KETCHIKAN GATEWAY BOROUGH

KETCHIKAN AQUATIC CENTER ALTERNATIVE ENERGY STUDY

JUNE 16, 2010

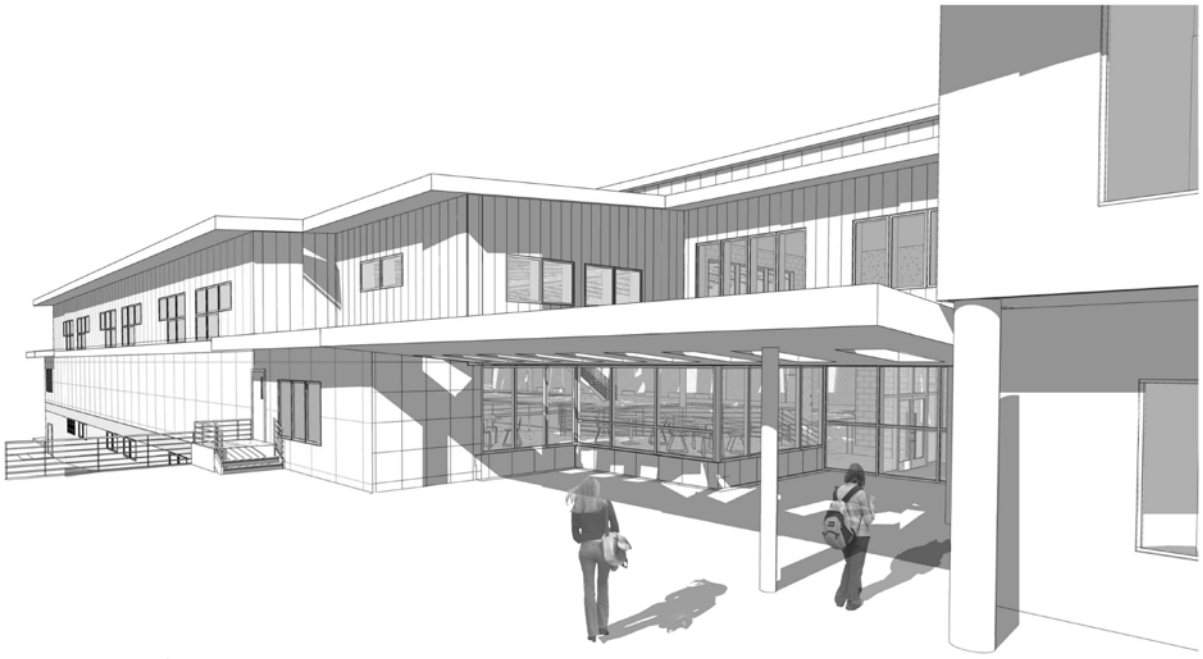

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Table of Contents

EXECUTIVE SUMMARY

The new Ketchikan Aquatic Center will have nearly eight (8) times the annual heating energy demand of an office building due to pool heating and natatorium ventilation demands. With fuel oil prices rising, Architects Alaska Inc. and their Mechanical-Electrical-Plumbing (MEP) consultant AMC Engineers was asked to evaluate two primary alternative energy options: Wood fired boilers (bio fuel) and Ground Source Heat Pumps (GSHP). This report discusses the economics of these two alternatives, plus the option of electrically heated boilers, and an innovative new alternative (Alternative 3) identified by AMC Engineers. This new alternative uses Air Source Heat Pumps to extract heat from the pool exhaust air.

All of the options considered are constructible within the building footprint and serve only the new facility. The idea of a central plant to heat the new Aquatic Center, plus the existing Recreational Center, Valley Park Elementary School, and the nearby Maintenance Building was considered, but not pursued. High costs for a central plant would constitute a major capital project of its own and site development issues are not compatible with the scope, schedule, and objectives of the new Aquatic Center project.

A 25 year life cycle cost analysis for the six options considered produced the following results:

Present Worth Costs for Study Alternatives

	Construction First Cost	Life Cycle Operating Cost	Total Present Worth Cost	Rank Order Lowest Cost = 1
Base Case (3) Oil Boilers (Lead/Lag/Standby)	$623,000	$7,328,000	$7,951,000	6
Base Case – Variation 1 One Electric Boiler (Lead) Two Fuel Oil Boilers (Lag/Standby)	$584,000	$5,119,000	$5,703,000	4
Base Case – Variation 2 Two Electric Boilers (Lead/Lag) One Fuel Oil Boiler (Standby)	$564,000	$5,096,000	$5,660,000	3
Alternative 1 One Wood Boiler (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	$2,115,000	$3,847,000	$5,962,000	5
Alternative 2 One Ground Source Heat Pump (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	$3,629,000	$1,876,000	$5,505,000	2
Alternative 3 Two Exhaust Air Heat Pumps (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	$1,458,000	$3,118,000	$4,576,000	1

Alternative 3 is recommended. This will require an increased project budget of $835,000 but will save $3,375,000 over the 25 year study life of the project compared to the Base Case of three oil fired boilers.

The choice of installing an oil fired boiler or going all electric should be considered in conversations with KPU Electric and/or SEAPA. The most conservative choice is to maintain a secondary energy source, but construction costs would be reduced by approximately $100,000 in an all electric system.

INTRODUCTION

Purpose and Scope of this Study

The Ketchikan Gateway Borough voters approved a $23,500,000 bond issue to build a new 35,000 square foot Aquatic Center to replace the forty year old Mike Smithers' Community Pool. This new natatorium will adjoin the existing Gateway Recreational Center and will include two pools (Competitive and Recreational), two water slides, plus locker rooms, a viewing area, and supporting spaces. The Ketchikan Gateway Borough selected Architects Alaska Inc. to design the new facility, with AMC Engineers to design the mechanical, electrical and plumbing systems. The mechanical design includes all of the heating systems for the project.

Swimming Pools are notorious consumers of energy. The combined surface area of the two swimming pools is nearly 10,000 square feet of water, heated between 80 and 90 degrees F. Left unventilated the relative humidity in the Natatorium would reach nearly 100% and the building walls and windows would be wet with condensation. Additionally, the sanitizer used to keep the water clean is chlorine based, which ultimately results in chlorine odor in the air. To keep the humidity in check and the air quality acceptable it is necessary to continuously ventilate with outdoor air 24 hours a day, 365 days a year. Heating the pool water and ventilating the space is a major expense, which accounts for nearly 75% of the annual heating energy demand for the Aquatic Center. Heating domestic hot water for showers accounts for another 12% of the annual heating energy demand. The remaining 13% is the heating energy associated with a normal building of this size. In round terms, this new Aquatic Center will have nearly eight (8) times the annual heating energy demand of an office building with a similar floor area.

The majority of buildings in Southeast Alaska are heated with fuel oil, which has historically been the lowest cost heating energy. Rising fuel oil prices, unstable world oil markets, and increasing awareness of renewable energy options have created interest in heating alternatives. To this end, AMC Engineers was asked to evaluate two primary alternative energy options: Wood fired boilers (bio fuel) and Ground Source Heat Pumps (GSHP). This report discusses the economics of these two alternatives, plus the option of electrically heated boilers, and an innovative new alternative identified by AMC Engineers. This new alternative uses Air Source Heat Pumps to extract heat from the Natatorium exhaust air system. The ultimate purpose of this analysis is to determine the lowest ownership cost option for the facility.

Alternatives not pursued

The opportunity for this study was greeted with great enthusiasm, and several very appealing creative ideas quickly surfaced. For example, the thought of building a wood fired boiler plant inspired the concept of creating a central plant to heat the new Aquatic Center, plus the existing Recreational Center, Valley Park Elementary School, and the nearby Maintenance Building. Variations included heating both the new building and the existing recreation center together, and permutations of the above. The same central heating concept also applies to the Ground Source Heap Pump Alternative.

There are several economic impediments to these central plant concepts when compared to staying within the confines of the Aquatic Center project. First is the realization is that each of the existing buildings already has an existing heating system with a significant remaining useful life, the value of which must be accounted. Next is the very significant cost of piping between buildings and the associated heat loss and pumping costs. Additionally, there is the cost of constructing a new standalone plant building on an already constrained site. In total, the higher costs for a central plant would constitute a major capital project of its own. Considering the scope, schedule, and objectives of the new Aquatic Center project it became clear that the first step is to evaluate the merits of each alternative within the context of the project at hand. Consequently, all of the options considered in this report are conceived to be constructible within footprint of the new building and serve only the new facility.

ALTERNATIVE ENERGY ANALYSIS

Approach

The analysis compares the 25-year life cycle cost of using fuel oil, electricity, and/or biomass to heat the pool. The evaluation of each option and alternative considers first costs, operating costs, and provides an estimate of the overall Present Worth (Present Cost) for each alternative. As part of the evaluation we corresponded with many interested parties and stakeholders in Ketchikan by telephone and email to gather information and better understand the opportunities available and the current costs of systems and energy. Without exception we received outstanding encouragement and support from everyone we contacted.

The Present Cost is the total amount of money that it would cost to purchase today all of the goods and services that would be spent over the next 25 years for the option considered. The goal is to find the lowest Present Cost. This is determined by summing the net present value of First Costs and Operating Costs including energy, maintenance labor, materials and anticipated contract services, midcourse replacement costs, and final salvage values.

The energy sources are evaluated in the following options for the heating the facility:

Base Case: Three oil-fired boilers (lead, lag, standby)

Base Case – Variation 1: One electric boiler (lead) and two fuel oil boilers (lag, standby)

Base Case – Variation 2: Two electric boilers (lead and lag) and fuel oil boiler (standby)

Alternative 1: One biomass boiler (lead), one electric boiler (lag), and fuel oil boiler (standby)

Alternative 2: One ground source heat pump (lead), one electric boiler (lag), and one fuel oil boiler (standby)

Alternative 3: Two pool exhaust air heat pumps (lead), one electric boiler (lag), and one fuel oil boiler (standby)

Heating System Options

Base Case: Three Oil-fired Boilers (Lead/Lag/Standby)

This heating system consists of three equal-sized fuel oil boilers operating in a lead/lag/standby configuration with modulating burners. The lead boiler operates continuously to heat the pool and building and the lag boiler operates during peak heating loads. The standby boiler provides redundancy and added heating capacity when filling the pools. Under the majority of operating conditions only one boiler is required. The oil boilers are supported by a 7,500 gallon aboveground fuel oil tank.

Base Case – Alternative 1: One Electric Boiler (Lead) and Two Fuel Oil Boilers (Lag/Standby)

This heating system consists of one electric boiler operating as the lead and two fuel oil boilers operating as lag/standby. The lead electric boiler operates continuously to heat the pool and building and the lag fuel oil boiler operates during peak heating loads for domestic hot water (showers) and cold weather. The standby fuel oil boiler provides redundancy and added heating capacity for filling the pools. The system can be operated so the fuel oil boilers are lead/standby, offering energy flexibility. The oil boilers are supported by a 4,000 gallon aboveground fuel oil tank.

Base Case – Alternative 2: Two Electric Boilers (Lead/Lag) and One Fuel Oil Boiler (Standby)

This heating system consists of two electric boilers operating as lead/lag and one fuel oil boiler operating as standby. The lead electric boiler operates continuously to heat the pool and building. The lag electric boiler operates during peak heating loads. The standby fuel oil boiler provides redundancy and the opportunity for fuel source flexibility and added heating capacity for filling the pools. The system can be

operated so the fuel oil boiler is lead, offering energy flexibility. The oil boiler is supported by a 4,000 gallon aboveground fuel oil tank.

Alternative 1: One Wood Boiler (Lead), One Electric Boiler (Lag) and One Fuel Oil Boiler (Standby)

This heating system consists of one wood pellet boiler operating as lead, one electric boiler operating as lag, and one fuel oil boiler operating as standby. The lead biomass boiler operates continuously to heat the pool and building. The electric boiler operates during peak heating loads for domestic hot water (showers) and cold weather. The standby boiler provides redundancy and added heating capacity for filling the pools. The system offers energy flexibility as any boiler can be operated as the lead boiler.

The pellet boiler system preliminarily includes the boiler, a large wood pellet storage silo, a feed auger to move pellets to the boiler, and a pneumatic ash blowdown system and collection system. The wood heated water is circulated to a large heating storage tank which acts as a buffer to prevent thermal shock of the boiler. The other two boilers interface with the wood fired boiler through this tank. The oil boiler is supported by a 4,000 gallon aboveground fuel oil tank.

