Wood Heating Analysis

Haines Borough

Administration Building
Public Library
Vocational Education Building
Haines School and Pool
Wastewater Treatment Plant
Chilkat Center

Draft Report
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Section 1

Executive Summary

INTRODUCTION

This report presents the findings of a Wood Heating Analysis for the Haines Borough. The intent of this analysis is to determine if there is economic incentive to invest in wood heating systems for Haines Borough buildings.

The analysis looks at individual wood heating systems and a district wood heating system to serve the following buildings: Administration Building; Public Library; Vocational Education Building; and School and Pool. In addition, we summarize the feasibility of converting the Chilkat Center and Wastewater Treatment plant to wood heating.

The scope of this study is limited to evaluating options for heating the buildings with wood pellets. While wood boilers are capable of burning a variety of wood fuel including pellets, chips, disks, and cordwood, only pellets are commercially available in consistent quality and sufficient quantity to be considered for the buildings.

The buildings that are part of this study are currently heated by a fuel oil boiler(s). Pellet boilers integrate well with the fuel-oil boiler heating systems because they both produce 180°F heating water. In multiple boiler installations, a pellet boiler can replace an existing fuel oil boiler, retaining the necessary heating redundancy.

For the smaller buildings (Administration, Library, Voc-Ed) a containerized wood boiler is evaluated. For the larger wood boilers to serve the School or District Plant, a separate boiler building is constructed to house the equipment.

LIFE CYCLE COST ANALYSIS

The analysis compares retaining the fuel oil boilers (status quo) with converting to wood pellet boilers. The wood heating option retains the fuel oil boilers for redundancy and backup.

Administration, Library, and Vocational Education

The status quo option requires replacement of the boilers in the Administration and Voc-Ed buildings. The Library boiler is in good condition and is retained. The wood heating conversion for each building installs a containerized boiler adjacent to each boiler room. The container includes the wood boiler, pellet storage tank, piping, and appurtenances.

The life cycle cost analysis determined that retaining the fuel oil boilers has the lowest life cycle cost. Wood boilers require significant investment and more maintenance than fuel oil boilers. These relatively small buildings with modest heating loads do not generate sufficient energy savings to offset these higher costs.

School and Pool

The status quo option retains the fuel oil boilers in the school. The wood heating option installs two pellet boilers in a boiler building located near the school boiler room.

A life cycle cost comparison determined that the two options have essentially equal life cycle costs. The high heating requirements of the school allows the wood boiler to generate sufficient energy savings to offset higher construction and operating costs.

District Heating System

The status quo option requires replacement of the older boilers in the Administration and Vocational Education Building. The Library and School boilers are retained. The wood heating option constructs a district heating plant near the school boiler room. Buried piping distributes the heat to each building.

A life cycle cost comparison of the base case shows that the status quo option has the lowest life cycle cost. The high heating requirements of the buildings does not generate sufficient energy savings to offset the high cost of constructing the wood heating plant and buried distribution piping.

Life Cycle Cost Comparison

Heating System	Construction	Operating	Energy	Total LCC
Administration Building				
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000
Pellet and Fuel Oil Boilers	$300,000	$167,000	$89,000	$556,000
Library				
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000
Pellet and Fuel Oil Boilers	$319,000	$157,000	$248,000	$724,000
Vocational Education Building				
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000
Pellet and Fuel Oil Boilers	$312,000	$165,000	$148,000	$625,000
School and Pool				
Status Quo: Fuel Oil Boilers	$0	$135,000	$5,086,000	$5,221,000
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,177,000	$5,442,000
District Heating System				
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,105,000	$6,807,000

Results based on 6.6% fuel oil inflation and 3.6% wood pellet inflation.
Highlighted costs are lowest life cycle cost.

WASTEWATER TREATMENT PLANT AND CHILKAT CENTER

The Borough has identified the Wastewater Treatment Plant and Chilkat Center as potential wood heating conversions.

Wastewater Treatment Plant

The Wastewater Treatment Plant (WWTP) is heated by three fuel oil furnaces that consume 7,400 gallons of fuel oil per year. The furnaces have a relatively high design load of 720 MBH due to ventilation loads.

Heating Options

Status Quo: The building is heated by three fuel oil furnaces; two are at the end of their service life. The status quo option would replace the two furnaces.

Wood Heating Conversion: One option is to replace the two furnaces and install a containerized wood boiler and a hydronic heating loop to supply the heat to a heating coil installed in each furnace. A less expensive option is to connect the building to a district plant via buried pipelines. This is only viable if the district plant is constructed.

Wood Heating Assessment

The wood heating options have a probable cost of construction of $750K for the connection to a district plant and $1,000K to construct a wood boiler plant. The life cycle energy savings to shift 7,400 gallons of fuel oil to wood pellets is approximately $530K.

The energy savings does not offset the cost of installing the wood boiler so there is no economic incentive to install a wood boiler. The factors that contribute to this finding are:

- The relatively high heating load increases the size of the wood boiler and the initial investment.
- The cost of converting is further increased by the need to install a hydronic heating system to supply heat to each furnace.

Chilkat Center

The Chilkat Center is heated by two fuel oil boilers that consume 11,000 gallons of fuel oil per year.

Heating Options

Status Quo: The two boilers are at the end of their service life. The status quo option replaces the boilers.

Wood Heating Conversion: This option replaces the existing heating system and adds a heat exchanger and pumps to separate the building heating system from the wood boiler system, and installs an exterior container that contains a wood boiler, pellet storage tank, boiler pump and appurtenances. A control system is installed to operate the boilers and pumps in a lead/standby configuration.

Wood Heating Assessment

The wood heating option has a probable cost of construction of $400K. The life cycle operating savings—energy savings minus added maintenance— is approximately $600K. The operating savings more than offset the investment so there is incentive to convert the building to wood heating.

It was noted in recent assessments of the building that it is currently operating inefficiently. Efforts to reduce energy consumption typically have a better return than investments in new heating systems. It is recommended that the building be brought up to optimal operation and then the wood heating assessment be based on the new baseline energy consumption.

SUMMARY

This analysis determined that there is not sufficient incentive to invest in wood heating systems. Wood heating is the higher life cycle cost option on the three smaller buildings, only breaks even for the School, and is higher for the district plant. The findings are typical of other analyses for buildings in Southeast Alaska.

The use of wood as a heating source is increasing in North America, primarily because of energy cost savings. The findings do not directly challenge this trend, but instead exhibit the following realities of wood heating in Haines:

- Energy Costs: Wood pellets are more expensive in Haines and are subject to greater price volatility due to imbedded transportation energy. In the Pacific Northwest, the delivered cost is $190 per ton. Sealaska Corporation is quoting $360 per ton (89% higher).
- Construction Costs: Haines has higher construction costs due to higher labor and material costs. This reality has historically hindered the incentive to invest in energy efficiency throughout Southeast Alaska.

The prudent course of action is to wait and see how this energy source plays out over time. Important signals will be the influx of private money into the industry and favorable long-term assessments of the resource that reduce the risk. There is little lost in waiting as the economics do not currently provide a strong incentive to invest in wood heating.

Relevant Considerations

Any building owner that is considering wood heating should be fully versed in the technology and requirements of the system. Wood heating systems require significant investment, considerably more maintenance, and the equipment has a shorter service life—wood boilers last 18 years, fuel oil boilers 35 years. While the technology has improved remarkably in recent years, wood heating is not a better way to heat buildings. A wood heating system requires a more hands-on ownership role than a fuel oil boiler system.

It is also prudent to consider that a wood boiler does not convert wood energy to heat at higher efficiency; there is no change in the amount of purchased energy. Wood heating still requires the purchasing a finite energy source from the energy market. In a world of increasing energy demands and finite supplies, it has yet to be proven that wood energy can retain its present cost advantage over the life of the investment (and beyond). The lack of knowledge on this point is a serious deficiency given that firm energy saving is the dominant reason for investing in a wood heating system.

Recommendation

It is recommended that the Haines Borough not invest in wood heating systems at this time. The wood heating industry is in its relative infancy and there remain unknowns and risks of the future availability and cost of wood energy.

The recently released Draft Southeast Alaska Integrated Resource Plan (IRP) makes a strong recommendation for wood heat conversions. However, the plan failed to provide a regional wood energy resource analysis of the sustainability and cost of wood heating energy throughout the region. Without the analysis, the wood heating recommendation lacks basis.

The recommendation to not invest in wood heating until the economics improve and more is known about the wood energy resource provides Haines a window for planning its energy future. While the IRP attempted to provide a plan for the entire Southeast Alaska region, each community essentially has its unique energy challenges and opportunities. Haines' long-term economic health can be fortified by developing a local energy plan. Since Haines and Skagway share hydroelectric resources, coordination between the communities is also needed. The energy plan can look at all potential sources of energy, evaluate their supply and demand, and assess how they contribute to meeting the future energy demands of the community.

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Section 2
Introduction

INTRODUCTION

This report presents the findings of a Wood Heating Analysis for the Haines Borough. The intent of this analysis is to determine if there is economic incentive to invest in wood heating systems for Haines Borough buildings.

The analysis looks at individual wood heating systems and a district wood heating system to serve the following buildings:

- Administration Building
- Haines Borough Public Library
- Vocational Education Building
- Haines School and Pool

In addition, we summarize the feasibility of converting the Chilkat Center and Wastewater Treatment plant to wood heating.

The purpose of this analysis is to compare the life cycle cost of maintaining the status quo of heating with fuel oil boilers with converting to wood pellet heating. The analysis is performed by:

- Jim Rehfeldt, P.E., Mechanical/Energy Engineer, Alaska Energy Engineering LLC
- Doug Murray, Mechanical Engineer, Murray & Associates P.C.
- Ben Haight, Electrical Engineer, Haight & Associates, Inc.

Scope of Work

The scope of work as defined in the Request for Proposals is:

- Provide a current resource assessment for finished wood pellets.
- Provide a 20-year life cycle cost analysis to heat the buildings with wood pellets. The analysis will evaluate the construction, maintenance, and energy costs of retaining the fuel oil heating systems, converting to a wood pellet heating system, or a wood pellet district heating system. On the wood boiler options, the fuel oil heating system is retained as backup.
- In addition to the buildings in the above analysis, provide an executive summary on the feasibility of using wood pellets to heat the following borough facilities: Sewage Treatment Plant and Chilkat Center.

CONCEPTUAL DESIGN INTENT

Pellet Boilers

The scope of this study is limited to evaluating options for heating the buildings with wood pellets. While wood boilers are capable of burning a variety of wood fuel including pellets, chips, disks, and cordwood, only pellets are currently commercially available in consistent quality and sufficient quantity to be considered for the buildings.

Heating Systems

The buildings that are the focus of this study are currently heated by a fuel oil boiler(s). Pellet boilers integrate well with the fuel-oil boiler heating systems because they both produce 180°F heating water. At the School, which is heated with multiple boilers, a pellet boiler can replace a fuel oil boiler, retaining the necessary heating redundancy.

A wood heat conversion will integrate a wood boiler with the existing boiler(s) to provide a dual-fuel heating system. The design intent is to provide an integrated dual-fuel system that operates the boilers in a lead (pellet) and lag (fuel oil) configuration to heat the building.

The wood boilers can be installed within the building or in a container as part of a preassembled package. None of the buildings have sufficient room within the boiler rooms for the pellet boiler. For the smaller boilers (Admin, Library, Voc-Ed) a containerized boiler has been selected. For the larger wood boilers to serve the School or District Plant, a separate boiler building is required for the heating plant.

The School site is highly constrained in the vicinity of the boiler room by an access road, buried utilities, and parking. It was reported that the adjacent property—currently occupied by the closed Elks Lodge—will be put up for sale. The corner of this lot closest to the boiler room offers a suitable, flat site for the wood boiler building. It is assumed that the Borough will purchase the property and a wood boiler building is suitable for the back corner of the lot.

All of the wood heating systems will require an anti-freeze solution so the outdoor piping and wood boiler do not freeze if it is shut down for service or repairs. Since anti-freeze would reduce the heating capacity of the existing building heating systems, a heat exchanger is required to separate the building heating system from the wood boiler system.

District Heating

A district heating plant that supplies the four buildings can be effectively located anywhere between the school and the Administration Building. Since the School has the highest heating load, it has been located near the School to reduce the cost of buried piping and associated heat loss.

If the Borough consolidates facilities in a location closer to the Library, the wood boiler building can be moved closer to the new facility without significant cost impact if its heating load is comparable to the School.

COST OF HEAT COMPARISON

The following chart provides a 20-year heating cost comparison for fuel oil, electric and wood pellet heat. Wood pellet heat is less expensive than both fuel oil and electric heat. See Section 3 for the basis of energy inflation factors.

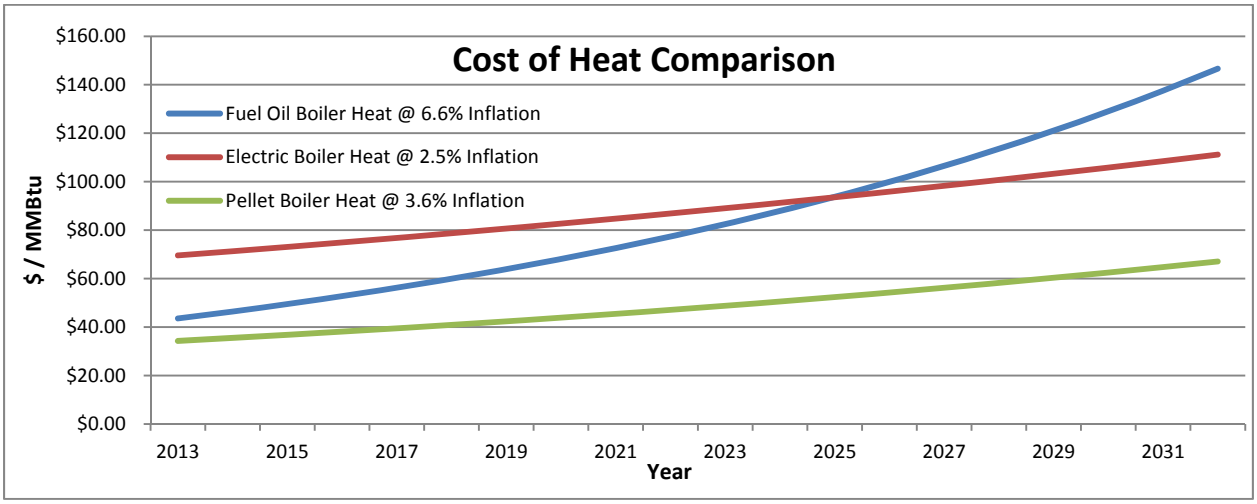

Fig 1: Cost of Heat Comparison

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Section 3

Life Cycle Cost Methodology

The purpose of this feasibility analysis is to compare the life cycle cost of retaining the fuel oil heating systems with converting them to wood pellet heating. The findings are highly sensitive to the economic factors, energy costs, and energy inflation used for the analysis. While future energy inflation has the greatest impact on the findings, there is no authority for these values. For this reason, a sensitivity analysis is used where base case, low, and high values for electricity and fuel oil inflation are evaluated.

