

**Pre-Feasibility Assessment for
Integration of Wood-Fired Heating Systems
Final Report
July 24, 2012**

**AVCP-RHA Housing Authority Complex
Bethel, Alaska**

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For
AVCP

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

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



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CTA Project: FEDC_BETHEL

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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 at the AVCP-Housing Authority Complex. The review was conducted on the assumption that the complex would be served by a district heating loop.

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

Table 1.1 - Fuel Use Summary				
Facility Name	Fuel Type	Avg. Use (Gallons)	Average Annual Cost	Average Cost/Gal.
Complex	Fuel Oil	60,000	\$377,400	\$6.29
Estimate for New Regional Headquarters Office / New Maintenance Facility	Fuel Oil	7,766	\$48,848.14	\$6.29
Total	Fuel Oil	67,766	\$426,248.14	\$6.29

Table 1.2 - Annual Wood Fuel Use Summary				
	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)	Chipped/Ground Wood (Tons)
Current Campus	60,000	524.4	478.0	781.7
Expanded Campus	7,766	67.9	61.9	101.2
Total	67,766	592.2	539.9	882.9
Note: Wood fuel use assumes offsetting 85% of the current energy use.				

Based on the available wood fuel and the estimated biomass boiler size, only a pellet option will be evaluated.

Pellet Wood Boiler Option

B.1: Central plant serving all buildings in the AVCP Complex.

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

Table 1.3 - Economic Evaluation Summary Bethel AVCP RHA 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	\$3,400,000	\$103,264	\$6,570,870	\$3,467,771	1.02	1.93	\$5,016,876	\$11,689,874	17

The AVCP-RHA campus appears to be a good candidate for the use of a district wood biomass heating system. With the current economic assumptions and the current fuel use the wood pellet boiler option has a B/C ratio of 1.02, which indicates an economically favorable project.

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 AVCP-Housing Authority Complex. The review was conducted on the assumption that the complex would be served by a district heating loop.

3.0 Existing Building Systems

The AVCP RHA campus that is located on Ptarmigan Road has 8 housing buildings, 2 office buildings, and 3 warehouses / maintenance facilities. The current heating system for the campus is a combination of heat loops and standalone systems. The table below indicates the current heating systems outputs and condition.

Table 3.1 - Existing Heating System Summary			
Building	Heat System	BTU/hr Output	Condition
Lulu Heron Assisted Living Facility	Boiler 1	764,000	Good
	Boiler 2	764,000	Good
	DHW	199,000	Good
Office / Bunkhouse (District System)	Boiler 1	145,000	Good
	Boiler 2	145,000	Good
Building A-E (District System)	Boiler 1	786,000	Fair
	Boiler 2	786,000	Fair
12-Unit Housing Addition	Boiler 1	561,000	Good
	Boiler 2	561,000	Good
	DHW 1	315,000	Good
	DHW 2	315,000	Good
	DHW 3	315,000	Good
Warehouse 1	Unit Heater	185,000	Good
Warehouse 2	Unit Heater	185,000	Good
New Regional Headquarters Office	Boiler 1	1,023,000	Excellent (New)
	Boiler 2	1,023,000	Excellent (New)

Lulu Heron Assisted Living Facility

The Lulu Heron Assisted Living Facility is a wood framed building constructed in 1998. The single story facility consists of approximately 15,480 square feet. The space consists of 16-unit housing for elders and people with disabilities. In addition to the residential units there are also support spaces including steam rooms, laundry facilities, and community gathering rooms.

Domestic hot water is provided by one fuel oil water heater rated at 199,000 BTUH input with 67 gallons of storage.

Office / Bunkhouse (District Heat Loop)

The Office and Bunkhouse facility consists of two separate wood framed buildings constructed in 2004. The Office building is approximately 3,160 square feet and the

Bunkhouse building is approximately 1,680 square feet. The combined facility is heated by two 145,000 Btu/hr output hot water boilers located in the Office building mechanical room. The heating water is then piped via utilidor to the Bunkhouse building for distribution. Domestic hot water is provided by an indirect-fired Amtrol Boilermate water heater with a 41 gallon storage capacity.