Alternative 2: One Ground Source Heat Pump (Lead), One Electric Boiler (Lag), and One Fuel Oil Boiler (Standby)

This heating system consists of one ground source heat pump coupled to a vertical well loopfield, one electric boiler operating as lag, and one fuel oil boiler operating as standby. The lead heat pump operates continuously to heat the pool and building and the lag electric boiler operates during peak heating loads. The standby boiler provides redundancy and added heating capacity for filling the pools. The heat pump will offer the lowest heating energy costs, but the system offers energy flexibility as any boiler can be operated as the lead boiler.

The ground source heat pump system preliminarily consists of an array of closed-loop vertical boreholes connected to a water-to-water heat pump. The loopfield will require 120 boreholes, each 6” in diameter and 333’ deep. The boreholes will be spaced 20’ apart with a 3/4” HDPE pipe loop in each bore. The loopfield is sized at an estimated heat transfer rate of 400 lineal feet of borehole per ton of heating based on experience with recent projects in Juneau. An anti-freeze solution circulates through the loopfield, gaining heat from the ground that is then transferred to the heat pumps. A thermal conductivity test is essential to verify and optimally size the loopfield. The cost of this is included in the cost estimate.

The heat pump is a commercial-grade chiller unit specifically manufactured for heating applications. The heated water is stored in a heating storage tank from where it is supplied to the building. The heating supply temperature is 115°F rather than 190°F for boilers, so heating coils and pool heat exchangers will need to be larger to transfer the same amount of heat. Additionally, either electric or oil heat will be required for domestic hot water heating, which requires 140°F water storage.

It is estimated that the ground source heat pump will extract 1.7 BTUs of heat from the ground for each BTU of purchased electricity. The system would be configured to maximize heat production of the heat pump with supplemental heat supplied by whichever boiler has the lowest energy cost. The analysis is based on the electric boiler operating as the lag heating source. The oil boiler is supported by a 4,000 gallon aboveground fuel oil tank.

Alternative 3: Two Pool Exhaust Air Heat Pumps (Lead), One Electric Boiler (Lag), and One Fuel Oil Boiler (lag)

This heating system uses two water-to-water heat pumps to extract heat from the pool exhaust air. Heat is transferred to the hydronic heating loop that heats the building and pools. The heat recovery heat pumps extract 1.7 BTUs of heat for each BTU of purchased electricity. Additional heat is supplied by one

electric boiler operating as lead and one fuel oil boiler operating as lag. The lead heat pumps operate continuously to heat the pool and building and the lag electric boiler operates when required to supplement the heat recovery system. The standby boiler provides redundancy and added heating capacity for peak loads, heating domestic hot water and filling the pools. The heat pumps will offer the lowest heating energy costs, but the system offers energy flexibility as any boiler can be configured as the lead boiler.

Each heat pump is a commercial-grade chiller unit specifically manufactured for heating applications. The heated water is stored in a heating storage tank from where it is supplied to the building. The heating supply temperature is 115°F rather than 190°F for boilers, so heating coils and pool heat exchangers will need to be larger to transfer the same amount of heat. Additionally, either electric or oil heat will be required for domestic hot water heating, which requires 140°F water storage. The oil boiler is supported by a 4,000 gallon aboveground fuel oil tank.

METHODOLOGY

The heating options are evaluated using life cycle cost analysis which compares the construction, maintenance, and energy costs over a 25-year period.

Economic Factors

The following economic factors are used in the analysis:

Discount Rate: Set at 5%, this is the nominal rate of return on an investment, without regard to inflation. (Note that within the range 3.25% to 5.5% the rank order of the outcomes is not affected by this rate).

Inflation Rate: Set at 2%, which is the rate currently assumed by KGB. This is the average nominal inflationary change in prices over time.

Real Discount Rate: Set at 1.9%, which is a calculated value derived from the discount rate and the inflation rate. The actual rate of return with regard to inflation.

Energy Inflation Rates: These vary by commodity are discussed below.

Economic Period: Set at a 25-year economic period with the first full year of operation beginning in 2013.

Energy Sources and Costs

Fuel Oil

The Borough currently purchases fuel under contract with Anderes Oil. The heating oil price is based on the OPIS (Oil Price Information Service) bulk price plus a markup for delivery at a flat rate per gallon. The study uses a current average price of $2.60 per gallon delivered based on an average spot price of $80 per barrel and delivery markup, with an increase for barge service reflecting the change to double hull barges.

The U.S. Department of Energy's Energy Information Agency (EIA) currently predicts a range of nominal oil distillate price inflation from 1% to 6% over the next 25 years. The EIA has historically under-predicted fuel oil inflation. From 1992 to 2006, the average price inflated at 6.3% per year. Between 2006 and 2008, prices increased at 31% per year, then decreased at 18% per year. Since 2008 when prices stabilized, oil price inflation has been averaging 6% per year.

It is assumed that historic inflation rates are an appropriate measure of future inflation. The analysis is based on a fuel cost of 2013 cost of $2.92 per gallon with fuel oil inflation of 6% per year.

Electricity

Electricity is supplied by Ketchikan Public Utilities (KPU), a municipality-owner utility under their Commercial General Service Rate. The rate includes energy charges, demand charges, and a diesel surcharge for supplemental diesel generation. Allowing for diesel surcharges and demand charges, a combined rate of $0.1112 / kWh was assumed for the evaluations.

Electricity -Commercial General Service – Schedule C

Component	Charge (¢/kWh)
Energy	8.97
Diesel Surcharge, per kWh	1.75
Demand Charge [1]	0.40
Total Energy Charge, per kWh	11.12

1. Demand charge of $2.91per kWh prorated over the number of hours in a month

KPU generates some hydroelectric power, but purchases the majority of its power from the Southeast Alaska Power Agency (SEAPA), which operates the Swan Lake and Tyee Lake hydroelectric projects. SEAPA currently has a hydroelectric surplus which affords the flexibility to manage reservoirs in a manner to minimize diesel supplementation. SEAPA is in a unique position where rising revenues from load growth attributed to electric heat conversions and expiring debt offers the flexibility to invest in new hydroelectric generation. SEAPA states that they are well-poised to construct additional hydropower ahead of load without raising electric rates. This scenario makes it likely that electricity will be available at a stable price for the new pool.

Electricity inflation has averaged 0.9% per year since 1990. A rate of 1% per year is used in the analysis.

Biomass

Potential biomass sources include pellets, chips, and cordwood. These sources have significant variations in heating value and moisture content, which are ultimately important to equipment selection, fuel requirements, and handling.

Pellets: A manufactured product with closest suppliers in Washington, Oregon, and British Columbia. Local companies are evaluating going into the pellet business. Benefits of using pellets are:

1. Manufactured to established standards for heating value and moisture content.
2. Sealaska Corporation has committed to supplying pellets to the pool and has set the price at $2.70 per short ton (2,000 pounds) delivered to the site.
3. There is confirmed interest by local suppliers to manufacturer pellets at a lower cost.
4. Pellets are comparable to fuel oil and electricity in terms of reliability of supply, prices are market-based, and the heating systems have similar operating and maintenance requirements.

Chips: Locally supplied material consisting of approximately 2"x2"x1/4" wood chips derived from waste wood products, slash, or whole trees.

1. The Viking Lumber Mill in Craig, Alaska and other local mills are a potential source of wood chips derived from lumber mill operations.
2. Wood from Southeast Alaska has a high moisture content. The chips must be seasoned or dried prior to burning.
3. The chips must meet quality specifications for chip size and moisture content. Chips that are too large can jam the feeder, too small and they inhibit combustion, too wet and they can freeze to the storage bin and reduce heating output.
4. Pound per pound, chips take more volume than pellets. This requires a larger storage bin and more frequent deliveries.
5. A supplier must be found that can dependably deliver 800 short tons per year with a peak monthly requirement of up to 100 short tons. A short ton is 2,000 pounds.

Cordwood: Locally supplied material consisting of whole or split wood cut to length and diameter.

1. There are no automatic feeding systems for cordwood. As such, cordwood is traditionally suited for much smaller heating systems.
2. The heat and moisture content of cordwood varies by lot, which affects the firing rate.
3. Handling costs would be high because there are no automatic feed systems.

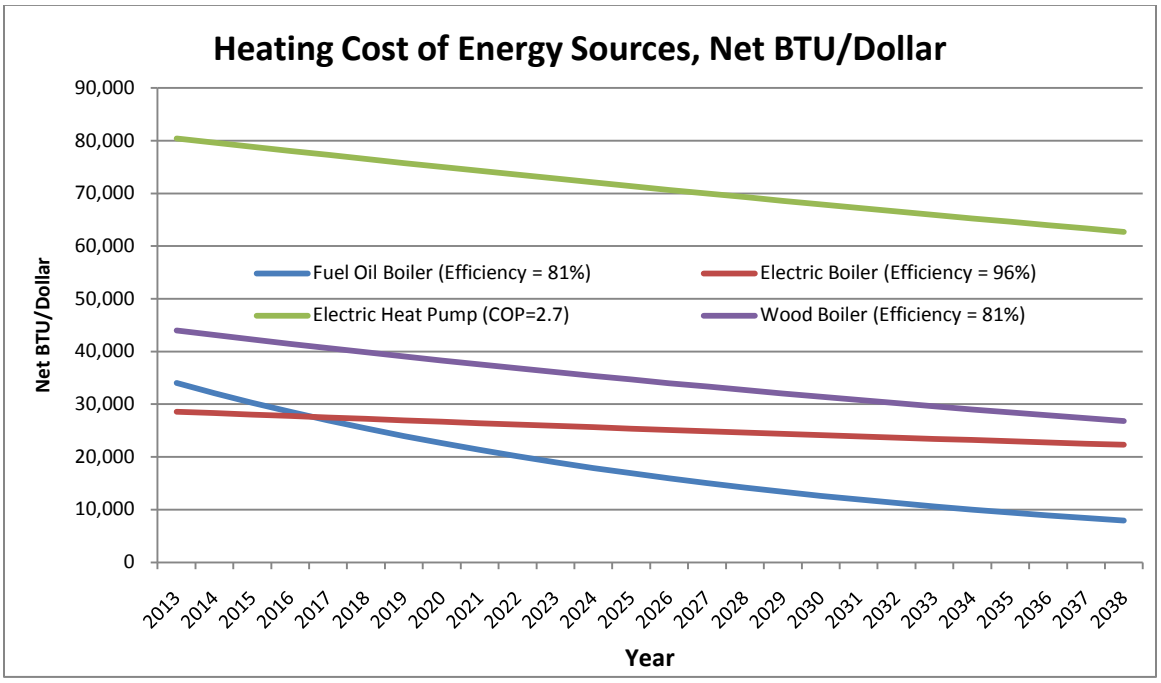
This study is based on the use of wood pellets as the bio-mass energy source.

Pellets are currently a superior source for large biomass heating systems in this size range. They can be initially imported from established suppliers at market-based prices. There is a potential for local manufacture of pellets to further reduce costs. Sealaska Corporation has committed to develop a distribution network that will deliver pellets to the building, similar to the keep-full system used by oil suppliers. This provides a biomass source that should be as reliable and consistent as fuel oil and electricity.

A pellet heating system can be designed for a future conversion to a chip system if planned in advance. This may be beneficial if a lower cost, local supply of chips comes available.

There is no historic data on inflation of wood pellets in Southeast Alaska. Pellet inflation in British Columbia has historically averaged less than 1% per year. At the recommendation of Sealaska Corporation, the analysis inflates wood pellets at 2% per year to take into account the higher imbedded energy in pellets transported (and possibly manufactured) in Southeast Alaska.

The following table compares the cost of heating energy in net BTUs per dollar of cost for each energy source over the 25-year analysis period. Each energy source offers less BTUs per dollar in later years as the price increases with energy inflation.



The chart shows that a heat pump will supply the most BTUs per energy dollar over the analysis period. This is predominately because the heat pump has a high conversion efficiency that allows it to supply 2.7 BTUs for each BTU of purchased electricity. A wood boiler produces the next highest number of BTUs per dollar due to the relatively low cost of pellets and low inflation. Initially, a fuel oil boiler produces more BTUs per dollar than an electric boiler, but higher fuel oil inflation causes it to drop below the electric boiler in 2016. The above discussion is based on the energy inflation assumptions listed previously.

The chart also illustrates how energy inflation reduces the number of BTU per dollar over time. Higher inflation has a greater impact on future wood boiler (2%) and fuel oil boiler (6%) energy costs than it does on electric boiler energy costs (1%).

