134500	0.8	107600	$5.00	$46.47	$37.17
					$5.67	$52.70	$42.16
					$6.00	$55.76	$44.61
Cord Wood	cords	16173800	0.65	10512970	$200.00	$19.02	$12.37
					$250.00	$23.78	$15.46
					$300.00	$28.54	$18.55

7.0 Boiler Plant Location and Site Access

None of the existing boiler rooms are large enough to fit a new biomass boiler so a new standalone boiler plant would be required. The existing gravel parking lot south of the Fire Department Garage has been identified as the preferred location for a central heating plant.

Any type of biomass boiler system will require access by delivery vehicles, typically a truck or truck and trailer. There is ample room on the site for both a standalone boiler plant and additional wood storage. The location is also under ¼ mile to the Aleknagik north village landing. This would allow cord wood to be delivered by barge or boat in the summer reducing the cost of overland hauling.

8.0 Integration with Existing Heating System

Integration of a wood fired boiler system would be relatively straight forward at the Health Clinic and Fire Department Garage. The field visit confirmed the location of each boiler room in order to identify an approximate point of connection from a district heating loop to each existing building. Connections would typically be achieved with arctic pipe extended to the face of each building, and extended up the exterior surface of the building in order to penetrate exterior wall into the boiler room. Once hot supply and return piping enters the existing boiler room, they would be connected to existing supply and return pipes in appropriate locations in order to utilize existing pumping systems within each building.

The integration of a wood fired boiler system to the City Building would be more challenging. Currently the facility is heated by individual Toyo Stoves. A new heating system would have to be installed to distribute the hot supply water. The existing fuel oil furnace in the mechanical room could be removed and the room could be used for the distribution system including a heat exchanger and pumping system. New radiators would be needed throughout the facility. The existing furnace could also possibly be replaced with a fan coil unit with at heating coil served by the new biomass boiler system, and this connected to the existing ductwork, if the ductwork is in good condition.

9.0 Air Quality Permits

Resource System Group has done a preliminary review of potential air quality issues in the area. The meteorological conditions of Aleknagik do not create thermal inversions very often, which it good because inversions are unfavorable for the dispersion of emissions. The proposed boiler size at this location is small enough, that the boiler is not likely to require any State or Federal permits. See the air quality memo in Appendix D.

10.0 Options

The technologies available to produce heating energy from wood based biomass are varied in their approach, but largely can be separated into three types of heating plants: cord wood, wood pellet and wood chip/ground wood fueled. See Appendix E for these summaries.

Based on the potential wood use the cord wood boiler option was investigated and results are as follows:

Cord Wood Boiler Options:
- C.1: City Hall and Health Clinic.
- C.2: City Hall, Health Clinic, and Future Washeteria.

Option C.1 and C.2 would be installed in a freestanding building with interior cordwood fuel storage.

11.0 Estimated Costs

The total project costs are at a preliminary design level and are based on RS Means and recent biomass project bid data. The estimates are shown in the appendix. These costs are conservative and if a deeper level feasibility analysis is undertaken and/o7r further design occurs, the costs may be able to be reduced.

12.0 Economic Analysis Assumptions

The cash flow analysis assumes fuel oil at $5.65/gal, electricity at $0.65/kwh, and cord wood delivered at $200/cord. The fuel oil, electricity, and cord wood costs are based on the costs reported by the facility.

It is assumed that the wood boiler would supplant 85% of the estimated heating use, and the existing heating systems would heat the remaining 15%. Each option assumes the total project can be funded with grants and non obligated capital money. The following inflation rates were used: O&M - 2%, Fossil Fuel – 5%, Wood Fuel – 3%, Discount Rate for NPV calculation – 3%. The fossil fuel inflation rate is based on the DOE EIA website. DOE is projecting a slight plateau with a long term inflation of approximately 5%. As a point of comparison, oil prices have increased at an annual rate of over 8% since 2001.

The analysis also accounts for additional electrical energy required for the wood fired boiler system, as well as the system pumps to distribute heating hot water to the buildings. Wood fired boiler systems also will require more maintenance, and these additional maintenance costs are factored into the analysis.

