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

July 24, 2012

Minto Village Council
Minto, Alaska

Presented by
CTA Architects Engineers
Nick Salmon & Nathan Ratz

Lars Construction Management Services
Rex Goolsby

For
Minto Village Council

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

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306 W. Railroad, Suite 104
Missoula, MT 59802
406.728.9522
www.ctagroup.com

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1.0 Executive Summary

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system in the Lakeview Lodge, the Health Center, the Community Hall, and a future Fire Station in Minto, Alaska.

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

Table 1.1 - Annual Fuel Use Summary

Facility Name	Fuel Type	Avg. Use (Gallons)	Current Cost $/Gal	Annual Cost
Lakeview Lodge	Fuel Oil	10,000	$5.65	$56,500
Community Hall	Fuel Oil	950	$5.65	$5,368
Future Fire Station	None	-	-	-
Medical Clinic	Fuel Oil	1,400	$5.65	$7,910

Table 1. 2 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)
Lakeview Lodge (LL)	10,000	87.4	79.7
Health Clinic (HC)	1,400	12.2	11.2
Community Center (CC)	950	8.3	7.6
Future Fire Department (FD)	1,250	10.9	10.0
LL + HC	11,400	99.6	90.8

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

Based on the potential wood use both pellet boiler and cord wood boiler options were investigated and were as follows:

Wood Pellet Boiler Options:
- B.1: Lakeview Lodge and Health Center.

Cord Wood Boiler Options:
- C.1: Lakeview Lodge.
- C.2: Lakeview Lodge and Health Center.

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

Table 1.3 - Economic Evaluation Summary Minto 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
B.1	$670,000	$5,199	$579,979	$286,108	0.43	0.87	$420,716	$1,053,449	25
C.1	$298,000	$17,176	$1,054,942	$571,617	1.92	3.54	$823,607	$1,862,159	11
C.2	$325,000	$21,463	$1,246,405	$682,006	2.10	3.84	$980,472	$2,192,971	10

The Lakeview Lodge combined with the Health Center appears to be a good candidate for the use of a wood biomass heating system. With the current economic assumptions, the estimated fuel use, and the reported fuel oil prices, this option has a very strong 20 year B/C ratio of 2.1. It is an increased benefit to add the health center to the lodge project even with the additional piping and pumping costs.

Additional sensitivity analysis has been performed. The sensitivity was performed on option C.2, with the cost of fuel oil being varied as well as varying the cost of wood fuel. With cord wood at $200/cord, the 20 year B/C exceeds 1.0 at $4.10/gallon for fuel oil. With cord wood at $150/cord, the 20 year B/C exceeds 1.0 at $3.70/gallon for fuel oil.

2.0 Introduction

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system in the Lakeview Lodge, the Health Center, the Community Hall, and a future Fire Station in Minto, Alaska.

3.0 Existing Building Systems

The buildings are all owned and operated by the Minto Village Council. The buildings are all located in the town of Minto.

The Lakeview Lodge is a two story wood framed building constructed in approximately 1982. The facility is approximately 11,300 square feet and is heated by a 348,000 Btu/hr output hot water boiler. Domestic hot water is provided by a 170,000 Btu/hr fuel oil fired hot water heater with a 70 gallon tank. The existing boiler is original to the building and is in fair condition. The heating system infrastructure is original to the building an in fair condition. The building envelop is in poor condition.

The Minto Community Hall is an 8-inch log building with some wood framed walls constructed in 2005. The facility is approximately 6,300 square feet and is heated by a 175,000 Btu/hr output hot water boiler and by a cord wood stove capable of receiving 4-foot length logs. The cord wood stove serves the large community room. The boiler heats the toilet rooms, the small kitchen, and some storage rooms at the entry. There is also a unit heater connected to the boiler system that heats the large community room, but it is valved off and the community room is currently unheated unless there is an event. Only approximately 1,700 square feet of the building is heated with the boiler system. Domestic hot water is provided by an electric water heater rated at 4.5 KW input with 40 gallon storage. The existing boiler is original to the building and is in good condition. The heating system infrastructure is original to the building and in good condition.

The future Fire Station is proposed to be located in an existing building next to the water plant. This existing building is a wood framed building approximately 5,000 square feet. The building is currently not heated and the boiler has been removed from the building. Portions of the building are abandoned and in disrepair, other portions are used for unheated storage, and the two bay garage on the west side is used by the Village Council for some vehicle maintenance. This two bay garage area and some of the adjacent rooms are proposed to be remodeled and used for the future fire station. There is no domestic hot water in the building.

Facilities Dropped from Feasibility Study
No facilities were dropped from the feasibility study.

Facilities Added to Feasibility Study
The Health Center was added to the feasibility study during the field visit. The clinic is a wood framed building constructed in approximately 2005 and located next to Lakeview Lodge. The facility is approximately 2,000 square feet and is heated by a 115,000 Btu/hr output hot water boiler. Domestic hot water is provided by a 40 gallon indirect water heater using the boiler water as a heating source. The existing boiler is original to the building and is in good condition. The heating system infrastructure is original to the building an in good condition.

4.0 Energy Use

The Minto Village Council purchases fuel oil in bulk and fills storage tanks which are then used to provide fuel to MVC vehicles, equipment, and building heat. The amount of fuel used at each building for heating is not currently tracked. The Village Council has estimated that 12,000 gallons is used for building heat at their facilities. CTA has estimated the potential fuel use at each building based on square footage and estimated heating energy use index. The following table summarizes the data:

Table 4.1 - Annual Fuel Use Summary

Facility Name	Fuel Type	Avg. Use (Gallons)	Current Cost $/Gal	Annual Cost
Lakeview Lodge	Fuel Oil	10,000	$5.65	$56,500
Community Hall	Fuel Oil	950	$5.65	$5,368
Future Fire Station	None	-	-	-
Medical Clinic	Fuel Oil	1,400	$5.65	$7,910

Electrical energy consumption will increase with the installation of a 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 boiler:

Table 5.1 - Connected Boiler Load Summary

			Output MBH	Peak Load Factor	Likely System Peak MBH
Lakeview Lodge	Boiler	Fuel Oil	348	1.00	348
Minto Health Clinic	Boiler	Fuel Oil	115	1.00	115
Community Center	Boiler	Fuel Oil	175	1.00	175
Future Fire Dept.	Boiler	Fuel Oil	150	1.00	150
Total Of All Buildings			**788**		**788**

Typically a wood heating system is sized to meet approximately 85% of the typical annual heating energy use of the building. The existing heating systems would be used for the remaining 15% of the time during peak heating conditions, during times when the biomass heating system 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
Lakeview Lodge (LL)	348	0.6	209
Health Center (HC)	115	0.6	69
Community Center (CC)	175	0.6	105
Future Fire Dept (FD)	150	0.6	90
LL + HC	463	0.6	278

The buildings are too far apart to consider a district heating system to connect all of them together. The Lakeview Lodge and the Health Center could be fed from a single boiler plant because they are adjacent to each other.

6.0 Wood Fuel Use

The types of fuel available in the area include cord wood and wood pellets. The estimated amount of wood fuel needed for 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)
Lakeview Lodge (LL)	10,000	87.4	79.7
Health Clinic (HC)	1,400	12.2	11.2
Community Center (CC)	950	8.3	7.6
Future Fire Department (FD)	1,250	10.9	10.0
LL + HC	11,400	99.6	90.8

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

The amount of wood fuels shown in the table is for offsetting 85% of the total fuel oil 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%

Based on the potential wood fuel use, cord wood and pellet boiler systems were analyzed for the Lakeview Lodge and the Health Center. The low potential wood fuel use makes a chip system not practical and no chip options will be reviewed. The low potential wood use and low potential savings for the Community Center and the future Fire Department makes those challenged projects and they will not be analyzed further.

The tribe and village corporation own over 80,000 acres of land, of which most of it is forested. There would be a sufficient supply to support a wood fired boiler for this campus. The tribe and village corporation do not currently have any active logging operations, but there are several local independent contractors that harvest firewood. Wood pellets are available from Superior Pellet Fuels out of North Pole and can be trucked own the Elliot Highway.

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	$4.00	$37.17	$29.74
					$5.00	$46.47	$37.17
					$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
Pellets	tons	16400000	0.7	11480000	$300.00	$26.13	$18.29
					$350.00	$30.49	$21.34
					$400.00	$34.84	$24.39

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 stand alone boiler plant would be required. The best location for a plant would be just west of the Lakeview Lodge, between the lodge and the health center.

Any type of biomass boiler system will require access by delivery vehicles. For cord wood systems this would likely be pick up trucks and trucks with trailers. For pellet systems, this would likely require large delivery vehicles such as 40 foot long trailers. The proposed plant location would allow for good access since it will be just off a wide road (Lakeview Road) and will allow for tractor trailers to maneuver. Minto connects to the Elliot Highway via Minto road and this road can handle the large truck traffic.

8.0 Integration with Existing Heating Systems

Integration of a wood fired heating system varies from facility to facility. Integration of a central heating system in the Lakeview Lodge would require piping heating hot water supply and return lines to the existing boiler room.

Integration of a central heating system in the Health Center would require the installation of heating hot water supply and return pipes in the existing boiler room.

The Minto Community Hall is not an obvious candidate for another wood fired heating system in addition to the existing wood stove.

The future Fire Station is not an obvious candidate for a wood fired heating system.

The field visit confirmed the location of each boiler room and heating unit location 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 or building. Once the heating water supply and return piping enters the existing boiler room it would be connected to existing supply and return lines in appropriate locations in order to utilize existing pumping systems within each building.

9.0 Air Quality Permits

Resource System Group has done a preliminary review of potential air quality issues in the area. Interior Alaska is prone to meteorological conditions that create thermal inversions, which 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 air quality memo in appendix D.

10.0 Wood Heating 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 both pellet boiler and cord wood boiler options were investigated and were as follows:

Wood Pellet Boiler Options:

B.1: Lakeview Lodge and Health Center.

Cord Wood Boiler Options:

C.1: Lakeview Lodge.

C.2: Lakeview Lodge and Health Center.

Option B.1 would be installed in a freestanding building and an adjacent free standing pellet silo. Option C.1 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/or 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, cord wood delivered at $200/ton, and pellets delivered at $375/ton. The fuel oil, electricity, and cord wood costs are based on the costs reported by the facility. Pellet costs were obtained from Superior Pellet Fuels. 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 also 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
Minto 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
B.1	$670,000	$5,199	$579,979	$286,108	0.43	0.87	$420,716	$1,053,449	25
C.1	$298,000	$17,176	$1,054,942	$571,617	1.92	3.54	$823,607	$1,862,159	11
C.2	$325,000	$21,463	$1,246,405	$682,006	2.10	3.84	$980,472	$2,192,971	10

The benefit to cost ration (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 Minto Village Tribal Council may pursue a biomass project grant from the Alaska Energy Authority.

The Minto Village Tribal Council 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.

15.0 Summary

The Lakeview Lodge combined with the Health Center appears to be a good candidate for the use of a wood biomass heating system. With the current economic assumptions, the estimated fuel use, and the reported fuel oil prices, this option has a very strong 20 year B/C ratio of 2.1. It is an increased benefit to add the health center to the lodge project even with the additional piping and pumping costs.

Additional sensitivity analysis has been performed and is attached. The sensitivity was performed on option C.2, with the cost of fuel oil being varied as well as varying the cost of wood fuel. With cord wood at $200/cord, the 20 year B/C exceeds 1.0 at $4.10/gallon for fuel oil. With cord wood at $150/cord, the 20 year B/C exceeds 1.0 at $3.70/gallon for fuel oil. This indicates that this is still an economically viable project with fuel oil around $4.00/gallon.

16.0 Recommended Action

Most grant programs will likely require a full feasibility assessment. A full assessment would provide more detail on the air quality issues, wood fuel resources, and a schematic design of the boiler systems and system integration to obtain more accurate costs.