Buildings A-E (District Heat Loop)

The Building A-E facility consists of 4 apartment buildings and one office building constructed in 1987-1988. Building A and B are each approximately 5,220 square feet and contain 4 apartment units each. Buildings C and D are approximately 6,700 square feet and contain 6 apartment units each. Building E is approximately 9,760 square feet and currently contains administrative offices. When the New Regional Headquarters Office is completed the office will be renovated into a 30-bed dormitory for students attending Yuut Yaquvial Plot Training School and AVCP Regional Aircraft Maintenance School.

The Building A-E facility is heated by two 786,000 Btu/hr output hot water boilers that are located in the Building E mechanical room. Two existing utilidors extend from Building E, one going to Building A and C, the other to Building B and D. Domestic hot water is provided by an indirect fired water heater with a 140 gallon storage capacity.

12-Unit Housing Addition

The 12-Unit Housing Addition is a two story wood framed buildings constructed in 1998. The facility is approximately 12,500 square feet and is heated by two 561,000 Btu/hr output hot water boilers. Domestic hot water is provided by three fuel oil water heaters rated at 315,000 input each. There currently is a laundry facility located at one end of the building. The intent is that this will be moved to the New Regional Headquarters Office when it is completed.

Warehouse 1

The warehouse is a metal building constructed in the mid-1990s. The facility is approximately 4,500 square feet and is heated by a 185,000 Btu/hr output fuel oil unit heater. There is no domestic hot water provided to the space.

Maintenance Facility

The warehouse is a metal building constructed in the mid-1990s. The facility is approximately 4,500 square feet and is heated by a 185,000 Btu/hr output fuel oil unit heater. Domestic hot water is provided by an electric water heaters rated at 4.5 KW input with a 30 gallon storage capacity.

New Regional Headquarters Office / New Maintenance Facility

The facilities are still under construction; however it is assumed they will be complete by the summer of 2012. The New Regional Headquarters Office is a two story, metal framed building containing approximately 34,000 square feet and is heated by two 1,023,000 Btu/hr output hot water boilers on the district heating system.

4.0 Energy Use

The AVCP-RHA purchases fuel oil in bulk and does not track individual building use. Also there are 2 additional buildings that are still under construction that fuel data was not available for. The following table summarizes the campus use and the estimated fuel use for the new buildings:

Table 4.1 - Fuel Use Summary				
Facility Name	Fuel Type	Avg. Use (Gallons)	Average Annual Cost	Average Cost/Gal.
Complex	Fuel Oil	60,000	\$377,400	\$6.29
Estimate for New Regional Headquarters Office / New Maintenance Facility	Fuel Oil	7,766	\$48,848.14	\$6.29
Total	Fuel Oil	67,766	\$426,248.14	\$6.29

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 the heating equipment:

Table 5.1 - Connected Boiler Load Summary					
			Output MBH	Peak Load Factor	Likely System Peak MBH
Lulu Heron Assisted Living Facility	Boiler 1	Fuel Oil	764	0.66	504
	Boiler 2	Fuel Oil	764	0.66	504
	DHW	Fuel Oil	199	0.66	131
	Total				
Office / Bunkhouse	Boiler 1	Fuel Oil	145	1.00	145
	Boiler 2	Fuel Oil	145	0.66	96
	Total				
Bldg A-E	Boiler 1	Fuel Oil	786	0.67	527
District System	Boiler 2	Fuel Oil	786	0.67	527
Total					1053
12-Unit Housing Addition	Boiler 1	Fuel Oil	561	1.00	561
	Boiler 2	Fuel Oil	561	0.66	370
	DWH	Fuel Oil	315	1.00	315
	DWH	Fuel Oil	315	1.00	315
	DWH	Fuel Oil	315	1.00	315
Total					1246
Warehouse 1	Boiler	Fuel Oil	185	1.00	185
Maintenance Facility	Boiler	Fuel Oil	185	1.00	185
New Regional Headquarters	Boiler	Fuel Oil	1023	0.60	614
	Boiler	Fuel Oil	1023	0.60	614
	Total				
Total Of All Buildings			8072		5182

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 other 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.