13.0 Results of Evaluation

The following table summarizes the economic evaluation for each option:

Table 13.1 - Economic Evaluation Summary
Aleknagik Biomass Heating System

	Project Cost	Year 1 Operating Savings	NPV 30 yr at 3%	NPV 20 yr at 3%	20 Yr B/C Ratio	30 Yr B/C Ratio	ACF YR 20	ACF YR 30	YR ACF=PC
C.1	$346,000	$797	$264,465	$125,334	0.36	0.76	$186,695	$486,354	27
C.2	$439,000	$4,173	$416,227	$212,664	0.48	0.95	$310,839	$748,746	24

The benefit to cost ratio (B/C) takes the net present value (NPV) of the net energy savings and divides it by the construction cost of the project. A B/C ratio greater than or equal to 1.0 indicates an economically advantageous project.

Accumulated cash flow (ACF) is another evaluation measure that is calculated in this report and is similar to simple payback with the exception that accumulated cash flow takes the cost of financing and fuel escalation into account. For many building owners, having the accumulated cash flow equal the project cost within 15 years is considered necessary for implementation. If the accumulated cash flow equals project cost in 20 years or more, that indicates a challenged project. Positive accumulated cash flow should also be considered an avoided cost as opposed to a pure savings.

14.0 Project Funding

The City of Aleknagik may pursue a biomass project grant from the Alaska Energy Authority.

The City of Aleknagik could also enter into a performance contract for the project. Companies such as Siemens, McKinstry, Johnson Controls and Chevron have expressed an interest in participating in funding projects of all sizes throughout Alaska. This allows the facility owner to pay for the project entirely from the guaranteed energy savings, and to minimize the project funds required to initiate the project. The scope of the project may be expanded to include additional energy conservation measures such as roof and wall insulation and upgrading mechanical systems.

15.0 Summary

A small district heating system connecting city buildings appears to be a poor candidate for the use of a wood biomass heating system. With the current economic assumptions, the economic viability of all the options is poor and none of the options meet the minimum requirement of the 20 year B/C ratio exceeding 1.0. Each building individually does not spend enough on heating fuel to be able to pay for a project through potential savings. Combining multiple buildings increases the project costs without substantially increasing the annual fossil fuel use.

16.0 Recommended Action

Revisit the viability of a wood heating project if after the Washeteria and/or other buildings are constructed and the campus of City buildings end up using over 10,000 gallons of fuel oil for heating.

APPENDIX A

Preliminary Estimates of Probable Cost

Preliminary Estimates of Probable Cost
Biomass Heating Options
Alegnagik, AK

Option C.1 - City Hall + Health Center

Biomass Boiler Building Including Wood Storage Area:	$55,000
Wood Boiler System:	$32,000
Stack:	$4,200
Mechanical/Electrical within Boiler Building:	$20,200
Underground Piping	$45,000
City Hall Integration	$32,000
Health Clinic Integration	$13,000
Subtotal:	$201,400
30% Remote Factor	$60,420
Subtotal:	$261,820
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$39,273
Subtotal:	$301,093
15% Contingency:	$45,164
Subtotal:	$ 346,257
Total Project Costs	**$346,257**

Option C.2 - City Hall + Health Center + Future Washeteria

Biomass Boiler Building Including Wood Storage Area:	$55,000
Wood Boiler System:	$32,000
Stack:	$4,200
Mechanical/Electrical within Boiler Building:	$20,200
Underground Piping	$75,000
City Hall Integration	$32,000
Health Clinic Integration	$13,000
Future Washeteria Integration	$24,000
Subtotal:	$255,400
30% Remote Factor	$76,620
Subtotal:	$332,020
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$49,803
Subtotal:	$381,823
15% Contingency:	$57,273
Subtotal:	$ 439,096
Total Project Costs	**$439,096**

APPENDIX B

Cash Flow Analysis

Aleknagik Municipal Buildings, City Hall and Health Clinic

Aleknagik, Alaska

Option C.1

Cord Wood Boiler

Date: July 24, 2012
Analyst: CTA Architects Engineers - Nick Salmon & Nathan Ratz