Summary of Criteria

The following tables summarize the economic and energy criteria used in the analysis.

Ketchikan Gateway Borough Costs	**Rate**	**Comments**
Discount Rate	5.0% (Nominal)	
Monetary inflation	2.0% (Inflation)	KGB current value ‡
Discount Rate	2.9% (Real)	Real= (1+Nominal)/(1+Inflation) -1
In-house Labor	$50.00 per hour	Fully loaded maintenance rate
Owner & A/E Soft Costs	20%	Includes Administration, Project Management, Design and CA
Project Contingency	5%	Allowance for unforeseen events

Energy Costs (2009)	**Rate**	**Information Resource**
Oil	$2.60 per gallon	Anderes Oil ‡‡
Electricity	$0.1112 per kWh average, including diesel surcharge and demand charges	Ketchikan Public Utilities Electric Division ‡‡‡
Wood Pellets	$270.00 per 2000 lbs	Sealaska Corporation ‡‡‡‡

Energy Cost Inflation	**Rate (Next 25 years)**	**Information Resource**
Fuel Oil	6.0% (nominal)	US Energy Information Agency
Electricity	1.0% (nominal)	KPU Electric actual 0.9% annual price rise since 1990
Wood Pellets	2.0% (nominal)	Per Sealaska

‡ Mike Houts, KGB Finance Director

‡‡ Dave Anderes, President Anderes Oil, Inc.

‡‡‡ Gregory Fast, KPU Electric Journeyman Meterman

‡‡‡‡ Wade Zammit, President & CEO Sealaska Corporation

LIFE CYCLE COST ANALYSIS

Heating Options

The analysis compares the primary differences between the heating equipment for each option – fuel oil boiler, electric boiler, or heat pump.

Base Case: Three Oil-fired Boilers (Lead/Lag/Standby)

This option uses three fuel oil boilers to heat the building. The primary components are:

Three 1,700 MBH fuel oil boilers

7,500 gallon aboveground fuel tank

Primary pumps, appurtenances, and controls for each boiler

Base Case – Variation 1: One Electric Boiler (Lead) and Two Fuel Oil Boilers (Lag/Standby)

This option uses one electric boiler and two fuel oil boilers to heat the building. The primary components are:

One 520 kW electric boiler with multiple stages for demand control

Two 1,700 MBH fuel oil boilers

4,000 gallon aboveground fuel tank

Larger capacity electric service for electric boiler

Primary pumps, appurtenances, and controls for each boiler

Base Case – Variation 2: Two Electric Boilers (Lead/Lag) and One Fuel Oil Boiler (Standby)

This option uses two electric boilers and one fuel oil boiler to heat the building. The primary components are:

Two 520 kW electric boiler with multiple stages for demand control

One 1,700 MBH fuel oil boilers

4,000 gallon aboveground fuel tank

Larger capacity electric service for electric boiler

Primary pumps, appurtenances, and controls for each boiler

Alternative 1: One Wood Boiler (Lead), One Electric Boiler (Lag) and One Fuel Oil Boiler (Standby)

This option uses one electric boiler and two fuel oil boilers to heat the building. The primary components are:

One 540 kW Viessmann Pyrot wood boiler

One 520 kW electric boiler with multiple stages for demand control

One 1,700 MBH fuel oil boiler

4,000 gallon aboveground fuel tank

Larger capacity electric service for electric boiler

Primary pumps, appurtenances, and controls for each boiler

Alternative 2: One Ground Source Heat Pump (Lead), One Electric Boiler (Lag), and One Fuel Oil Boiler (Standby)

This option uses one ground source heat pump coupled to a vertical loopfield, one electric boiler and one fuel oil boiler to heat the building. The primary components are:

One 1,200 MBH water-to-water heat pump connected to a loopfield consisting of 120 boreholes, each 333' deep, with a ¾" HDPE pipe loop in each bore. The loopfield will have four separate circuits so that in the unlikely event of a leak in one circuit, it can be isolated and repaired while the rest of the loopfield remains in service.

One 520 kW electric boiler with multiple stages for demand control

One 1,700 MBH fuel oil boiler

4,000 gallon aboveground fuel tank

Larger capacity electric service for electric boiler and heat pump

Primary pumps, appurtenances, and controls for each boiler

Alternative 3: Two Pool Exhaust Air Heat Pumps (Lead), One Electric Boiler (Lag), and One Fuel Oil Boiler (lag)

This option uses two water-to-water heat pumps that extracts heat from the pool exhaust air and supply it to the building heating loop, one electric boiler and one fuel oil boiler to heat the building. The primary components are:

Two 840 MBH water-to-water heat pumps connected to a heat recovery coil in the pool exhaust air. The heat pumps extract the heat and transfer it to the building heating loop.

One 520 kW electric boiler with multiple stages for demand control

One 1,700 MBH fuel oil boiler

4,000 gallon aboveground fuel tank

Larger capacity electric service for electric boiler and heat pumps

Primary pumps, appurtenances, and controls for each boiler

Construction Costs

The following table shows the distribution of construction costs for each heating system, rounded for clarity. The three alternative energy options require additional investment for heat pump(s), loopfield, or a biomass boiler, as applicable.

Detailed construction cost estimates are attached in the Appendix. Owner & A/E soft costs and Project contingency are added in the values below.

Construction Costs, $K

Component	Base Case (3) Fuel Oil	Base+Var 1 (1) Electric, (2) Fuel Oil	Base+Var 2 (2) Electric (1) Fuel Oil	Alternative 1 (1) Biomass (1) Electric (1) Fuel Oil	Alternative 2 (1) Heat Pump (1) Electric (1) Fuel Oil	Alternative 3 (2) Heat Pump (1) Electric (1) Fuel Oil
Fuel oil Boiler(s)	$ 433 K	$ 290 K	$ 185 K	$ 185 K	$ 185 K	$ 185 K
Electric Boiler(s)	0 K	104 K	188 K	104 K	104K	104 K
Biomass Boiler	0 K	0 K	0 K	1,635 K	0 K	0 K
Heat Pump(s)	0 K	0 K	0 K	0 K	3,150 K	979 K
Primary Heating Loop	190 K	190 K	190 K	190 K	190 K	$190 K
Total Cost	**$623 K**	**$584 K**	**$563 K**	**$2,114 K**	**$3,629 K**	**$1,458 K**

Major Replacement Costs

Cast iron boilers have a service life exceeding the study period, but electric boilers, wood augers, and heat pumps have a statistically shorter life and must replaced before the end of the 25 year period.

Mid-Study Period Major Replacement Costs, $K

Component	Base Case (3) Fuel Oil	Base+Var 1 (1) Electric, (2) Fuel Oil	Base+Var 2 (2) Electric (1) Fuel Oil	Alternative 1 (1) Biomass (1) Electric (1) Fuel Oil	Alternative 2 (1) Heat Pump (1) Electric (1) Fuel Oil	Alternative 3 (2) Heat Pump (1) Electric (1) Fuel Oil
Electric Boiler(s)	0 K	65 K	124 K	65 K	65 K	65 K
Wood Augers	0 K	0 K	0 K	67 K	0 K	0 K
Heat Pump(s)	0K	0 K	0 K	0 K	315 K	$581 K
Total Cost	**$0 K**	**$65 K**	**$124 K**	**$132 K**	**$380 K**	**$646 K**

Salvage Value

The major equipment with a remaining useful life was assigned a salvage value based on straight line depreciation of the material only cost.

Maintenance Costs

Annual maintenance requirements for the different heating system are estimated as follows:

Fuel Oil Boiler: 50 hours plus a contracted burner tune-up every five years ($3,000)

Electric Boiler: 12 hours

Wood Boiler: 120 hours which includes two day-long shutdowns per year and 2 hours per week to remove ash and check the boiler and augers. The wood boiler maintenance cost assumes the KGB will have in-house expertise to maintain the equipment.

Heat Pump: 24 hours plus a contracted annual tune-up ($4,500)

Energy Profile for the New Building

On average, the total heating energy usage for the building is shown in the table below, based on average monthly weather data published by ASHRAE and the conceptual energy model for the building developed using ASHRAE algorithms. Weather bin data for Ketchikan is not available, but even so this refinement would not change the outcome of this study.

Total Annual Heating Load

	(kBtu/year)	
Building Envelope & Normal Ventilation	1,970,000	13 %
Domestic Hot Water	1,750,000	12 %
Pool Water Heating	6,080,000	40 %
Natatorium Ventilation	5,340,000	35 %
Total Heating Energy (without heat recovery)	15,140,000	100 %

Energy Profile for the Study Alternatives

A fair comparison requires that all alternatives are evaluated against the same benchmarks. Because the Heat Pump alternatives produce heating water at only 115°F, they cannot be used for domestic hot water heating to 140°F. Domestic hot water is common to all options, so removing this load enables an uncomplicated comparison without affecting the rank order of the results.

Another consideration is the method of heat recovery from the natatorium exhaust air system. The base case design includes a run around loop (run around coil) heat recovery system that uses pumped glycol to transfer heat from a coil in the exhaust air to a coil in the outside air supply for the natatorium. This saves approximately 4,270.000 kBtu/year (28% of total energy) and must be accounted when evaluating the various heating system options.

The basic benchmark for comparisons is 9,115,000 kBtu/year. This is the Total Annual Heating Load less the Domestic Hot Water Load, less the Run around Loop Heat Recovery energy saved. There is one exception: the Air Source Heat Pump option which extracts heat from the natatorium exhaust air. Since the Air Source Heat Pump system supplants the run around loop heat recovery system, it must be evaluated with full consideration of that energy. The benchmark for the Air Source Heat Pump is 13,390,000 kBtu/year.

Benchmark Annual Heating Load for Study Alternatives

Study Case	Base Case all Oil Variation 1 Electric Alternative 1 Wood	Variation 2 Electric Alternative 2 GSHP	Alternative 3: ASHP
Building Envelope & Normal Ventilation		1,970,000	1,970,000
Domestic Hot Water		0	0
Run around loop heat recovery		(4,270.000)	0
Pool Water Heating		6,080,000	6,080,000
Natatorium Ventilation		5,340,000	5,340,000
Total Heating Energy (crediting heat recovery)		9,115,000 kBtu/year	13,390,000 kBtu/year

Energy Consumption and Costs

Each heating system offers the flexibility to operate using a secondary energy source. The following table shows how the energy analysis allocated the heating load and compares the annual energy costs.

Annual Energy Use and Costs for Study Alternatives

	Fuel Oil (gallons)	Electricity (MWh)	Pellets (tons)	Annual Cost (2013)	Life Cycle Energy Cost
Base Case (3) Oil Boilers (Lead/Lag/Standby)	86,580	-	-	$268 K	$7,169 K
Base Case – Variation 1 One Electric Boiler (Lead) Two Fuel Oil Boilers (Lag/Standby)	1,300	2,740	-	$318 K	$4,983 K
Base Case – Variation 2 Two Electric Boilers (Lead/Lag) One Fuel Oil Boiler (Standby)	1,300	2,740	-	$318 K	$4,983 K
Alternative 1 One Wood Boiler (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	-	42	720	$211 K	$3,627 K
Alternative 2 One Ground Source Heat Pump (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	1,300	974	-	$115 K	$1,841 K
Alternative 3 Two Exhaust Air Heat Pumps (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	1,300	1,430	-	$166 K	$2,630 K

The heat pump systems have considerably lower annual and life cycle energy costs. The ground source heat pump system has lower energy costs because it incorporates exhaust air heat recovery at lower energy costs. While the exhaust air heat pump system was not analyzed with an exhaust air heat recovery system, an optimization analysis may determine that a heat recovery loop will reduce energy costs and decrease installed heat pump capacity.

Domestic Hot Water Only - Annual Energy Use and Costs

	Fuel Oil (gallons)	Electricity (MWh)	Pellets (tons)	Annual Cost (2013)	Life Cycle Energy Cost
Domestic Hot Water (heated by oil)	16,600			$52 K	$1,378 K
Domestic Hot Water (heated by electricity)		535		$61 K	$951 K

Costs are provided above for heating domestic hot water with *either* oil or electricity. Domestic hot water heating costs can be added to the Annual Energy Use and Costs for Study Alternatives to estimate the total heating energy under each alternative.