Table 5.2 - Proposed Biomass Boiler Size			
	Likely System Peak MBH	Biomass Boiler Factor	Biomass Boiler Size MBH
Lulu Heron Assisted Living Facility	1140	0.6	684
Office / Bunkhouse	145	0.6	87
District Heat Loop	1053	0.6	632
12-Unit Housing Addition	1246	0.6	748
Warehouse 1	185	0.6	111
Maintenance Facility	185	0.6	111
New Regional Headquarters	1228	0.6	737
Campus District Heating System	5182	0.6	3109

6.0 Wood Fuel Use

The types of wood fuel available in the area include cord wood and wood pellets. 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)	Chipped/ Ground Wood (Tons)
Current Campus	60,000	524.4	478.0	781.7
Expanded Campus	7,766	67.9	61.9	101.2
Total	67,766	592.2	539.9	882.9

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

The amount of wood fuel 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%.

There is no wood harvesting or wood products industry in the area. Cord wood comes from up river. Since there is a large enough potential demand of pellets, it is viable to purchase pellets from plants in British Columbia, Washington, or Oregon and barge them up to Bethel.

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		Delivered \$/MMBtu	Gross \$/MMBtu
				System Btu/unit	\$/unit		
Fuel Oil	gal	134500	0.8	107600	\$5.50	\$51.12	\$40.89
					\$6.29	\$58.46	\$46.77
					\$7.00	\$65.06	\$52.04
Cord Wood	cords	16173800	0.65	10512970	\$550.00	\$52.32	\$34.01
					\$600.00	\$57.07	\$37.10
					\$650.00	\$61.83	\$40.19
Pellets	tons	16400000	0.7	11480000	\$400.00	\$34.84	\$24.39
					\$460.00	\$40.07	\$28.05
					\$520.00	\$45.30	\$31.71
Chips	tons	10800000	0.65	7020000	N/A	N/A	N/A

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 an addition to the new maintenance facility building. During the master planning of the campus by Larsen Consulting Group the future addition location has been identified and planned.

Any type of biomass boiler system will require access by delivery vehicles. For pellet and chip boiler systems this would require an area for a trailer to turn around. The proposed plant location would allow for good access.

8.0 **Integration with Existing Heating Systems**

Integration of a wood fired heating system varies from facility to facility. The 12 Unit Apartment, Buildings A through E, New Office Building, Lulu Assisted Living Center, Bunkhouse, and Office space would require the installation of new heating hot water supply and return pipes to connect to the existing boiler supply and return pipes.

The Maintenance facility and Warehouse 2 would require the installation of new hot water unit heaters.

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 (RSG) has completed an air quality feasibility study for three new wood boilers in Bethel, Alaska. Bethel has favorable meteorology for dispersion of emissions. Prevailing winds would likely blow emissions towards the southeast. In addition, the proposed wood boilers will be small emission sources, whose sizes preclude them from state permitting requirements. Therefore, we do not suggest advanced emission control such as an ESP or baghouse. However, other design criteria have been suggested to minimize emissions and maximize dispersion. These projects may be subject to federal requirements.

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 available wood fuel and the estimated biomass boiler size, only a pellet option will be evaluated.

Pellet Wood Boiler Option

B.1: Central plant serving all buildings in the AVCP Complex.

The wood pellet boiler option assumes a freestanding boiler building with adjacent free standing pellet silo.

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 \$6.29/gal, electricity at \$0.50/kwh, cord wood delivered at \$600/cord, and wood pellets delivered at \$460/ton. The fuel oil, electricity, and cord wood costs are based on the costs reported by the facility. Pellet costs were obtained from an engineering study investigating using pellet boilers at the AVCP Housing Authority Complex.

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 Bethel AVCP RHA Biomass Heating System									
	Year 1	NPV	NPV	20	30				
Project	Operating	30 yr	20 yr	Yr	Yr	ACF	ACF	YR	
Cost	Savings	at 3%	at 3%	B/C	B/C	YR 20	YR 30	ACF=PC	
				Ratio	Ratio				
B.1	\$3,400,000	\$103,264	\$6,570,870	\$3,467,771	1.02	1.93	\$5,016,876	\$11,689,874	17

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

AVCP-RHA may pursue a biomass project grant from the Alaska Energy Authority.

AVCP-RHA 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

The AVCP-RHA campus appears to be a good candidate for the use of a district wood biomass heating system. With the current economic assumptions and the current fuel use the wood pellet boiler option has a B/C ratio of 1.02, which indicates an economically favorable project.

16.0 Recommended Actions

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 would be also in the best interest of AVCP to evaluate if a wood biomass infrastructure could be developed to help lower the overall cost of the wood fuel.

