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

July 24, 2012

Shaan Seet, Inc.
Craig, Alaska

Presented by
CTA Architects Engineers
Nick Salmon & Nathan Ratz

Lars Construction Management Services
Rex Goolsby

For
Shaan Seet Native Corporation

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

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

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

TABLE OF CONTENTS

<u>Appendixes</u>

1.0 Executive Summary

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system in the Shaan-Seet Office, the Modular Home Rental, the Shaan-Seet Hotel and the Heated Storage Building in Craig 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
Shaan Seet Office	Fuel Oil	2,000	$4.10	$8,400
Rental Trailer	Fuel Oil	800	$4.10	$3,360
Shaan Seet Hotel	Fuel Oil	2250	$4.10	$9,450
Storage Building	Fuel Oil	500	$4.10	$2,100

Table 1.2 - Annual Wood Fuel Use Summary			
	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)
Shaan Seet Office (SSO)	2,000	17.5	15.9
Shaan Seet House (SSH)	820	7.2	6.5
Shaan Seet Heated Storage (SSHS)	500	4.4	4.0
Shaan Seet Hotel (SSH)	2,250	19.7	17.9
SSO + SSH	2,820	24.6	22.5
SSO + SSH + SSHS	3,320	29.0	26.5
SSO + SSH + SSHS + SSH	5,570	48.7	44.4

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

Based on the estimated volume of wood and the estimated biomass boiler size, a pellet option and cord wood option will be evaluated. Chipped/ground fuel boilers were not considered because the potential fuel cost savings would not pay for the high capital cost of these system types. The options reviewed were:

Pellet Boiler Options:
- B.1: Shaan Seet Office and House
- B.2: Shaan Seet Office, House, and Heated Storage
- B.3: Shaan Seet Office, House, Heated Storage, and Hotel

Cord Wood Boiler Option:
- C.1: Shaan Seet Office and House

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

Table 1.3 - Economic Evaluation Summary
Shaan Seet 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	$745,000	-$4,122	$28,454	-$9,009	-0.01	0.04	-$4,943	$76,568	>30
B.2	$884,000	-$3,626	$60,561	$7,816	0.01	0.07	$19,429	$133,811	>30
B.3	$1,100,000	-$1,241	$209,568	$86,541	0.08	0.19	$133,277	$398,792	>30
C.1	$350,000	-$4,786	$33,107	-$11,094	-0.03	0.09	-$6,335	$89,794	>30

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

2.0 Introduction

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system in the Shaan-Seet Office, the Modular Home Rental, the Shaan-Seet Hotel, the Heated Storage Building in Craig Alaska.

3.0 Existing Building Systems

The Shaan-Seet Office a wood framed building constructed in 1992. The facility is approximately 3,600 square feet and is heated by a 140,000 Btu/hr output furnace and two 40,000 Btu/hr output Toyo stoves. The stoves are the primary source of heat, and the furnace is only turned on in extremely cold weather. Domestic hot water is provided by a 32 gallon fuel oil fired hot water heater with approximately 100,000 Btu/hr. The existing furnace is original to the building and in fair condition. The Toyo stoves are more recent and are in good condition. The heating system infrastructure is ductwork from the furnace and the ductwork appears to be in fair condition.

The Trailer (Rental) is a modular wood framed building constructed in 1984. The facility is approximately 2,000 square feet and is heated by a 76,000 Btu/hr output furnace and a 40,000 Btu/hr Toyo stove. The Toyo stove is the primary source of heat and the furnace does not run very often. Domestic hot water was not found. The existing furnace is original to the building and is in fair condition. The Toyo stove is more recent, and is in good condition.

The Shaan-Seet Hotel is a wood framed building constructed in 1994. The facility is approximately 6,200 square feet and is heated by a 145,000 Btu/hr output hot water boiler. Domestic hot water is provided by an 80 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.

The Heated Storage Building a wood framed building constructed in 1994. The facility is approximately 960 square feet and is heated by a 40,000 Btu/hr output Toyo stove. No domestic hot water is provided. The age of the stove is unknown, but it is in good condition.

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

Facilities Added to Feasibility Study
No facilities were added to the feasibility study.

4.0 Energy Use

Fuel oil bills for the facilities were provided. 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
Shaan Seet Office	Fuel Oil	2,000	$4.10	$8,400
Rental Trailer	Fuel Oil	800	$4.10	$3,360
Shaan Seet Hotel	Fuel Oil	2250	$4.10	$9,450
Storage Building	Fuel Oil	500	$4.10	$2,100

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 augers, conveyors, draft fans, etc. 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 oil fired boilers, Toyo stoves and domestic water heaters:

Table 5.1 - Connected Boiler Load Summary					
			Output MBH	Peak Load Factor	Likely System Peak MBH
Shaan Seet Office	Furnace	Fuel Oil	112	1.00	112
	DWH	Fuel Oil	75	0.20	15
Total					127
Rental Trailer	Toyo	Fuel Oil	40	1.00	40
SS Heated Storage	Toyo	Fuel Oil	40	1.00	40
Shaan Seet Hotel	Boiler	Fuel Oil	145	1.00	145
Total Of All Buildings			**412**		**352**

Typically a wood heating system is sized to meet approximately 85% of the typical annual heating energy use of the building. The existing heating boilers and furnaces would be used for the other 15% of the time during peak heating conditions, during times when the biomass boiler is down for servicing, and during swing months when only a few hours of heating each day are required. Recent energy models have found that a boiler sized at 50% to 60% of the building peak load will typically accommodate 85% of the boiler run hours. Several projects are under consideration for Shaan Seet, therefore the boiler size will vary with each option as noted below.

Table 5.2 - Proposed Biomass Boiler Size			
	Likely System Peak MBH	Biomass Boiler Factor	Biomass Boiler Size MBH
Shaan Seet Office (SSO)	127	0.6	76
Shaan Seet House (SSH)	40	0.6	24
Shaan Seet Heated Storage (SSHS)	40	0.6	24
Shaan Seet Hotel (SSH)	145	0.6	87
SSO + SSH	167	0.6	100
SSO + SSH + SSHS	207	0.6	124
SSO + SSH + SSHS + SSH	352	0.6	211

6.0 <u>Wood Fuel Use</u>

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)
Shaan Seet Office (SSO)	2,000	17.5	15.9
Shaan Seet House (SSH)	820	7.2	6.5
Shaan Seet Heated Storage (SSHS)	500	4.4	4.0
Shaan Seet Hotel (SSH)	2,250	19.7	17.9
SSO + SSH	2,820	24.6	22.5
SSO + SSH + SSHS	3,320	29.0	26.5
SSO + SSH + SSHS + SSH	5,570	48.7	44.4

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%.