Present Worth Analysis

Present Worth Costs for Study Alternatives

	Construction First Cost	Life Cycle Operating Cost	Total Present Worth Cost	Rank Order Lowest Cost = 1
Base Case (3) Oil Boilers (Lead/Lag/Standby)	$623,000	$7,328,000	$7,951,000	6
Base Case – Variation 1 One Electric Boiler (Lead) Two Fuel Oil Boilers (Lag/Standby)	$584,000	$5,119,000	$5,703,000	4
Base Case – Variation 2 Two Electric Boilers (Lead/Lag) One Fuel Oil Boiler (Standby)	$564,000	$5,096,000	$5,660,000	3
Alternative 1 One Wood Boiler (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	$2,115,000	$3,847,000	$5,962,000	5
Alternative 2 One Ground Source Heat Pump (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	$3,629,000	$1,876,000	$5,505,000	2
Alternative 3 Two Exhaust Air Heat Pumps (Lead) One Electric Boiler (Lag) One Fuel Oil Boiler (Standby)	$1,458,000	$3,118,000	$4,576,000	1

CONCLUSIONS

Economically, the best alternative is the one with the lowest Present Worth Cost.

Alternative 3 (Air Source Heat Pumps) is the best value and will save nearly $3.375 million over the study life of the project compared to the Base Case. This option can be accomplished within the confines of the project footprint and does not require a loop field or site work other than a larger electrical transformer and feeders to the building. The next lowest Present Worth Cost is Alternative 2 (Ground Source Heat Pump), but it offers very little advantage over an electric boiler system (Variation 2).

Alternative 3 is a creative variation on the ground source heat pump; it simply uses the exhaust air from the natatorium as the energy source instead of the ground. Pool dehumidifiers with direct expansion heat pumps are commonly used outside of Alaska, but they are typically packaged units that are limited in their configuration and application. The innovative part of Alternative 3 is that it uses a water chiller and transfers the heat directly the building hydronic heating system. All of the heat available can be captured and used elsewhere without the constraints of a packaged system. If this idea has been used elsewhere it is obscure. Alternative 3 surfaced during the evaluation of the other options and would likely have been missed if KGB had not commissioned this study. In short, this is an unexpected and very welcome outcome.

Ketchikan is a primary fuel distribution point for Southeast Alaska and enjoys the lowest fuel oil costs in the region. At today's cost, fuel oil is the lowest cost source of heating energy currently delivered when fired in conventional appliances. At today's cost, electricity only becomes attractive for heating when

used in heat pump application. However, as shown in the Heating Cost of Energy Sources Chart, it is price inflation that dominates the long term cost of energy.

All options powered by electricity show a lower Present Worth Cost than either oil or wood pellets. Ketchikan is extremely fortunate to enjoy low cost hydroelectric power. Hopefully, KPU Electric and/or SEAPA will be able to keep up with the growing demand for electricity by expanding the availability of hydroelectric power.

There is growing interest in using biomass to heat buildings. Wood pellets are a very attractive alternative to fuel oil and should be available on a reliable basis in the very near future. Outside of the SEAPA intertie system, it appears likely that wood pellets may be more economical than fuel oil on a life cycle cost basis. In Ketchikan, wood pellets do not win in a head to head competition with low cost hydroelectric power.

As a topic for further consideration, the long term availability of hydroelectric power for heating may be limited. If so, wood pellets would be a better long term choice than oil, assuming that favorable delivery and pricing contracts are negotiated. The commercial-scale biomass fuel industry is in its infancy in Southeast Alaska and it would benefit the regional economy for the KGB to be an advocate for developing and maintaining the viability of a biomass supply industry. Local suppliers for wood pellets are interested, viable, and eager to enter the market place. It would only take the spark of a few significant projects to ignite this new industry.

RECOMMENDATIONS

The following course of action is recommended for heating the new Ketchikan Aquatic Center:

1) Select Alternative 3, which uses air source heat pumps to extract heat from the natatorium exhaust air system. This will require an increase in the project budget of $835,000 but will save $3,375,000 over the study life of the project compared to the Base Case of three oil fired boilers.

2) Decide if one oil fired boiler should be provided. The advantage of installing oil fired boiler and fuel oil tank is that it provides a choice in event there is a price spike for electricity or a shortage due to drought or similar crisis. Alternatively, conversations with KPU Electric may conclude that an alternative source of energy is not required. Replacing the oil fired boiler and fuel oil tank with a third electric boiler would reduce construction costs by approximately $100,000 but this will result in an all electric system.

APPENDICES

Owning and Operating Cost Calculations

HMS Cost Estimate

Synergy Systems Budget Proposal (Biomass)

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Owning & Operating Cost Summary

This evaluation compares the following alternative:

Base Case - Three (3) Oil Fired Boilers

Base Case - Variation 1: One Electric Boiler (lead) + Two (2) Oil Fired Boilers

Base Case - Variation 2: Two Electric Boilers (lead) + One (1) Oil Fired Boiler

Alternative - One (1)Wood + (1)Electric Boiler (lag) + One (1) Oil Fired Boiler

Alternative - One (1) Ground Source Heat Pump + (1) Electric Blr (lag) + One (1) Oil Fired Boiler

Alternative - Two (2) Pool Exh Air Heat Pumps + (1) Electric Blr (lag) + One (1) Oil Fired Blr

Common Data and Assumptions are listed below. Net Present Value calulations for each alternative follow.

The results of this evaluation are as follows:

Based on REAL energy cost increases of	**Oil**		**6.0%**			
	Electricity		**1.0%**	**Oil Gal/yr**	**kWh/Yr**	**Wood Tons/Yr**
	Wood Pellets			**Htg only**	**Htg only**	**Htg only**
					Excludes Dom HW	
Base Case - Three (3) Oil Fired Boilers						
	First Cost	$	623,000			
	Operating PW	$	7,328,000	**86,580**		
	Present Cost	**$**	**7,951,389**	**Gal/Yr**	**kWh/Yr**	
Base Case - Variation 1: One Electric Boiler (lead) + Two (2) Oil Fired Boilers						
	First Cost	$	584,000			
	Operating PW	$	5,119,000	**1,300**	**2,739,707**	
	Present Cost	**$**	**5,703,018**	**Gal/Yr**	**kWh/Yr**	
Base Case - Variation 2: Two Electric Boilers (lead) + One (1) Oil Fired Boiler						
	First Cost	$	564,000			
	Operating PW	$	5,096,000	**1,300**	**2,739,707**	
	Present Cost	**$**	**5,659,685**	**Gal/Yr**	**kWh/Yr**	
Alternative - One (1)Wood + (1)Electric Boiler (lag) + One (1) Oil Fired Boiler						
	First Cost	$	2,115,000			
	Operating PW	$	3,847,000	**-**	**41,721**	**720**
	Present Cost	**$**	**5,962,019**	**Gal/Yr**	**kWh/Yr**	**Tons/yr**
Alternative - One (1) Ground Source Heat Pump + (1) Electric Blr (lag) + One (1) Oil Fired Boiler						
	First Cost	$	3,629,000			
	Operating PW	$	1,876,000	**1,300**	**974,118**	
	Present Cost	**$**	**5,505,264**	**Gal/Yr**	**kWh/Yr**	
Alternative - Two (2) Pool Exh Air Heat Pumps + (1) Electric Blr (lag) + One (1) Oil Fired Blr						
	First Cost	$	1,458,000			
	Operating PW	$	3,118,000	**1,300**	**1,430,574**	
	Present Cost	**$**	**4,575,600**	**Gal/Yr**	**kWh/Yr**	

Conclusion: A heat pump system using pool exhaust air as a heat source is the most economical choice

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Owning & Operating Cost Summary

Common Data and Assumptions

Financial Costs

Analysis Period	**25**	Years	
Discount Rate - Nominal	5%	**Discount Rate**	Used for PW calculations
Monetary Inflation - Nominal	2%	Inflation Rate	Used to inflate costs expressed in today's dollars
Discount Rate - Real	**2.9%**	Real Rate	Informational

Operating Costs

Now is **2010** **Costs begin in** **3** **years =** **2013**

	Energy Source	Basis	Current Cost		Cost Escalation	Remarks
Energy	Fuel Oil	Anderes Fuel	$ 2.60	per Gallon	3.9% Real	US Energy Info Agency data
	Ketchikan				4.0%	High Fuel Cost Scenario
		Use	$ 3.10	Cost 2013	**Use** 6.0% Nominal	3.1% Probable Fuel Cost Scenario
						US Energy Info Agency data
						0.0% Low Fuel Cost Scenario
	Electricity	KPU Electric	$ 0.1112	per kWh incl Demand	-1.0% Real	
		Use	$ 0.1146	Cost 2013	**Use** 1.0% Nominal	KPU historical Ave is 0.9% Nominal
	Wood Pellets	Sealaska	$ 270	per short ton delivered	0.0% Real	Per KAC Teleconf 100602 (RISE notes)
		Use	$ 286.53	Cost 2013	**Use** 2.0% Nominal	less CPI + 1.1% for load growth
Labor	Owner's In-house Maintenance Labor Cost		$ 50.00	Fully loaded charge rate		

Administrative Costs

Itemize if they occur.

Capital Costs

Assume: Base Case cost is ZERO. All options have INCREMENTAL OPTIONAL COSTS that are higher or lower that Base Case

First Costs includes:
Construction Costs
20% Owner + A/E Costs
5% Project Contingency

Annual Owning Costs include 0% Taxes 0% Insurance 0% Other Owning costs

Major Maintenance Costs = System Specific Lump Sum allowance for major overhauls at year shown

Service Life Estimates
Median Service Life from 2007 ASHRAE p 36.3 Table 4, or other source as noted
133% x Median Service Life = Assumed Service Life for equipment listed, except Chillers (Heat Pumps)
Heat Pump Chillers will operate continuously year around, which is more hours per year than normal. Assumed life is shortened as noted below.

Item	Median Life (yrs)	Assumed Life (yrs)	Source	Assumed Life < Analysis Period? Replace?	Salvage Value?	
Boiler, Cast Iron	25	33	ASHRAE		Salvage Value	
Boiler, Electric	15	19	ASHRAE	Replace		
Burner	21	27	ASHRAE		Salvage Value	
Fan, Centrifugal	25	33	ASHRAE		Salvage Value	
Coils, Water	20	26	ASHRAE		Salvage Value	
Heat Exchanger	24	31	ASHRAE		Salvage Value	
Chiller, Centrif	23	15	ASHRAE	Replace		
Pump, base mtd	20	26	ASHRAE		Salvage Value	Applies to Heat Pumps
Pump, Pipe mtd	10	13	ASHRAE	Replace		
Electric Motor	18	23	ASHRAE	Replace		
Controls,elctronic	15	19	ASHRAE	Replace		

Replacement Cost = Cost of Major Equipment Replacement at end of ASSUMED Service Life

Salvage Value = Remainder assuming Straight Line Depreciation based on ASSUMED Service life. Applies to Equipmer Material Cost only

Owning & Operating Cost Summary

Annual Energy Use

The following options all assume that a run around coil heat recovery system is installed in the natatorium ventilation system.

Base Case - Three (3) Oil Fired Boilers
Base Case - Variation 1: One Electric Boiler (lead) + Two (2) Oil Fired Boilers
Base Case - Variation 2: Two Electric Boilers (lead) + One (1) Oil Fired Boiler
Alternative - One (1)Wood + (1)Electric Boiler (lag) + One (1) Oil Fired Boiler
Alternative - One (1) Ground Source Heat Pump + (1) Electric Blr (lag) + One (1) Oil Fired Boiler

To allow "apples to apples" comparisons the energy use is normalized as follows:

Total Energy	15,139,556	Kbtu/year	
Dom Hot Water	(1,752,000)	Kbtu/year	Exclude from Study; Heat Pump output is too cold. Assume DHW heated by Oil or Elec
Total less DHW	**13,387,556**	Kbtu/year	
Base heat recovery	(4,271,592)	Kbtu/year	Exclude from Study; Base case includes "run around coil" heat recovery
Net for Study	**9,115,964**	Kbtu/year	

The final option is an Air Source Heat Pump that extracts heat from the Natatorium Exhaust Air.