ECONOMIC FACTORS

The following economic factors are used in the analysis:

- Economic Period: The scope of work sets the economic period at 20 years with all costs based on 2013 construction.
- Nominal Interest Rate: This is the nominal rate of return on an investment, without regard to inflation. If the Haines Borough were to finance a large project it would do so by issuing bonds through the Alaska Municipal Bond Bank. The bond bank's most recent issue in April paid an interest rate of 2.94% for a 20 year maturity. The analysis is based on a rate of return of 3%.
- Inflation Rate: The Consumer Price Index has risen at a rate of 2.9% over the past 20-years. The State of Alaska predicts general inflation of 2.5-3% per year. The analysis is based on a 2.75% rate of inflation over the 20-year economic period.

CONSTRUCTION COSTS

It is preferable to install wood boilers within the building for ease of maintenance and to minimize the impact to the aesthetics of the site. Unfortunately, none of the boiler rooms have sufficient space for a wood boiler.

Adding a wood boiler will require constructing an addition to the building or installing a containerized boiler. The containerized option is less expensive and acceptable to the Borough, so the conceptual design is based on this option. This option is suitable for the Admin Building, Library, and Voc-Ed Building. The larger boiler plant for the school and district heating system requires a standalone building to house the boilers and accessories.

All of the wood boilers are sized for 70% of the design heating load. This sizing will optimize the efficiency of the boiler. Fuel oil boiler supplementation will be required during cold weather and when undergoing maintenance and repair. The pellet boiler will supply 90% of the heating load and the fuel oil boiler 10%.

Appendix C contains specifications for the wood boilers.

OPERATING COSTS

Operating costs include maintenance and repair cost—on an annual and intermittent basis—and equipment replacement costs at the end of its expected service life. The costs are derived from industry standards for the long-term operation of the systems.

Maintenance and Repair

The heating systems will have the following maintenance and repair requirements. Wood boilers have higher maintenance requirements than the existing systems.

Fuel Oil Boilers

The following describes the maintenance requirements for fuel oil boilers. For the wood heating options, where the fuel oil boiler is operated as the lag boiler, these requirements are reduced by 50%.

- Daily: Inspection of boiler operation; 5 min/day
- Monthly: Check burner and fuel system; Check gaskets for unusual wear, overheating, and leakage; 2 hours.
- Annual Maintenance: Drain boiler, check interior for scale, clean combustion surfaces, perform combustion test, remove and clean low water cutoff probe, burner maintenance, replace any leaking elements or element gaskets; 2x per year, 8 hours each.
- Annual Parts Allowance: $150 per year.

Wood Boilers

It is assumed that daily and weekly maintenance will be performed in-house and monthly and annual maintenance will be performed under a service contract. The wood boilers have considerably higher maintenance requirements. It is incumbent with a wood heating system that the operating personnel have a strong sense of ownership in the system and a willingness to monitor and maintain it.

- Daily: Visual inspection of the boiler; 5 minutes (small boilers, 10 minutes large boilers). This work can be performed by Borough building maintenance.
- Weekly: Close visual inspection of plant equipment; 30 minutes. This work can be performed by Borough building maintenance.
- Monthly: Check critical functions, remove ash and clinkers; 2 hours. This work will require specialize training. The analysis is based on contracting this work.
- Biannual: Inspections, lubing, burner maintenance, internal critical function checks, possible equipment replacement; 8 hours. This work will require specialize training. The analysis is based on contracting this work.
- Annual Parts Allowance: $250 per year.

Pumps

- Require annual lubrication and periodic replacement.

Replacement

The fuel oil boilers have an expected service life of 35 years and will not require replacement during the 20-year analysis period. The wood boilers have an expected service life of 18 years. The analysis assumes that will operate satisfactorily throughout the 20-year analysis period.

ENERGY COSTS

Fuel Oil

Current Cost

The Haines Borough currently pays $4.22 per gallon for #2 heating oil.

Future Inflation

Base Fuel Oil Case: In recent years, fuel oil inflation has been very sporadic, with a decidedly upward trend in prices. Looking at oil prices over a longer period will smooth out the data and provide a longer-term assessment of future costs. Using this perspective over the past 25-years, fuel oil inflation has averaged 6.6% per year. The base case assumes that future fuel inflation will continue at this rate. This results in a 2013 price of $4.50 per gallon.

High Fuel Oil Case: There is potential for world oil demand to increase due to increased consumption by developing countries and/or an expanding global economy. Disruption of the world oil supplies could also affect supply, causing prices to rise. The high case assumes these factors and others could cause fuel inflation to be higher than the base case at 8% per year.

Low Fuel Oil Case: The U.S. Energy Information Agency predicts fuel oil inflation of 4.8% per year for the next 25-years. While this reference has historically under-predicted actual fuel oil inflation, it is possible that future fuel oil inflation may be lower than the base case due to: new technologies that increase oil field production; new sources such as oil sands; and efficiency gains that reduce global oil demand. These factors and others could lead to less demand which would result in fuel oil inflation lower than the base case at 4.8% per year.

Wood Pellets

Supply Source

Wood heating of commercial and institutional buildings is increasing in use in the United States, but the industry is in its relative infancy in Southeast Alaska. Boilers can burn pellets, chips, discs, cordwood, and hog fuel (chopped wood). Of these energy sources, only pellets are manufactured to known standards for energy content, moisture levels, ash content, etc.

Premium-grade pellets are currently the only suitable wood energy fuel for the buildings. This selection does not exclude other local wood energy supplies from being considered in the future if the Haines Borough installs a wood heating system(s). Other sources that can demonstrate the capability to supply wood heating energy in suitable quality and quantity, and offer a life cycle savings, will be considered.

The following institutional Haines buildings are currently heating with wood pellets:

- Chilkoot Indian Association Housing: Two 4-plexes. They direct purchase their pellets from Washington, ship them to the site, and load them in the pellet hopper. There current cost is $155 per ton plus $5.30 per 40# bag for shipping which comes to $420 per ton plus labor to load the hopper.

Sealaska Corporation, through their Sealaska Global Logistics subsidiary, is committed to distributing wood pellets throughout Southeast Alaska. There are no local pellet sources, so they purchase pellets from the Pacific Northwest and distribute them to buildings in Southeast Alaska. The analysis is based on their pellet price. This does not exclude any other supplier from bidding on future pellet supply contracts if they can meet the pellet procurement requirements.

Other Sources

The Chilkoot Indian Association has studied the idea of constructing a wood pellet plant in Haines. The plant could source beetle-killed wood from the Yukon or from the Haines State Forest. At the present time, they do not have firm plans to build the plant.

Dakwakak Development Corporation in the Yukon has looked into constructing a pellet plant but is not actively pursuing the idea.

A pellet plant has just begun operation in Fairbanks. There have been some issues with quality control and the formation of clinkers within the boiler. Unfortunately, it is cost prohibitive to ship pellets for Fairbanks to Haines.

Current Costs

Sealaska has quoted a pellet price of $360 per ton.

Future Inflation

The recently released Draft Southeast Alaska Integrated Resource Plan (IRP) lays out a goal to convert 80% of the fuel oil heating load to wood heating. Unfortunately, the IRP does not provide or reference a market analysis of future pellet inflation, information that is basic to performing a wood heating analysis or making a long-term investment in a wood heating boiler.

While Alaska and all of the states in the Pacific Northwest recognize wood heating as a viable heating option, none of them have performed research on long-term costs and sustainability under various load growth scenarios.

Research on pellet pricing trends has failed to produce definitive information that can be used in predicting the rate of inflation in a Southeast Alaska energy analysis. Local pellet production is without history, with just one Ketchikan pellet mill in production for a few months. At this point, any pricing should assume pellets will be imported from the Pacific Northwest.

Baseline Case: Historic pellet inflation factored over 20 years has approximated the rate of general inflation in the U.S. and in Europe, approximately 3%. In the shorter and more recent past (5-7 years) pellet inflation for some mills has averaged 4.5 to 5 percent. The following examples were found:

- Tongass Forest Enterprises, Ketchikan: Current contract with Federal Government includes a 5% per year annual escalation factor.
- Manke Lumber, Seattle: Price increases of ~5% over the past 5 years.
- Pellets in New England averaged 4.6% annual increase from 1998-2010. However, Charlie Neibling of New England Wood Pellet recommends using 3% pellet inflation.
- Case studies reviewed from Oregon, Montana and New England used inflation rates of 3.0 to 4.25 percent.

From our research, a pellet inflation rate between 3% and 4.5% is defensible. This is a wide range that reflects the lack of independent study; critical information that is essential to evaluating the economics of wood heat. The analysis is based on a median pellet inflation rate of 3.75%.

There are two sides to the issue of pellet inflation. A low inflation rate improves the short-term economics of conversion. From a long-term perspective, a higher inflation rate improves pellet manufacturer cash flow to cover increasing labor, material, and energy costs while offering incentive to invest in production equipment. This in turn leads to competition, which hopefully leads to better pricing. A 3.75% inflation rate aligns with the long-term perspective that is inherent with investment in a wood boiler.

Transportation accounts for 56% of the cost of pellets delivered to Haines. The fuel surcharge quoted by Alaska Marine Lines is 20% of the shipping cost. The following calculation uses this breakdown to determined that the sum of each of these factors and returns a delivered inflation rate of 3.6%

Pellet Inflation = 44% of total cost x 3.75% pellet inflation =	1.7%
Transportation (non-fuel) = 80% of 56% of total cost x 2.75% general inflation =	1.2%
Transportation (Fuel) = 20% of 56% total cost x 6.6% oil inflation =	0.7%
Total Pellet Inflation Rate =	3.6%

High Case: If in the near term, pellets and fuel oil inflate at their base case predictions of 4% and 6.6%, the cost differential between them will increase in the future. This will provide greater incentive to convert to wood heating and the increasing cost difference will give pellet manufacturers an incentive to raise prices. Other factors that can lead to higher pellet costs are localized supply reductions that have occurred from time to time. Because this is a regional market the loss of one major supplier through fire or business shut-down can cause market disturbance. A high case of 5% reflects these factors.

Low Case: If local pellet mill production develops, with competition, pellet prices for Southeast Alaska consumers could see a reduction because of reduced shipping costs. Or, if a robust wood products industry develops in Southeast Alaska, there will be more "waste" material that can be made into pellets. If this were to happen, pellet inflation could remain at the historic inflation rate of 3%.

Electricity

Current Cost

The Alaska Power Company supplies power to the buildings. A review of the billing data shows that electric costs average $0.24 per kWh. Since electricity consumption is a minor part of a heating systems total energy use, this value is accepted for use in the analysis.

Future Inflation

It is assumed that electric rates will increase at 3% per year. This increases 2013 cost to $.25 per kWh.

Summary

The following table summarizes the energy and economic factors used in the analysis. A sensitivity analysis is also provided to determine how modest variations in energy inflation affect the results. The following table shows the base, high and low case energy inflation that is applied to the analysis.

Summary of Economic and Energy Factors

Factor	Rate or Cost
Nominal Discount Rate	3%
General Inflation Rate	2.75%
Electricity, 2013	25¢ per kWh
Electricity Inflation	3%
Fuel Oil, 2013	$4.50 / gallon
Fuel Oil Inflation [1]	4.8%, 6.6% (Base), 8%
Pellets	$373.00 / ton
Pellet Inflation [1]	2.75%, 3.6% (Base), 5%

1. The inflation rates for fuel oil and wood pellets represent the base case and the low and high cases used for the sensitivity analysis.

Section 4

Life Cycle Cost Analysis

INTRODUCTION

This section provides the conceptual design and life cycle cost comparison of retaining the existing heating systems or converting to wood pellet heating systems. Incorporating wood boilers will require added investment in the boilers, storage, and integration with the existing building heating systems.

ADMINISTRATION BUILDING

Heating Options

Status Quo

The building is heated by a fuel oil boiler that is at the end of its service life. This option replaces the heating system including the boiler, pumps, piping, domestic hot water heating system, and appurtenances.

Wood Heating Conversion

This option replaces the existing heating system and adds a heat exchanger and pumps to separate the building heating system from the wood boiler system, and installs an exterior container that contains a wood boiler, pellet storage tank, boiler pump and appurtenances. The container is located within 5' of the boiler room so the piping can be routed aboveground. A control system is installed to operate the boilers and pumps in a lead/standby configuration.

Annual Costs

The following table compares the 2013 annual maintenance and operating costs of the two options. In the initial years, the annual cost of operating a wood boiler will exceed the annual cost of the status quo option. This difference will decrease over time as fuel oil prices inflate faster than pellet costs. However, the lack of initial savings reduces the incentive to invest in a wood heating plant.