EXISTING CONDITIONS	City Hall	Health Clinic			Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$5.70	$5.70	$5.70	$5.70	
Estimated Average Annual Fuel Usage:	1,300	2,350	0		3,650
Annual Heating Costs:	$7,410	$13,395	$0	$0	$20,805
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	138500	138500	138500	138500	
Current Annual Fuel Volume (Btu):	180,050,000	325,475,000	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	144,040,000	260,380,000	0	0	404,420,000

WOOD FUEL COST	Cord Wood
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/cord) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	38
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	33
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	-$346,000

Project Financing Information	
Percent Financed	0.0%
Amount Financed	$0
Amount of Grants	$346,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use		
Est. Pwr Use	1150 kWh	
Elec Rate	$0.650 /kWh	

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	10.0	40	400	$20.00	$8,000
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

		Net Benefit	B/C Ratio
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	434.1 years	Net Benefit	B/C Ratio
Net Present Value (30 year analysis):	$264,465	-$81,535	0.76
Net Present Value (20 year analysis):	$125,334	-$220,666	0.36
Year Accumulated Cash Flow > 0	#N/A		
Year Accumulated Cash Flow > Project Capital Cost	27		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	5.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Existing Heating System Operating Costs														
Displaced heating costs	$5.70		1300	gal	$7,410	$7,781	$8,170	$8,578	$9,007	$9,457	$9,930	$10,427	$10,948	$11,495
Displaced heating costs	$5.70		2350	gal	$13,395	$14,065	$14,768	$15,506	$16,282	$17,096	$17,951	$18,848	$19,791	$20,780
Displaced heating costs	$5.70		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$5.70		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs														
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	33	cords	$6,540	$6,736	$6,938	$7,146	$7,360	$7,581	$7,809	$8,043	$8,284	$8,533
Small load existing fuel	$5.70	15%	195	gal	$1,112	$1,167	$1,225	$1,287	$1,351	$1,419	$1,490	$1,564	$1,642	$1,724
Small load existing fuel	$5.70	15%	353	gal	$2,009	$2,110	$2,215	$2,326	$2,442	$2,564	$2,693	$2,827	$2,969	$3,117
Small load existing fuel	$5.70	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$5.70	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189	$9,373	$9,561
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632								
Additional Electrical Cost	$0.650				$748	$785	$824	$865	$909	$954	$1,002	$1,052	$1,104	$1,160
Annual Operating Cost Savings					***$797***	***$1,256***	***$3,412***	***$3,971***	***$4,567***	***$5,202***	***$5,879***	***$6,599***	***$7,366***	***$8,181***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Displaced System Replacement Costs (year one only)					***0***									
Net Annual Cash Flow					***797***	***1,256***	***3,412***	***3,971***	***4,567***	***5,202***	***5,879***	***6,599***	***7,366***	***8,181***
Accumulated Cash Flow					***797***	***2,053***	***5,464***	***9,435***	***14,002***	***19,204***	***25,083***	***31,682***	***39,048***	***47,229***

Cash flow Descriptions	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs								
Displaced heating costs	$12,070	$12,674	$13,307	$13,973	$14,671	$18,725	$23,898	$30,501
Displaced heating costs	$21,819	$22,910	$24,055	$25,258	$26,521	$33,848	$43,200	$55,136
Displaced heating costs	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs								
Wood Fuel ($/ton, delivered to boiler site)	$8,789	$9,052	$9,324	$9,604	$9,892	$11,467	$13,294	$15,411
Small load existing fuel	$1,811	$1,901	$1,996	$2,096	$2,201	$2,809	$3,585	$4,575
Small load existing fuel	$3,273	$3,436	$3,608	$3,789	$3,978	$5,077	$6,480	$8,270
Small load existing fuel	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years								
Additional Electrical Cost	$1,218	$1,278	$1,342	$1,410	$1,480	$1,889	$2,411	$3,077
Annual Operating Cost Savings	***$9,047***	***$9,968***	***$10,946***	***$11,984***	***$13,086***	***$19,676***	***$28,461***	***$40,096***
Financed Project Costs - Principal and Interest								
Displaced System Replacement Costs (year one only)								
Net Annual Cash Flow	***9,047***	***9,968***	***10,946***	***11,984***	***13,086***	***19,676***	***28,461***	***40,096***
Accumulated Cash Flow	***56,276***	***66,244***	***77,190***	***89,175***	***102,261***	***186,695***	***310,436***	***486,354***