Based on the potential wood fuel use, a cord wood system and a pellet system are the most viable. The fuel use is too low to generate enough savings to make a chipped/ground fuel option viable.

There are sawmills and active logging operations in the region. Tongass Forest Enterprises has stared up a pellet plant in Ketchikan and is providing pellets to Sealaska. Pellets are also available from plants in British Columbia, Washington, and Oregon. There appears to be a sufficient available supply to service the boiler plant.

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
					$4.50	$41.82	$33.46
					$5.00	$46.47	$37.17
Cord Wood	cords	16173800	0.65	10512970	$150.00	$14.27	$9.27
					$200.00	$19.02	$12.37
					$250.00	$23.78	$15.46
Pellets	tons	16400000	0.7	11480000	$200.00	$17.42	$12.20
					$250.00	$21.78	$15.24
					$300.00	$26.13	$18.29

7.0 <u>Boiler Plant Location and Site Access</u>

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 south of the Shaan Seet office building.

Any type of biomass boiler system will require access by delivery vehicles. For cord wood systems this would likely be pickup trucks and trucks with trailers. The proposed plant location would allow for good access since it will be on the road up to the office building, which is maintained year round.

8.0 <u>Integration with Existing Heating Systems</u>

Integration of a wood fired heating system varies from facility to facility. Integration of a central heating system in the Shaan Seet Office and Shaan Seet House would require installing hot water fan coil unit.

Integration of a central heating system in the Heated Storage building would require the installation of a ceiling hung unit heater.

Integration of a central heating system for the Shaan Seet Hotel would require installing heating hot water supply and return pipes in the existing boiler room.

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. Piping from the biomass boiler plant would be run below ground with pre-insulated pipe and extended to the face of each building, and extended up the exterior surface of the school in order to penetrate exterior wall into the boiler room. Once the hot water supply and return piping enters the existing boiler room it would be connected to existing supply and return pipes 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. Southeast Alaska is has meteorological conditions that can 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 the 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 estimated volume of wood and the estimated biomass boiler size, a pellet option and cord wood option will be evaluated. Chipped/ground fuel boilers were not considered because the potential fuel cost savings would not pay for the high capital cost of these system types. The options reviewed were:

Pellet Boiler Options:

- B.1: Shaan Seet Office and House
- B.2: Shaan Seet Office, House, and Heated Storage
- B.3: Shaan Seet Office, House, Heated Storage, and Hotel

Cord Wood Boiler Option:

- C.1: Shaan Seet Office and House

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 $4.20/gal, electricity at $0.27/kwh, wood pellets delivered at $300/ton, and cord wood fuel delivered at $200/cord. The fuel oil, electricity, and cord wood costs are based on the costs reported by the facility. Pellet costs were obtained from Tongass Forest Enterprises.

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
Shaan Seet 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	$745,000	-$4,122	$28,454	-$9,009	-0.01	0.04	-$4,943	$76,568	>30
B.2	$884,000	-$3,626	$60,561	$7,816	0.01	0.07	$19,429	$133,811	>30
B.3	$1,100,000	-$1,241	$209,568	$86,541	0.08	0.19	$133,277	$398,792	>30
C.1	$350,000	-$4,786	$33,107	-$11,094	-0.03	0.09	-$6,335	$89,794	>30

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

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

14.0 Project Funding

The Shaan Seet, Inc. may pursue a biomass project grant from the Alaska Energy Authority.

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

16.0 Recommended Actions

If pellets or bio bricks begin are available for $300/ton or less, consider replacing the Toyo stoves with pellet stoves. The electric generation plant for the area is located next to the Shaan Seet hotel. Investigate if APT would be willing to sell heat from the generators to heat the hotel.

APPENDIX A

Preliminary Estimates of Probable Cost

Preliminary Estimates of Probable Cost
Biomass Heating Options - Shaan Seet, Inc.
Craig, AK

Option B.1 Pellet - SSO + SSH

Biomass Boiler Building:	$90,000
Wood Heating, Wood Handling System, & Silo:	$110,000
Stack/Air Pollution Control Device:	$50,000
Mechanical/Electrical within Boiler Building:	$75,000
Underground Piping	$73,000
Shaan-Seet Office Integration	$24,250
Shaan-Seet House Inegration	$11,500
Subtotal:	$433,750
30% Remote Factor	$130,125
Subtotal:	$563,875
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$84,581
Subtotal:	$648,456
15% Contingency:	$97,268
Total Project Costs	**$ 745,725**

Option B.2 Pellet - SSO + SSH + HS

Biomass Boiler Building:	$90,000
Wood Heating, Wood Handling System, & Silo:	$110,000
Stack/Air Pollution Control Device:	$50,000
Mechanical/Electrical within Boiler Building:	$75,000
Underground Piping	$140,000
Shaan-Seet Office Integration	$24,250
Shaan-Seet House Inegration	$11,500
Shaan-Seet Heated Storage Integration	$13,750
Subtotal:	$514,500
30% Remote Factor	$154,350
Subtotal:	$668,850
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$100,328
Subtotal:	$769,178
15% Contingency:	$115,377
Total Project Costs	**$ 884,554**

Preliminary Estimates of Probable Cost
Biomass Heating Options - Shaan Seet, Inc.
Craig, AK

Option B.3 Pellet - SSO + SSH + HS + SS Hotel

Biomass Boiler Building:	$90,000
Wood Heating, Wood Handling System, & Silo:	$110,000
Stack/Air Pollution Control Device:	$50,000
Mechanical/Electrical within Boiler Building:	$75,000
Underground Piping	$250,000
Shaan-Seet Office Integration	$24,250
Shaan-Seet House Inegration	$11,500
Shaan-Seet Heated Storage Integration	$13,750
Shaan-Seet Hotel Integration	$23,000
Subtotal:	$647,500
30% Remote Factor	$194,250
Subtotal:	$841,750
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$126,263
Subtotal:	$968,013
15% Contingency:	$145,202
Total Project Costs	**$ 1,113,214**

Option C.1 Cord Wood - SSO + SSH

Cord Wood Storage/ Boiler Building:	$55,000
Wood Heating & Wood Handling System:	$24,000
Stack/Air Pollution Control Device:	$6,700
Mechanical/Electrical within Boiler Building:	$12,000
Underground Piping	$73,000
Shaan-Seet Office Integration	$24,250
Shaan-Seet House Inegration	$11,500
Subtotal:	$206,450
30% Remote Factor	$61,935
Subtotal:	$268,385
Design Fees, Building Permit, Miscellaneous Expenses 15%:	$40,258
Subtotal:	$308,643
15% Contingency:	$46,296
Total Project Costs	**$ 354,939**