Annual Costs – Administration Building

Item	Consumption	2013 Cost
Status Quo		
Maintenance	78 hours	$3,300
Fuel Oil	990 gals	4,500
Electricity	400 kWh	100
Total		$ 7,900
Wood Pellet Conversion		
Maintenance	134 hours	$8,600
Fuel Oil	100 gals	400
Pellets	9 tons	3,400
Electricity	2,200 kWh	500
Total		$ 12,900

Life Cycle Costs

A life cycle cost comparison of the options shows that retaining the status quo fuel oil boiler has the lowest life cycle cost. When comparing the options under the base case, the wood boiler option has the following life cycle cost factors that are central to this result:

- The construction costs are 390% higher.
- The maintenance costs are 260% higher.
- The energy costs are 29% lower.

The findings indicate that the higher construction and operating costs are not offset by the energy savings. This causes the wood heating option to have a higher life cycle cost.

For the Administration Building, the heating load is relatively low due to the lack of a ventilation system. The wood boiler is not able to generate sufficient energy savings to offset the higher construction and maintenance costs. This is true under all of the energy inflation cases. For the wood heating option to be preferred over the status quo—likely siphoning current dollars from other priorities—the system should overwhelmingly have a lower life cycle cost. This is not the case.

Life Cycle Cost Comparison – Administration Building

Heating System	Construction	Operating	Energy	Total LCC
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000
Pellet and Fuel Oil Boilers	$300,000	$167,000	$89,000	$556,000
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$154,000	$295,000
Pellet and Fuel Oil Boilers	$300,000	$167,000	$98,000	$565,000
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$110,000	$251,000
Pellet and Fuel Oil Boilers	$300,000	$167,000	$93,000	$560,000
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000
Pellet and Fuel Oil Boilers	$300,000	$167,000	$107,000	$574,000
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000
Pellet and Fuel Oil Boilers	$300,000	$167,000	$89,000	$556,000

Note: Highlighted costs are lowest life cycle cost in each category.

PUBLIC LIBRARY

Heating Options

Status Quo

The building is heated by a fuel oil boiler that has over 20-years of remaining service life. The status quo option retains the existing heating system.

Wood Heating Conversion

This option retains the existing heating system, installs an exterior container that contains a wood boiler, pellet storage tank, boiler pump and appurtenances, and adds a heat exchanger and pumps to separate the building heating system from the wood boiler system. The container is located within 5' of the boiler room so the piping can be routed aboveground. A control system is installed to operate the boilers and pumps in a lead/standby configuration.

Annual Costs

The following table compares the 2013 annual maintenance and operating costs of the two options. In the initial years, the annual cost of operating a wood boiler will exceed the annual cost of the status quo option. This difference will decrease over time as fuel oil prices inflate faster than pellet costs. However, the lack of initial savings reduces the incentive to invest in a wood heating plant.

Annual Costs - Library

Item	Consumption	2013 Cost
Status Quo		
Maintenance	74 hours	$3,100
Fuel Oil	3,300 gals	14,800
Electricity	600 kWh	100
Total		$ 18,000
Wood Pellet Conversion		
Maintenance	126 hours	$8,000
Fuel Oil	340 gals	1,600
Pellets	26 tons	9,700
Electricity	3,000 kWh	700
Total		$ 20,000

Life Cycle Costs

A life cycle cost comparison of the options shows that retaining the status quo fuel oil boiler has the lowest life cycle cost. When comparing the options under the base case, the wood boiler option has the following life cycle cost factors that are central to this result:

- An investment of $319,000 is required for the heating system.
- The maintenance costs are 260% higher.
- The energy costs are 43% lower.

The findings indicate that the higher construction and operating costs are not offset by the energy savings. This causes the wood heating option to have a higher life cycle cost.

The wood boiler is not able to generate sufficient energy savings to offset the higher construction and maintenance costs. This is true under all of the energy inflation cases. For the wood heating option to be preferred over the status quo—likely siphoning current dollars from other priorities—the system should overwhelmingly have a lower life cycle cost. This is not the case.

Life Cycle Cost Comparison - Library

Heating System	Construction	Operating	Energy	Total LCC
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000
Pellet and Fuel Oil Boilers	$319,000	$157,000	$248,000	$724,000
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$61,000	$504,000	$565,000
Pellet and Fuel Oil Boilers	$319,000	$157,000	$273,000	$749,000
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$61,000	$357,000	$418,000
Pellet and Fuel Oil Boilers	$319,000	$157,000	$258,000	$734,000
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000
Pellet and Fuel Oil Boilers	$319,000	$157,000	$298,000	$774,000
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000
Pellet and Fuel Oil Boilers	$319,000	$157,000	$248,000	$724,000

Note: Highlighted costs are lowest life cycle cost in each category.

VOCATIONAL EDUCATION BUILDING

Heating Options

Status Quo

The building is heated by a fuel oil boiler that is at the end of its service life. This option replaces the heating system including the boiler, pumps, piping, domestic hot water system, and appurtenances.

Wood Heating Conversion

This option replaces the existing heating system and adds a heat exchanger and pumps to separate the building heating system from the wood boiler system, and installs an exterior container that contains a wood boiler, pellet storage tank, boiler pump and appurtenances. The container is located within 5’ of the boiler room so the piping can be routed aboveground. A control system is installed to operate the boilers and pumps in a lead/standby configuration.

Annual Costs

The following table compares the 2013 annual maintenance and operating costs of the two options. In the initial years, the annual cost of operating a wood boiler will exceed the annual cost of the status quo option. This difference will decrease over time as fuel oil prices inflate faster than pellet costs. However, the lack of initial savings reduces the incentive to invest in a wood heating plant.

Annual Costs – Vocational Education

Item	Consumption	2013 Cost
Status Quo		
Maintenance	78 hours	$ 3,300
Fuel Oil	1,650 gals	7,400
Electricity	390 kWh	200
Total		$ 10,900
Wood Pellet Conversion		
Maintenance	132 hours	$8,500
Fuel Oil	170 gals	800
Pellets	14 tons	5,200
Electricity	3,000 kWh	700
Total		$ 15,200

Life Cycle Costs

A life cycle cost comparison of the options shows that retaining the status quo fuel oil boiler has the lowest life cycle cost. When comparing the options under the base case, the wood boiler option has the following life cycle cost factors that are central to this result:

- The construction costs are 480% higher.
- The maintenance costs are 260% higher.
- The energy costs are 33% lower.

The findings indicate that the higher construction and operating costs are not offset by the energy savings. This causes the wood heating option to have a higher life cycle cost.

Life Cycle Cost Comparison – Vocational Education

Heating System	Construction	Operating	Energy	Total LCC
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000
Pellet and Fuel Oil Boilers	$312,000	$165,000	$148,000	$625,000
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$182,600	$311,700
Pellet and Fuel Oil Boilers	$312,000	$165,000	$145,000	$622,000
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$67,500	$63,900	$182,600	$314,000
Pellet and Fuel Oil Boilers	$312,000	$165,000	$145,000	$622,000
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000
Pellet and Fuel Oil Boilers	$312,000	$165,000	$166,000	$643,000
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000
Pellet and Fuel Oil Boilers	$312,000	$165,000	$139,000	$616,000

Note: Highlighted costs are lowest life cycle cost in each category.

SCHOOL AND POOL

Heating Options

The School Building boilers also supply heat to the Borough swimming pool.

Status Quo

The school building has a three-boiler heating plant with over 20-years of remaining service life. The status quo option retains the existing heating system.

Wood Heating Conversion

Wood Heating System: This option retains the existing heating system but disables one of the fuel oil boilers. A boiler building is constructed on the adjacent Elks Lodge property—it is assumed that the Borough will purchase the property—and a two wood boiler heating plant is constructed to supply the building. A heat exchanger and pumps are installed in the boiler room to separate the building heating system from the wood boiler system. A control system is installed to operate the boilers and pumps in a priority lead/standby configuration.

Annual Costs

The following table compares the 2013 annual maintenance and operating costs of the two options. The wood boiler option has lower annual costs throughout the life of the boiler due to energy cost savings offsetting higher maintenance costs.

Annual Costs – School and Pool

Item	Consumption	2013 Cost
Status Quo		
Maintenance	162 hours	$7,000
Fuel Oil	38,400 gals	173,000
Electricity	6,800 kWh	2,000
Total		$ 182,000
Wood Pellet Conversion		
Maintenance	288 hours	$18,000
Fuel Oil	3,800 gals	17,000
Pellets	323 tons	121,000
Electricity	21,000 kWh	5,000
Total		$ 161,000

Life Cycle Costs

A life cycle cost comparison of the base case shows that the two options have essentially equal life cycle costs. The high heating requirements of the school give the wood boiler the ability to generate sufficient energy savings to offset higher construction and operating costs. When comparing the options, the wood boiler option has the following life cycle cost factors that are central to this result:

- An investment of $1,917,000 in the wood heating system is required.
- The maintenance costs are 260% higher.
- The energy costs are 38% lower.

The life cycle cost comparison changes in a predictable way with the different energy inflation cases. Where fuel oil inflation is lower or pellet inflation is higher, the fuel oil boiler option has a lower life cycle cost. Under the scenarios where fuel oil inflation is higher or pellet inflation is lower, the wood boiler option has a lower life cycle cost. All of the options and scenarios have a life cycle cost of $5.5M +/- 10%, which is very close when estimating and forecasting costs for 20 years.

For the wood heating option to be preferred over the status quo—likely siphoning current dollars from other priorities—the system should overwhelmingly have a lower life cycle cost. There is no compelling reason to invest in a wood heating system.

Life Cycle Cost Comparison – School and Pool

Heating System	Construction	Operating	Energy	Total LCC
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,086,000	$5,221,000
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,177,000	$5,442,000
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,931,000	$6,066,000
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,261,400	$5,526,400
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$135,000	$4,198,000	$4,333,000
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,088,100	$5,353,100
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,086,000	$5,221,000
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,581,800	$5,846,800
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,086,000	$5,221,000
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$2,963,300	$5,228,300

Note: Highlighted costs are lowest life cycle cost in each category.

DISTRICT HEATING SYSTEM

Heating Options

Status Quo

The four buildings will have the same scope of work as for the individual wood boiler systems.

- Administration Building: The building is heated by a fuel oil boiler that is at the end of its service life. This option replaces the heating system including the boiler, pumps, piping, domestic hot water system, and appurtenances.
- Library: The building is heated by a fuel oil boiler that has over 20-years of remaining service life. The status quo option retains the existing heating system.
- School and Pool: The school building has a three-boiler heating plant with over 20-years of remaining service life. The status quo option retains the existing heating system.
- Vocational Education: The building is heated by a fuel oil boiler that is at the end of its service life. This option replaces the heating system including the boiler, pumps, piping, domestic hot water system, and appurtenances.

Wood Heating Conversion

Wood Heating System: This option retains the existing heating systems in each building. A district heating plant is constructed on the adjacent Elks Lodge property—it is assumed that the Borough will purchase the property—with two wood boilers to supply the buildings. The buildings are connected by buried piping in insulated enclosures. A heat exchanger and pump is installed in each boiler room to separate the building heating system from the wood heat distribution system. A control system is installed in each boiler room to operate the local boilers and pumps when the wood boiler is not supplying sufficient heat.

Annual Costs

The following table compares the 2013 annual maintenance and operating costs of the two options. The wood boiler option has lower annual costs throughout the life of the boiler due to lower maintenance and energy costs.

Annual Costs – District Heating System

Item	Consumption	2013 Cost
Status Quo		
Maintenance	398 hours	$ 17,000
Fuel Oil	44,000 gals	199,000
Electricity	8,500 kWh	2,000
Total		$ 218,000
Wood Pellet Conversion		
Maintenance	324 hours	$ 20,000
Fuel Oil	2,500 gals	11,000
Pellets	416 tons	155,000
Electricity	53,000 kWh	13,000
Total		$ 199,000

Life Cycle Costs

A life cycle cost comparison of the base case shows that the status quo option has the lowest life cycle cost under all scenario except the high fuel oil case at 8% inflation. The high heating requirements of the buildings fail to generate sufficient energy savings to offset the high cost of installing the wood heating plant and buried distribution piping.

The district plant does reduce maintenance costs over the status quo because the majority of the maintenance is shifted from the individual fuel oil boilers to the wood boilers.

When comparing the options, the wood boiler option has the following life cycle cost factors that are central to this result:

- An additional investment of $3,248,000 in the wood heating system is required.
- The maintenance costs are 7% lower because the maintenance of the wood plant is less than maintaining individual boilers.
- The energy costs are 47% lower. The district plant supplies 95% of the heating load consuming less expensive wood energy.

All of the options and scenarios have a life cycle cost of $6.3 +/- 10%, which is very close when estimating and forecasting costs for 20 years.

For the wood heating option to be preferred over the status quo—likely siphoning current dollars from other priorities—the system should overwhelmingly have a lower life cycle cost. There is no compelling incentive to invest in a wood heating system.

Life Cycle Cost Comparison – District Heating System

Heating System	Construction	Operating	Energy	Total LCC
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,105,000	$6,807,000
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$6,825,000	$7,302,000
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,144,000	$6,846,000
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$4,832,000	$5,309,000
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,062,000	$6,764,000
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,492,000	$7,194,000
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation				
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$2,899,000	$6,601,000

Note: Highlighted costs are lowest life cycle cost in each category.

SUMMARY

This analysis determined that there is not sufficient incentive to invest in wood heating systems. Wood heating is the higher life cycle cost option on the three smaller buildings, only breaks even for the School, and is higher for the district plant. The findings are typical of other analyses for buildings in Southeast Alaska.

The use of wood as a heating source is increasing in North America, primarily because of energy cost savings. The findings do not directly challenge this trend, but instead exhibit the following realities of wood heating in Haines:

- Energy Costs: Wood pellets are more expensive in Haines and are subject to greater price volatility due to imbedded transportation energy. In the Pacific Northwest, the delivered cost is $190 per ton. Sealaska Corporation is quoting $360 per ton (89% higher).
- Construction Costs: Haines has higher construction costs due to higher labor and material costs. This reality has historically hindered the incentive to invest in energy efficiency throughout the region.