Aleknagik Municipal Buildings, City Hall, Clinic, Future Washateria Option C.2

Aleknagik, Alaska — **Cord Wood Boiler**

Date: July 24, 2012
Analyst: CTA Architects Engineers - Nick Salmon & Nathan Ratz

EXISTING CONDITIONS	City Hall	Health Clinic	Washateria		Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$5.70	$5.70	$5.70	$5.70	
Estimated Average Annual Fuel Usage:	1,300	2,350	1,127		4,777
Annual Heating Costs:	$7,410	$13,395	$6,424	$0	$27,229
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	138500	138500	138500	138500	
Current Annual Fuel Volume (Btu):	180,050,000	325,475,000	156,089,500	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	144,040,000	260,380,000	124,871,600	0	529,291,600

WOOD FUEL COST	Cord Wood
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/cord) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	50
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	43
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	-$439,000

Project Financing Information	
Percent Financed	0.0%
Amount Financed	$0
Amount of Grants	$439,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1250 kWh
Elec Rate	$0.650 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	10.0	40	400	$20.00	$8,000
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

		Net Benefit	B/C Ratio
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	105.2 years	Net Benefit	B/C Ratio
Net Present Value (30 year analysis):	$416,227	-$22,773	0.95
Net Present Value (20 year analysis):	$212,664	-$226,336	0.48
Year Accumulated Cash Flow > 0	#N/A		
Year Accumulated Cash Flow > Project Capital Cost	24		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	5.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Existing Heating System Operating Costs													
Displaced heating costs	$5.70		1300	gal	$7,410	$7,781	$8,170	$8,578	$9,007	$9,457	$9,930	$10,427	$10,948
Displaced heating costs	$5.70		2350	gal	$13,395	$14,065	$14,768	$15,506	$16,282	$17,096	$17,951	$18,848	$19,791
Displaced heating costs	$5.70		1127	gal	$6,424	$6,745	$7,082	$7,436	$7,808	$8,199	$8,609	$9,039	$9,491
Displaced heating costs	$5.70		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs													
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	43	cords	$8,559	$8,816	$9,080	$9,353	$9,633	$9,922	$10,220	$10,526	$10,842
Small load existing fuel	$5.70	15%	195	gal	$1,112	$1,167	$1,225	$1,287	$1,351	$1,419	$1,490	$1,564	$1,642
Small load existing fuel	$5.70	15%	353	gal	$2,009	$2,110	$2,215	$2,326	$2,442	$2,564	$2,693	$2,827	$2,969
Small load existing fuel	$5.70	15%	169	gal	$964	$1,012	$1,062	$1,115	$1,171	$1,230	$1,291	$1,356	$1,424
Small load existing fuel	$5.70	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189	$9,373
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632							
Additional Electrical Cost	$0.650				$813	$853	$896	$941	$988	$1,037	$1,089	$1,143	$1,200
Annual Operating Cost Savings					***$4,173***	***$4,841***	***$7,218***	***$8,010***	***$8,852***	***$9,747***	***$10,698***	***$11,708***	***$12,779***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Displaced System Replacement Costs (year one only)					***0***								
Net Annual Cash Flow					***4,173***	***4,841***	***7,218***	***8,010***	***8,852***	***9,747***	***10,698***	***11,708***	***12,779***
Accumulated Cash Flow					***4,173***	***9,014***	***16,232***	***24,242***	***33,094***	***42,841***	***53,539***	***65,247***	***78,026***