It is also recommended to measure and track the amount of fuel oil used by the lodge and health center to validate the usage assumptions of this report. A detailed energy analysis could also be performed to better estimate the usage, however, actual measured fuel oil use is the best since it is actual usage.

APPENDIX A

Preliminary Estimates of Probable Cost

Preliminary Estimates of Probable Cost
Biomass Heating Options
Minto, AK

Pellet Option B.1 - Lakeview Lodge + Health Center

Biomass Boiler Building:	$90,000
Wood Heating, Wood Handling System, & Pellet Silo:	$140,000
Stack/Air Pollution Control Device:	$50,000
Mechanical/Electrical within Boiler Building:	$75,000
Underground Piping	$18,000
Lakeview Lodge Integration	$9,500
Health Clinic Integration	$7,200
Subtotal:	$389,700
30% Remote Factor	$116,910
Subtotal:	$506,610
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$75,992
Subtotal:	$582,602
15% Contingency:	$87,390
Subtotal:	$ 669,992
Total Project Costs	**$669,992**

Preliminary Estimates of Probable Cost
Biomass Heating Options
Minto, AK

Cord Wood Option C.1 - Lakeview Lodge

Cord Wood Storage/ Boiler Building:		$97,500
Wood Heating Boiler:		$32,000
Stack:		$4,400
Mechanical/Electrical within Boiler Building:		$20,200
Underground Piping		$10,000
Lakeview Lodge Integration		$9,500
Subtotal:		$173,600
30% Remote Factor		$52,080
Subtotal:		$225,680
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$33,852
Subtotal:		$259,532
15% Contingency:		$38,930
Subtotal:	$	298,462
Total Project Costs		**$298,462**

Cord Wood Option C.2 - Lakeview Lodge + Health Center

Cord Wood Storage/ Boiler Building:		$97,500
Wood Heating Boiler:		$32,000
Stack:		$4,400
Mechanical/Electrical within Boiler Building:		$20,200
Underground Piping		$18,000
Lakeview Lodge Integration		$9,500
Health Clinic Integration		$7,200
Subtotal:		$188,800
30% Remote Factor		$56,640
Subtotal:		$245,440
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$36,816
Subtotal:		$282,256
15% Contingency:		$42,338
Subtotal:	$	324,594
Total Project Costs		**$324,594**

APPENDIX B

Cash Flow Analysis
&
Economic Sensitivity Analysis

Lakeview Lodge
Minto, Alaska

Option B.1
Wood Pellet Boiler

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

EXISTING CONDITIONS	**Lakeview Ldg**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$5.65	$5.65	$5.65	$5.65	
Estimated Average Annual Fuel Usage:	10,000				10,000
Annual Heating Costs:	$56,500	$0	$0	$0	$56,500
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	1,345,000,000	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	1,076,000,000	0	0	0	1,076,000,000

WOOD FUEL COST	**Wood Pellets**
$/ton:	$375.00
Assumed efficiency of wood heating system (%):	70%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 7% MC**	8200
Tons of wood fuel to supplant net equivalent of 100% annual heating load.	94
Tons of wood fuel to supplant net equivalent of 85% annual heating load.	80
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	3

Project Capital Cost	**-$670,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$670,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	15000 kWh
Elec Rate	$0.650 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	2.0	40	80	$20.00	$1,600
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:	128.9 years		
Net Present Value (30 year analysis):	$579,979	-$90,021	0.87
Net Present Value (20 year analysis):	$286,108	-$383,892	0.43
Year Accumulated Cash Flow > 0	#N/A		
Year Accumulated Cash Flow > Project Capital Cost	25		

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	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs																						
Displaced heating costs	$5.65		10000	gal	$56,500	$59,325	$62,291	$65,406	$68,676	$72,110	$75,715	$79,501	$83,476	$87,650	$92,033	$96,634	$101,466	$106,539	$111,866	$142,773	$182,218	$232,562
Displaced heating costs	$5.65		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$5.65		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$5.65		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$375.00	85%	80	tons	$29,876	$30,772	$31,695	$32,646	$33,626	$34,634	$35,673	$36,744	$37,846	$38,981	$40,151	$41,355	$42,596	$43,874	$45,190	$52,388	$60,731	$70,404
Small load existing fuel	$5.65	15%	1500	gal	$8,475	$8,899	$9,344	$9,811	$10,301	$10,816	$11,357	$11,925	$12,521	$13,148	$13,805	$14,495	$15,220	$15,981	$16,780	$21,416	$27,333	$34,884
Small load existing fuel	$5.65	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$5.65	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$5.65	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$1,600	$1,632	$1,665	$1,698	$1,732	$1,767	$1,802	$1,838	$1,875	$1,912	$1,950	$1,989	$2,029	$2,070	$2,111	$2,331	$2,573	$2,841
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.650				$9,750	$10,238	$10,749	$11,287	$11,851	$12,444	$13,066	$13,719	$14,405	$15,125	$15,882	$16,676	$17,510	$18,385	$19,304	$24,638	$31,445	$40,132
Annual Operating Cost Savings					***$5,199***	***$6,153***	***$8,838***	***$9,964***	***$11,166***	***$12,449***	***$13,817***	***$15,275***	***$16,829***	***$18,484***	***$20,245***	***$22,119***	***$24,111***	***$26,230***	***$28,481***	***$42,001***	***$60,136***	***$84,299***
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					***5,199***	***6,153***	***8,838***	***9,964***	***11,166***	***12,449***	***13,817***	***15,275***	***16,829***	***18,484***	***20,245***	***22,119***	***24,111***	***26,230***	***28,481***	***42,001***	***60,136***	***84,299***
Accumulated Cash Flow					***5,199***	***11,352***	***20,190***	***30,154***	***41,320***	***53,769***	***67,586***	***82,861***	***99,690***	***118,174***	***138,419***	***160,537***	***184,649***	***210,879***	***239,359***	***420,716***	***683,022***	***1,053,449***