The prudent course of action is to wait and see how this energy source plays out over time. Important signals will be the influx of private money into the industry and favorable long-term assessments of the resource that reduce the risk. There is little lost in waiting as the economics do not currently provide a strong incentive to invest in wood heating.

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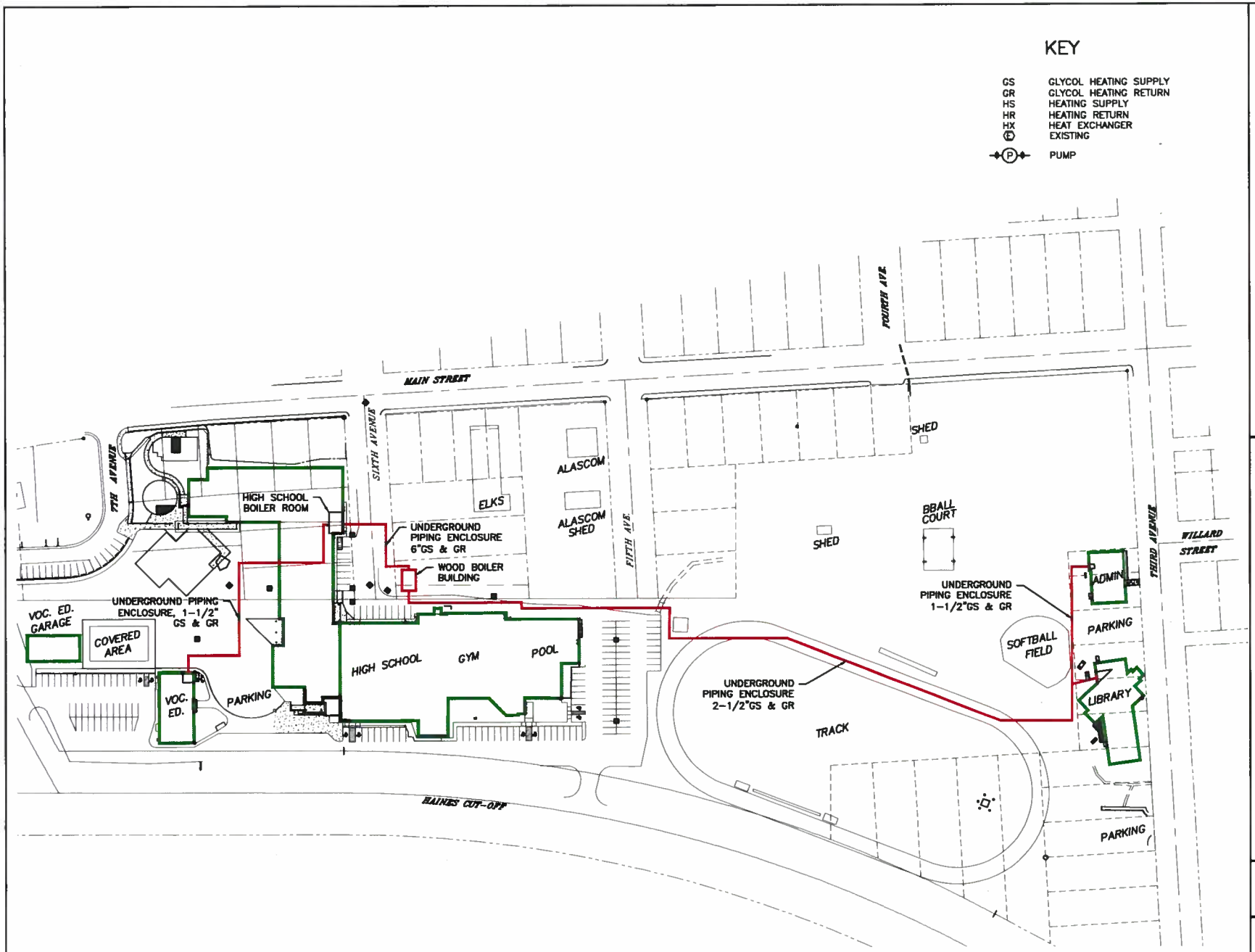
Appendix A

Conceptual Design Diagrams



1 DISTRICT HEATING PLANT CONCEPTUAL DESIGN SITE PLAN

SCALE: 0 2' 4' 8'

MURRAY & ASSOCIATES, P. C.
CONSULTING ENGINEERS
P O BOX 21081
JUNEAU, ALASKA 99802
TEL: 907 780-6151
FAX: 907 780-6182

HAINES BOROUGH WOOD STUDY
CONCEPTUAL DESIGN
HAINES, ALASKA

SHEET TITLE:
DISTRICT SITE PLAN

DATE: 6/8/2012
DRAWN: BS
DESIGNED: DM
CHECKED: DM

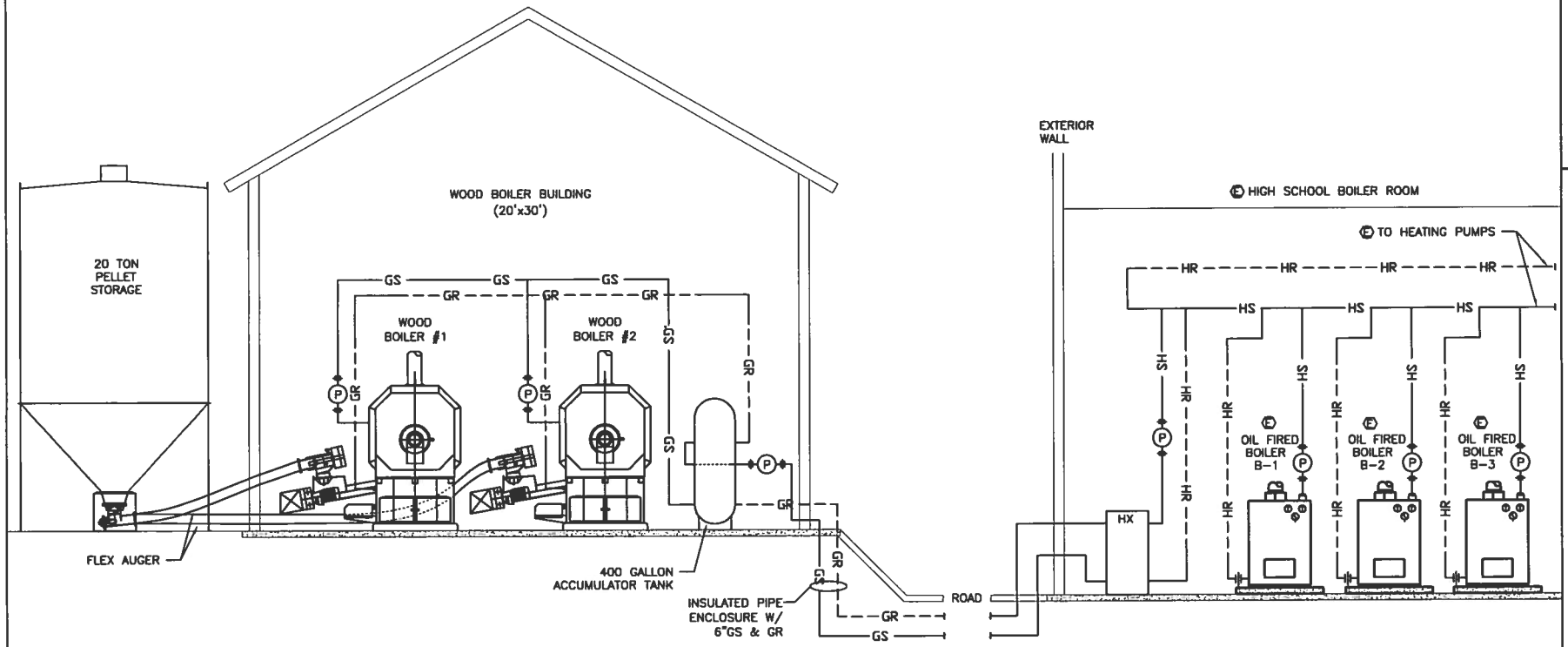
SHEET NO.
M-1
JOB NO.

WOOD BOILER CAPACITIES

BUILDING	CAPACITY	DESIGN MANUFACTURE/ MODEL
HIGH SCHOOL	TWO BOILERS @ 1,300,000 BTU/HR	ACT BIOENERGY MODEL 400

KEY

GS	GLYCOL HEATING SUPPLY
GR	GLYCOL HEATING RETURN
HS	HEATING SUPPLY
HR	HEATING RETURN
HX	HEAT EXCHANGER
(E)	EXISTING
(P)	PUMP



1 WOOD HEATING PLANT CONCEPTUAL DESIGN
SCHOOL/POOL BUILDINGS

SCALE: 0 1' 2' 4'

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HAINES BOROUGH WOOD STUDY
CONCEPTUAL DESIGN
HAINES, ALASKA

SHEET TITLE:
SCHOOL/POOL

DATE: 6/8/2012
DRAWN: BS
DESIGNED: DM
CHECKED: DM

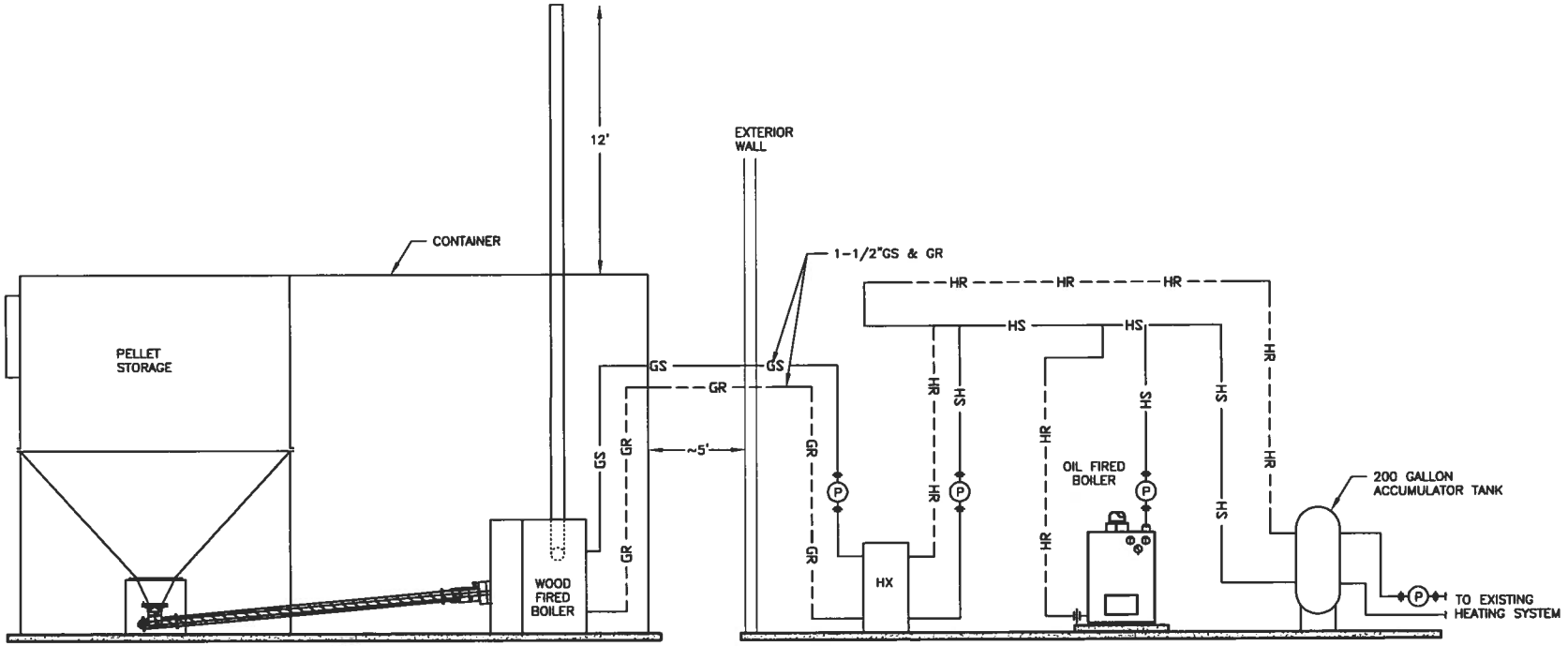
SHEET NO.
M-2
JOB NO.