Cash flow Descriptions	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs									
Displaced heating costs	$11,495	$12,070	$12,674	$13,307	$13,973	$14,671	$18,725	$23,898	$30,501
Displaced heating costs	$20,780	$21,819	$22,910	$24,055	$25,258	$26,521	$33,848	$43,200	$55,136
Displaced heating costs	$9,966	$10,464	$10,987	$11,536	$12,113	$12,719	$16,233	$20,718	$26,442
Displaced heating costs	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs									
Wood Fuel ($/ton, delivered to boiler site)	$11,167	$11,502	$11,848	$12,203	$12,569	$12,946	$15,008	$17,399	$20,170
Small load existing fuel	$1,724	$1,811	$1,901	$1,996	$2,096	$2,201	$2,809	$3,585	$4,575
Small load existing fuel	$3,117	$3,273	$3,436	$3,608	$3,789	$3,978	$5,077	$6,480	$8,270
Small load existing fuel	$1,495	$1,570	$1,648	$1,730	$1,817	$1,908	$2,435	$3,108	$3,966
Small load existing fuel	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs	$9,561	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years									
Additional Electrical Cost	$1,260	$1,323	$1,390	$1,459	$1,532	$1,609	$2,053	$2,620	$3,344
Annual Operating Cost Savings	***$13,916***	***$15,122***	***$16,401***	***$17,756***	***$19,193***	***$20,714***	***$29,769***	***$41,757***	***$57,545***
Financed Project Costs - Principal and Interest	***0***								
Displaced System Replacement Costs (year one only)									
Net Annual Cash Flow	***13,916***	***15,122***	***16,401***	***17,756***	***19,193***	***20,714***	***29,769***	***41,757***	***57,545***
Accumulated Cash Flow	***91,942***	***107,064***	***123,465***	***141,222***	***160,414***	***181,128***	***310,839***	***494,319***	***748,746***

APPENDIX C

Site Plan

Drawn By SSF
Checked By NHR
Date 07/24/2012
CTA # FEDC
Cad File: J:aleknagikSITE

BIOMASS PRE-FEASIBILITY ASSESSMENT

ALEKNAGIK MAIN CITY HALL
ALEKNAGIK, ALASKA

CTA
MISSOULA, MT
(406)728-9522
Fax (406)728-8287

SITE PLAN

APPENDIX D

Air Quality Report

To:	Nick Salmon
From:	John Hinckley
Subject:	Aleknagik Cluster Feasibility Study
Date:	24 July 2012

INTRODUCTION

At your request, RSG has conducted an air quality feasibility study for a biomass energy installation in Aleknagik. Aleknagik is located in - southwest Alaska at the head of the Wood River and has a population of 219 people. A cord wood boiler is planned for the Aleknagik Main City Hall. The boiler will have an estimated heat output of 205,000 Btu's per hour and a heat input of 256,250 Btu's per hour, assuming 80% thermal efficiency.

STUDY AREA

A USGS map of the study area is provided below in Figure 1. As shown, the study area is located on Lake Aleknagik in the midst of hilly to mountainous topography and very little development. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