APPENDIX B

Cash Flow Analysis

Shaan Seet Office and Mobile Home
Craig, Alaska

Option B.1
Wood Pellet Boiler

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

EXISTING CONDITIONS	Office	Mobile Home			Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$4.20	$4.20	$4.20	$4.20	
Estimated Average Annual Fuel Usage:	2,000	800			2,800
Annual Heating Costs:	$8,400	$3,360	$0	$0	$11,760
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):	269,000,000	107,600,000	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	215,200,000	86,080,000	0	0	301,280,000

WOOD FUEL COST	Wood Pellets
$/ton:	$300.00
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.	26
Tons of wood fuel to supplant net equivalent of 85% annual heating load.	22
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	1

Project Capital Cost	-$745,000

Project Financing Information	
Percent Financed	0.0%
Amount Financed	$0
Amount of Grants	$745,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use		
Est. Pwr Use	15650	kWh
Elec Rate	$0.270	/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:	-180.8 years		
Net Present Value (30 year analysis):	$28,454	-$716,546	0.04
Net Present Value (20 year analysis):	-$9,009	-$754,009	-0.01
Year Accumulated Cash Flow > 0	22		
Year Accumulated Cash Flow > Project Capital Cost	31		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	3.0%
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	$4.20		2000	gal	$8,400	$8,820	$9,261	$9,724	$10,210	$10,721	$11,257	$11,820	$12,411	$13,031	$13,683	$14,367	$15,085	$15,839	$16,631	$21,226	$27,091	$34,576
Displaced heating costs	$4.20		800	gal	$3,360	$3,528	$3,704	$3,890	$4,084	$4,288	$4,503	$4,728	$4,964	$5,212	$5,473	$5,747	$6,034	$6,336	$6,653	$8,491	$10,836	$13,830
Displaced heating costs	$4.20		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$4.20		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)	$300.00	85%	22	tons	$6,692	$6,893	$7,100	$7,313	$7,532	$7,758	$7,991	$8,231	$8,477	$8,732	$8,994	$9,264	$9,541	$9,828	$10,123	$11,735	$13,604	$15,771
Small load existing fuel	$4.20	15%	300	gal	$1,260	$1,323	$1,389	$1,459	$1,532	$1,608	$1,689	$1,773	$1,862	$1,955	$2,052	$2,155	$2,263	$2,376	$2,495	$3,184	$4,064	$5,186
Small load existing fuel	$4.20	15%	120	gal	$504	$529	$556	$583	$613	$643	$675	$709	$745	$782	$821	$862	$905	$950	$998	$1,274	$1,625	$2,075
Small load existing fuel	$4.20	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	$4.20	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	$0.270				$4,226	$4,352	$4,483	$4,617	$4,756	$4,899	$5,045	$5,197	$5,353	$5,513	$5,679	$5,849	$6,025	$6,205	$6,391	$7,409	$8,590	$9,958
Annual Operating Cost Savings					***-$4,122***	***-$4,013***	***-$2,227***	***-$2,056***	***-$1,870***	***-$1,665***	***-$1,443***	***-$1,200***	***-$936***	***-$650***	***-$340***	***-$5***	***$356***	***$746***	***$1,166***	***$3,784***	***$7,471***	***$12,575***
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					***(4,122)***	***(4,013)***	***(2,227)***	***(2,056)***	***(1,870)***	***(1,665)***	***(1,443)***	***(1,200)***	***(936)***	***(650)***	***(340)***	***(5)***	***356***	***746***	***1,166***	***3,784***	***7,471***	***12,575***
Accumulated Cash Flow					***(4,122)***	***(8,135)***	***(10,362)***	***(12,418)***	***(14,288)***	***(15,953)***	***(17,396)***	***(18,596)***	***(19,532)***	***(20,182)***	***(20,523)***	***(20,528)***	***(20,172)***	***(19,426)***	***(18,259)***	***(4,943)***	***24,548***	***76,568***

Shaan Seet Office, Mobile Home, and Heated Storage

Craig, Alaska

Option B.2

Wood Pellet Boiler

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

EXISTING CONDITIONS	Office	Mobile Home	Heated Storage		Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$4.20	$4.20	$4.20	$4.20	
Estimated Average Annual Fuel Usage:	2,000	800	500		3,300
Annual Heating Costs:	$8,400	$3,360	$2,100	$0	$13,860
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):	269,000,000	107,600,000	67,250,000	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	215,200,000	86,080,000	53,800,000	0	355,080,000

WOOD FUEL COST	Wood Pellets
$/ton:	$300.00
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.	31
Tons of wood fuel to supplant net equivalent of 85% annual heating load.	26
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	1

Project Capital Cost	-$884,000

Project Financing Information	
Percent Financed	0.0%
Amount Financed	$0
Amount of Grants	$884,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use		
Est. Pwr Use	16000	kWh
Elec Rate	$0.270	/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:	-243.8 years		
Net Present Value (30 year analysis):	$60,561	-$823,439	0.07
Net Present Value (20 year analysis):	$7,816	-$876,184	0.01
Year Accumulated Cash Flow > 0	17		
Year Accumulated Cash Flow > Project Capital Cost	31		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	3.0%
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
Existing Heating System Operating Costs												
Displaced heating costs	$4.20		2000	gal	$8,400	$8,820	$9,261	$9,724	$10,210	$10,721	$11,257	$11,820
Displaced heating costs	$4.20		800	gal	$3,360	$3,528	$3,704	$3,890	$4,084	$4,288	$4,503	$4,728
Displaced heating costs	$4.20		500	gal	$2,100	$2,205	$2,315	$2,431	$2,553	$2,680	$2,814	$2,955
Displaced heating costs	$4.20		0	gal	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs												
Wood Fuel ($/ton, delivered to boiler site)	$300.00	85%	26	tons	$7,887	$8,124	$8,368	$8,619	$8,877	$9,143	$9,418	$9,700
Small load existing fuel	$4.20	15%	300	gal	$1,260	$1,323	$1,389	$1,459	$1,532	$1,608	$1,689	$1,773
Small load existing fuel	$4.20	15%	120	gal	$504	$529	$556	$583	$613	$643	$675	$709
Small load existing fuel	$4.20	15%	75	gal	$315	$331	$347	$365	$383	$402	$422	$443
Small load existing fuel	$4.20	15%	0	gal	$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
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632						
Additional Electrical Cost	$0.270				$4,320	$4,450	$4,583	$4,721	$4,862	$5,008	$5,158	$5,313
Annual Operating Cost Savings					***-$3,626***	***-$3,467***	***-$1,627***	***-$1,399***	***-$1,151***	***-$882***	***-$590***	***-$274***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Displaced System Replacement Costs (year one only)					***0***							
Net Annual Cash Flow					***(3,626)***	***(3,467)***	***(1,627)***	***(1,399)***	***(1,151)***	***(882)***	***(590)***	***(274)***
Accumulated Cash Flow					***(3,626)***	***(7,094)***	***(8,720)***	***(10,119)***	***(11,271)***	***(12,153)***	***(12,743)***	***(13,017)***