WOOD BOILER CAPACITIES

BUILDING	CAPACITY	DESIGN MANUFACTURER/MODEL	CONTAINTER SIZE L x W x H
ADMIN. BLDG	62,000 BTU/HR	MAINE ENERGY SYSTEMS CONTAINERIZED SYSTEM A	10'-6" x 8'-0" x 8'-8"
VOC. ED.	88,000 BTU/HR	MAINE ENERGY SYSTEMS CONTAINERIZED SYSTEM B	15'-9" x 8'-0" x 8'-8"
LIBRARY	148,000 BTU/HR	MAINE ENERGY SYSTEMS CONTAINERIZED SYSTEM C	20'-4" x 8'-0" x 8'-8"

KEY

GS	GLYCOL HEATING SUPPLY
GR	GLYCOL HEATING RETURN
HS	HEATING SUPPLY
HR	HEATING RETURN
HX	HEAT EXCHANGER
E	EXISTING
P	PUMP



1 **W0OD HEATING PLANT CONCEPTUAL DESIGN - LIBRARY, ADMINISTRATION, VOC-ED BUILDINGS**

SCALE: 0 6" 1' 2'

MURRAY & ASSOCIATES, P. C.
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JUNEAU, ALASKA 99802
TEL: 907 780-6151
FAX: 907 780-6182

HAINES BOROUGH WOOD STUDY
CONCEPTUAL DESIGN
HAINES, ALASKA

SHEET TITLE:
LIBRARY, ADMIN., VOC-ED BUILDINGS

DATE: 6/8/2012
DRAWN: BS
DESIGNED: DM
CHECKED: DM

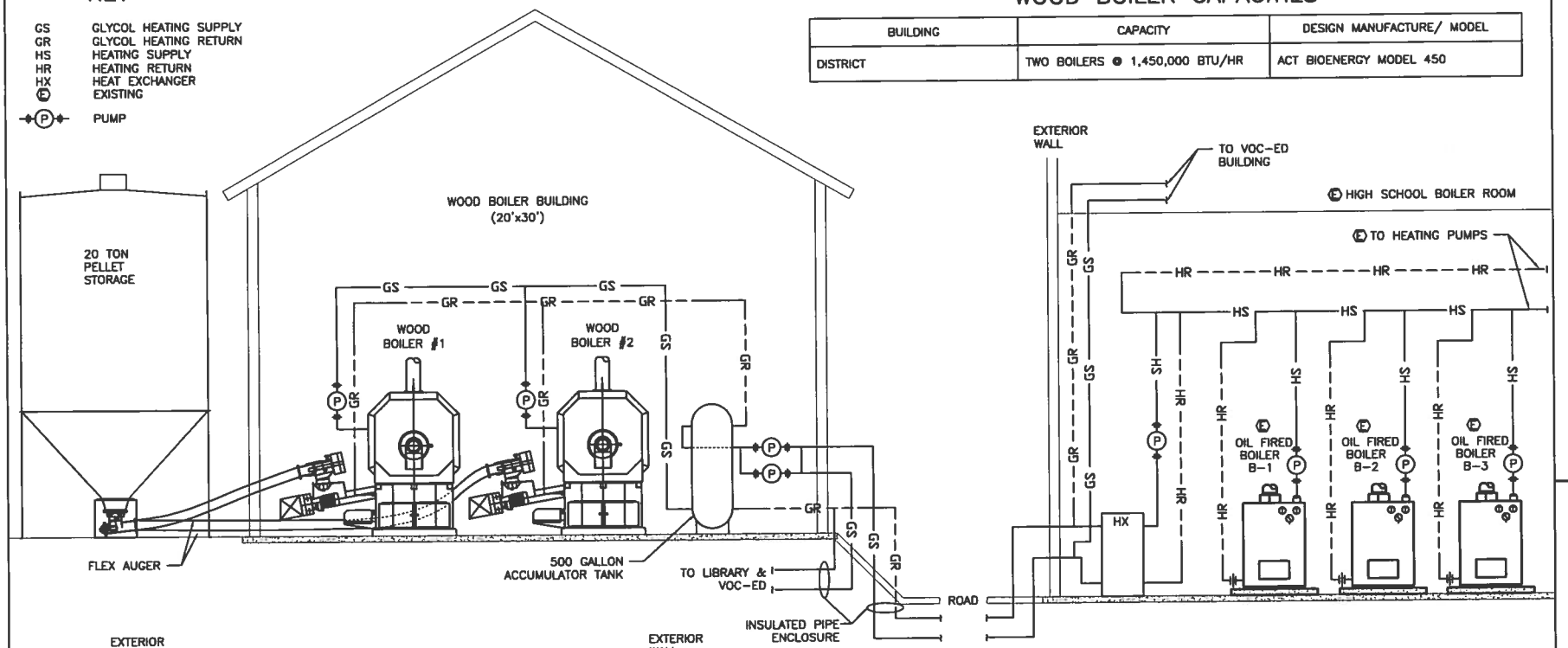
SHEET NO.
M-3
JOB NO.

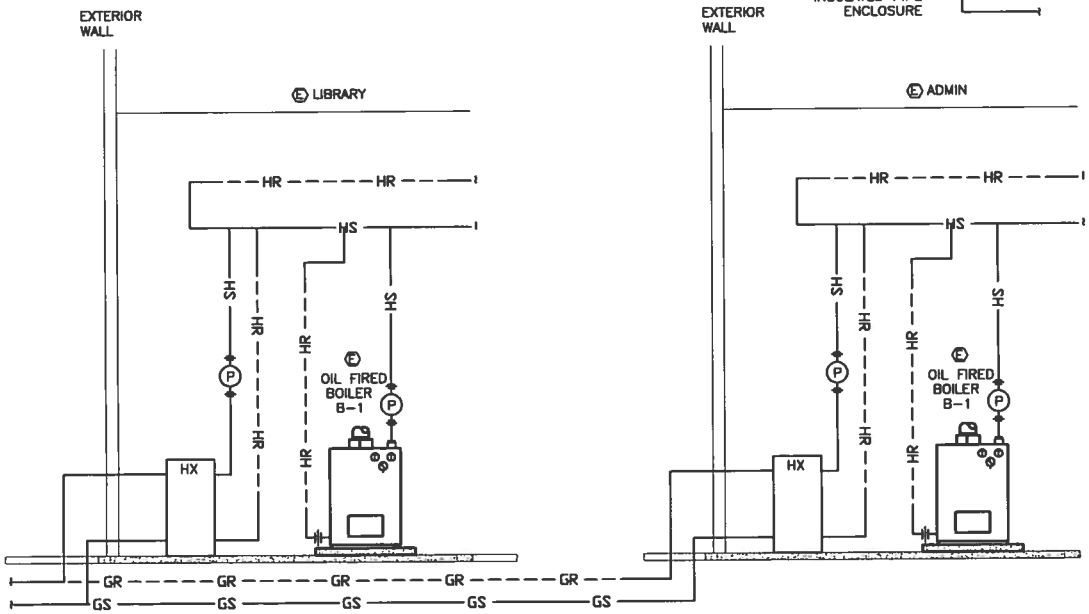
KEY

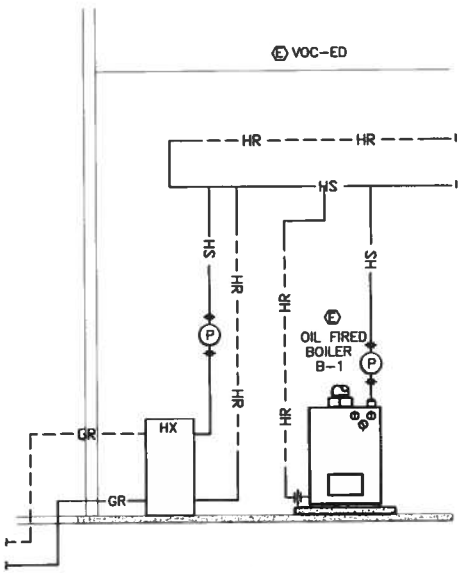
GS	GLYCOL HEATING SUPPLY
GR	GLYCOL HEATING RETURN
HS	HEATING SUPPLY
HR	HEATING RETURN
HX	HEAT EXCHANGER
(E)	EXISTING
(P)	PUMP

WOOD BOILER CAPACITIES

BUILDING	CAPACITY	DESIGN MANUFACTURE/ MODEL
DISTRICT	TWO BOILERS @ 1,450,000 BTU/HR	ACT BIOENERGY MODEL 450







1 **WOOD HEATING PLANT CONCEPTUAL DESIGN**
DISTRICT WIDE

SCALE: 0 1' 2' 4'

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HAINES BOROUGH WOOD STUDY
CONCEPTUAL DESIGN
HAINES, ALASKA

SHEET TITLE:
DISTRICT WIDE

DATE: 6/8/2012
DRAWN: BS
DESIGNED: DM
CHECKED: DM

SHEET NO.
M-4
JOB NO.

Appendix B

Sizing and Life Cycle Cost Calculations

Alaska Energy Engineering LLC

25200 Amalga Harbor Road Tel/Fax: 907.789.1226
Juneau, Alaska 99801 jim@alaskaenergy.us

Life Cycle Cost Analysis

June 7, 2012

Administration Building

Summary

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.6%	Fuel Inflation
0.2%	Real Discount Rate	3.0%	Electricity Inflation
		2.75%	Pellet Inflation

Results

	Construction	Annual	Energy	Total	% of Base
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000	-
Pellet and Fuel Oil Boilers	$300,000	$167,000	$89,000	$556,000	203%
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$154,000	$295,000	-
Pellet and Fuel Oil Boilers	$300,000	$167,000	$98,000	$565,000	192%
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$110,000	$251,000	-
Pellet and Fuel Oil Boilers	$300,000	$167,000	$93,000	$560,000	223%
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000	-
Pellet and Fuel Oil Boilers	$300,000	$167,000	$107,000	$574,000	209%
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$77,000	$64,000	$133,000	$274,000	-
Pellet and Fuel Oil Boilers	$300,000	$167,000	$89,000	$556,000	203%

Alaska Energy Engineering LLC
25200 Amalga Harbor Road Tel/Fax: 907.789.1226
Juneau, Alaska 99801 alaskaenergy@earthlink.net

Admin Building

Annual Energy Requirements

Sizing Analysis

Design Heating Load, Estimated	BTUH/sqft	sqft	MBH
	25	3,538	88

Existing Boilers	Boiler	MBH
	B-1	129

Boiler Sizing	Boiler	Design MBH	Factor	Size, MBH	Firm MBH
	Wood	88	70%	62	62
	B-1	88	146%	129	0
			Total	191	62
			% Design	216%	70%

Annual Heating Load

Fuel Oil Use	Year	Gallons
	2010	980
	2011	1,120
	Average	1,050

Heating Load, kBTU	Fuel, gals	kBTU/gal	Efficiency	Load, kBTU
	1,050	138.5	68%	98,889

Status Quo: Fuel Oil Boilers

Fuel Oil Boilers	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	98,889	100%	98,889	72%	138.5	992

Boiler Pumping	Ave MBH	ΔT	Ave GPM	Head	bhp	n	kWh
	11	15	4	25	0.04	70%	400

Option 1: Wood Boiler (Lead) and Fuel Oil Boiler (Lag)

Wood Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/ton	tons	Container Loss	tons
	98,889	90%	89,000	70%	15,560	9.0	0%	9.0

Fuel Oil Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	98,889	10%	9,889	72%	138.5	99

Electric Loads	Load	Ave GPM	Head	bhp	n	Hours	kWh
	Boiler pump	4	15	0.03	70%	8,760	240
	HX Pump	4	15	0.03	70%	8,760	240
	Silo Auger			0.50	70%	500	266
	Feed Auger			0.25	70%	3,000	799
	Induction Fan			0.25	89%	3,000	629
							2,174

Alaska Energy Engineering LLC

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Juneau, Alaska 99801 alaskaenergy@gci.net

Life Cycle Cost Analysis

June 7, 2012

Administration Building

Status Quo: Fuel Oil Boiler

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.60%	Fuel Inflation
0.24%	Real Discount Rate	3.00%	Electricity Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Replace Heating Plant					
Demolition (assume no soil remediation)					
Heating Plant	0	1	ea	$5,000	$5,000
Fuel tank, aboveground	0	1	ea	$500	$500
62 MBH fuel oil boiler	0	1	ea	$9,000	$9,000
Chimney	0	1	ea	$1,600	$1,600
Heating pumps	0	1	ea	$1,500	$1,500
Piping and appurtenances	0	1	ls	$5,000	$5,000
DHW heat pump	0	1	ea	$4,000	$4,000
Replace fuel system	0	1	ea	$6,000	$6,000
Single phase electric service	0	3	ea	$600	$1,800
Contingencies					
Estimating contingency	0			15%	$5,160
Haines locality factor	0			30%	$11,868
Overhead & profit	0			30%	$11,868
Design fees	0			10%	$6,330
Project management	0			10%	$6,963
				Total Construction Costs	**$77,000**

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Monthly: 2 hours per month	1 - 20	24	hrs	$40.00	$18,673
Annual: 8 hours, 2x per year	1 - 20	16	hrs	$40.00	$12,448
Parts Allowance	1 - 20	1	LS	$150.00	$2,918
Pump Maintenance	1 - 20	4	hrs	$40.00	$3,112
DHW heat pump maintenance	1 - 20	4	hrs	$40.00	$3,112
				Total Annual Costs	**$64,000**

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	992	gal	$4.50	$130,544
Electricity	1 - 20	400	kWh	$0.25	$1,998
				Total Energy Costs	**$133,000**

Present Worth	**$274,000**

Alaska Energy Engineering LLC

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Life Cycle Cost Analysis

June 7, 2012

Administration Building

Pellet and Fuel Oil Boilers

Basis

20	Study Period (years)	6.60%	Fuel Inflation
3.00%	Nominal Discount Rate	3.00%	Electricity Inflation
0.24%	Real Discount Rate	2.75%	Pellet Inflation
2.75%	General Inflation		

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Replace Heating Plant					
Demolition (assume no soil remediation)					
Heating Plant	0	1	ea	$5,000	$5,000
Fuel tank	0	1	ea	$500	$500
62 MBH fuel oil boiler	0	1	ea	$9,000	$9,000
Chimney	0	1	ea	$1,600	$1,600
Heating pumps	0	1	ea	$1,500	$1,500
Piping and appurtenances	0	1	ls	$5,000	$5,000
DHW heat pump	0	1	ea	$4,000	$4,000
Replace fuel system	0	1	ea	$4,000	$4,000
Electrical	0	3	ea	$600	$1,800
Pellet Boiler					
Containerized 88 MBH pellet boiler, storage, pump, appurt	0	1	ea	$50,000	$50,000
Installation: Pad	0	1	ea	$2,500	$2,500
Piping to Bldg	0	1	ea	$1,000	$1,000
Startup	0	1	ea	$5,000	$5,000
Pellets	0	3.5	ton	$373	$1,306
Heat exchanger, pump, glycol pump, and piping	0	1	ea	$4,000	$4,000
Accumulator tank	0	1	ea	$2,500	$2,500
Piping and connection to primary loop	0	1	ea	$4,000	$4,000
Electrical					
Single phase electric load	0	4	ea	$1,500	$6,000
Pellet boiler service	0	1	ea	$6,000	$6,000
Controls	0				$0
Lead/lag control	0	1	ea	$20,000	$20,000
Contingencies					
Estimating contingency	0			15%	$20,206
Haines locality factor	0			30%	$46,473
Overhead & profit	0			30%	$46,473
Design fees	0			10%	$24,786
Project management	0			10%	$27,264
				Total Construction Costs	**$300,000**