Figure 1: USGS Map Illustrating the Study Area

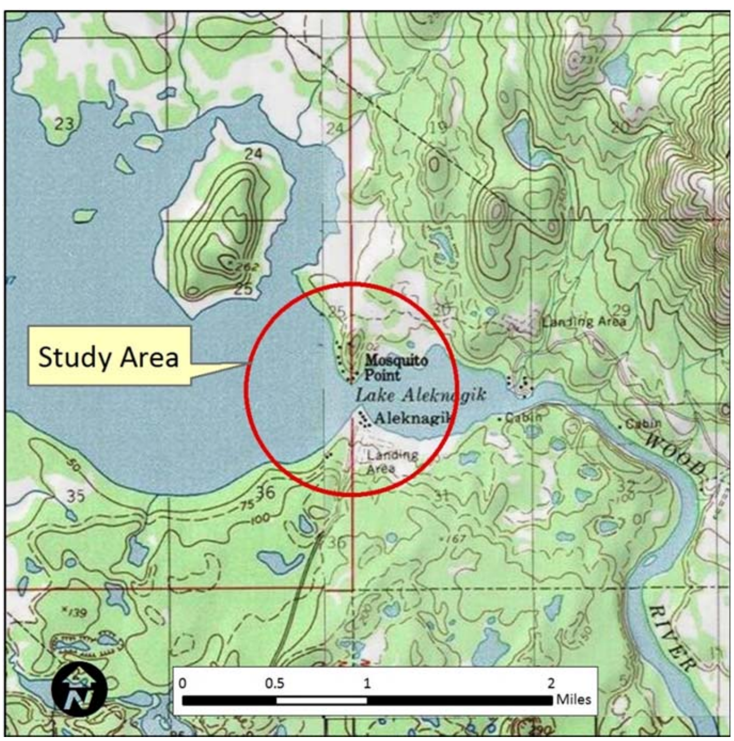


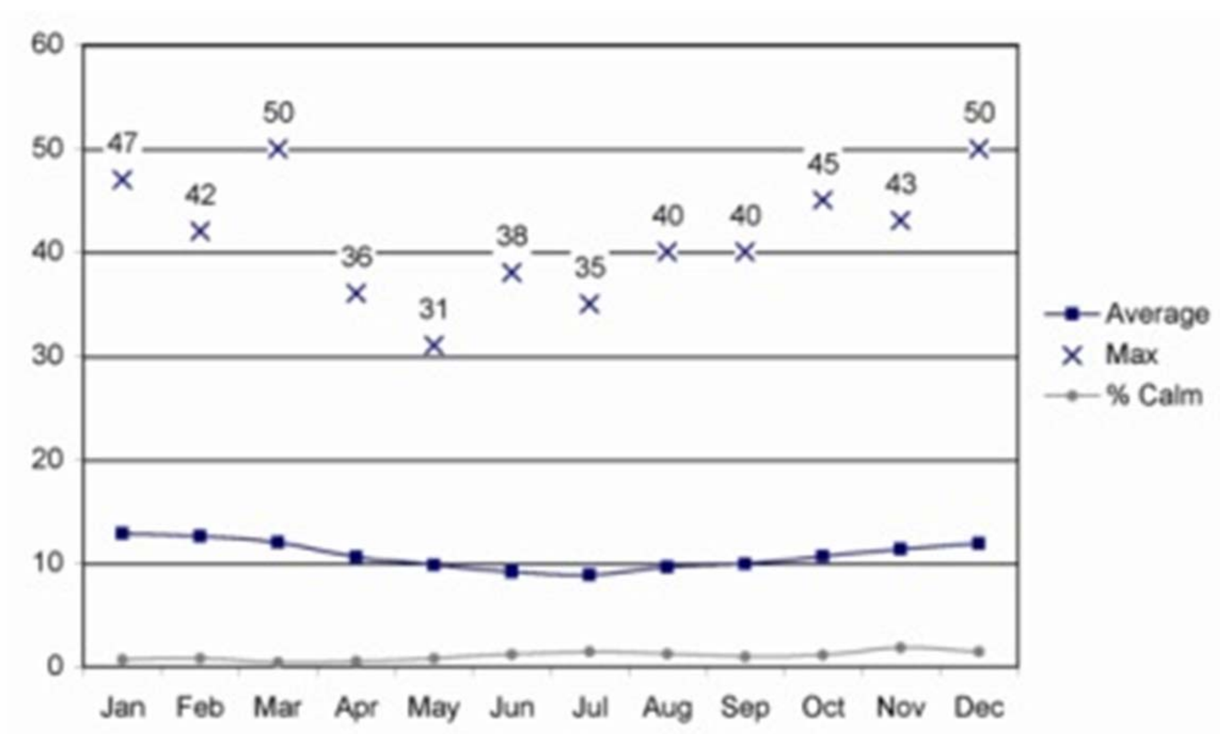
Figure 2 shows CTA Architects' plan of the location of the proposed biomass facility and surrounding buildings. The site is relatively flat and sparsely populated with buildings. The facility will be located in a separate building south of the fire department garage. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 2: Location of Proposed Biomass Facility

METEOROLOGY

Aleknagik is located relatively close (approximately 40 miles) to the ocean and therefore has a mostly maritime climate. Meteorological data from Bethel, AK, was reviewed to develop an understanding of the weather conditions. Bethel is approximately 150 miles away, but also located in the same climactic region of Alaska and therefore experiences similar weather patterns. As shown in the bottom of Figure 3, there is a relatively low percentage of "calms" (times when the wind is not blowing) during most of the year.[1] This data indicates only 1% of the year when "calms" occur, which suggests there will be minimal time periods when thermal inversions and, as a result, poor emission dispersion conditions occur.