Cash flow Descriptions	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	$12,411	$13,031	$13,683	$14,367	$15,085	$15,839	$16,631	$21,226	$27,091	$34,576
Displaced heating costs	$4,964	$5,212	$5,473	$5,747	$6,034	$6,336	$6,653	$8,491	$10,836	$13,830
Displaced heating costs	$3,103	$3,258	$3,421	$3,592	$3,771	$3,960	$4,158	$5,307	$6,773	$8,644
Displaced heating costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs										
Wood Fuel ($/ton, delivered to boiler site)	$9,991	$10,291	$10,600	$10,918	$11,245	$11,583	$11,930	$13,830	$16,033	$18,587
Small load existing fuel	$1,862	$1,955	$2,052	$2,155	$2,263	$2,376	$2,495	$3,184	$4,064	$5,186
Small load existing fuel	$745	$782	$821	$862	$905	$950	$998	$1,274	$1,625	$2,075
Small load existing fuel	$465	$489	$513	$539	$566	$594	$624	$796	$1,016	$1,297
Small load existing fuel	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs	$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										
Additional Electrical Cost	$5,472	$5,637	$5,806	$5,980	$6,159	$6,344	$6,534	$7,575	$8,782	$10,180
Annual Operating Cost Savings	***$67***	***$436***	***$834***	***$1,262***	***$1,723***	***$2,218***	***$2,750***	***$6,034***	***$10,607***	***$16,884***
Financed Project Costs - Principal and Interest	***0***	***0***								
Displaced System Replacement Costs (year one only)										
Net Annual Cash Flow	***67***	***436***	***834***	***1,262***	***1,723***	***2,218***	***2,750***	***6,034***	***10,607***	***16,884***
Accumulated Cash Flow	***(12,950)***	***(12,514)***	***(11,679)***	***(10,417)***	***(8,694)***	***(6,476)***	***(3,726)***	***19,429***	***62,726***	***133,811***

Shaan Seet Office, Mobile Home, Heated Storage, and Hotel

Craig, Alaska

Option B.3

Wood Pellet Boiler

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

EXISTING CONDITIONS	Office	Mobile Home	Heated Storage	Hotel	Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$4.20	$4.20	$4.20	$4.20	
Estimated Average Annual Fuel Usage:	2,000	800	500	2,250	5,550
Annual Heating Costs:	$8,400	$3,360	$2,100	$9,450	$23,310
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):	269,000,000	107,600,000	67,250,000	302,625,000	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	215,200,000	86,080,000	53,800,000	242,100,000	597,180,000

WOOD FUEL COST	Wood Pellets
$/ton:	$300.00
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.	52
Tons of wood fuel to supplant net equivalent of 85% annual heating load.	44
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	2

Project Capital Cost	-$1,100,000

Project Financing Information	
Percent Financed	0.0%
Amount Financed	$0
Amount of Grants	$1,100,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use		
Est. Pwr Use	17000	kWh
Elec Rate	$0.270	/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:	-886.1 years		
Net Present Value (30 year analysis):	$209,568	-$890,432	0.19
Net Present Value (20 year analysis):	$86,541	-$1,013,459	0.08
Year Accumulated Cash Flow > 0	4		
Year Accumulated Cash Flow > Project Capital Cost	31		

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

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Existing Heating System Operating Costs														
Displaced heating costs	$4.20		2000	gal	$8,400	$8,820	$9,261	$9,724	$10,210	$10,721	$11,257	$11,820	$12,411	$13,031
Displaced heating costs	$4.20		800	gal	$3,360	$3,528	$3,704	$3,890	$4,084	$4,288	$4,503	$4,728	$4,964	$5,212
Displaced heating costs	$4.20		500	gal	$2,100	$2,205	$2,315	$2,431	$2,553	$2,680	$2,814	$2,955	$3,103	$3,258
Displaced heating costs	$4.20		2250	gal	$9,450	$9,923	$10,419	$10,940	$11,487	$12,061	$12,664	$13,297	$13,962	$14,660
Biomass System Operating Costs														
Wood Fuel ($/ton, delivered to boiler site)	$300.00	85%	44	tons	$13,265	$13,663	$14,073	$14,495	$14,930	$15,378	$15,839	$16,314	$16,804	$17,308
Small load existing fuel	$4.20	15%	300	gal	$1,260	$1,323	$1,389	$1,459	$1,532	$1,608	$1,689	$1,773	$1,862	$1,955
Small load existing fuel	$4.20	15%	120	gal	$504	$529	$556	$583	$613	$643	$675	$709	$745	$782
Small load existing fuel	$4.20	15%	75	gal	$315	$331	$347	$365	$383	$402	$422	$443	$465	$489
Small load existing fuel	$4.20	15%	338	gal	$1,418	$1,488	$1,563	$1,641	$1,723	$1,809	$1,900	$1,995	$2,094	$2,199
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
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632								
Additional Electrical Cost	$0.270				$4,590	$4,728	$4,870	$5,016	$5,166	$5,321	$5,481	$5,645	$5,814	$5,989
Annual Operating Cost Savings					***-$1,241***	***-$850***	***$1,237***	***$1,728***	***$2,256***	***$2,822***	***$3,430***	***$4,082***	***$4,781***	***$5,529***
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					***(1,241)***	***(850)***	***1,237***	***1,728***	***2,256***	***2,822***	***3,430***	***4,082***	***4,781***	***5,529***
Accumulated Cash Flow					***(1,241)***	***(2,092)***	***(854)***	***874***	***3,130***	***5,952***	***9,382***	***13,465***	***18,246***	***23,774***