Alaska Energy Engineering LLC

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Life Cycle Cost Analysis

June 7, 2012

Administration Building

Pellet and Fuel Oil Boilers

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Wood Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Weekly: 30 minutes per week	1 - 20	26	hrs	$40.00	$20,229
Monthly: 2 hours per month	1 - 20	24	hrs	$110.00	$51,350
Annual: 8 hours, 2x per year	1 - 20	16	hrs	$110.00	$34,233
Parts Allowance	1 - 20	1	LS	$250.00	$4,863
Fuel Oil Boiler Maintenance					
Monthly: 1 hours per month	1 - 20	12	hrs	$40.00	$9,336
Annual: 8 hours, 1x per year	1 - 20	8	hrs	$40.00	$6,224
Parts Allowance	1 - 20	1	LS	$150.00	$2,918
Pump Maintenance, 4 hrs ea	1 - 20	12	hrs	$40.00	$9,336
Glycol tank and pump	1 - 20	2	hrs	$40.00	$1,556
DHW heat pump maintenance	1 - 20	4	hrs	$40.00	$3,112
				Total Annual Costs	$167,000

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	99	gal	$4.50	$13,054
Pellets	1 - 20	9.0	tons	$373.00	$65,455
Electricity	1 - 20	2,174	kWh	$0.25	$10,869
				Total Energy Costs	$89,000

Present Worth	$556,000

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Life Cycle Cost Analysis

June 7, 2012

Haines Public Library

Summary

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.6%	Fuel Inflation
0.2%	Real Discount Rate	3.0%	Electricity Inflation
		2.75%	Pellet Inflation

Results

	Construction	Annual	Energy	Total	% of Base
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000	-
Pellet and Fuel Oil Boilers	$319,000	$157,000	$248,000	$724,000	147%
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$61,000	$504,000	$565,000	-
Pellet and Fuel Oil Boilers	$319,000	$157,000	$273,000	$749,000	133%
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$61,000	$357,000	$418,000	-
Pellet and Fuel Oil Boilers	$319,000	$157,000	$258,000	$734,000	176%
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000	-
Pellet and Fuel Oil Boilers	$319,000	$157,000	$298,000	$774,000	157%
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$61,000	$432,000	$493,000	-
Pellet and Fuel Oil Boilers	$319,000	$157,000	$248,000	$724,000	147%

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Annual Energy Requirements

Sizing Analysis

Design Heating Load, Estimated			BTUH/sqft	sqft	MBH
			30	7,040	211

Existing Boilers	Boiler	MBH
	B-1	448

Boiler Sizing	Boiler	Design MBH	Factor	Size, MBH	Firm MBH
	Wood	211	70%	148	148
	B-1	211	212%	448	0
			Total	596	148
			% Design	282%	70%

Annual Heating Load

Fuel Oil Use	Year	Gallons
	2010	3,240
	2011	3,270
	Average	3,260

Heating Load, kBTU	Fuel, gals	kBTU/gal	Efficiency	Load, kBTU
	3,260	138.5	68%	307,027

Status Quo: Fuel Oil Boilers

Fuel Oil Boilers	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	307,027	100%	307,027	68%	138.5	3,260

Boiler Pumping	Ave MBH	ΔT	Ave GPM	Head	bhp	η	kWh
	35	20	12	12	0.06	70%	596

Option 1: Wood Boiler (Lead) and Fuel Oil Boiler (Lag)

Wood Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/ton	tons	Container Loss	tons
	307,027	90%	276,324	70%	15,560	26.0	0%	26.0

Fuel Oil Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	307,027	10%	30,703	70%	138.5	317

Electric Loads	Load	Ave GPM	Head	bhp	η	Hours	kWh
	Boiler pump	12	12	0.06	70%	8,760	596
	HX Pump	12	8	0.04	70%	8,760	397
	Silo Auger			0.50	70%	500	266
	Feed Auger			0.25	70%	3,500	933
	Induction Fan			0.25	89%	3,500	733
							2,925

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Life Cycle Cost Analysis

June 7, 2012

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Status Quo: Fuel Oil Boiler

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.60%	Fuel Inflation
0.24%	Real Discount Rate	3.00%	Electricity Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Existing Heating Plant					
Retain existing boiler	0	1	ea	$0	$0
Contingencies					
Estimating contingency	0			15%	$0
Haines locality factor	0			30%	$0
Overhead & profit	0			30%	$0
Design fees	0			10%	$0
Project management	0			10%	$0
				Total Construction Costs	**$0**

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Monthly: 2 hours per month	1 - 20	24	hrs	$40.00	$18,673
Annual: 8 hours, 2x per year	1 - 20	16	hrs	$40.00	$12,448
Parts Allowance	1 - 20	1	LS	$150.00	$2,918
Pump Maintenance	1 - 20	4	hrs	$40.00	$3,112
				Total Annual Costs	**$61,000**

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	3,260	gal	$4.50	$429,149
Electricity	1 - 20	596	kWh	$0.25	$2,978
				Total Energy Costs	**$432,000**

Present Worth	**$493,000**

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Life Cycle Cost Analysis

June 7, 2012

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Pellet and Fuel Oil Boilers

Basis

20	Study Period (years)	6.60%	Fuel Inflation
3.00%	Nominal Discount Rate	3.00%	Electricity Inflation
0.24%	Real Discount Rate	2.75%	Pellet Inflation
2.75%	General Inflation		

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Existing Heating Plant					
Convert to primary/secondary	0	1	ea	$6,000	$6,000
Heat exchanger, pump, glycol pump, and piping	0	1	ea	$4,000	$4,000
Accumulator tank	0	1	ea	$4,000	$4,000
Piping and connection to primary loop	0	1	ea	$4,000	$4,000
Pellet Boiler					
Containerized 148 MBH pellet boiler, storage, pump, appurt	0	1	ea	$67,000	$67,000
Installation: Concrete Pad	0	1	ea	$3,000	$3,000
Piping to Bldg	0	1	ea	$1,200	$1,200
Pellets	0	9.5	ton	$373	$3,544
Startup	0	1	ea	$5,000	$5,000
Heat exchanger, pump, glycol pump, and piping	0	1	ea	$5,000	$5,000
Accumulator tank	0	1	ea	$4,000	$4,000
Piping and connection to primary loop	0	1	ea	$6,000	$6,000
Electrical					
Electric - single phase load	0	3	ea	$1,500	$4,500
Pellet boiler service	0	1	ea	$6,000	$6,000
Controls	0				$0
Lead/lag control	0	1	ea	$20,000	$20,000
Contingencies					
Estimating contingency	0			15%	$21,487
Haines locality factor	0			30%	$49,419
Overhead & profit	0			30%	$49,419
Design fees	0			10%	$26,357
Project management	0			10%	$28,992
				Total Construction Costs	**$319,000**

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Life Cycle Cost Analysis

June 7, 2012

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Pellet and Fuel Oil Boilers

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Wood Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Weekly: 30 minutes per week	1 - 20	26	hrs	$40.00	$20,229
Monthly: 2 hours per month	1 - 20	24	hrs	$110.00	$51,350
Annual: 8 hours, 2x per year	1 - 20	16	hrs	$110.00	$34,233
Parts Allowance	1 - 20	1	LS	$250.00	$4,863
Fuel Oil Boiler Maintenance					
Monthly: 1 hours per month	1 - 20	12	hrs	$38.50	$8,986
Annual: 8 hours, 1x per year	1 - 20	8	hrs	$38.50	$5,991
Parts Allowance	1 - 20	1	LS	$150.00	$2,918
Pump Maintenance	1 - 20	4	hrs	$40.00	$3,112
Glycol tank and pump	1 - 20	2	hrs	$40.00	$1,556
				Total Annual Costs	$157,000

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	340	gal	$4.50	$44,758
Pellets	1 - 20	26.0	tons	$373.00	$189,092
Electricity	1 - 20	2,925	kWh	$0.25	$14,624
				Total Energy Costs	$248,000

Present Worth	$724,000

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Life Cycle Cost Analysis

June 7, 2012

Vocational Education Building

Summary

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.6%	Fuel Inflation
0.2%	Real Discount Rate	3.0%	Electricity Inflation
		3.60%	Pellet Inflation

Results

	Construction	Annual	Energy	Total	% of Base
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000	-
Pellet and Fuel Oil Boilers	$312,000	$165,000	$148,000	$625,000	179%
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$182,600	$311,700	-
Pellet and Fuel Oil Boilers	$312,000	$165,000	$145,000	$622,000	200%
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$67,500	$63,900	$182,600	$314,000	-
Pellet and Fuel Oil Boilers	$312,000	$165,000	$145,000	$622,000	198%
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000	-
Pellet and Fuel Oil Boilers	$312,000	$165,000	$166,000	$643,000	184%
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$65,200	$63,900	$220,900	$350,000	-
Pellet and Fuel Oil Boilers	$312,000	$165,000	$139,000	$616,000	176%

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Vocational Education Building

Annual Energy Requirements

Sizing Analysis

Design Heating Load, Estimated	BTUH/sqft	sqft	MBH
	25	5,000	125

Existing Boilers	Boiler	MBH
	B-1	190

Boiler Sizing	Boiler	Design MBH	Factor	Size, MBH	Firm MBH
	Wood	125	70%	88	88
	B-1	190	70%	133	0
			Total	221	88
			% Design	176%	70%

Annual Heating Load

Fuel Oil Use	Year	Gallons
	2010	1,705
	2011	1,787
	Average	1,750

Heating Load, kBTU	Fuel, gals	kBTU/gal	Efficiency	Load, kBTU
	1,750	138.5	68%	164,815

Status Quo: Fuel Oil Boilers

Fuel Oil Boilers	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	164,815	100%	164,815	72%	138.5	1,653

Boiler Pumping	Ave MBH	ΔT	Ave GPM	Head	bhp	η	kWh
	19	20	6	25	0.07	70%	666

Option 1: Wood Boiler (Lead) and Fuel Oil Boiler (Lag)

Wood Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/ton	tons	Container Loss	tons
	164,815	90%	148,334	70%	15,560	14.0	0%	14.0

Fuel Oil Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	164,815	10%	16,482	70%	138.5	170

Electric Loads	Load	Ave GPM	Head	bhp	η	Hours	kWh
	Boiler Pump	6	25	0.07	70%	8,760	666
	HX Pump	6	15	0.04	70%	8,760	400
	Silo Auger			0.50	70%	500	266
	Feed Auger			0.25	70%	3,500	933
	Induction Fan			0.25	89%	3,500	733
							2,998

Alaska Energy Engineering LLC

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Life Cycle Cost Analysis

June 7, 2012

Vocational Education Building
Status Quo: Fuel Oil Boiler

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.60%	Fuel Inflation
0.24%	Real Discount Rate	3.00%	Electricity Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Replace Heating Plant					
Demolish heating plant	0	1	ea	$5,000	$5,000
190 MBH fuel oil boiler	0	1	ea	$10,500.00	$10,500
Chimney	0	1	ea	$1,600.00	$1,600
Heating pumps	0	1	ea	$2,000.00	$2,000
Piping and appurtenances	0	1	ls	$5,000.00	$5,000
DHW heat pump	0	1	ea	$4,000.00	$4,000
Electrical	0	2	ea	$600.00	$1,200
Contingencies					
Estimating contingency	0			15%	$4,395
Haines locality factor	0			30%	$10,108.50
Overhead & profit	0			30%	$10,108.50
Design fees	0			10%	$5,391.20
Project management	0			10%	$5,930.32
				Total Construction Costs	**$65,200**

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Monthly: 2 hours per month	1 - 20	24	hrs	$40.00	$18,673
Annual: 8 hours, 2x per year	1 - 20	16	hrs	$40.00	$12,448
Parts Allowance	1 - 20	1	LS	$150.00	$2,918
Pump Maintenance	1 - 20	4	hrs	$40.00	$3,112
DHW heat pump maintenance	1 - 20	4	hrs	$40.00	$3,112
				Total Annual Costs	**$63,900**

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	1,653	gal	$4.50	$217,573
Electricity	1 - 20	666	kWh	$0.25	$3,330
				Total Energy Costs	**$220,900**

Present Worth	**$350,000**

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Life Cycle Cost Analysis

June 7, 2012

Vocational Education Building
Pellet and Fuel Oil Boilers

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.60%	Fuel Inflation
0.24%	Real Discount Rate	3.00%	Electricity Inflation
		3.60%	Pellet Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Replace Heating Plant					
Demolish heating plant	0	1	ea	$5,000	$5,000
133 MBH fuel oil boiler	0	1	ea	$10,000	$10,000
Chimney	0	1	ea	$1,600	$1,600
Heating pumps	0	1	ea	$1,500	$1,500
Piping and appurtenances	0	1	ls	$5,000	$5,000
DHW heat pump	0	1	ea	$4,000	$4,000
Electrical	0	3	ea	$600	$1,800
Pellet Boiler					
Containerized 88 MBH pellet boiler, storage, pump, appurt	0	1	ea	$55,000	$55,000
Installation: Concrete Pad	0	1	ea	$2,500	$2,500
Piping to Bldg	0	1	ea	$1,000	$1,000
Startup	0	1	ea	$5,000	$5,000
Pellets	0	3.5	ton	$373	$1,306
Heat exchanger, pump, glycol pump, and piping	0	1	ea	$4,000	$4,000
Accumulator tank	0	1	ea	$2,500	$2,500
Piping and connection to primary loop	0	1	ea	$4,000	$4,000
Electrical					
Single phase loads	0	4	ea	$1,500	$6,000
Pellet boiler service	0	1	ea	$10,000	$10,000
Controls	0				$0
Lead/lag control	0	1	ea	$20,000	$20,000
Contingencies					
Estimating contingency	0			15%	$21,030.83
Haines locality factor	0			30%	$48,370.90
Overhead & profit	0			30%	$48,370.90
Design fees	0			10%	$25,797.81
Project management	0			10%	$28,377.59
				Total Construction Costs	**$312,000**

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Vocational Education Building