Since this system also takes the place of the "run around coil" heat recovery system, it is necessary to also include that heat in the analysis.
Pumping electrical energy associated with the "run around coil" system is credited back in the energy cost analysis for this option

Alternative - Two (2) Pool Exh Air Heat Pumps + (1) Electric Blr (lag) + One (1) Oil Fired Blr

Energy use is normalized as follows:

Total Energy	15,139,556	Kbtu/year	
Dom Hot Water	(1,752,000)	Kbtu/year	Exclude from Study; Heat Pump output is too cold. Assume DHW heated by Oil or Elec
Total less DHW	**13,387,556**	Kbtu/year	
Base heat recovery	-	Kbtu/year	Run around coil heat is captured by heat pumps in this option
Net for Study	**13,387,556**	Kbtu/year	

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Owning & Operating Cost Summary

Base Case - Three (3) Oil Fired Boilers

System Includes

3 Fuel Oil Fired Boilers ***1,700 MBH*** Each **Weil McLain 788**
7500 Gallon Aboveground Oil Storage Tank

Ownership Cost Data

Initial Capital Cost $623,136

Annual Owning Cost: Taxes, etc (none)

Major Maintenance Costs (none)

Replacement Costs (none)

Salvage Value

Boilers		3	Oil Boilers first cost	$21,000	=	$	63,000		
		33	Yrs Assumed Life	Straight Line Depr/yr		$	1,909		
	After	25	Yr Analysis Period	Remaining Value				$ 15,000	Salvage Value
					Total Salvage Value			$ 15,000	Current dollars

Operating Cost Data

Energy Cost

Assume **9,115,964** MBtu/ year 100% Percent Load 9,115,964 MBtu output
130,000 BTU Fuel Energy Content per gallon
81% Boiler Efficiency

Calc: Annual Oil Usage

86,580	Gallons per year			Capacity	14.2	GPH
$ 3.10	per Gallon	6.0%	Nominal Escalation	Average load	9.9	GPH
$ 268,107	Cost 2013	assumed first full year of operation				

Maintenance Labor Cost (annual) Allow 50 hrs/oil blr, 12 hr/electric blr, 120 hr/wood blr, 24 hr/Heat pump for routine maintenance

150 hours	$ 50.00	=	**$ 7,500**	**Annually**	Labor		
Maintenance Material Cost (annual)		Allowance	**$ 700**	**Annually**	Material		
Contract Service Cost		Special work annually	**$ -**	**Annually**	Contract		
$ 3,000 Pro burner Tuneup per boiler		For all oil boilers	$ 9,000	**Periodic**	Contract		
5 year intervals			**$ 9,000**	**combined**	Contract		

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Owning & Operating Cost Summary

Base Case - Three (3) Oil Fired Boilers

Life Cycle Costs

Year End	Initial Capital First Cost	Annual Owning Cost (Tax. Ins etc) Escalate 2%	Major Maint Cost Escalate 2%	Replacement Cost Escalate 2%	Salvage Value (Credit) Escalate 2%	Annual Electricity Cost Escalate 1%	Annual Oil Cost Escalate 6%	Maint Labor Cost Escalate 2%	Maint Material Cost Escalate 2%	Contract Services Cost Escalate 2%
	$ 623,136									.
1		$ (0)	$ (0)	$ (0)	$ (0)		$ 268,107	$ 7,500	$ 700	$ -
2		$ (0)	$ (0)	$ (0)	$ (0)		$ 284,194	$ 7,650	$ 714	$ -
3		$ (0)	$ (0)	$ (0)	$ (0)		$ 301,245	$ 7,803	$ 728	$ -
4		$ (0)	$ (0)	$ (0)	$ (0)		$ 319,320	$ 7,959	$ 743	$ -
5		$ (0)	$ (0)	$ (0)	$ (0)		$ 338,479	$ 8,118	$ 758	$ 9,937
6		$ (0)	$ (0)	$ (0)	$ (0)		$ 358,788	$ 8,281	$ 773	$ -
7		$ (0)	$ (0)	$ (0)	$ (0)		$ 380,315	$ 8,446	$ 788	$ -
8		$ (0)	$ (0)	$ (0)	$ (0)		$ 403,134	$ 8,615	$ 804	$ -
9		$ (0)	$ (0)	$ (0)	$ (0)		$ 427,322	$ 8,787	$ 820	$ -
10		$ (0)	$ (0)	$ (0)	$ (0)		$ 452,962	$ 8,963	$ 837	$ 10,971
11		$ (0)	$ (0)	$ (0)	$ (0)		$ 480,139	$ 9,142	$ 853	$ -
12		$ (0)	$ (0)	$ (0)	$ (0)		$ 508,948	$ 9,325	$ 870	$ -
13		$ (0)	$ (0)	$ (0)	$ (0)		$ 539,484	$ 9,512	$ 888	$ -
14		$ (0)	$ (0)	$ (0)	$ (0)		$ 571,853	$ 9,702	$ 906	$ -
15		$ (0)	$ (0)	$ (0)	$ (0)		$ 606,165	$ 9,896	$ 924	$ 12,113
16		$ (0)	$ (0)	$ (0)	$ (0)		$ 642,535	$ 10,094	$ 942	$ -
17		$ (0)	$ (0)	$ (0)	$ (0)		$ 681,087	$ 10,296	$ 961	$ -
18		$ (0)	$ (0)	$ (0)	$ (0)		$ 721,952	$ 10,502	$ 980	$ -
19		$ (0)	$ (0)	$ (0)	$ (0)		$ 765,269	$ 10,712	$ 1,000	$ -
20		$ (0)	$ (0)	$ (0)	$ (0)		$ 811,185	$ 10,926	$ 1,020	$ 13,374
21		$ (0)	$ (0)	$ (0)	$ (0)		$ 859,856	$ 11,145	$ 1,040	$ -
22		$ (0)	$ (0)	$ (0)	$ (0)		$ 911,448	$ 11,367	$ 1,061	$ -
23		$ (0)	$ (0)	$ (0)	$ (0)		$ 966,134	$ 11,595	$ 1,082	$ -
24		$ (0)	$ (0)	$ (0)	$ (0)		$ 1,024,103	$ 11,827	$ 1,104	$ -
25		$ (0)	$ (0)	$ (0)	$ (24,609)		$ 1,085,549	$ 12,063	$ 1,126	$ -
Subtotal Costs	$ 623,136	$ (0)	$ (0)	$ (0)	$ (24,609)	$ -	$ 14,709,572	$ 240,227	$ 22,421	$ 46,394
Discount Rate		5%	5%	5%	5%	5%	5%	5%	5%	5%
NPV	$ 623,136	$ (0)	$ (0)	$ (0)	$ (7,267)	$ -	$ 7,169,223	$ 128,881	$ 12,029	$ 25,388

First Cost	$ 623,000
Operating PW	$ 7,328,000
Present Cost	**$ 7,951,389**

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Owning & Operating Cost Summary

Base Case - Variation 1: One Electric Boiler (lead) + Two (2) Oil Fired Boilers

System Includes

1	Electric Boiler	**520**	**KW**	**Precision HW20**
2	Fuel Oil Fired Boilers	***1,700 MBH***	Each	**Weil McLain 788**
4,000	Gallon Aboveground Oil Storage Tank			

Ownership Cost Data

Initial Capital Cost $583,966

Major Maintenance Costs $ - (none)

Replacement Costs

Boilers	1	Electric Boilers first cost		$22,250	=	$	22,250	
		Labor	100%	$22,250	=	$	22,250	
	19	Yrs Assumed Life				$	44,500	Replacement cost
								Current dollars

Salvage Value

Boilers	1	Electric Boilers first cost		$22,250	=	$	22,250	
	19	Yrs Assumed Life		Straight Line Depr/yr		$	1,171	
After	25	Yr Analysis Period			Remaining Value	$	15,200	Salvage Value
Boilers	2	Oil Boilers first cost		$21,000	=	$	42,000	
	33	Yrs Assumed Life		Straight Line Depr/yr		$	1,273	
After	25	Yr Analysis Period			Remaining Value	$	10,100	Salvage Value
					Total Salvage Value	$	25,300	Current dollars

Operating Cost Data

Electrical Energy Cost

Assume boiler operates **9,115,964** MBtu/ year 99% Percent Load 8,979,225 MBtu output Electric

Calc: Annual Electricity Usage

2,739,707	kWh per year	96%	Boiler efficiency	Input	520	kW
$ 0.115	per kWh+kWD	1.0%	Nominal Escalation	Average load	313	kW
$ 313,887	Cost 2013					

Oil Energy Cost

Assume **9,115,964** MBtu/ year 2% Percent Load 136,739 MBtu output
130,000 BTU Fuel Energy Content per gallon
81% Boiler Efficiency

Calc: Annual Oil Usage

1,300	Gallons per year			Capacity	14.2	GPH
$ 3.10	per Gallon	6.0%	Nominal Escalation	Average load	0.1	GPH
$ 4,026	Cost 2013	assumed first full year of operation				

Maintenance Labor Cost (annual) **112** hours $ 50.00 = **$ 5,600** **Annually** Labor
Allow 50 hrs/oil blr, 12 hr/electric blr, 120 hr/wood blr, 24 hr/Heat pump

Maintenance Material Cost (annual) Allowance **$ 550** **Annually** Material

Contract Service Cost Special work annually **$ -** **Annually** Contract

$ 3,000	Pro burner Tuneup per boiler	For all oil boilers	$ 6,000	**Periodic**	Contract
5	year intervals				
			$ 6,000	**combined**	Contract

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Project Name: **Ketchikan Aquatic Center**
Project Number: **10803 KETPOOL**
Engineer: **Boyd Morgenthaler, P.E.** Printed: 12-Jun-10
Checked: **Jim Rehfeldt, P.E.**
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Owning & Operating Cost Summary

Base Case - Variation 1: One Electric Boiler (lead) + Two (2) Oil Fired Boilers

Life Cycle Costs

Year End	Initial Capital First Cost	Annual Owning Cost (Tax. Ins etc) Escalate 2%	Major Maint Cost Escalate 2%	Replacement Cost Escalate 2%	Salvage Value (Credit) Escalate 2%	Annual Electical Cost Escalate 1%	Annual Oil Cost Escalate 6%	Maint Labor Cost Escalate 2%	Maint Material Cost Escalate 2%	Contract Services Cost Escalate 2%
0	**$ 583,966**									.
1		$ (0)	$ (0)	$ (0)	$ (0)	$ 313,887	$ 4,026	$ 5,600	$ 550	$ -
2		$ (0)	$ (0)	$ (0)	$ (0)	$ 317,026	$ 4,267	$ 5,712	$ 561	$ -
3		$ (0)	$ (0)	$ (0)	$ (0)	$ 320,196	$ 4,523	$ 5,826	$ 572	$ -
4		$ (0)	$ (0)	$ (0)	$ (0)	$ 323,398	$ 4,795	$ 5,943	$ 584	$ -
5		$ (0)	$ (0)	$ (0)	$ (0)	$ 326,632	$ 5,082	$ 6,062	$ 595	$ 6,624
6		$ (0)	$ (0)	$ (0)	$ (0)	$ 329,898	$ 5,387	$ 6,183	$ 607	$ -
7		$ (0)	$ (0)	$ (0)	$ (0)	$ 333,197	$ 5,710	$ 6,307	$ 619	$ -
8		$ (0)	$ (0)	$ (0)	$ (0)	$ 336,529	$ 6,053	$ 6,433	$ 632	$ -
9		$ (0)	$ (0)	$ (0)	$ (0)	$ 339,894	$ 6,416	$ 6,561	$ 644	$ -
10		$ (0)	$ (0)	$ (0)	$ (0)	$ 343,293	$ 6,801	$ 6,693	$ 657	$ 7,314
11		$ (0)	$ (0)	$ (0)	$ (0)	$ 346,726	$ 7,209	$ 6,826	$ 670	$ -
12		$ (0)	$ (0)	$ (0)	$ (0)	$ 350,194	$ 7,642	$ 6,963	$ 684	$ -
13		$ (0)	$ (0)	$ (0)	$ (0)	$ 353,695	$ 8,100	$ 7,102	$ 698	$ -
14		$ (0)	$ (0)	$ (0)	$ (0)	$ 357,232	$ 8,586	$ 7,244	$ 711	$ -
15		$ (0)	$ (0)	$ (0)	$ (0)	$ 360,805	$ 9,102	$ 7,389	$ 726	$ 8,075
16		$ (0)	$ (0)	$ (0)	$ (0)	$ 364,413	$ 9,648	$ 7,537	$ 740	$ -
17		$ (0)	$ (0)	$ (0)	$ (0)	$ 368,057	$ 10,227	$ 7,688	$ 755	$ -
18		$ (0)	$ (0)	$ (0)	$ (0)	$ 371,737	$ 10,840	$ 7,841	$ 770	$ -
19		$ (0)	$ (0)	$ (0)	$ 64,828	$ 375,455	$ 11,491	$ 7,998	$ 786	$ -
20		$ (0)	$ (0)	$ (0)	$ (0)	$ 379,209	$ 12,180	$ 8,158	$ 801	$ 8,916
21		$ (0)	$ (0)	$ (0)	$ (0)	$ 383,002	$ 12,911	$ 8,321	$ 817	$ -
22		$ (0)	$ (0)	$ (0)	$ (0)	$ 386,832	$ 13,685	$ 8,488	$ 834	$ -
23		$ (0)	$ (0)	$ (0)	$ (0)	$ 390,700	$ 14,507	$ 8,657	$ 850	$ -
24		$ (0)	$ (0)	$ (0)	$ (0)	$ 394,607	$ 15,377	$ 8,831	$ 867	$ -
25		$ (0)	$ (0)	$ (0)	$ (41,507)	$ 398,553	$ 16,300	$ 9,007	$ 885	$ -
Subtotal Costs	$ 583,966	$ (0)	$ (0)	$ 64,828	$ (41,507)	$ 8,865,166	$ 220,864	$ 179,370	$ 17,617	$ 30,929
Discount Rate	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%
NPV	$ 583,966	$ (0)	$ (0)	$ 25,655	$ (12,257)	$ 4,875,401	$ 107,646	$ 96,231	$ 9,451	$ 16,925