Figure 3: Wind Speed Data from Bethel, AK



[1] See: http://climate.gi.alaska.edu/Climate/Wind/Direction/Bethel/BET.html

DESIGN & OPERATION RECOMMENDATIONS

The following are suggested for designing this project:

- Burn natural wood, whose characteristics (moisture content, bark content, species, geometry) - result in optimal combustion in the equipment selected for the project.
- Do not install a rain cap above the stack. Rain caps obstruct vertical airflow and reduce dispersion of emissions.
- Construct the stack to at least 1.5 times the height of the tallest roofline of the adjacent building. Hence, a 20 foot roofline would result in a minimum 30 foot stack.
- Operate and maintain the boiler according to manufacturer's recommendations.
- Perform a tune-up at least every other year as per manufacturer's recommendations and EPA guidance (see below for more discussion of EPA requirements)
- Conduct regular observations of stack emissions. If emissions are not characteristic of good boiler operation, make corrective actions.

These design and operation recommendations are based on the assumption that state-of-the-art combustion equipment is installed.

STATE AND FEDERAL PERMIT REQUIREMENTS

This project will not require an air pollution control permit from the Alaska Department of Environmental Quality given the boilers' relatively small size and corresponding quantity of emissions. However, this project will be subject to new proposed requirements in the federal "Area Source Rule" (40 CFR 63 JJJJJJ). A federal permit is not needed. However, there are various record keeping, reporting and operation and maintenance requirements which must be performed to demonstrate compliance with the requirements in the Area Source Rule. The proposed changes have not been finalized. Until that time, the following requirements are applicable:

- Submit initial notification form to EPA within 120 days of startup.
- Complete biennial tune ups per EPA method.
- Submit tune-up forms to EPA.

Please note the following:

- Oil and coal fired boilers are also subject to this rule.
- Gas fired boilers are not subject to this rule.
- More requirements are applicable to boilers equal to or greater than 10 MMBtu/hr heat input. These requirements typically warrant advanced emission controls, such as a baghouse or an electrostatic precipitator (ESP).

The compliance guidance documents and compliance forms can be obtained on the following EPA web page: http://www.epa.gov/boilercompliance/

SUMMARY & CONCLUSIONS

RSG has completed an air quality feasibility study for a new cord wood boiler for the Aleknagik Main City Hall. The boiler is not subject to state permitting requirements, but is subject to federal requirements. Design criteria have been suggested to minimize emissions and maximize dispersion.

The following conditions suggest advanced emission control devices (ESP, baghouse) are not warranted:

1. Aleknagik is a very rural area with no significant emission sources.
2. Aleknagik has favorable meteorology for emissions dispersion.
3. The wood boiler will be a relatively small emission source.
4. There are no applicable federal or state emission limits.

While not mandatory, we recommend exploring the possibility of a cyclone or multi-cyclone technology for control of fly ash and larger particulate emissions. We also recommend developing a compliance plan for the aforementioned federal requirements.

Please contact me if you have any comments or questions.

APPENDIX E

Wood Fired Heating Technologies

WOOD FIRED HEATING TECHNOLOGIES

CTA has developed wood-fired heating system projects using cord wood, wood pellet and wood chips as the primary feedstock. A summary of each system type with the benefits and disadvantages is noted below.

Cord Wood

Cord wood systems are hand-stoked wood boilers with a limited heat output of 150,000-200,000 British Thermal Units per hour (Btu/hour). Cord wood systems are typically linked to a thermal storage tank in order to optimize the efficiency of the system and reduce the frequency of stoking. Cord wood boiler systems are also typically linked to existing heat distribution systems via a heat exchanger. Product data from Garn, HS Tarm and KOB identify outputs of 150,000-196,000 Btu/hr based upon burning eastern hardwoods and stoking the boiler on an hourly basis. The cost and practicality of stoking a wood boiler on an hourly basis has led most operators of cord wood systems to integrate an adjacent thermal storage tank, acting similar to a battery, storing heat for later use. The thermal storage tank allows the wood boiler to be stoked to a high fire mode 3 times per day while storing heat for distribution between stoking. Cord wood boilers require each piece of wood to be hand fed into the firebox, hand raking of the grates and hand removal of ash. Ash is typically cooled in a barrel before being stock piled and later broadcast as fertilizer.