Pellet and Fuel Oil Boilers

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Wood Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Weekly: 30 minutes per week	1 - 20	26	hrs	$40.00	$20,229
Monthly: 2 hours per month	1 - 20	24	hrs	$110.00	$51,350
Annual: 8 hours, 2x per year	1 - 20	16	hrs	$110.00	$34,233
Parts Allowance	1 - 20	1	LS	$250.00	$4,863
Fuel Oil Boiler Maintenance					
Monthly: 1 hours per month	1 - 20	12	hrs	$38.50	$8,986
Annual: 8 hours, 1x per year	1 - 20	8	hrs	$38.50	$5,991
Parts Allowance	1 - 20	1	LS	$150.00	$2,918
Pump Maintenance	1 - 20	12	hrs	$40.00	$9,336
DHW heat pump maintenance	1 - 20	4	hrs	$40.00	$3,112
				Total Annual Costs	$165,000

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	170	gal	$4.50	$22,379
Pellets	1 - 20	14.0	tons	$373.00	$111,070
Electricity	1 - 20	2,998	kWh	$0.25	$14,990
				Total Energy Costs	$148,000

Present Worth	$625,000

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Life Cycle Cost Analysis

June 7, 2012

Haines School and Pool Wood Heating Analysis

Summary

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.6%	Fuel Inflation
0.2%	Real Discount Rate	3.0%	Electricity Inflation
		3.60%	Pellet Inflation

Results

	Construction	Annual	Energy	Total	% of Base
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,086,000	$5,221,000	-
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,177,000	$5,442,000	104%
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,931,000	$6,066,000	-
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,261,400	$5,526,400	91%
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$135,000	$4,198,000	$4,333,000	-
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,088,100	$5,353,100	124%
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,086,000	$5,221,000	-
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$3,581,800	$5,846,800	112%
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$0	$135,000	$5,086,000	$5,221,000	-
Pellet and Fuel Oil Boilers	$1,917,000	$348,000	$2,963,300	$5,228,300	100%

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CALCULATIONS

June 7, 2012

Haines School and Pool Wood Heating Analysis

Annual Energy Requirements

Sizing Analysis

Design Heating Load, Estimated			BTUH/sqft	sqft	MBH
			39	94,612	3,690

Existing Boilers	Boiler	MBH	Firm
	B-1	1,632	1,632
	B-2	1,632	1,632
	B-3	1,632	
		4,896	3,264

Boiler Sizing	Boiler	Design MBH	Factor	Size, MBH	Firm MBH
	Wood	3,690	35%	1,291	1,291
	Wood	3,690	35%	1,291	1,291
	B-1	1,632	100%	1,632	1,632
	B-2	1,632	100%	1,632	
			Total	5,847	4,215
			% Design	158%	114%

Annual Heating Load

Fuel Oil Use	Year	Gallons
	2011	38,522
	2012	38,241
	Average	38,380

Heating Load, kBTU	Fuel, gals	kBTU/gal	Efficiency	Load, kBTU
	38,380	138.5	68%	3,614,628

Status Quo: Fuel Oil Boilers

Fuel Oil Boilers	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	3,614,628	100%	3,614,628	68%	138.5	38,380

Boiler Pumping	Ave MBH	ΔT	Ave GPM	Head	bhp	η	kWh
	413	20	103	20	0.95	91%	6,809

Option 1: Wood Boiler (Lead) and Fuel Oil Boiler (Lag)

Wood Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/ton	tons	Bldg Loss	tons
	3,614,628	90%	3,253,166	68%	15,560	308	5%	323

Fuel Oil Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	3,614,628	10%	361,463	68%	138.5	3,838

Electric Loads	Load	Ave GPM	Head	bhp	η	Hours	kWh
	Boiler pump	103	30	1.42	91%	8,760	10,214
	HX Pump	103	15	0.71	91%	8,760	5,107
	Silo Auger			0.50	70%	1,000	533
	Feed Auger			0.25	70%	7,800	2,078
	Induction Fan			0.5	89%	7,800	3,269
							21,201

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Life Cycle Cost Analysis

June 7, 2012

Haines School and Pool Wood Heating Analysis
Status Quo: Fuel Oil Boiler

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.60%	Fuel Inflation
0.24%	Real Discount Rate	3.00%	Electricity Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Existing Heating Plant					
Retain existing heating plant	0	1	ea	$0.00	$0
Contingencies					
Estimating contingency	0			15%	$0
Haines locality factor	0			30%	$0
Overhead & profit	0			30%	$0
Design fees	0			10%	$0
Project management	0			10%	$0
				Total Construction Costs	**$0**

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Monthly: 2 hours per month	1 - 20	72	hrs	$40.00	$56,018
Annual: 8 hours, 2x per year	1 - 20	48	hrs	$40.00	$37,345
Parts Allowance	1 - 20	3	LS	$150.00	$8,753
Pump Maintenance	1 - 20	12	hrs	$40.00	$9,336
				Total Annual Costs	**$135,000**

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	38,380	gal	$4.50	$5,052,373
Electricity	1 - 20	6,809	kWh	$0.25	$34,047
				Total Energy Costs	**$5,086,000**

Present Worth	**$5,221,000**

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Haines School and Pool Wood Heating Analysis
Pellet and Fuel Oil Boilers

Basis

20	Study Period (years)	6.60%	Fuel Inflation
3.00%	Nominal Discount Rate	3.00%	Electricity Inflation
0.24%	Real Discount Rate	3.60%	Pellet Inflation
2.75%	General Inflation		

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Existing Heating Plant					
Disable fuel oil boiler: 1 of 3	0	1	ea	$1,000.00	$1,000
Pellet Boiler					
Site Work					
Site survey, building site work	0	1	ls	$25,000	$25,000
Water service, paving repair	0	50	lnft	$200	$10,000
Sanitary sewer, paving repair	0	50	lnft	$200	$10,000
Building					
Building: 30'x20'	0	600	sqft	$300	$180,000
Service sink, cold water, DWH heater	0	1	ls	$15,000	$15,000
Waste piping	0	1	ls	$10,000	$10,000
Heating piping, unit heater	0	1	ls	$15,000	$15,000
Ventilating unit with controls	0	4,000	cfm	$6	$24,000
1,300 MBH pellet boiler w/ scrubbers and augers	0	2	ea	$147,000	$294,000
Pellet silo	0	1	LS	$40,000.00	$40,000
Pellets	0	20	tons	$373.00	$7,460
Chimney	0	2	ea	$8,000	$16,000
Accumulator tank	0	1	ea	$12,000	$12,000
Boiler pumps, piping, glycol system	0	1	ea	$25,000	$25,000
Startup	0	1	ea	$6,500	$6,500
Piping to Bldg	0	100	lnft	$350	$35,000
Electrical					
Electric service to Building	0	1	ls	$23,000	$23,000
Panelboard	0	1	ls	$9,000	$9,000
Lighting	0	1	ls	$7,500	$7,500
Receptacles and circuiting	0	1	ls	$3,000	$3,000
Single-phase Electrical	0	4	ls	$1,500	$6,000
Three-phase electrical	0	4	ls	$3,500	$14,000
Controls					
Boiler lead/lag control	0	1	ea	$40,000.00	$40,000
Boiler pump control	0	1	ea	$10,000.00	$10,000
School Boiler Room					
Heat exchanger, pump, and piping connection to primary loop	0	1	ea	$15,000	$15,000
Three-phase electrical	0	1	ls	$7,500	$7,500
Contingencies					
Estimating contingency	0			15%	$129,144
Haines locality factor	0			30%	$297,031
Overhead & profit	0			30%	$297,031
Design fees	0			10%	$158,417
Project management	0			10%	$174,258.30
				Total Construction Costs	**$1,917,000**

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Life Cycle Cost Analysis

June 7, 2012

Haines School and Pool Wood Heating Analysis

Pellet and Fuel Oil Boilers

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Wood Boiler Maintenance					
Daily: 10 minutes per day	1 - 20	61	hrs	$40.00	$47,330
Weekly: 30 minutes per week, ea	1 - 20	52	hrs	$40.00	$40,457
Monthly: 2 hours per month, ea	1 - 20	48	hrs	$110.00	$102,700
Annual: 8 hours, 2x per year, ea	1 - 20	32	hrs	$110.00	$68,467
Parts Allowance	1 - 20	2	LS	$250.00	$9,725
Fuel Oil Boiler Maintenance					
Daily: 5 minutes per day	1 - 20	30	hrs	$40.00	$23,665
Monthly: 1 hours per month	1 - 20	24	hrs	$40.00	$18,673
Annual: 8 hours, 1x per year	1 - 20	16	hrs	$40.00	$12,448
Parts Allowance	1 - 20	2	LS	$150.00	$5,835
Pump Maintenance	1 - 20	24	hrs	$40.00	$18,673
				Total Annual Costs	$348,000

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	3,838	gal	$4.50	$505,237
Pellets	1 - 20	323.4	tons	$373.00	$2,565,718
Electricity	1 - 20	21,201	kWh	$0.25	$106,006
				Total Energy Costs	$3,177,000

Present Worth	$5,442,000

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Life Cycle Cost Analysis

June 7, 2012

Haines Borough District Wood Heating System
Summary

Basis

20	Study Period (years)	2.75%	General Inflation
5.25%	Nominal Discount Rate	6.6%	Fuel Inflation
2.4%	Real Discount Rate	3.0%	Electricity Inflation
		3.60%	Pellet Inflation

Results

	Construction	Annual	Energy	Total	% of Base
Base Case: 6.6% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000	-
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,105,000	$6,807,000	108%
High Fuel Oil Case: 8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$6,825,000	$7,302,000	-
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,144,000	$6,846,000	94%
Low Fuel Oil Case: 4.8% Fuel Oil, 3.6% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$4,832,000	$5,309,000	-
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,062,000	$6,764,000	127%
High Pellet Case: 6.6% Fuel Oil, 5% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000	-
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$3,492,000	$7,194,000	114%
Low Pellet Case: 6.6% Fuel Oil, 2.75% Wood Pellet Inflation					
Status Quo: Fuel Oil Boiler	$150,000	$327,000	$5,854,000	$6,331,000	-
Pellet Plant and Fuel Oil Boilers	$3,398,000	$304,000	$2,899,000	$6,601,000	104%

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Vocational Education Building

Annual Energy Requirements

Sizing Analysis

Wood Boiler Sizing	Building	Design MBH	Factor	Size, MBH	GPM	Pipe
	Admin	88	70%	62	9	1-1/2
	Library	211	70%	148	22	1-1/2
	School	3,690	70%	2,583	369	6
	Voc-Ed	125	70%	88	13	1-1/2
		4,115	Total	2,880	413	6
			% Design	70%		

Annual Heating Load

Buildings

Building	Load, kBtu
Admin	98,889
Library	307,027
School	3,614,628
Voc-Ed	164,815
	4,185,359

Distribution Losses

Serve	Size	Length	Loss, Btuh/sqft	Loss, kBtu	
CHP to HS	6	300	26	68,328	
HS to VocEd	1-1/2	700	12	73,584	
CHP to Library	2-1/2	2,200	14	269,808	
Lib to Admin	1-1/2	320	12	33,638	
				445,358	11%

Heating Load, kBTU	Load, kBTU
	4,630,718

Status Quo: Fuel Oil Boilers

Building	Fuel, gal	Elect, kWh
Admin	992	400
Library	3,260	596
School	38,241	6,809
Voc-Ed	1,653	666
	44,145	8,471

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Vocational Education Building

Annual Energy Requirements

Option 1: Wood Boiler (Lead) and Fuel Oil Boiler (Lag)

Wood Boiler	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/ton	tons
	4,630,718	95%	4,399,182	68%	15,560	416

Fuel Oil Boilers	Load, kBTU	% Load	Net, kBTU	Efficiency	kBTU/gal	Fuel, gals
	4,630,718	5%	231,536	68%	138.5	2,458

Pumping	System	Ave MBH	ΔT	Ave GPM	Head	bhp	n	kWh
	Pri Pumps			207	18	1.71	91%	12,268
	Dist Pumps	529	20	136	55	3.45	91%	24,741
	Bldg Pumps							8,471
					HP	n	Hours	
	Silo Auger				0.50	70%	2,000	1,066
	Feed Auger				0.25	70%	8,760	2,334
	Induction Fan				0.5	89%	8,760	3,671
								52,550

Electric Loads	Load	Number	GPM	Head	bhp	n	kW
	Pri Pumps	1	413	18	3.42	89%	2.9
	Sec Pumps	2	413	55	10.44	89%	17.5
	Silo Auger	1			0.50	70%	0.5
	Feed Auger	2			0.25	70%	0.5
	Induction Fan	2			0.5	89%	0.8
							22.3

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Life Cycle Cost Analysis

June 7, 2012

Haines Borough District Wood Heating System

Status Quo: Fuel Oil Boiler

Basis

20	Study Period (years)	2.75%	General Inflation
3.00%	Nominal Discount Rate	6.60%	Fuel Inflation
0.24%	Real Discount Rate	3.0%	Electricity Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Replace Admin Heating Plant					
Remove heating plant	0	1	ea	$5,000	$5,000
Remove fuel tank, assume no remediation	0	1	ea	$500	$500
62 MBH fuel oil boiler	0	1	ea	$9,000.00	$9,000
Chimney	0	1	ea	$1,600.00	$1,600
Heating pumps	0	2	ea	$1,500.00	$3,000
Piping and appurtenances	0	1	ls	$5,000.00	$5,000
DHW heat pump	0	1	ea	$4,000.00	$4,000
Replace fuel system	0	1	ea	$4,000.00	$4,000
Electrical	0	3	ea	$1,500.00	$4,500
Replace Voc-Ed Heating Plant					
Demolish heating plant	0	1	ea	$5,000	$5,000
150 MBH fuel oil boiler	0	1	ea	$10,000.00	$10,000
Chimney	0	1	ea	$1,600.00	$1,600
Heating pumps	0	1	ea	$2,000.00	$2,000
Piping and appurtenances	0	1	ls	$5,000.00	$5,000
DHW heat pump	0	1	ea	$4,000.00	$4,000
Electrical	0	2	ea	$1,500.00	$3,000
Contingencies					
Estimating contingency	0			15%	$10,080
Haines locality factor	0			30%	$23,184
Overhead & profit	0			30%	$23,184
Design fees	0			10%	$12,364.80
Project management	0			10%	$13,601.28
				Total Construction Costs	**$150,000**