APPENDIX A

Preliminary Estimates of Probable Cost

**Preliminary Estimates of Probable Cost
AVCP-RHA Biomass Heating Options
Bethel, AK**

Option B.1 - AVCP Housing Campus

Biomass Boiler Building:	\$360,000
Wood Heating, Wood Handling System, & Pellet Silo:	\$470,000
Stack/Air Pollution Control Device:	\$100,000
Mechanical/Electrical within Boiler Building:	\$375,000
Underground Piping	\$275,000
12 Unit Apartment Integration	\$65,000
A to E Buildings Integration	\$72,000
New Office Building Integration	\$50,000
Bunkhouse Integration	\$37,000
Office Integration	\$37,000
Lulu Assisted Living Center Integation	\$42,250
Maintenance Facility Integration	\$47,000
Warehouse 2 Integration	\$47,000
Subtotal:	\$1,977,250
30% Remote Factor	\$593,175
Subtotal:	\$2,570,425
Design Fees, Building Permit, Miscellaneous Expenses 15%:	\$385,564
Subtotal:	\$2,955,989
15% Contingency:	\$443,398
Total Project Costs	\$ 3,399,387

APPENDIX B

Cash Flow Analysis

AVCP: RHA Campus System

Bethel, Alaska

Option B.1

Wood Pellet Boiler

Date: July 24, 2012

Analyst: CTA Architects Engineers - Jesse Vigil & Nathan Ratz

EXISTING CONDITIONS

	RHA	Fuel Oil	Fuel Oil	Fuel Oil	Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	\$6.29	\$6.29	\$6.29	\$6.29	
Estimated Average Annual Fuel Usage:	67,766				67,766
Annual Heating Costs:	\$426,248	\$0	\$0	\$0	\$426,248

ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)

	RHA	Fuel Oil	Fuel Oil	Fuel Oil	Total
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	9,114,527,000	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	7,291,621,600	0	0	0	7,291,621,600

WOOD FUEL COST

\$/ton:
Assumed efficiency of wood heating system (%):

Wood Pellets
\$460.00
70%
8200
635
540
22

PROJECTED WOOD FUEL USAGE

Estimated Btu content of wood fuel (Btu/lb) - Assumed 7% MC
Tons of wood fuel to supplant net equivalent of 100% annual heating load.
Tons of wood fuel to supplant net equivalent of 85% annual heating load.
25 ton chip van loads to supplant net equivalent of 85% annual heating load.

Project Capital Cost	-\$3,400,000
-----------------------------	---------------------

Project Financing Information	
Percent Financed	0.0%
Amount Financed	\$0
Amount of Grants	\$3,400,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	\$0

Additional Power Use	
Est. Pwr Use	15000 kWh
Elec Rate	\$0.500 /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

Simple Payback: Total Project Cost/Year One Operating Cost Savings:	32.9 years	Net Benefit	B/C Ratio
Net Present Value (30 year analysis):	\$6,570,870	\$3,170,870	1.93
Net Present Value (20 year analysis):	\$3,467,771	\$67,771	1.02
Year Accumulated Cash Flow > 0	#N/A		
Year Accumulated Cash Flow > Project Capital Cost	17		