First Cost	$ 584,000
Operating PW	$ 5,119,000
Present Cost	**$ 5,703,018**

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Project Name: **Ketchikan Aquatic Center**
Project Number: **10803 KETPOOL**
Engineer: **Boyd Morgenthaler, P.E.** Printed: 12-Jun-10
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Owning & Operating Cost Summary

Base Case - Variation 2: Two Electric Boilers (lead) + One (1) Oil Fired Boiler

System Includes

2	Electric Boilers	**520 KW**		**Precision HW20**
1	Fuel Oil Fired Boiler	***1,700 MBH***	Each	**Weil McLain 788**
4,000	Gallon Aboveground Oil Storage Tank			

Ownership Cost Data

Initial Capital Cost $563,561

Major Maintenance Costs **$ -** (none)

Replacement Costs

Boilers	2	Electric Boilers first cost		$22,250	=	$ 44,500		
		Labor	100%	$22,250	=	$ 44,500		
	19	Yrs Assumed Life				$ 89,000	Replacement cost	
							Current dollars	

Salvage Value

Boilers	2	Electric Boilers first cost		$22,250	=	$ 44,500		
	19	Yrs Assumed Life		Straight Line Depr/yr		$ 2,342		
After	25	Yr Analysis Period		Remaining Value		$ 30,400	Salvage Value	
Boilers	1	Oil Boilers first cost		$21,000	=	$ 21,000		
	33	Yrs Assumed Life		Straight Line Depr/yr		$ 636		
After	25	Yr Analysis Period		Remaining Value		$ 5,000	Salvage Value	
					Total Salvage Value	$ 35,400	Current dollars	

Operating Cost Data

Electrical Energy Cost

Assume boiler operates **9,115,964** MBtu/ year 98.5% Percent Load 8,979,225 MBtu output Electric

Calc: Annual Electricity Usage

2,739,707	kWh per year	96%	Boiler efficiency	Input	520	kW	
$ 0.115	per kWh+kWD	1.0%	Nominal Escalation	Average load	313	kW	
$ 313,887	Cost 2013						

Oil Energy Cost

Assume **9,115,964** MBtu/ year 1.5% Percent Load 136,739 MBtu output
130,000 BTU Fuel Energy Content per gallon
81% Boiler Efficiency

Calc: Annual Oil Usage

1,300	Gallons per year			Capacity	14.2	GPH	
$ 3.10	per Gallon	6.0%	Nominal Escalation	Average load	0.1	GPH	
$ 4,026	Cost 2013	assumed first full year of operation					

Maintenance Labor Cost (annual) **74** hours $ 50.00 = **$ 3,700** **Annually** Labor
Allow 50 hrs/oil blr, 12 hr/electric blr, 120 hr/wood blr, 24 hr/Heat pump

Maintenance Material Cost (annual) Allowance **$ 400** **Annually** Material

Contract Service Cost Special work annually **$ -** **Annually** Contract

$ 3,000 Pro burner Tuneup per boiler For all oil boilers $ 3,000 **Periodic** Contract
5 year intervals

$ 3,000 **combined** Contract

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Owning & Operating Cost Summary

Base Case - Variation 2: Two Electric Boilers (lead) + One (1) Oil Fired Boiler

Life Cycle Costs

Year End	Initial Capital First Cost	Escalate 2% Annual Owning Costs (Tax. Ins etc)	Escalate 2% Major Maint Cost	Escalate 2% Replacemer Cost	Escalate 2% Salvage Value (Credit)	Escalate 1% Annual Electical Cost	Escalate 6% Annual Oil Cost	Escalate 2% Maint Labor Cost	Escalate 2% Maint Material Cost	Escalate 2% Contract Services Cost
0	**$ 563,561**									
1		$ (0)	$ (0)	$ (0)	$ (0)	$ 313,887	$ 4,026	$ 3,700	$ 400	$ -
2		$ (0)	$ (0)	$ (0)	$ (0)	$ 317,026	$ 4,267	$ 3,774	$ 408	$ -
3		$ (0)	$ (0)	$ (0)	$ (0)	$ 320,196	$ 4,523	$ 3,849	$ 416	$ -
4		$ (0)	$ (0)	$ (0)	$ (0)	$ 323,398	$ 4,795	$ 3,926	$ 424	$ -
5		$ (0)	$ (0)	$ (0)	$ (0)	$ 326,632	$ 5,082	$ 4,005	$ 433	$ 3,312
6		$ (0)	$ (0)	$ (0)	$ (0)	$ 329,898	$ 5,387	$ 4,085	$ 442	$ -
7		$ (0)	$ (0)	$ (0)	$ (0)	$ 333,197	$ 5,710	$ 4,167	$ 450	$ -
8		$ (0)	$ (0)	$ (0)	$ (0)	$ 336,529	$ 6,053	$ 4,250	$ 459	$ -
9		$ (0)	$ (0)	$ (0)	$ (0)	$ 339,894	$ 6,416	$ 4,335	$ 469	$ -
10		$ (0)	$ (0)	$ (0)	$ (0)	$ 343,293	$ 6,801	$ 4,422	$ 478	$ 3,657
11		$ (0)	$ (0)	$ (0)	$ (0)	$ 346,726	$ 7,209	$ 4,510	$ 488	$ -
12		$ (0)	$ (0)	$ (0)	$ (0)	$ 350,194	$ 7,642	$ 4,600	$ 497	$ -
13		$ (0)	$ (0)	$ (0)	$ (0)	$ 353,695	$ 8,100	$ 4,692	$ 507	$ -
14		$ (0)	$ (0)	$ (0)	$ (0)	$ 357,232	$ 8,586	$ 4,786	$ 517	$ -
15		$ (0)	$ (0)	$ (0)	$ (0)	$ 360,805	$ 9,102	$ 4,882	$ 528	$ 4,038
16		$ (0)	$ (0)	$ (0)	$ (0)	$ 364,413	$ 9,648	$ 4,980	$ 538	$ -
17		$ (0)	$ (0)	$ (0)	$ (0)	$ 368,057	$ 10,227	$ 5,079	$ 549	$ -
18		$ (0)	$ (0)	$ (0)	$ (0)	$ 371,737	$ 10,840	$ 5,181	$ 560	$ -
19		$ (0)	$ (0)	$ (0)	$ 129,656	$ 375,455	$ 11,491	$ 5,285	$ 571	$ -
20		$ (0)	$ (0)	$ (0)	$ (0)	$ 379,209	$ 12,180	$ 5,390	$ 583	$ 4,458
21		$ (0)	$ (0)	$ (0)	$ (0)	$ 383,002	$ 12,911	$ 5,498	$ 594	$ -
22		$ (0)	$ (0)	$ (0)	$ (0)	$ 386,832	$ 13,685	$ 5,608	$ 606	$ -
23		$ (0)	$ (0)	$ (0)	$ (0)	$ 390,700	$ 14,507	$ 5,720	$ 618	$ -
24		$ (0)	$ (0)	$ (0)	$ (0)	$ 394,607	$ 15,377	$ 5,835	$ 631	$ -
25		$ (0)	$ (0)	$ (0)	$ (58,077)	$ 398,553	$ 16,300	$ 5,951	$ 643	$ -
Subtotal Costs	$ 563,561	$ (0)	$ (0)	$ 129,656	$ (58,077)	$ 8,865,166	$ 220,864	$ 118,512	$ 12,812	$ 15,465
Discount Rate	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%
NPV	$ 563,561	$ (0)	$ (0)	$ 51,309	$ (17,150)	$ 4,875,401	$ 107,646	$ 63,581	$ 6,874	$ 8,463

First Cost	$ 564,000
Operating PW	$ 5,096,000
Present Cost	**$ 5,659,685**

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Owning & Operating Cost Summary

Alternative - One (1)Wood + (1)Electric Boiler (lag) + One (1) Oil Fired Boiler

System Includes

1	Wood Pellet Boiler	***1,842 MBH***	Each	**Viessmann/KOB Pyrot 540 (540 kW)**
1	Electric Boiler	**520**	**KW**	**Precision HW20**
1	Fuel Oil Fired Boiler	***1,700 MBH***	Each	**Weil McLain 788**
4,000	Gallon Aboveground Oil Storage Tank			

Ownership Cost Data

Initial Capital Cost $2,114,881

Major Maintenance Costs $ - (none)

Replacement Costs

Boilers	1	Electric Boilers first cost	$22,250	=	$	22,250		
		Labor 100%	$22,250	=	$	22,250		
	19	Yrs Assumed Life			$	44,500	Replacement cost	
							Current dollars	
Augers	1	Auger System	$25,000	=	$	25,000		
		Labor 100%	$25,000	=	$	25,000		
	15	Yrs Assumed Life			$	50,000	Replacement cost	
							Current dollars	

Salvage Value

Boilers	1	Electric Boilers first cost	$22,250	=	$	22,250		
	19	Yrs Assumed Life	Straight Line Depr/yr		$	1,171		
After	25	Yr Analysis Period		Remaining Value			$ 15,200	Salvage Value
Augers	1	Auger System	$25,000	=	$	25,000		
	19	Yrs Assumed Life	Straight Line Depr/yr		$	1,316		
	25	Yr Analysis Period		Remaining Value			$ 17,100	Salvage Value
Boilers	2	Boiler 1st cost (oil & wood)	$40,500	=	$	81,000		
	33	Yrs Assumed Life	Straight Line Depr/yr		$	2,455		
After	25	Yr Analysis Period		Remaining Value			$ 19,600	Salvage Value
				Total Salvage Value			$ 51,900	Current dollars

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Owning & Operating Cost Summary

Alternative - One (1)Wood + (1)Electric Boiler (lag) + One (1) Oil Fired Boiler

Operating Cost Data

Wood Energy Cost

Assume **9,115,964** MBtu/ year 98.5% Percent Load 8,979,225 MBtu output
7800 Btu/lb LHV
2000 lb/Ton Max output 1,842 MBH
15,600,000 BTU Fuel Energy Content per Short Ton Average load 1,041 MBH 56%
81% Boiler Efficiency

Calc: Annual Wood Usage 720 Tons per year
$ 286.53 per Ton 2.0% Nominal Escalation
$ 206,299 Cost 2013

Electrical Energy Cost

Assume boiler operates **9,115,964** MBtu/ year 1.5% Percent Load 136,739 MBtu output

Calc: Annual Electricity Usage 41,721 kWh per year 96% Boiler efficiency Input 520 kW
$ 0.115 per kWh+kWD 1.0% Nominal Escalation Average load 5 kW
$ 4,780 Cost 2013

Oil Energy Cost

Assume **9,115,964** MBtu/ year 0.0% Percent Load 0 MBtu output
0 BTU Fuel Energy Content per gallon
81% Boiler Efficiency

Calc: Annual Oil Usage - Gallons per year Capacity 14.2 GPH
$ 3.10 per Gallon 6.0% Nominal Escalation Average load 0.0 GPH
$ - Cost 2013 assumed first full year of operation