Cash flow Descriptions	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs								
Displaced heating costs	$13,683	$14,367	$15,085	$15,839	$16,631	$21,226	$27,091	$34,576
Displaced heating costs	$5,473	$5,747	$6,034	$6,336	$6,653	$8,491	$10,836	$13,830
Displaced heating costs	$3,421	$3,592	$3,771	$3,960	$4,158	$5,307	$6,773	$8,644
Displaced heating costs	$15,393	$16,163	$16,971	$17,819	$18,710	$23,880	$30,477	$38,897
Biomass System Operating Costs								
Wood Fuel ($/ton, delivered to boiler site)	$17,827	$18,362	$18,913	$19,480	$20,064	$23,260	$26,965	$31,260
Small load existing fuel	$2,052	$2,155	$2,263	$2,376	$2,495	$3,184	$4,064	$5,186
Small load existing fuel	$821	$862	$905	$950	$998	$1,274	$1,625	$2,075
Small load existing fuel	$513	$539	$566	$594	$624	$796	$1,016	$1,297
Small load existing fuel	$2,309	$2,424	$2,546	$2,673	$2,807	$3,582	$4,572	$5,835
Additional Operation and Maintenance Costs	$1,950	$1,989	$2,029	$2,070	$2,111	$2,331	$2,573	$2,841
Additional Operation and Maintenance Costs First 2 years								
Additional Electrical Cost	$6,169	$6,354	$6,544	$6,741	$6,943	$8,049	$9,331	$10,817
Annual Operating Cost Savings	***$6,328***	***$7,183***	***$8,096***	***$9,071***	***$10,111***	***$16,428***	***$25,032***	***$36,637***
Financed Project Costs - Principal and Interest								
Displaced System Replacement Costs (year one only)								
Net Annual Cash Flow	***6,328***	***7,183***	***8,096***	***9,071***	***10,111***	***16,428***	***25,032***	***36,637***
Accumulated Cash Flow	***30,102***	***37,286***	***45,382***	***54,453***	***64,564***	***133,277***	***240,184***	***398,792***

Shaan Seet Office and Mobile Home
Craig, Alaska

Option C.1
Cord Wood Boiler

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

EXISTING CONDITIONS	Office	Mobile Home			Total
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$4.20	$4.20	$3.60	$3.60	
Estimated Average Annual Fuel Usage:	2,000	800			2,800
Annual Heating Costs:	$8,400	$3,360	$0	$0	$11,760
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):	269,000,000	107,600,000	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	215,200,000	86,080,000	0	0	301,280,000

WOOD FUEL COST	Cord Wood
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/cord) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	29
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	24
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	-$350,000

Project Financing Information	
Percent Financed	0.0%
Amount Financed	$0
Amount of Grants	$350,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1150 kWh
Elec Rate	$0.270 /kWh

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

		Net Benefit	B/C Ratio
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-73.1 years	Net Benefit	B/C Ratio
Net Present Value (30 year analysis):	$33,107	-$316,893	0.09
Net Present Value (20 year analysis):	-$11,094	-$361,094	-0.03
Year Accumulated Cash Flow > 0	22		
Year Accumulated Cash Flow > Project Capital Cost	31		

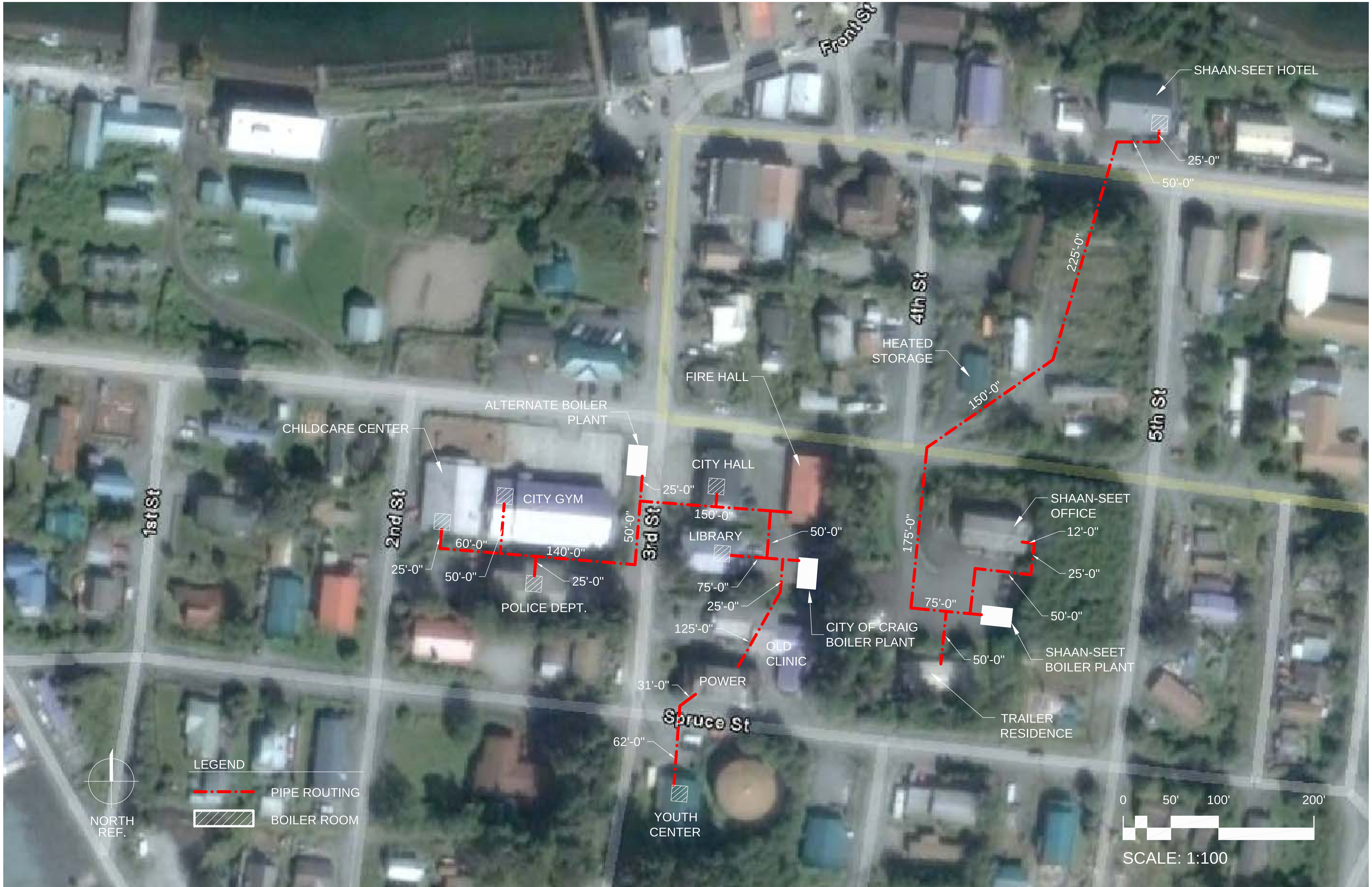
Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	3.0%
Discount Rate for Net Present Value Calculation	3.0%