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	\$6.29		67766 gal		\$426,248	\$447,561	\$469,939	\$493,436	\$518,107	\$544,013	\$571,213	\$599,774	\$629,763	\$661,251	\$694,313	\$729,029	\$765,480	\$803,754	\$843,942	\$1,077,108	\$1,374,693	\$1,754,495
Displaced heating costs	\$6.29		0 gal		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Displaced heating costs	\$6.29		0 gal		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Displaced heating costs	\$6.29		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)	\$460.00	85%	540 tons		\$248,347	\$255,797	\$263,471	\$271,376	\$279,517	\$287,902	\$296,539	\$305,436	\$314,599	\$324,037	\$333,758	\$343,770	\$354,083	\$364,706	\$375,647	\$435,478	\$504,838	\$585,246
Small load existing fuel	\$6.29	15%	10165 gal		\$63,937	\$67,134	\$70,491	\$74,015	\$77,716	\$81,602	\$85,682	\$89,966	\$94,464	\$99,188	\$104,147	\$109,354	\$114,822	\$120,563	\$126,591	\$161,566	\$206,204	\$263,174
Small load existing fuel	\$6.29	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	\$6.29	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	\$6.29	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	\$0.500				\$7,500	\$7,875	\$8,269	\$8,682	\$9,116	\$9,572	\$10,051	\$10,553	\$11,081	\$11,635	\$12,217	\$12,828	\$13,469	\$14,142	\$14,849	\$18,952	\$24,188	\$30,871
Annual Operating Cost Savings					\$103,264	\$113,490	\$126,043	\$137,665	\$150,026	\$163,170	\$177,139	\$191,981	\$207,744	\$224,479	\$242,242	\$261,087	\$281,077	\$302,273	\$324,743	\$458,781	\$636,889	\$872,362
Financed Project Costs - Principal and Interest					0																	
Displaced System Replacement Costs (year one only)					0																	
Net Annual Cash Flow					103,264	113,490	126,043	137,665	150,026	163,170	177,139	191,981	207,744	224,479	242,242	261,087	281,077	302,273	324,743	458,781	636,889	872,362
Accumulated Cash Flow					103,264	216,754	342,797	480,461	630,488	793,657	970,797	1,162,778	1,370,522	1,595,002	1,837,243	2,098,330	2,379,407	2,681,680	3,006,423	5,016,876	7,825,065	11,689,874

APPENDIX C

Site Plan

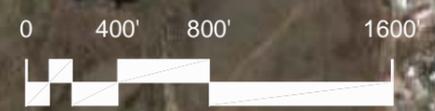


Drawn By _____ SSF
 Checked By _____ NHR
 Date 07/24/2012
 CTA # _____ FEDC
 Cad File: J: Bethel

BIOMASS PRE-FEASIBILITY ASSESSMENT
 BETHEL OVERVIEW
 BETHEL, ALASKA

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

SITE PLAN



SCALE: 1:800

3006 ft

Image © 2012 GeoEye

Image © 2012 DigitalGlobe

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

BIOMASS PRE-FEASIBILITY ASSESSMENT
 AVCP HOUSING
 BETHEL, 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: Bethel 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 Bethel. Bethel is located in southwest Alaska at the head of the Wood River and has a population of 6,000 people. The following equipment is proposed:

- A 250,000 Btu/hr (heat output) cord wood boiler at the Tukgar Building.
- A 3,100,000 Btu/hr (heat output) pellet boiler at the AVCP Housing Complex.
- A 250,000 Btu/hr (heat output) cord wood boiler at the Lomack Building.

STUDY AREA

A USGS map of the study area is provided in Figure 1 below. As shown, the area is flat with much low-lying areas along the Kuskokwin River. Relative to other sites in Alaska, the area is densely populated. 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