Lakeview Lodge
Minto, Alaska

Option C.1
Cord Wood Boiler

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

EXISTING CONDITIONS	**Lakeview Ldg**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$5.65	$5.65	$5.65	$5.65	
Estimated Average Annual Fuel Usage:	10,000				10,000
Annual Heating Costs:	$56,500	$0			$56,500
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	1,345,000,000	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	1,076,000,000	0	0	0	1,076,000,000

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/lb) - **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.	102.3
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	87.0
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$298,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$298,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	17.4 years
Net Present Value (30 year analysis):	$1,054,942
Net Present Value (20 year analysis):	$571,617
Year Accumulated Cash Flow > 0	#N/A
Year Accumulated Cash Flow > Project Capital Cost	11

	Net Benefit	B/C Ratio
	$756,942	3.54
	$273,617	1.92

Additional Power Use	
Est. Pwr Use	1000 kWh
Elec Rate	$0.650 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	14.0	40	560	$20.00	$11,200
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

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	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs																						
Displaced heating costs	$5.65		10000	gal	$56,500	$59,325	$62,291	$65,406	$68,676	$72,110	$75,715	$79,501	$83,476	$87,650	$92,033	$96,634	$101,466	$106,539	$111,866	$142,773	$182,218	$232,562
Displaced heating costs	$5.65		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$5.65		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$5.65		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	87	cords	$17,399	$17,921	$18,459	$19,013	$19,583	$20,171	$20,776	$21,399	$22,041	$22,702	$23,383	$24,085	$24,807	$25,552	$26,318	$30,510	$35,370	$41,003
Small load existing fuel	$5.65	15%	1500	gal	$8,475	$8,899	$9,344	$9,811	$10,301	$10,816	$11,357	$11,925	$12,521	$13,148	$13,805	$14,495	$15,220	$15,981	$16,780	$21,416	$27,333	$34,884
Small load existing fuel	$5.65	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$5.65	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$5.65	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$11,200	$11,424	$11,652	$11,886	$12,123	$12,366	$12,613	$12,865	$13,123	$13,385	$13,653	$13,926	$14,204	$14,488	$14,778	$16,316	$18,014	$19,889
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.650				$650	$683	$717	$752	$790	$830	$871	$915	$960	$1,008	$1,059	$1,112	$1,167	$1,226	$1,287	$1,643	$2,096	$2,675
Annual Operating Cost Savings					***$17,176***	***$18,766***	***$22,119***	***$23,944***	***$25,878***	***$27,927***	***$30,098***	***$32,397***	***$34,831***	***$37,407***	***$40,133***	***$43,017***	***$46,067***	***$49,293***	***$52,703***	***$72,888***	***$99,405***	***$134,109***
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					***17,176***	***18,766***	***22,119***	***23,944***	***25,878***	***27,927***	***30,098***	***32,397***	***34,831***	***37,407***	***40,133***	***43,017***	***46,067***	***49,293***	***52,703***	***72,888***	***99,405***	***134,109***
Accumulated Cash Flow					***17,176***	***35,942***	***58,061***	***82,005***	***107,883***	***135,811***	***165,909***	***198,306***	***233,137***	***270,543***	***310,676***	***353,693***	***399,760***	***449,052***	***501,755***	***823,607***	***1,264,728***	***1,862,159***

Lakeview Lodge and Health Center

Minto, Alaska

Option C.2

Cord Wood Boiler

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

EXISTING CONDITIONS	**Lakeview Ldg**	**Health Cl.**			**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$5.65	$5.65			
Estimated Average Annual Fuel Usage:	10,000	1,400			11,400
Annual Heating Costs:	$56,500	$7,910			$64,410
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	1,345,000,000	188,300,000	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	1,076,000,000	150,640,000	0	0	1,226,640,000

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/lb) - **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.	116.7
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	99.2
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$325,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$325,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1000 kWh
Elec Rate	$0.650 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	14.0	40	560	$20.00	$11,200
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:	15.1 years		
Net Present Value (30 year analysis):	$1,246,405	$921,405	3.84
Net Present Value (20 year analysis):	$682,006	$357,006	2.10
Year Accumulated Cash Flow > 0	#N/A		
Year Accumulated Cash Flow > Project Capital Cost	10		

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	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs																						
Displaced heating costs	$5.65		10000	gal	$56,500	$59,325	$62,291	$65,406	$68,676	$72,110	$75,715	$79,501	$83,476	$87,650	$92,033	$96,634	$101,466	$106,539	$111,866	$142,773	$182,218	$232,562
Displaced heating costs	$5.65		1400	gal	$7,910	$8,306	$8,721	$9,157	$9,615	$10,095	$10,600	$11,130	$11,687	$12,271	$12,885	$13,529	$14,205	$14,915	$15,661	$19,988	$25,511	$32,559
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	99	cords	$19,835	$20,430	$21,043	$21,675	$22,325	$22,995	$23,684	$24,395	$25,127	$25,881	$26,657	$27,457	$28,281	$29,129	$30,003	$34,781	$40,321	$46,743
Small load existing fuel	$5.65	15%	1500	gal	$8,475	$8,899	$9,344	$9,811	$10,301	$10,816	$11,357	$11,925	$12,521	$13,148	$13,805	$14,495	$15,220	$15,981	$16,780	$21,416	$27,333	$34,884
Small load existing fuel	$5.65	15%	210	gal	$1,187	$1,246	$1,308	$1,374	$1,442	$1,514	$1,590	$1,670	$1,753	$1,841	$1,933	$2,029	$2,131	$2,237	$2,349	$2,998	$3,827	$4,884
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$11,200	$11,424	$11,652	$11,886	$12,123	$12,366	$12,613	$12,865	$13,123	$13,385	$13,653	$13,926	$14,204	$14,488	$14,778	$16,316	$18,014	$19,889
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.650				$650	$683	$717	$752	$790	$830	$871	$915	$960	$1,008	$1,059	$1,112	$1,167	$1,226	$1,287	$1,643	$2,096	$2,675
Annual Operating Cost Savings					***$21,463***	***$23,317***	***$26,948***	***$29,066***	***$31,309***	***$33,685***	***$36,200***	***$38,862***	***$41,679***	***$44,659***	***$47,811***	***$51,144***	***$54,668***	***$58,393***	***$62,330***	***$85,606***	***$116,137***	***$156,044***
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					***21,463***	***23,317***	***26,948***	***29,066***	***31,309***	***33,685***	***36,200***	***38,862***	***41,679***	***44,659***	***47,811***	***51,144***	***54,668***	***58,393***	***62,330***	***85,606***	***116,137***	***156,044***
Accumulated Cash Flow					***21,463***	***44,780***	***71,728***	***100,793***	***132,102***	***165,787***	***201,987***	***240,848***	***282,527***	***327,186***	***374,997***	***426,141***	***480,809***	***539,203***	***601,533***	***980,472***	***1,496,810***	***2,192,971***