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
Existing Heating System Operating Costs												
Displaced heating costs	$4.20		2000	gal	$8,400	$8,820	$9,261	$9,724	$10,210	$10,721	$11,257	$11,820
Displaced heating costs	$4.20		800	gal	$3,360	$3,528	$3,704	$3,890	$4,084	$4,288	$4,503	$4,728
Displaced heating costs	$3.60		0	gal	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$3.60		0	gal	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs												
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	24	cords	$4,872	$5,018	$5,169	$5,324	$5,483	$5,648	$5,817	$5,992
Small load existing fuel	$4.20	15%	300	gal	$1,260	$1,323	$1,389	$1,459	$1,532	$1,608	$1,689	$1,773
Small load existing fuel	$4.20	15%	120	gal	$504	$529	$556	$583	$613	$643	$675	$709
Small load existing fuel	$3.60	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$3.60	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632						
Additional Electrical Cost	$0.270				$311	$320	$329	$339	$349	$360	$371	$382
Annual Operating Cost Savings					***-$4,786***	***-$4,634***	***-$2,801***	***-$2,581***	***-$2,342***	***-$2,083***	***-$1,802***	***-$1,498***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Displaced System Replacement Costs (year one only)					***0***							
Net Annual Cash Flow					***(4,786)***	***(4,634)***	***(2,801)***	***(2,581)***	***(2,342)***	***(2,083)***	***(1,802)***	***(1,498)***
Accumulated Cash Flow					***(4,786)***	***(9,420)***	***(12,221)***	***(14,802)***	***(17,144)***	***(19,227)***	***(21,028)***	***(22,526)***

Cash flow Descriptions	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	$12,411	$13,031	$13,683	$14,367	$15,085	$15,839	$16,631	$21,226	$27,091	$34,576
Displaced heating costs	$4,964	$5,212	$5,473	$5,747	$6,034	$6,336	$6,653	$8,491	$10,836	$13,830
Displaced heating costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs										
Wood Fuel ($/ton, delivered to boiler site)	$6,172	$6,357	$6,547	$6,744	$6,946	$7,154	$7,369	$8,543	$9,903	$11,481
Small load existing fuel	$1,862	$1,955	$2,052	$2,155	$2,263	$2,376	$2,495	$3,184	$4,064	$5,186
Small load existing fuel	$745	$782	$821	$862	$905	$950	$998	$1,274	$1,625	$2,075
Small load existing fuel	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs	$9,373	$9,561	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years										
Additional Electrical Cost	$393	$405	$417	$430	$443	$456	$470	$544	$631	$732
Annual Operating Cost Savings	***-$1,169***	***-$815***	***-$434***	***-$24***	***$417***	***$890***	***$1,397***	***$4,518***	***$8,836***	***$14,726***
Financed Project Costs - Principal and Interest	***0***	***0***								
Displaced System Replacement Costs (year one only)										
Net Annual Cash Flow	***(1,169)***	***(815)***	***(434)***	***(24)***	***417***	***890***	***1,397***	***4,518***	***8,836***	***14,726***
Accumulated Cash Flow	***(23,696)***	***(24,511)***	***(24,945)***	***(24,969)***	***(24,553)***	***(23,663)***	***(22,266)***	***(6,335)***	***28,661***	***89,794***

APPENDIX C

Site Plan



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

BIOMASS PRE-FEASIBILITY ASSESSMENT

CITY OF CRAIG & SHAAN-SEET BOILER PLANTS

CRAIG, ALASKA

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

APPENDIX D

Air Quality Report

To:	Nick Salmon
From:	John Hinckley
Subject:	Ketchikan-Craig Cluster Feasibility Study
Date:	24 July 2012

INTRODUCTION

At your request, RSG has conducted an air quality feasibility study for seven biomass energy installations in Ketchikan and Craig, Alaska. These sites are located in the panhandle of Alaska. The following equipment is proposed:

- Ketchikan
  - One 4,700,000 Btu/hr (heat output) pellet boiler at the Ketchikan High School.
  - One 800,000 Btu/hr (heat output) pellet boiler at the Ketchikan Indian Council Medical Facility.
  - One 150,000 Btu/hr (heat output) pellet boiler at the Ketchikan Indian Council Votec School.
  - One 200,000 Btu/hr (heat output) pellet boiler at the old Ketchikan Indian Council Administration Building.
- Craig
  - One 450,000 Btu/hr (heat output) cord wood boiler at the Craig Tribal Association Building.
  - One 450,000 Btu/hr (heat output) cord wood boiler near the Fire Hall.
  - One 250,000 Btu/hr (heat output) cord wood boiler at the Shaan-Seet Office.

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

A USGS map of the Ketchikan study area is provided in Figure 1 below. As shown, the area is mountainous, with Ketchikan located on the southwest side of a mountain range. Ketchikan has a population of 14,070. The area is relatively fairly well populated and developed relative to other areas in Alaska. The area is also a port for cruise ships, which are significant sources of air pollution. The topography, population, level of development, and existing emission sources has the potential to create localized, temporary problematic air quality.