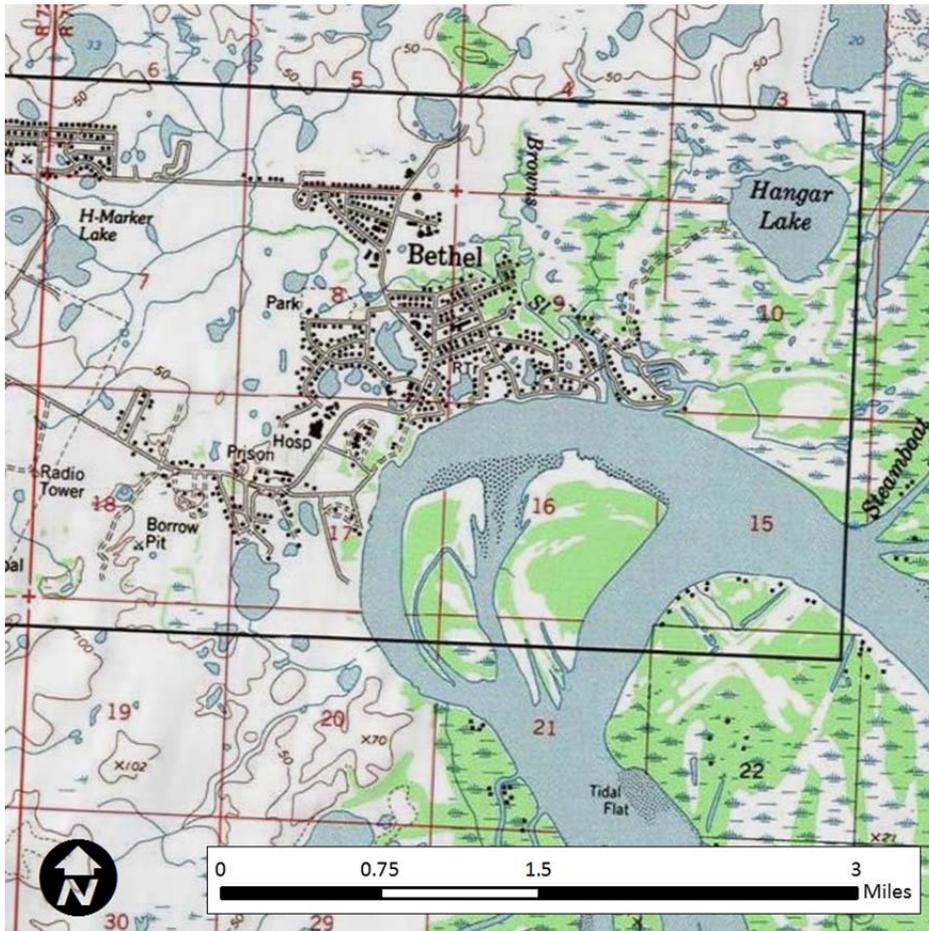


Figure 1 shows CTA Architects' plan of the location of the proposed biomass facility at the Tukgar Building and the surrounding buildings. As shown, two locations are being considered for the proposed biomass equipment. The site is relatively flat and relatively densely populated with one to two story tall buildings. The precise stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 1: Overview of Tukgar Site



Figure 2 shows CTA Architects' plan of the proposed biomass facility at the AVCP Building and the surrounding buildings. Most of the buildings are approximately one to two stories tall. A stand-alone biomass facility is planned on the southeast corner of the site. The remote location of the facility will provide a dispersion buffer between the stack and the office buildings.

Figure 2: Overview of AVCP Housing Site



Figure 3 shows CTA Architects' plan of the proposed biomass facility at the Lomack Building and the surrounding buildings. Most of the buildings are approximately one to two stories tall. An addition is planned for the northern side of the building.

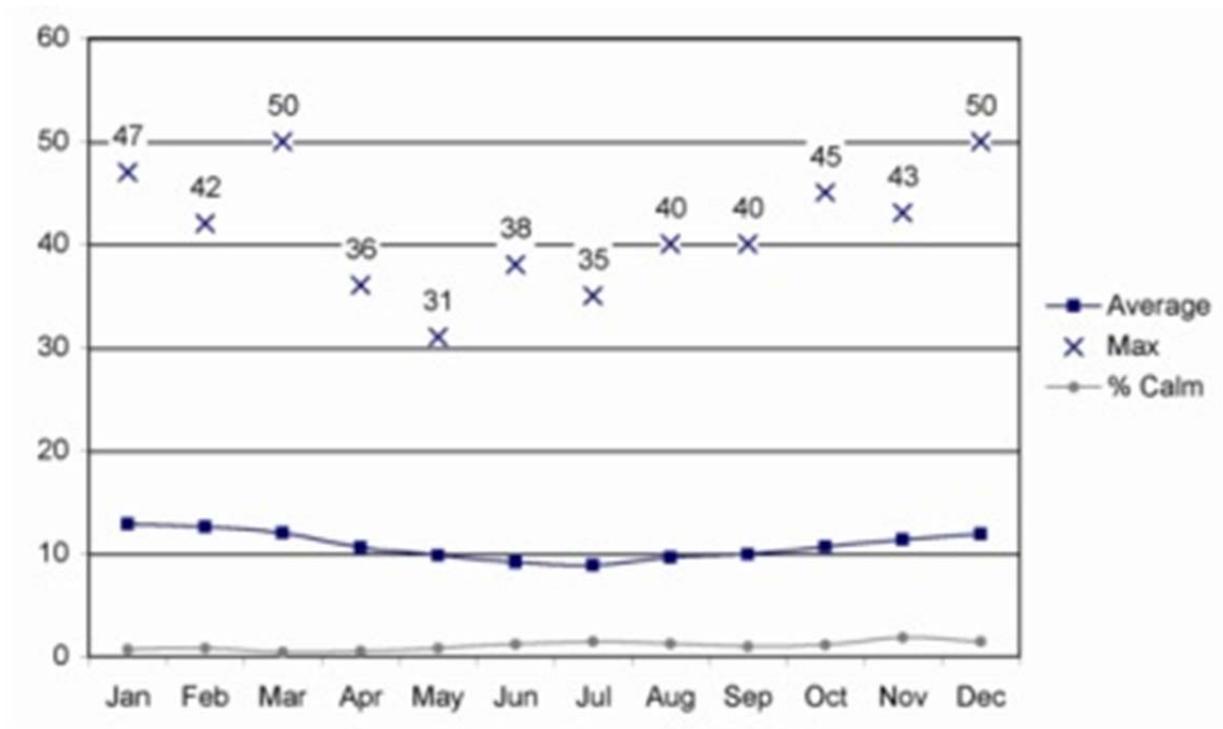
Figure 3: Overview of Lomack Building Building Site