Economic Sensitiviy Analysis
Minto Biomass Heating System

Line No.	Project Cost	Fuel Oil Usage Gal	Fuel Oil Unit Cost $/Gal.	Wood Fuel Cost $/cord ton	Fuel Oil & Elec Inflation	Wood Fuel Inflation	Additional O&M	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 10	ACF YR 20	ACF YR 30	YR ACF=PC
	All Options - Base Cases															
B.1	$670,000	10,000	$5.65	$375	5.0%	3.0%	$1,600	$5,199	$579,979	$286,108	0.43	0.87	$118,174	$420,716	$1,053,449	25
C.1	$298,000	10,000	$5.65	$200	5.0%	3.0%	$11,200	$17,176	$1,054,942	$571,617	1.92	3.54	$270,543	$823,607	$1,862,159	11
C.2	$325,000	11,400	$5.65	$200	5.0%	3.0%	$11,200	$21,463	$1,246,405	$682,006	2.10	3.84	$327,186	$980,472	$2,192,971	10
1	**Option C.2 is the strongest economic case and will be used for further sensitivity analysis.**															
2																
3	**C.2 - Adjusting Fuel Oil Cost**															
4	$325,000	11,400	$3.50	$200	5.0%	3.0%	$11,200	$630	$433,291	$193,391	0.60	1.33	$65,144	$291,592	$808,817	21
5	$325,000	11,400	$4.00	$200	5.0%	3.0%	$11,200	$5,475	$622,387	$307,023	0.94	1.92	$126,084	$451,797	$1,130,713	17
6	$325,000	11,400	$4.10	$200	5.0%	3.0%	$11,200	$6,444	$660,207	$329,749	1.01	2.03	$138,272	$483,838	$1,195,093	17
7	$325,000	11,400	$4.50	$200	5.0%	3.0%	$11,200	$10,320	$811,484	$420,654	1.29	2.50	$187,024	$612,001	$1,452,610	15
8	$325,000	11,400	$5.00	$200	5.0%	3.0%	$11,200	$15,165	$1,000,580	$534,285	1.64	3.08	$247,964	$772,206	$1,774,506	12
9	$325,000	11,400	$5.50	$200	5.0%	3.0%	$11,200	$20,010	$1,189,676	$647,917	1.99	3.66	$308,904	$932,410	$2,096,402	11
10	$325,000	11,400	$6.00	$200	5.0%	3.0%	$11,200	$24,855	$1,378,772	$761,548	2.34	4.24	$369,844	$1,092,615	$2,418,298	10
11																
12	**C.2 - Adjusting Fuel Oil Cost and Wood Fuel Cost**															
13	$325,000	11,400	$3.70	$150	5.0%	3.0%	$11,200	$7,526	$653,362	$335,132	1.03	2.01	$146,368	$488,920	$1,173,495	17
14	$325,000	11,400	$4.00	$150	5.0%	3.0%	$11,200	$10,433	$766,820	$403,311	1.24	2.36	$182,932	$585,043	$1,366,633	15
15	$325,000	11,400	$4.50	$150	5.0%	3.0%	$11,200	$15,278	$955,916	$516,942	1.59	2.94	$243,872	$745,247	$1,688,529	13
16	$325,000	11,400	$5.00	$150	5.0%	3.0%	$11,200	$20,123	$1,145,012	$630,574	1.94	3.52	$304,812	$905,452	$2,010,425	11
17	$325,000	11,400	$4.00	$200	5.0%	3.0%	$11,200	$5,475	$622,387	$307,023	0.94	1.92	$126,084	$451,797	$1,130,713	17
18	$325,000	11,400	$4.10	$200	5.0%	3.0%	$11,200	$6,444	$660,207	$329,749	1.01	2.03	$138,272	$483,838	$1,195,093	17
19	$325,000	11,400	$4.50	$200	5.0%	3.0%	$11,200	$10,320	$811,484	$420,654	1.29	2.50	$187,024	$612,001	$1,452,610	15
20	$325,000	11,400	$5.00	$200	5.0%	3.0%	$11,200	$15,165	$1,000,580	$534,285	1.64	3.08	$247,964	$772,206	$1,774,506	12
21																

22 NPV: Net Present Value

YR ACF=PC : Year Accumulated Cash Flow equals Project Cost

CTA

July 24, 2012

APPENDIX C

Site Plan

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

BIOMASS PRE-FEASIBILITY ASSESSMENT
MINTO OVERVIEW
MINTO, ALASKA

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

SITE PLAN

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

BIOMASS PRE-FEASIBILITY ASSESSMENT

LAKEVIEW LODGE & MINTO HEALTH CLINIC

MINTO, 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:	Fairbanks Cluster Feasibility Study
Date:	24 July 2012

INTRODUCTION

At your request, RSG has conducted an air quality feasibility study for three biomass energy installations in Manley, Minto and Nenana. These sites are located in the interior of Alaska near Fairbanks. The following equipment is proposed:

- Minto - one 300,000 Btu/hr (heat output) cord wood boiler at the Minto Health Clinic.
- Manley - one 150,000 Btu/hr (heat output) cord wood boiler at the Village Express Maintenance Shop.
- Nenana – one 4,200,000 Btu/hr (heat output) wood chip boiler at the Nenana School.