Figure 1: USGS Map Illustrating the Ketchikan Study Area

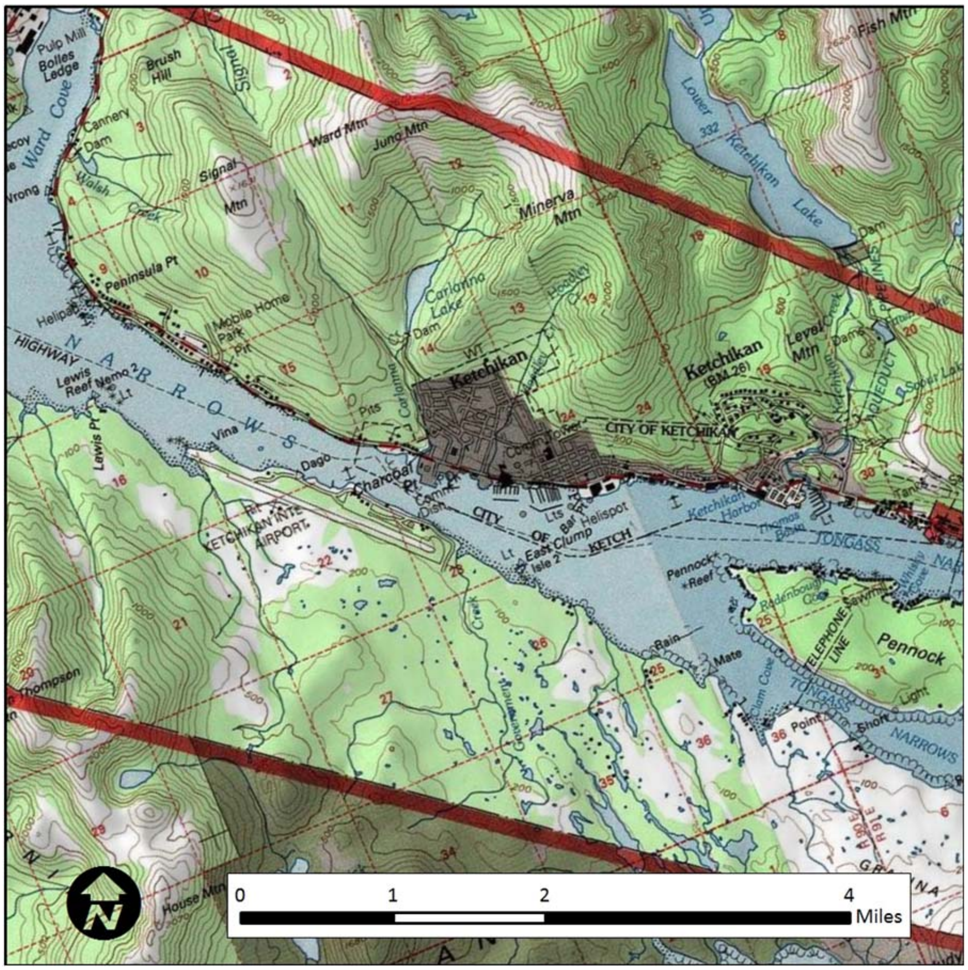


Figure 2 shows CTA Architects' plan of the location of the proposed biomass facility at the Ketchikan High School. The site slopes moderately to steeply downward in the southeasterly direction with the grade becoming very steep to the northeast of the High School building. The school building is between two to three stories high. The biomass facility will be located in a stand-alone building on the north side of the school building, which is the high side of the building. There are residential areas west, north, and east of the proposed biomass facility which are uphill (above) the facility. 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: Site Map of the Ketchikan High School Project

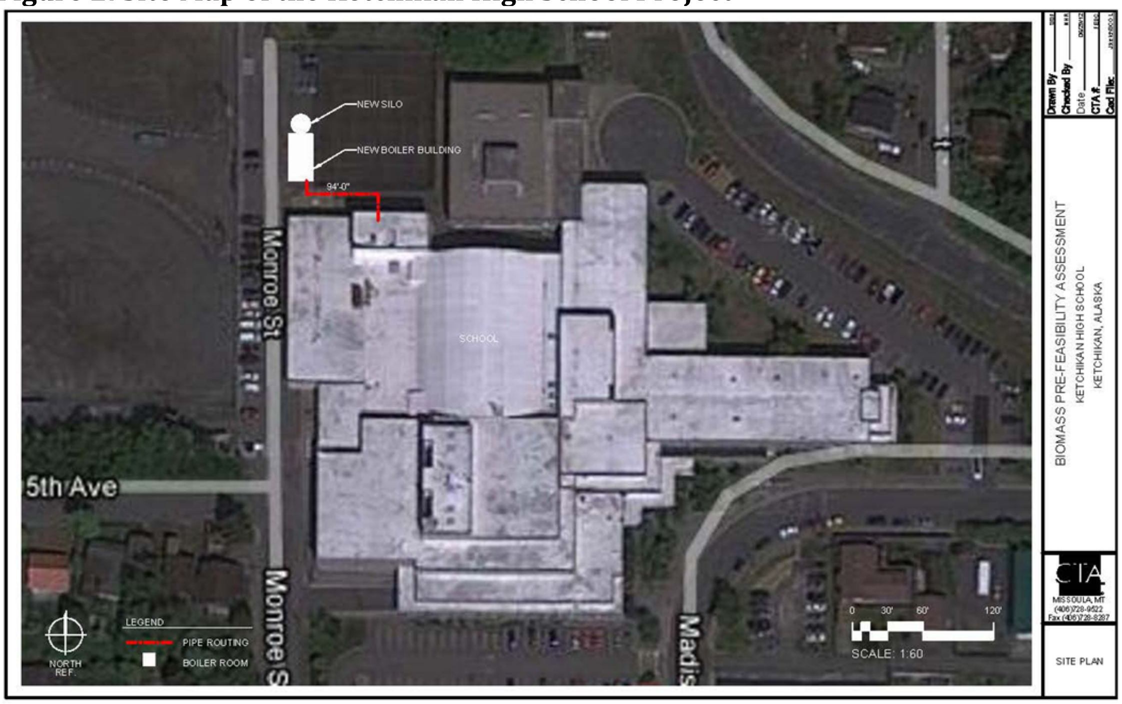


Figure 3 shows CTA Architects' plan of the location of the proposed biomass facility at the Ketchikan Indian Council Medical Facility. The site slopes moderately to steeply downward in the southeasterly direction. As a result, there are buildings above and below the site. The biomass facility will be located in a stand-alone building on the northeast (uphill) side of the school building. 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 small buffer for emissions dispersion.

Figure 3: Site Map of the Ketchikan Indian Council Medical Facility

Figure 4 shows CTA Architects' plan of the location of the Ketchikan Indian Council Votec School (marked Stedman) and Ketchikan Indian Council Admin Building (marked Deermount). The sites slope moderately to steeply downward in the southeasterly direction. As a result, there are buildings above and below the sites. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 4: Site Map of Ketchikan Indian Council Votec School (Stedman) and the Admin Building (Deermount)

A USGS map is provided below in Figure 5. As shown, Craig Island is relatively flat with mountainous terrain to the west, and water in all other directions. The area is relatively sparsely populated. The population of Craig is 1,397. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