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil Boiler Maintenance					
Daily: 5 minutes per day, ea	1 - 20	122	hrs	$40.00	$94,660
Monthly: 2 hours per month, ea	1 - 20	144	hrs	$40.00	$112,036
Annual: 8 hours, 2x per year, ea	1 - 20	96	hrs	$40.00	$74,691
Parts Allowance	1 - 20	6	LS	$150.00	$17,506
Pump Maintenance	1 - 20	24	hrs	$40.00	$18,673
DHW heat pump maintenance	1 - 20	12	hrs	$40.00	$9,336
				Total Annual Costs	**$327,000**

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	44,145	gal	$4.50	$5,811,340
Electricity	1 - 20	8,471	kWh	$0.25	$42,353
				Total Energy Costs	**$5,854,000**

Present Worth	**$6,331,000**

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Haines Borough District Wood Heating System
Pellet Plant and Fuel Oil Boilers

Basis

20	Study Period (years)	2.75%	General Inflation
5.25%	Nominal Discount Rate	6.60%	Fuel Inflation
2.43%	Real Discount Rate	3.00%	Electricity Inflation
		3.60%	Pellet Inflation

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Replace Heating Plant					
Admin Bldg					
Demolition (assume no soil remediation)					
Heating Plant	0	1	ea	$5,000	$5,000
Fuel tank, aboveground	0	1	ea	$500	$500
106 MBH fuel oil boiler	0	1	ea	$9,000.00	$9,000
Heating pumps	0	2	ea	$1,500.00	$3,000
Piping and appurtenances	0	1	ls	$8,000.00	$8,000
DHW heat pump	0	1	ea	$4,000.00	$4,000
Replace fuel system	0	1	ea	$6,000.00	$6,000
Vocational Education					
Demolish heating plant	0	1	ea	$5,000	$5,000
106 MBH fuel oil boiler	0	1	ea	$9,000.00	$9,000
Heating pumps	0	2	ea	$1,500.00	$3,000
Piping and appurtenances	0	1	ls	$8,000.00	$8,000
DHW heat pump	0	1	ea	$4,000.00	$4,000
District Heat Plant					
Site Work					
Site survey, building site work	0	1	ls	$25,000	$25,000
Water service, paving repair	0	50	lnft	$200	$10,000
Sanitary sewer, paving repair	0	50	lnft	$200	$10,000
Building					
Building: 30'x20'	0	600	sqft	$250	$150,000
Service sink, cold water, hot water, DHW heater	0	1	ls	$15,000	$15,000
Waste piping	0	1	ls	$10,000	$10,000
Heating piping, Unit Heater	0	1	ls	$10,000	$10,000
Ventilating unit with controls	0	4,000	cfm	$6	$24,000
Heating Plant					
1,300 MBH pellet boiler w/ augers	0	2	ea	$147,000	$294,000
Pellet silo, 20 tons	0	1	LS	$40,000.00	$40,000
Pellets	0	20	tons	$360.00	$7,200
Chimney	0	2	ea	$8,000	$16,000
Accumulator tank	0	1	ea	$12,000	$12,000
Boiler pumps, piping, glycol system	0	1	ea	$27,500	$27,500
Startup	0	1	ea	$6,500	$6,500
Distribution pumps, piping, appurtenances	0	1	ea	$20,000	$20,000
Controls	0	1	ea	$40,000	$40,000
Controls					
Boiler lead/lag control	0	1	ea	$40,000.00	$40,000
Boiler pump control	0	1	ea	$10,000.00	$10,000
Distribution pump controls	0	1	ea	$15,000.00	$15,000
Energy meters	0	2	ea	$2,000.00	$4,000

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Haines Borough District Wood Heating System

Pellet Plant and Fuel Oil Boilers

Construction Costs	Year	Qty	Unit	Base Cost	Year 0 Cost
Electrical					
Electric service to Building	0	1	ls	$23,000	$23,000
Panelboard	0	1	ls	$9,000	$9,000
Lighting	0	1	ls	$7,500	$7,500
Receptacles and circuiting	0	1	ls	$3,000	$3,000
Single-phase Electrical	0	4	ls	$1,500	$6,000
Three-phase electrical	0	4	ls	$3,500	$14,000
Distribution System					
Plant to HS					
Direct bury piping to boiler room; two @ 6"	0	150	lnft	$350.00	$52,500
Piping to heat exchanger	0	1	ls	$5,000.00	$5,000
Heat exchanger and primary pump	0	1	ls	$30,000.00	$30,000
Primary pump and piping to building connection	0	1	ls	$12,000.00	$12,000
High School to Voc-Ed	0				
Indoor piping	0	100	lnft	$40	$4,000
Buried piping	0	250	lnft	$175	$43,750
Piping to heat exchanger	0	1	ls	$2,000.00	$2,000
Heat exchanger and primary pump	0	1	ls	$6,000.00	$6,000
Primary pump and piping to building connection	0	1	ls	$3,500.00	$3,500
Plant to Library	0				$0
Buried piping	0	1,100	lnft	$225	$247,500
Piping to heat exchanger	0	1	ls	$2,500.00	$2,500
Heat exchanger and primary pump	0	1	ls	$7,000.00	$7,000
Primary pump and piping to building connection	0	1	ls	$4,000.00	$4,000
Library to Admin	0				$0
Buried piping	0	160	lnft	$175	$28,000
Increase boiler room size	0	50	sqft	$100	$5,000
Piping to heat exchanger	0	1	ls	$2,000.00	$2,000
Heat exchanger and primary pump	0	1	ls	$6,000.00	$6,000
Primary pump and piping to building connection	0	1	ls	$3,500.00	$3,500
Controls	0				$0
Admin Bldg	0	1	ea	$20,000.00	$20,000
Library	0	1	ea	$20,000.00	$20,000
School//Pool	0	1	ea	$25,000.00	$25,000
Vocational Education	0	1	ea	$20,000.00	$20,000
Contingencies					
Estimating contingency	0			20%	$292,490
Haines locality factor	0			30%	$526,482
Overhead & profit	0			30%	$526,482
Design fees	0			10%	$280,790
Project management	0			10%	$308,869
				Total Construction Costs	**$3,398,000**

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Life Cycle Cost Analysis

June 7, 2012

Haines Borough District Wood Heating System

Pellet Plant and Fuel Oil Boilers

Annual Costs	Years	Qty	Unit	Base Cost	Present Value
Wood Boiler Maintenance					
Daily: 10 minutes per day	1 - 20	61	hrs	$40.00	$37,268
Weekly: 30 minutes per week, ea	1 - 20	52	hrs	$40.00	$31,856
Monthly: 2 hours per month, ea	1 - 20	48	hrs	$110.00	$80,866
Annual: 8 hours, 2x per year, ea	1 - 20	32	hrs	$110.00	$53,911
Parts Allowance	1 - 20	2	LS	$250.00	$7,658
Fuel Oil Boiler Maintenance					
Monthly: 1 hours per month	1 - 20	60	hrs	$40.00	$36,757
Annual: 8 hours, 1x per year	1 - 20	40	hrs	$40.00	$24,505
Parts Allowance	1 - 20	5	LS	$150.00	$11,487
Pump Maintenance	1 - 20	32	hrs	$40.00	$19,604
				Total Annual Costs	$304,000

Energy Costs	Years	Qty	Unit	Base Cost	Present Value
Fuel Oil	1 - 20	2,458	gal	$4.50	$253,625
Pellets	1 - 20	416.0	tons	$373.00	$2,639,847
Electricity	1 - 20	52,550	kWh	$0.25	$211,042
				Total Energy Costs	$3,105,000

Present Worth	$6,807,000

Appendix C

Equipment Specifications

WOOD PELLET BOILERS – SMALL CAPACITY

PART 1 - PRODUCTS

1.1 DESCRIPTION

A. Boiler: ASME certified, hydronic pellet fired wood boiler packaged assembly in container with automatic fuel supply, stainless steel combustion chamber with three way ash removal, automatic cleaning system, integrated ash box with automatic ash compression system, and fully automated digital controls. Chimney of high grade stainless steel with double wall construction. Assembly pre-installed.

B. Pellet Store Room: Dust proof, sloping floor with augers and self-feeding vacuum pellet distribution.

C. Container: Durable timber construction with triple laminated sections, 1-hour rated, totally enclosed with separate boiler and pellet storage compartment. Double access doors with keyed entry lever entry. with heavy duty solid brass and ball bearing hinge Floor and ceiling of boiler room with aluminum diamond plate surface. Roof completely wrapped with ice and water shield. Roof to be galvanized steel material capable of minimum 70 lbs per sq. ft. snow load. Pellet access doors to be insulated aluminum, keyed, and minimum of 3 ft x 3 ft. size.

D. Foundation: Reinforced concrete pad 6 inches thick.

E. Installation: Trained and licensed by boiler manufacturer.

1.2 OUTPUT CAPACITIES

A. Admin Building: 62 MBH

B. Voc-Ed Building: 88 MBH

C. Library: 148,000 MBH

1.3 FUEL DELIVERY (INTERNAL TO CONTAINER)

A. Admin Building and Voc-Ed Building: Auger delivery.

B. Library: Vacuum suction with flexible tubing

1.4 FUEL STORAGE CAPACITIES

A. Admin Building: 3.5 tons.

B. Voc-Ed Building: 5.0 tons

C. Library: 9.5 tons.

1.5 HEATING WATER CONNECTIONS

A. 1-1/2 inch supply and return.

1.6 ELECTRICAL REQUIREMENTS

A. 208 volt, 6 amps. Minimum 60 amp circuit.

1.7 MONITORING

A. Remote monitoring via web based interface.

B. User can remotely see key boiler functions and error messages.

1.8 WARRANTY

A. Warranty is 5 years on the ASME Stamped Boiler Vessel and 2 years on all other parts and pieces of the boiler.

B. Warranty does not include labor and but may be extended via the local dealer.

1.9 CERTIFIED DEALERS:

A. The Plumbing and Heating Company in Juneau 907-789-3332

B. Schmolck Mechanical Contractors - Ketchikan Alaska - 907-225-6648

1.10 STARTUP, COMMISSIONING, AND TRAINING

A. Start-up, commissioning and training provided by Certified Dealer.

1.11 REFERENCES:

A. Ken Coville - Superintendent School Admin. District 74, Anson, ME - (207) 635-2727 Ext 1

B. City of Gardiner Maine - Chuck Applebee - (207) 582-4408

C. Town of Marshfield, Vermont - 802-426-3305

1.12 FINANCING

A. Financing is not available directly from the company.

End of Section

WOOD BOILERS - MEDIUM CAPACITY

PART 1 - PRODUCTS

1.1 DESCRIPTION

A. Boiler: ASME certified, hydronic pellet fired wood boiler packaged assembly consisting of stainless steel combustion chamber, heat exchanger, control panel and fuel storage and delivery system.

B. Components: Additional components include Intermediate fuel storage bin, agitator to prevent fuel bridging, emergency extinguishing system, ignition blower, primary, secondary and tertiary blower motors all with VFD's, burner ring for primary gasification zone, rotating ash grate, secondary and tertiary introduction rings, ash collection bin, double insulated heat exchanger, rotating tabulators, and cyclone precipitator with industrial utility type exhaust fan controlled by VFD. Chimney of high grade stainless steel with double wall construction. Assembly pre-installed.

C. Fuel Delivery System: Bin conveying auger and auger channel with back burn preventing flap valve at the boiler.

D. Fuel Storage: 20 ton silo with hopper bottom and top loading port. OSHA approved ladder access. Silo mounted on reinforced concrete pad 6 inches thick.

E. Installation: Trained and licensed by boiler manufacturer.

1.2 OUTPUT CAPACITIES

A. High School/Pool: Two boilers at 1,300 MBH

B. District Plant: Two boilers at 1,450 MBH

1.3 HEATING WATER CONNECTIONS

A. Each boiler with 4-inch supply and return.

1.4 ELECTRICAL REQUIREMENTS

A. Each Boiler @ 208 volt, 30 amps. Minimum 60 amp circuit.

1.5 DIMENSIONS

A. High School/Pool: Each Boiler at 8'-10" long, 9'-3" long, 6'-6" high.

B. District Plant: Each Boiler at 9'-3" long, 9'-3" long, 6'-6" high.

1.6 MONITORING

A. Remote monitoring via web based interface.

B. User can remotely see key boiler functions and error messages. The boiler output temperature can be remotely adjusted and the boiler can be turned on and off.

1.7 WARRANTY

A. 1 Year standard warranty with extended warranty available.

1.8 CERTIFIED DEALERS

A. None in Alaska. Installation and start-up typically done by ACT Bioenergy.

1.9 REFERENCES

A. David St. Onge, Senior Facilities Technician
The Wild Center, Natural History Museum of the Adirondacks
45 Museum Drive
Tupper Lake, NY 12986-9712
518-359-7800, ext. 118
dstonge@wildcenter.org
1.7 MMBtu (pellets)

B. Bill Hollywood - Onsite Maintenance of Federal Building
Total System Service
648 Mission Street Room 108
Ketchikan, Alaska 99901
(907) 220-9229
1.0 MMBtu (pellets)

C. John Culpepper, Director of Facilities North Country School
Lake Placid, NY
(518) 523-9329
1.4 MMBtu (chip/pellet)

1.10 STARTUP, TRAINING, COMMISISONING

A. Boiler pricing includes 3 days of on-site startup, commissioning support and training by an ACT Bioenergy technician.

1.11 FINANCING

A. Financing not available directly from the company. The Company does work with companies who do provide leasing for public and private sector customers.

End of Section