MINTO STUDY AREA

A USGS map of the Minto study area is provided in Figure 1 below. As shown, the area is flat with much low-lying areas to the east and hilly to the west. The site is adjacent to a hillside. The area is relatively sparsely populated. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

55 Railroad Row ▪ White River Junction, Vermont 05001
TEL 802.295.4999 ▪ FAX 802.295.1006 ▪ www.rsginc.com

Figure 1: USGS Map Illustrating the Minto Study Area

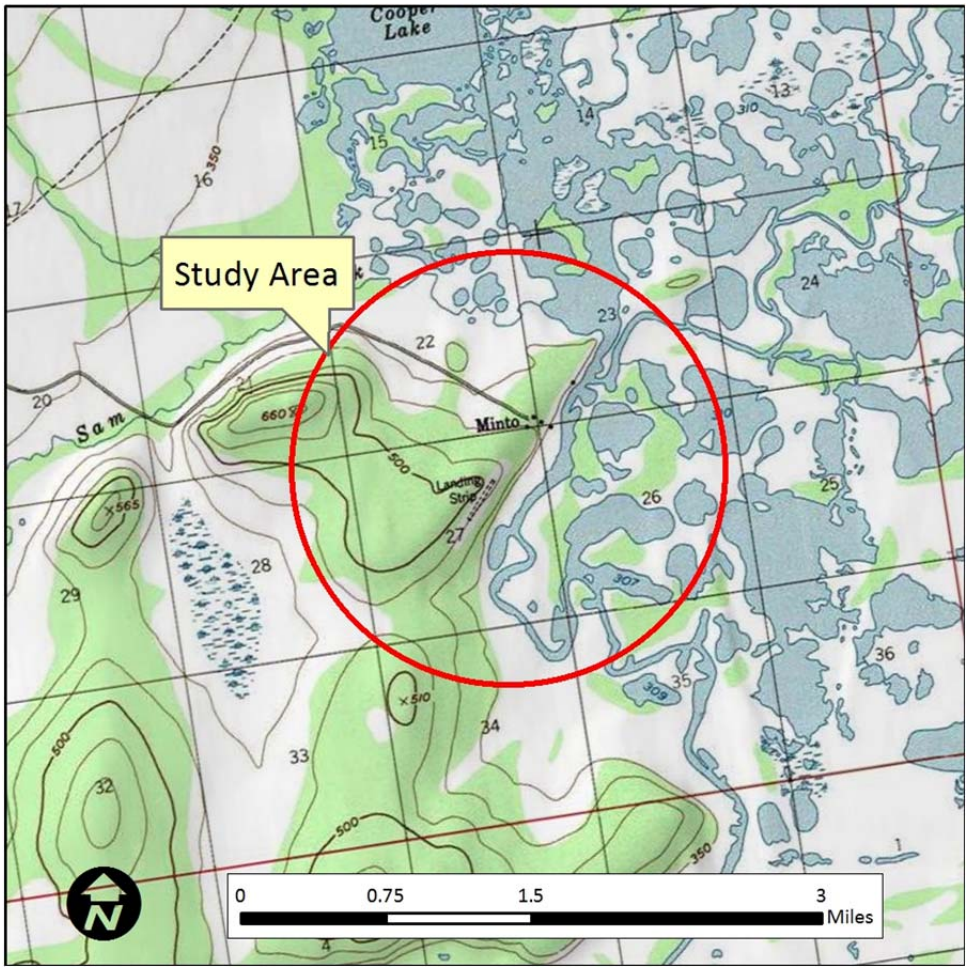


Figure 2 shows CTA Architects' plan of the location of the proposed biomass facility and the surrounding buildings in Minto. The site is relatively flat and sparsely populated with buildings. The facility will be located in a remote building on the southeast side of two buildings. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined. The degree of separation of the biomass building from the other buildings will create a buffer for emissions dispersion.

Figure 2: Location of Proposed Facility in Minto

A USGS map of the Manley study area is provided Figure 3. As shown, the area is hilly to mountainous to the north and flat to the south. The site is near the higher terrain to the north. The area is relatively sparsely populated. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