Figure 5: USGS Map Illustrating the Craig Study Area

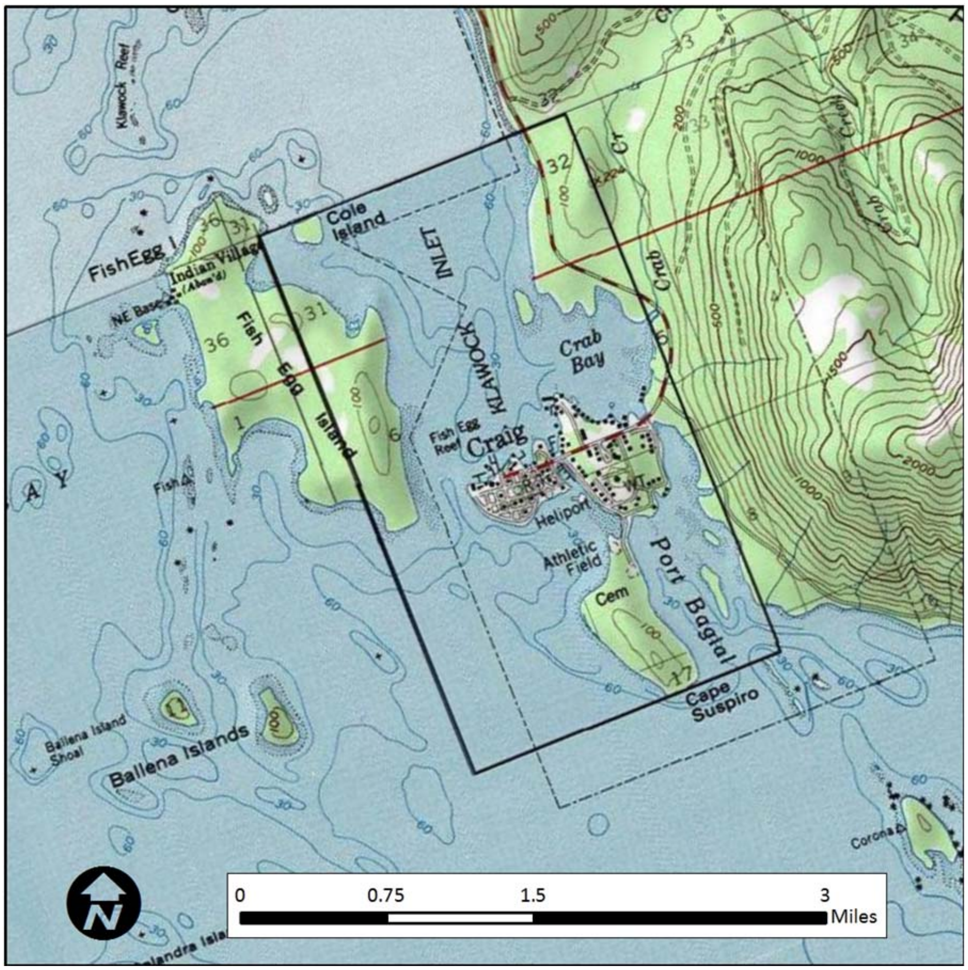


Figure 6 shows CTA Architects' plan of the location of the proposed biomass facility and the surrounding buildings. The site is relatively flat and moderately populated with one and two story high buildings. The boiler plant is located in a stand-alone building to the west of the Tribal Association Building and east of another building. The stack should be designed to provide plume rise above both of these buildings. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 6: Site Map of the Craig Tribal Association Building

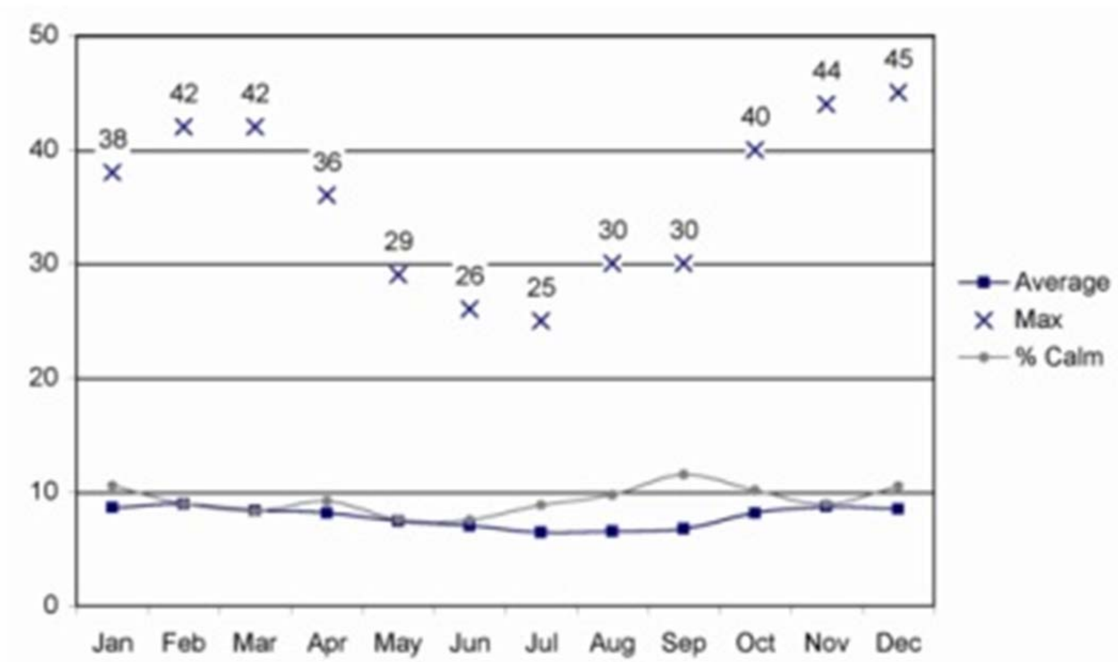
Figure 7 shows CTA Architects' plan of the proposed Shaan-Seet biomass facility and the surrounding buildings. The site is relatively flat and moderately populated with one and two story high buildings. The boiler plant is located in a stand-alone building. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 7: Site Map of Shaan-Seet Boiler Plant Site

METEOROLOGY

Meteorological data from Annette, AK, was reviewed to develop an understanding of the weather conditions. Annette is the closest weather data representing the climactic conditions occurring in the Panhandle and is therefore a good proxy of Ketchikan and Craig weather conditions. This data indicates calm winds occur only 10% of the year when, which suggests there will be minimal time periods when thermal inversions and therefore poor emission dispersion conditions can occur.[1]

Figure 8: Wind Speed Data from Annette, AK



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

DESIGN & OPERATION RECOMMENDATIONS

The following are suggested for designing this project:

- 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. ***Attention should be given to constructing stacks higher than 1.5 times the tallest roofline given higher elevations of surrounding residences due to the moderate to steep slopes present.***
- 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 Ketchikan High School: install at minimum a multicyclone to filter particulate matter emissions.

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

STATE AND FEDERAL PERMIT REQUIREMENTS

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

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

Please note the following:

- Oil and coal fired boilers are also subject to this rule.

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

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

SUMMARY

RSG has completed an air quality feasibility study for Ketchikan and Craig, Alaska. These 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 in Ketchikan and Craig:

1. The wood boilers will be relatively small emission sources.
2. Most of 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.
4. Meteorological conditions are favorable for dispersion.

The following conditions suggest additional attention should be given to controlling emissions in Ketchikan:

1. Presence of other emission sources.
2. Relatively high population density.
3. The sensitive populations housed by all Ketchikan 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 for all the aforementioned boilers. We also recommend developing a compliance plan for the aforementioned federal requirements.

Given its size and sensitive population served, air dispersion modeling can be performed for the Ketchikan High School site to determine the stack height and degree of emission control (multicyclone vs ESP).

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