METEOROLOGY

Meteorological data from Bethel, AK, was reviewed to develop an understanding of the weather conditions. As shown, there is a relatively low percentage of “calms” or times when the wind is not blowing.¹ This data indicates only 1% of the year when calm winds occur, which suggests there will be minimal time periods when thermal inversions and therefore poor emission dispersion conditions can occur.

Figure 4: Wind Speed Data from Bethel, AK

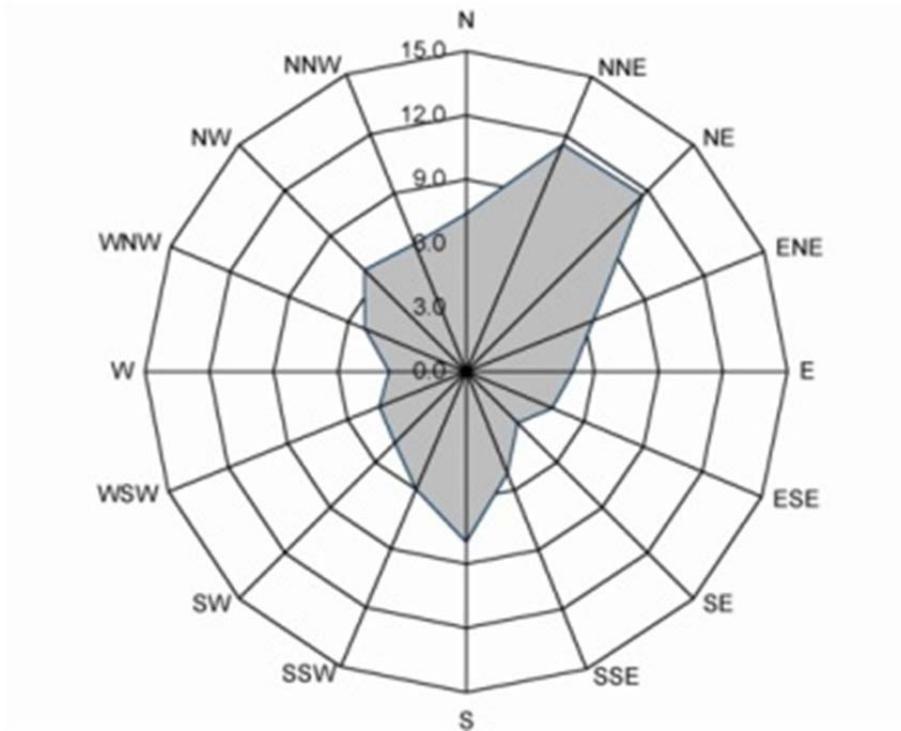


¹ See: <http://climate.gi.alaska.edu/Climate/Wind/Direction/Bethel/BET.html>



Figure 5 is a wind rose developed from wind speed and direction data collected in Bethel.¹ This shows prevailing winds are from the northeast (NNE and NE), meaning, they frequently blow towards the southeast. Average wind speeds are up to 12 miles per hour in those directions. This suggests emissions would typically be blown towards the southeast.

Figure 5: Wind Rose Showing Wind Speed and Direction



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 JJJJJ). 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 three new wood boilers in Bethel, 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. We do not suggest advanced emission controls (ESP, baghouse) for the following reasons:

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

Given the prevailing winds, we recommend wherever possible to construct boiler stacks on the south to southwest sides of buildings.

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 boiler 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