Figure 3: USGS Map Illustrating the Manley Hot Springs Study Area

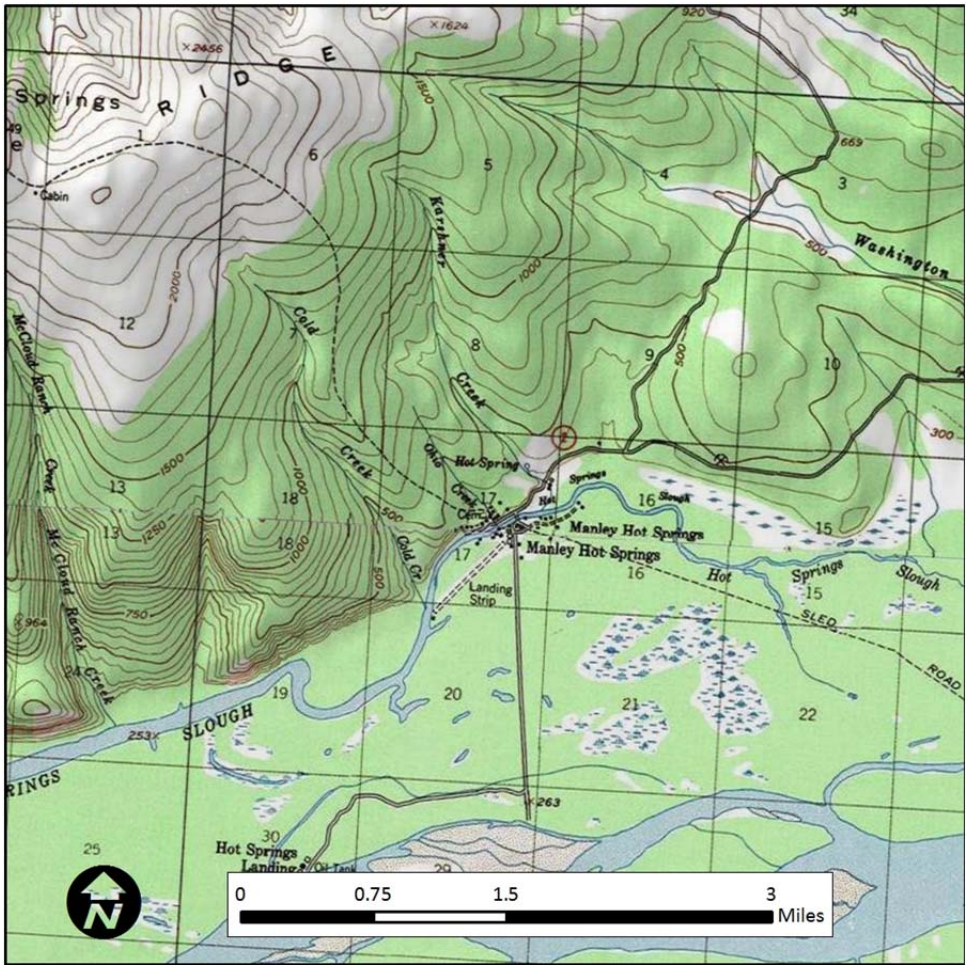


Figure 4 shows CTA Architects' plan of the location of the proposed biomass facility and the surrounding buildings. The site is surrounded by forest, relatively flat and has only a few buildings. The facility will be located in a new building on the west side of the site. A generator building is also indicated on the plan. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 4: Location of Proposed Facility in Manley

A USGS map of the Nenana study area is provided Figure 3. As shown, the area is hilly to mountainous to the north and flat to the south and northeast. The site is across the river from higher terrain to the north. The area is moderately populated relative to the other sites discussed. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

Figure 5: USGS Map Illustrating the Nenana Study Area

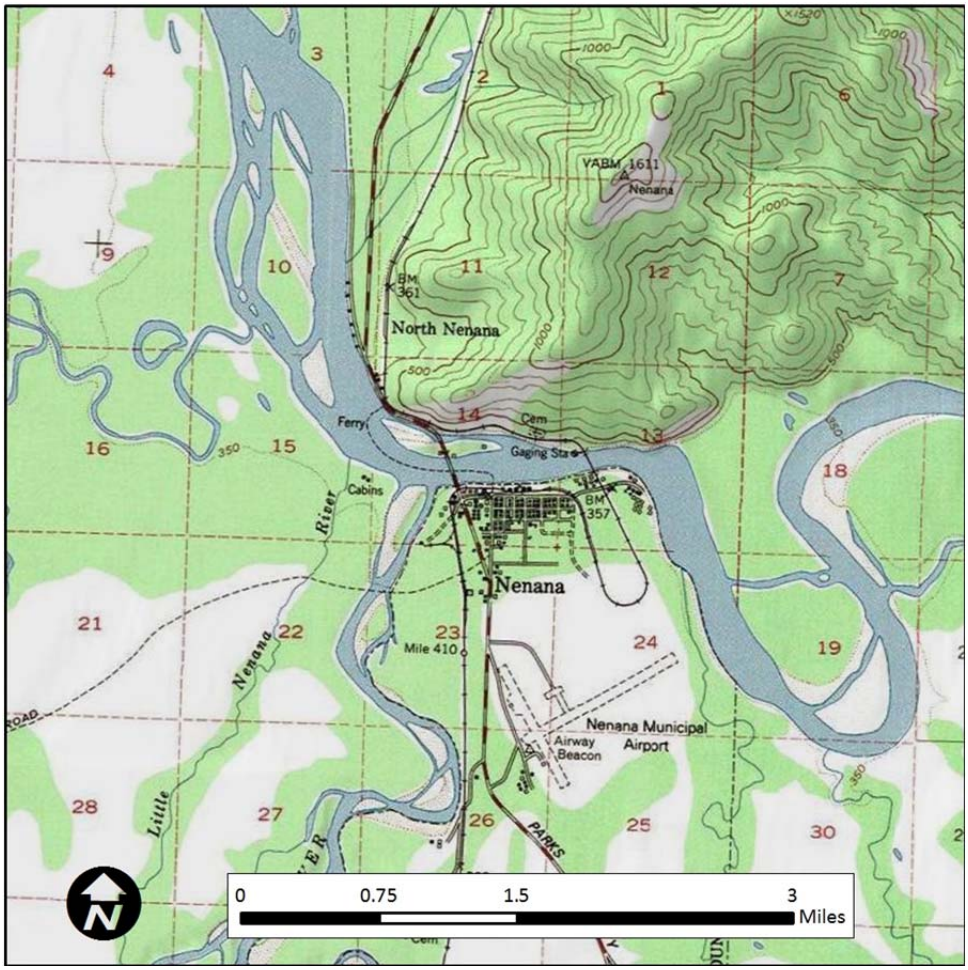
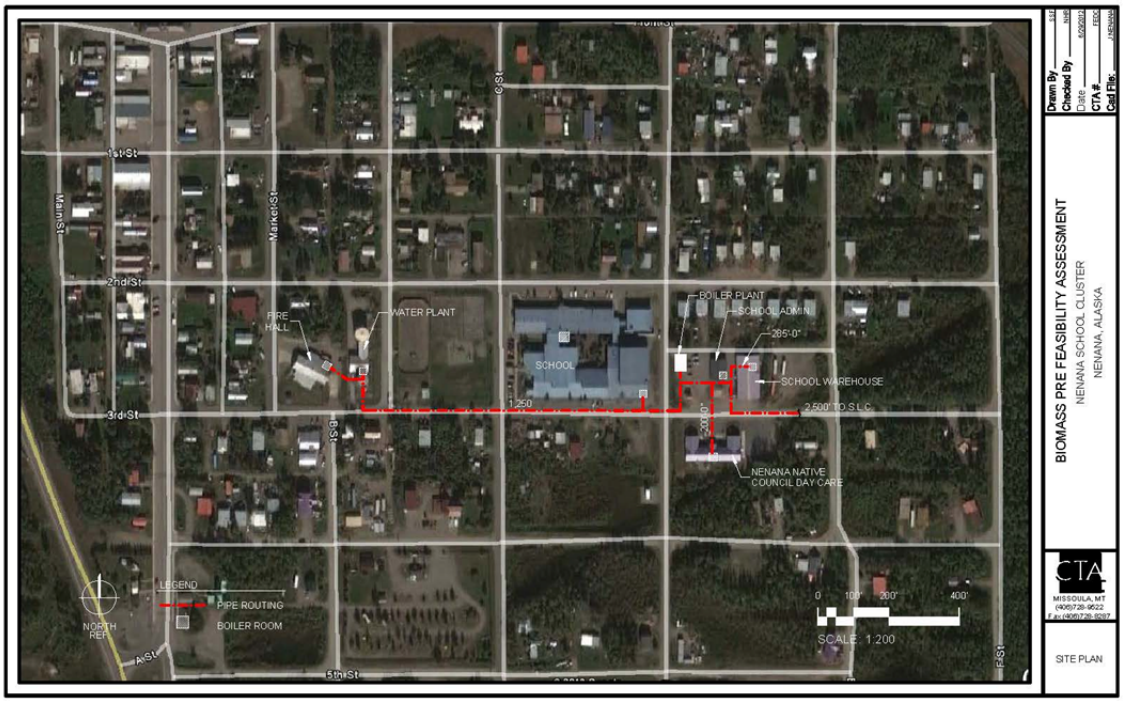