Cordwood boilers are manufactured by a number of European manufacturers and an American manufacturer with low emissions. These manufacturers currently do not fabricate equipment with ASME (American Society of Mechanical Engineers) certifications. When these non ASME boilers are installed in the United States, atmospheric boilers rather than pressurized boilers are utilized. Atmospheric boilers require more frequent maintenance of the boiler chemicals.

Emissions from cord wood systems are typically as follows:

PM2.5	>0.08 lb/MMbtu
NOx	0.23 lb/MMbtu
SO2	0.025 lb/MMbtu
CO2	195 lb/MMbtu

Benefits:

Small size
Lower cost
Local wood resource
Simple to operate

Disadvantages:

Hand fed - a large labor commitment
Typically atmospheric boilers (not ASME rated)
Thermal Storage is required

Wood Pellet
Wood pellet systems can be hand fed from 40 pound bags, hand shoveled from 2,500 pound sacks of wood pellets, or automatically fed from an adjacent agricultural silo with a capacity of 30-40 tons. Pellet boilers systems are typically linked to existing heat distribution systems via a heat exchanger. Product data from KOB, Forest Energy and Solagen identify outputs of 200,000-5,000,000 Btu/hr based upon burning pellets made from waste products from the western timber industry. A number of pellet fuel manufacturers produce all tree pellets utilizing bark and needles. All tree pellets have significantly higher ash content, resulting in more frequent ash removal. Wood pellet boilers typically require hand raking of the grates and hand removal of ash 2-3 times a week. Automatic ash removal can be integrated into pellet boiler systems. Ash is typically cooled in a barrel before being stock piled and later broadcast as fertilizer. Pellet storage is very economical. Agricultural bin storage exterior to the building is inexpensive and quick to install. Material conveyance is also borrowed from agricultural technology. Flexible conveyors allow the storage to be located 20 feet or more from the boiler with a single auger.

Emissions from wood pellet systems are typically as follows:

PM2.5	>0.09 lb/MMbtu
NOx	0.22 lb/MMbtu
SO2	0.025 lb/MMbtu
CO2	220 lb/MMbtu

Benefits:
Smaller size (relative to a chip system)
Consistent fuel and easy economical storage of fuel
Automated

Disadvantages:
Higher system cost
Higher cost wood fuel ($/MMBtu)

Wood Chip

Chip systems utilize wood fuel that is either chipped or ground into a consistent size of 2-4 inches long and 1-2 inches wide. Chipped and ground material includes fine sawdust and other debris. The quality of the fuel varies based upon how the wood is processed between the forest and the facility. Trees which are harvested in a manner that minimizes contact with the ground and run through a chipper or grinder directly into a clean chip van are less likely to be contaminated with rocks, dirt and other debris. The quality of the wood fuel will also be impacted by the types of screens placed on the chipper or grinder. Fuel can be screened to reduce the quantity of fines which typically become airborne during combustion and represent lost heat and increased particulate emissions.

Chipped fuel is fed from the chip van into a metering bin, or loaded into a bunker with a capacity of 60 tons or more. Wood chip boilers systems are typically linked to existing heat distribution systems via a heat exchanger. Product data from Hurst, Messersmith and Biomass Combustion Systems identify outputs of 1,000,000 - 50,000,000 Btu/hr based upon burning western wood fuels. Wood chip boilers typically require hand raking of the grates and hand removal of ash daily. Automatic ash removal can be integrated into wood chip boiler systems. Ash is typically cooled in a barrel before being stock piled and later broadcast as fertilizer.

Emissions from wood chip systems are typically as follows:

PM2.5	0.21 lb/MMbtu
NOx	0.22 lb/MMbtu
SO2	0.025 lb/MMbtu
CO2	195 lb/MMbtu

Benefits:

Lowest fuel cost of three options ($/MMBtu)
Automated
Can use local wood resources

Disadvantages:

Highest initial cost of three types
Larger fuel storage required
Less consistent fuel can cause operational and performance issues