Maintenance Labor Cost (annual)	**182** hours	$ 50.00	=	**$ 9,100**	**Annually**	Labor
Allow 50 hrs/oil blr, 12 hr/electric blr, 120 hr/wood blr, 24 hr/Heat pump						
Maintenance Material Cost (annual)			Allowance	**$ 800**	**Annually**	Material
Contract Service Cost			Special work annually	**$ -**	Annually	Contract
$ 3,000 Pro burner Tuneup per boiler			For all oil boilers	$ 6,000	Periodic	Contract
5 year intervals						
				$ 6,000	**combined**	Contract

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Owning & Operating Cost Summary

Alternative - One (1)Wood + (1)Electric Boiler (lag) + One (1) Oil Fired Boiler

Life Cycle Costs

Year End	Initial Capital First Cost	Escalate 2% Major Maint Cost	Escalate 2% Replacement Cost	Escalate 2% Salvage Value (Credit)	Escalate 2% Annual Wood Cost	Escalate 2% Annual Electical Cost	Escalate 6% Annual Oil Cost	Escalate 2% Maint Labor Cost	Escalate 2% Maint Material Cost	Escalate 2% Contract Services Cost
0	**$ 2,114,881**									
1		$ (0)	$ (0)	$ (0)	$ 206,299	$ 4,780	$ -	$ 9,100	$ 800	$ -
2		$ (0)	$ (0)	$ (0)	$ 210,425	$ 4,876	$ -	$ 9,282	$ 816	$ -
3		$ (0)	$ (0)	$ (0)	$ 214,633	$ 4,973	$ -	$ 9,468	$ 832	$ -
4		$ (0)	$ (0)	$ (0)	$ 218,926	$ 5,073	$ -	$ 9,657	$ 849	$ -
5		$ (0)	$ (0)	$ (0)	$ 223,304	$ 5,174	$ -	$ 9,850	$ 866	$ 6,624
6		$ (0)	$ (0)	$ (0)	$ 227,771	$ 5,278	$ -	$ 10,047	$ 883	$ -
7		$ (0)	$ (0)	$ (0)	$ 232,326	$ 5,383	$ -	$ 10,248	$ 901	$ -
8		$ (0)	$ (0)	$ (0)	$ 236,973	$ 5,491	$ -	$ 10,453	$ 919	$ -
9		$ (0)	$ (0)	$ (0)	$ 241,712	$ 5,601	$ -	$ 10,662	$ 937	$ -
10		$ (0)	$ (0)	$ (0)	$ 246,546	$ 5,713	$ -	$ 10,875	$ 956	$ 7,314
11		$ (0)	$ (0)	$ (0)	$ 251,477	$ 5,827	$ -	$ 11,093	$ 975	$ -
12		$ (0)	$ (0)	$ (0)	$ 256,507	$ 5,943	$ -	$ 11,315	$ 995	$ -
13		$ (0)	$ (0)	$ (0)	$ 261,637	$ 6,062	$ -	$ 11,541	$ 1,015	$ -
14		$ (0)	$ (0)	$ (0)	$ 266,870	$ 6,183	$ -	$ 11,772	$ 1,035	$ -
15		$ (0)	$ 67,293	$ (0)	$ 272,207	$ 6,307	$ -	$ 12,007	$ 1,056	$ 8,075
16		$ (0)	$ (0)	$ (0)	$ 277,651	$ 6,433	$ -	$ 12,247	$ 1,077	$ -
17		$ (0)	$ (0)	$ (0)	$ 283,204	$ 6,562	$ -	$ 12,492	$ 1,098	$ -
18		$ (0)	$ (0)	$ (0)	$ 288,868	$ 6,693	$ -	$ 12,742	$ 1,120	$ -
19		$ (0)	$ 64,828	$ (0)	$ 294,646	$ 6,827	$ -	$ 12,997	$ 1,143	$ -
20		$ (0)	$ (0)	$ (0)	$ 300,538	$ 6,964	$ -	$ 13,257	$ 1,165	$ 8,916
21		$ (0)	$ (0)	$ (0)	$ 306,549	$ 7,103	$ -	$ 13,522	$ 1,189	$ -
22		$ (0)	$ (0)	$ (0)	$ 312,680	$ 7,245	$ -	$ 13,793	$ 1,213	$ -
23		$ (0)	$ (0)	$ (0)	$ 318,934	$ 7,390	$ -	$ 14,068	$ 1,237	$ -
24		$ (0)	$ (0)	$ (0)	$ 325,312	$ 7,538	$ -	$ 14,350	$ 1,262	$ -
25		$ (0)	$ (0)	$ (85,147)	$ 331,819	$ 7,688	$ -	$ 14,637	$ 1,287	$ -
Subtotal Costs	$ 2,114,881	$ (0)	$ 132,122	$ (85,147)	$ 6,607,814	$ 153,105	$ -	$ 291,476	$ 25,624	$ 30,929
Discount Rate	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%
NPV	$ 2,114,881	$ (0)	$ 58,024	$ (25,144)	$ 3,545,070	$ 82,140	$ -	$ 156,376	$ 13,747	$ 16,925

First Cost	$ 2,115,000
Operating PW	$ 3,847,000
Present Cost	**$ 5,962,019**

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Owning & Operating Cost Summary

Alternative - One (1) Ground Source Heat Pump + (1) Electric Blr (lag) + One (1) Oil Fired Boiler

System Includes

1	Ground Source Heat Pump	***1,200 MBH***	**Each**	**Carrier, Trane, McQuay**
1	Electric Boiler	**520**	**KW**	**Precision HW20**
1	Fuel Oil Fired Boiler	***1,700 MBH***	Each	**Weil McLain 788**
4,000	Gallon Aboveground Oil Storage Tank			

Ownership Cost Data

Initial Capital Cost $3,629,250

Major Maintenance Costs **$ -** (none)

Replacement Costs

GSHP	1	Heat Pump		$195,000	=	$ 195,000		
		Labor	20%	$39,000	=	$ 39,000		
	15	Yrs Assumed Life				$ 234,000	Replacement cost	
							Current dollars	
Boilers	1	Electric Boilers first cost		$22,250	=	$ 22,250		
		Labor	100%	$22,250	=	$ 22,250		
	19	Yrs Assumed Life				$ 44,500	Replacement cost	
							Current dollars	

Salvage Value

GSHP	1	Heat Pump		$195,000	=	$ 195,000		
	15	Yrs Assumed Life		Straight Line Depr/yr		$ 13,000		
After	25	Yr Analysis Period		Remaining Value			$ 65,000	Salvage Value
GSHP	1	Loop Field		$1,040,000	=	$ 1,040,000		
	50	Yrs Assumed Life		Straight Line Depr/yr		$ 20,800		
After	25	Yr Analysis Period		Remaining Value			$ 520,000	Salvage Value
Boilers	1	Electric Boilers first cost		$22,250	=	$ 22,250		
	19	Yrs Assumed Life		Straight Line Depr/yr		$ 1,171		
After	25	Yr Analysis Period		Remaining Value			$ 15,200	Salvage Value
Boilers	1	Oil Boilers first cost		$21,000	=	$ 21,000		Current dollars
	33	Yrs Assumed Life		Straight Line Depr/yr		$ 636		
After	25	Yr Analysis Period		Remaining Value			$ 5,000	Salvage Value
					Total Salvage Value		$ 605,200	Current dollars

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Value-Added Engineering Services 701 E. TUDOR ROAD, SUITE 250
Project Name: **Ketchikan Aquatic Center** ANCHORAGE, AK 99503
Project Number: **10803 KETPOOL** (907) 257-9100
Engineer: **Boyd Morgenthaler, P.E.** Printed: 12-Jun-10 FAX (907) 257-9191
Checked: **Jim Rehfeldt, P.E.** *e-mail: amc@amc-engineers.com*
Input date: **12-Jun-10** File: X:\10803 KETPOOL\Alt Energy Studies\!NPV calc all Alts\[NPV Calc all Alts.xls]NPV GSHP

Owning & Operating Cost Summary

Alternative - One (1) Ground Source Heat Pump + (1) Electric Blr (lag) + One (1) Oil Fired Boiler

Operating Cost Data

GSHP Electrical Energy Cost

Assume boiler operates **9,115,964** MBtu/ year 98.5% Percent Load 8,979,225 MBtu output Electric

Calc: Annual Electricity Usage

2,630,119	kWh per year load			Max output	1,200 MBH	
2.70	COP			Average load	1,025 MBH	85%
974,118	kWh per year used					
$ 0.1146	per kWh+kWD	1.0%	Nominal Escalation			
$ 111,604	Cost 2013					

Electrical Energy Cost

Assume boiler operates **9,115,964** MBtu/ year 0% Percent Load - MBtu output Electric

Calc: Annual Electricity Usage

-	kWh per year	96%	Boiler efficiency	Input	520	kW
$ 0.115	per kWh+kWD	1.0%	Nominal Escalation	Average load	0	kW
$ -	Cost 2013					

Oil Energy Cost

Assume **9,115,964** MBtu/ year 1.5% Percent Load 136,739 MBtu output

130,000 BTU Fuel Energy Content per gallon
81% Boiler Efficiency

Calc: Annual Oil Usage

1,300	Gallons per year			Capacity	14.2	GPH
$ 3.10	per Gallon	6.0%	Nominal Escalation	Average load	0.1	GPH
$ 4,026	Cost 2013	assumed first full year of operation				

Maintenance Labor Cost (annual) **86** hours $ 50.00 = **$ 4,300** **Annually** Labor
Allow 50 hrs/oil blr, 12 hr/electric blr, 120 hr/wood blr, 24 hr/Heat pump

Maintenance Material Cost (annual) Allowance **$ 400** **Annually** Material

Contract Service Cost Chiller tuneup annually **$ 4,500** **Annually** Contract

$ 3,000 Pro burner Tuneup per boiler For all oil boilers $ 3,000 **Periodic** Contract
5 year intervals

$ 7,500 **combined** Contract

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Owning & Operating Cost Summary

Alternative - One (1) Ground Source Heat Pump + (1) Electric Blr (lag) + One (1) Oil Fired Boiler

Life Cycle Costs

Year End	Initial Capital First Cost	Annual Owning Cost (Tax. Ins etc) Escalate 2%	Major Maint Cost Escalate 2%	Replacemen Cost Escalate 2%	Salvage Value (Credit) Escalate 2%	Annual Electical Cost Escalate 1%	Annual Oil Cost Escalate 6%	Maint Labor Cost Escalate 2%	Maint Material Cost Escalate 2%	Contract Services Cost Escalate 2%
0	**$ 3,629,250**									
1		$ (0)	$ (0)	$ (0)	$ (0)	$ 111,604	$ 4,026	$ 4,300	$ 400	$ 4,500
2		$ (0)	$ (0)	$ (0)	$ (0)	$ 112,720	$ 4,267	$ 4,386	$ 408	$ 4,500
3		$ (0)	$ (0)	$ (0)	$ (0)	$ 113,847	$ 4,523	$ 4,474	$ 416	$ 4,500
4		$ (0)	$ (0)	$ (0)	$ (0)	$ 114,986	$ 4,795	$ 4,563	$ 424	$ 4,500
5		$ (0)	$ (0)	$ (0)	$ (0)	$ 116,136	$ 5,082	$ 4,654	$ 433	$ 7,500
6		$ (0)	$ (0)	$ (0)	$ (0)	$ 117,297	$ 5,387	$ 4,748	$ 442	$ 4,500
7		$ (0)	$ (0)	$ (0)	$ (0)	$ 118,470	$ 5,710	$ 4,842	$ 450	$ 4,500
8		$ (0)	$ (0)	$ (0)	$ (0)	$ 119,655	$ 6,053	$ 4,939	$ 459	$ 4,500
9		$ (0)	$ (0)	$ (0)	$ (0)	$ 120,851	$ 6,416	$ 5,038	$ 469	$ 4,500
10		$ (0)	$ (0)	$ (0)	$ (0)	$ 122,060	$ 6,801	$ 5,139	$ 478	$ 7,500
11		$ (0)	$ (0)	$ (0)	$ (0)	$ 123,280	$ 7,209	$ 5,242	$ 488	$ 4,500
12		$ (0)	$ (0)	$ (0)	$ (0)	$ 124,513	$ 7,642	$ 5,347	$ 497	$ 4,500
13		$ (0)	$ (0)	$ (0)	$ (0)	$ 125,758	$ 8,100	$ 5,453	$ 507	$ 4,500
14		$ (0)	$ (0)	$ (0)	$ (0)	$ 127,016	$ 8,586	$ 5,563	$ 517	$ 4,500
15		$ (0)	$ (0)	$ (0)	$ 314,933	$ 128,286	$ 9,102	$ 5,674	$ 528	$ 7,500
16		$ (0)	$ (0)	$ (0)	$ (0)	$ 129,569	$ 9,648	$ 5,787	$ 538	$ 4,500
17		$ (0)	$ (0)	$ (0)	$ (0)	$ 130,865	$ 10,227	$ 5,903	$ 549	$ 4,500
18		$ (0)	$ (0)	$ (0)	$ (0)	$ 132,173	$ 10,840	$ 6,021	$ 560	$ 4,500
19		$ (0)	$ (0)	$ (0)	$ 64,828	$ 133,495	$ 11,491	$ 6,141	$ 571	$ 4,500
20		$ (0)	$ (0)	$ (0)	$ (0)	$ 134,830	$ 12,180	$ 6,264	$ 583	$ 7,500
21		$ (0)	$ (0)	$ (0)	$ (0)	$ 136,178	$ 12,911	$ 6,390	$ 594	$ 4,500
22		$ (0)	$ (0)	$ (0)	$ (0)	$ 137,540	$ 13,685	$ 6,517	$ 606	$ 4,500
23		$ (0)	$ (0)	$ (0)	$ (0)	$ 138,915	$ 14,507	$ 6,648	$ 618	$ 4,500
24		$ (0)	$ (0)	$ (0)	$ (0)	$ 140,305	$ 15,377	$ 6,781	$ 631	$ 4,500
25		$ (0)	$ (0)	$ (0)	$ (992,895)	$ 141,708	$ 16,300	$ 6,916	$ 643	$ 4,500
Subtotal Costs	$ 3,629,250	$ (0)	$ (0)	$ 379,761	$ (992,895)	$ 3,152,059	$ 220,864	$ 137,730	$ 12,812	$ 124,500
Discount Rate	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%
NPV	$ 3,629,250	$ (0)	$ (0)	$ 177,143	$ (293,205)	$ 1,733,476	$ 107,646	$ 73,892	$ 6,874	$ 70,189