Figure 6 shows CTA Architects' plan of the location of the proposed biomass facility at the Nenana School and the surrounding buildings. The site is relatively flat and relatively densely populated with one to two story tall buildings. The proposed biomass equipment will be installed in a remote building located to the east of the school. This will provide a buffer for dispersion of air emissions between the stack and surrounding buildings. The precise stack location and dimensions, and the biomass equipment specifications have not been determined.

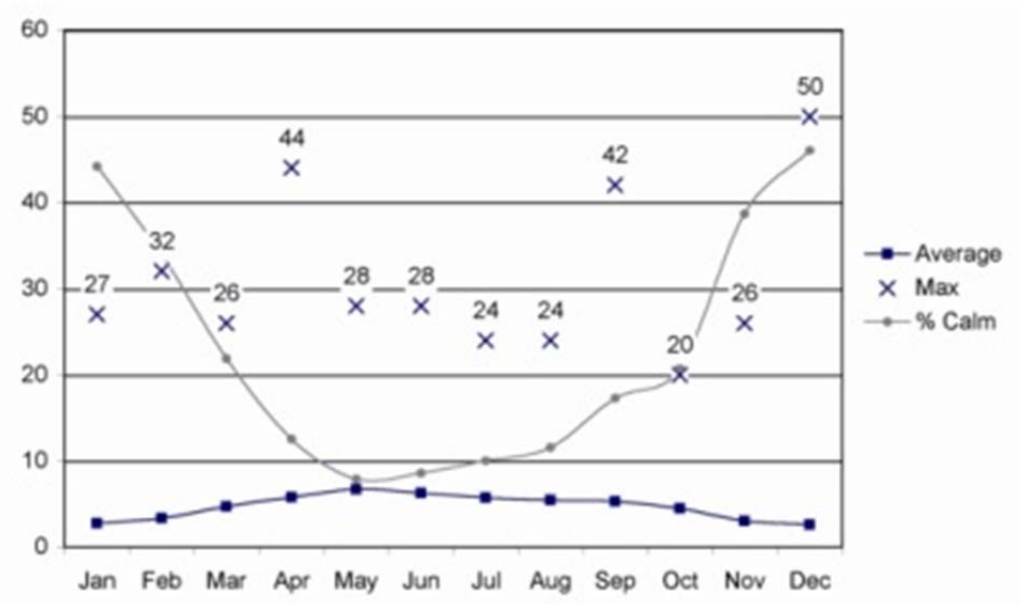
Figure 6: Overview of Nenana School Cluster Site



METEOROLOGY

Meteorological data from Fairbanks, AK was reviewed to develop an understanding of weather conditions. While Fairbanks is approximately 90 miles, 50 miles, and 45 miles away from Manley, Minto, and Nenana respectively, it is located in a similar climactic zone (Alaska Interior) and is therefore a good proxy of weather in those locations. As shown, there is a relatively high percentage of "calms" or times when the wind is not blowing during the colder months.[1] These conditions create thermal inversions which are unfavorable for the dispersion of emissions.

Figure 7: Wind Speed Data from Fairbanks, AK



DESIGN & OPERATION RECOMMENDATIONS

The following are suggested for designing the stack:

[1] See: http://climate.gi.alaska.edu/Climate/Wind/Speed/Fairbanks/FAI.html

- Burn natural wood, whose characteristics (moisture content, bark content, species, geometry) results 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.
- For the Nenana School: while there are no state or federal requirements mandating advanced emission control from and ESP or baghouse, we feel advanced emission control should be strongly considered. Alternatively, the school should consider using pellets in lieu of wood chips.

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

RSG has completed an air quality feasibility study for Minto, Manley, and Nenana, Alaska. The boilers are not subject to state permitting requirements, but are 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 mandatory:

1. The wood boilers, with the exception of the boiler at Nenana, will be relatively small emission sources.
2. The wood boilers will be located in a separate building which will create a dispersion buffer between the boiler stack and the building.
3. There are no applicable federal or state emission limits.

Sustained poor meteorology suggests emissions should be minimized as much as possible.

Given these findings, we would recommend at minimum the following be done to minimize emissions:

1. Nenana: consider burning pellets in lieu of wood chips or consider advanced emission control. If wood chips are preferable, consider conducting air dispersion modeling to determine the stack height and degree of emission control.
2. While not mandatory, we recommend exploring the possibility of a cyclone or multi-cyclone technology for control of fly ash and larger particulate emissions for all the aforementioned boilers.
3. Obtain a not-to-exceed emission guarantees from boiler equipment vendors.

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