First Cost	$ 3,629,000
Operating PW	$ 1,876,000
Present Cost	**$ 5,505,264**

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Project Number: **10803 KETPOOL**
Engineer: **Boyd Morgenthaler, P.E.** Printed: 12-Jun-10
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Owning & Operating Cost Summary

Alternative - Two (2) Pool Exh Air Heat Pumps + (1) Electric Blr (lag) + One (1) Oil Fired Blr

System Includes

2	Air Source Heat Pumps	***840 MBH***	**Each**	**Carrier, Trane, McQuay**
1	Electric Boiler	**520**	**KW**	**Precision HW20**
1	Fuel Oil Fired Boiler	***1,700 MBH***	Each	**Weil McLain 788**
4,000	Gallon Aboveground Oil Storage Tank			

Ownership Cost Data

Initial Capital Cost $1,457,610

Major Maintenance Costs **$ -** (none)

Replacement Costs

GSHP	2	Heat Pump		$180,000	=	$ 360,000		
		Labor	20%	$36,000	=	$ 72,000		
	15	Yrs Assumed Life				$ 432,000	Replacement cost	
							Current dollars	
Boilers	1	Electric Boilers first cost		$22,250	=	$ 22,250		
		Labor	100%	$22,250	=	$ 22,250		
	19	Yrs Assumed Life				$ 44,500	Replacement cost	
							Current dollars	

Salvage Value

GSHP	2	Heat Pump		$180,000	=	$ 360,000		
	15	Yrs Assumed Life		Straight Line Depr/yr		$ 24,000		
After	25	Yr Analysis Period		Remaining Value			$ 120,000	Salvage Value
Boilers	1	Electric Boilers first cost		$22,250	=	$ 22,250		
	19	Yrs Assumed Life		Straight Line Depr/yr		$ 1,171		
After	25	Yr Analysis Period		Remaining Value			$ 15,200	Salvage Value
Boilers	1	Oil Boilers first cost		$21,000	=	$ 21,000		
	33	Yrs Assumed Life		Straight Line Depr/yr		$ 636		
After	25	Yr Analysis Period		Remaining Value			$ 5,100	Salvage Value
					Total Salvage Value		$ 140,300	Current dollars

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Owning & Operating Cost Summary

Alternative - Two (2) Pool Exh Air Heat Pumps + (1) Electric Blr (lag) + One (1) Oil Fired Blr

Operating Cost Data

GSHP Electrical Energy Cost

Assume boiler operates **13,387,556** MBtu/ year 98.5% Percent Load 13,186,743 MBtu output Electric

Calc: Annual Electricity Usage

	3,862,549	kWh per year load			Max output	1,680 MBH	
	2.70	COP			Average load	1,505 MBH	90%
	1,430,574						
less	(13,052)	kWh per year used	2	Brake HP Pump for "run around coil"			
	1,417,521						
	$ 0.115	per kWh+kWD	1.0%	Nominal Escalation			
	$ 162,405	Cost 2013					

Electrical Energy Cost

Assume boiler operates **9,115,964** MBtu/ year 0.0% Percent Load - MBtu output Electric

Calc: Annual Electricity Usage

-	kWh per year	96%	Boiler efficiency	Input	520	kW
$ 0.115	per kWh+kWD	1.0%	Nominal Escalation	Average load	0	kW
$ -	Cost 2013					

Oil Energy Cost

Assume **9,115,964** MBtu/ year 1.5% Percent Load 136,739 MBtu output

130,000 BTU Fuel Energy Content per gallon
81% Boiler Efficiency

Calc: Annual Oil Usage

1,300	Gallons per year			Capacity	14.2	GPH
$ 3.10	per Gallon	6.0%	Nominal Escalation	Average load	0.1	GPH
$ 4,026	Cost 2013	assumed first full year of operation				

Maintenance Labor Cost (annual) **110** hours $ 50.00 = **$ 5,500** **Annually** Labor
Allow 50 hrs/oil blr, 12 hr/electric blr, 120 hr/wood blr, 24 hr/Heat pump

Maintenance Material Cost (annual) Allowance **$ 1,300** **Annually** Material

Contract Service Cost

2	Chiller tuneup	**$ 4,500**	each	**$ 9,000**	**Annually**	Contract
$ 3,000	Pro burner Tuneup per boiler		For all oil boilers	**$ 3,000**	**Periodic**	Contract
5	year intervals					
				$ 12,000	**combined**	Contract

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Owning & Operating Cost Summary

Alternative - Two (2) Pool Exh Air Heat Pumps + (1) Electric Blr (lag) + One (1) Oil Fired Blr

Life Cycle Costs

Year End	Initial Capital First Cost	Escalate 2% Annual Owning Cost (Tax. Ins etc)	Escalate 2% Major Maint Cost	Escalate 2% Replacement Cost	Escalate 2% Salvage Value (Credit)	Escalate 1% Annual Electical Cost	Escalate 6% Annual Oil Cost	Escalate 2% Maint Labor Cost	Escalate 2% Maint Material Cost	Escalate 2% Contract Services Cost
0	**$ 1,457,610**									
1		$ (0)	$ (0)	$ (0)	$ (0)	$ 162,405	$ 4,026	$ 5,500	$ 1,300	$ 9,000
2		$ (0)	$ (0)	$ (0)	$ (0)	$ 164,029	$ 4,267	$ 5,610	$ 1,326	$ 9,000
3		$ (0)	$ (0)	$ (0)	$ (0)	$ 165,669	$ 4,523	$ 5,722	$ 1,353	$ 9,000
4		$ (0)	$ (0)	$ (0)	$ (0)	$ 167,326	$ 4,795	$ 5,837	$ 1,380	$ 9,000
5		$ (0)	$ (0)	$ (0)	$ (0)	$ 168,999	$ 5,082	$ 5,953	$ 1,407	$ 12,000
6		$ (0)	$ (0)	$ (0)	$ (0)	$ 170,689	$ 5,387	$ 6,072	$ 1,435	$ 9,000
7		$ (0)	$ (0)	$ (0)	$ (0)	$ 172,396	$ 5,710	$ 6,194	$ 1,464	$ 9,000
8		$ (0)	$ (0)	$ (0)	$ (0)	$ 174,120	$ 6,053	$ 6,318	$ 1,493	$ 9,000
9		$ (0)	$ (0)	$ (0)	$ (0)	$ 175,861	$ 6,416	$ 6,444	$ 1,523	$ 9,000
10		$ (0)	$ (0)	$ (0)	$ (0)	$ 177,620	$ 6,801	$ 6,573	$ 1,554	$ 12,000
11		$ (0)	$ (0)	$ (0)	$ (0)	$ 179,396	$ 7,209	$ 6,704	$ 1,585	$ 9,000
12		$ (0)	$ (0)	$ (0)	$ (0)	$ 181,190	$ 7,642	$ 6,839	$ 1,616	$ 9,000
13		$ (0)	$ (0)	$ (0)	$ (0)	$ 183,002	$ 8,100	$ 6,975	$ 1,649	$ 9,000
14		$ (0)	$ (0)	$ (0)	$ (0)	$ 184,832	$ 8,586	$ 7,115	$ 1,682	$ 9,000
15		$ (0)	$ (0)	$ 581,415	$ (0)	$ 186,680	$ 9,102	$ 7,257	$ 1,715	$ 12,000
16		$ (0)	$ (0)	$ (0)	$ (0)	$ 188,547	$ 9,648	$ 7,402	$ 1,750	$ 9,000
17		$ (0)	$ (0)	$ (0)	$ (0)	$ 190,432	$ 10,227	$ 7,550	$ 1,785	$ 9,000
18		$ (0)	$ (0)	$ (0)	$ (0)	$ 192,337	$ 10,840	$ 7,701	$ 1,820	$ 9,000
19		$ (0)	$ (0)	$ 64,828	$ (0)	$ 194,260	$ 11,491	$ 7,855	$ 1,857	$ 9,000
20		$ (0)	$ (0)	$ (0)	$ (0)	$ 196,203	$ 12,180	$ 8,012	$ 1,894	$ 12,000
21		$ (0)	$ (0)	$ (0)	$ (0)	$ 198,165	$ 12,911	$ 8,173	$ 1,932	$ 9,000
22		$ (0)	$ (0)	$ (0)	$ (0)	$ 200,146	$ 13,685	$ 8,336	$ 1,970	$ 9,000
23		$ (0)	$ (0)	$ (0)	$ (0)	$ 202,148	$ 14,507	$ 8,503	$ 2,010	$ 9,000
24		$ (0)	$ (0)	$ (0)	$ (0)	$ 204,169	$ 15,377	$ 8,673	$ 2,050	$ 9,000
25		$ (0)	$ (0)	$ (0)	$ (230,177)	$ 206,211	$ 16,300	$ 8,846	$ 2,091	$ 9,000
Subtotal Costs	$ 1,457,610	$ (0)	$ (0)	$ 646,243	$ (230,177)	$ 4,586,827	$ 220,864	$ 176,167	$ 41,639	$ 237,000
Discount Rate	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%
NPV	$ 1,457,610	$ (0)	$ (0)	$ 305,325	$ (67,972)	$ 2,522,527	$ 107,646	$ 94,513	$ 22,339	$ 133,612

First Cost	$ 1,458,000
Operating PW	$ 3,118,000
Present Cost	**$ 4,575,600**

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Capital Cost Summary

Based on HMS Cost Estimates

	HMS Total Constr.Cost	20% Owner+A/E Costs	5% Project Contingency	**TOTAL PROJECT First Cost**
CAPITAL COST ESTIMATE BASE CASE (3) Oil Fired Boilers	$ 494,552	$ 98,910	$ 29,673	**$ 623,136**
Variation 1 - (2) Oil Fired Boilers and (1) Electric Boiler	$ 463,465	$ 92,693	$ 27,808	**$ 583,966**
Variation 2 - (1) Oil Fired Boiler and (2) Electric Boilers	$ 447,271	$ 89,454	$ 26,836	**$ 563,561**
ALTERNATIVE ENERGY WOOD PELLET BOILER (1) Oil and (1) Electric Boiler	$ 1,678,477	$ 335,695	$ 100,709	**$ 2,114,881**
ALTERNATIVE ENERGY GROUND SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	$ 2,880,357	$ 576,071	$ 172,821	**$ 3,629,250**
ALTERNATIVE ENERGY AIR SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	$ 1,156,833	$ 231,367	$ 69,410	**$ 1,457,610**

Prices for all options ignore items common to all variations and alteratives

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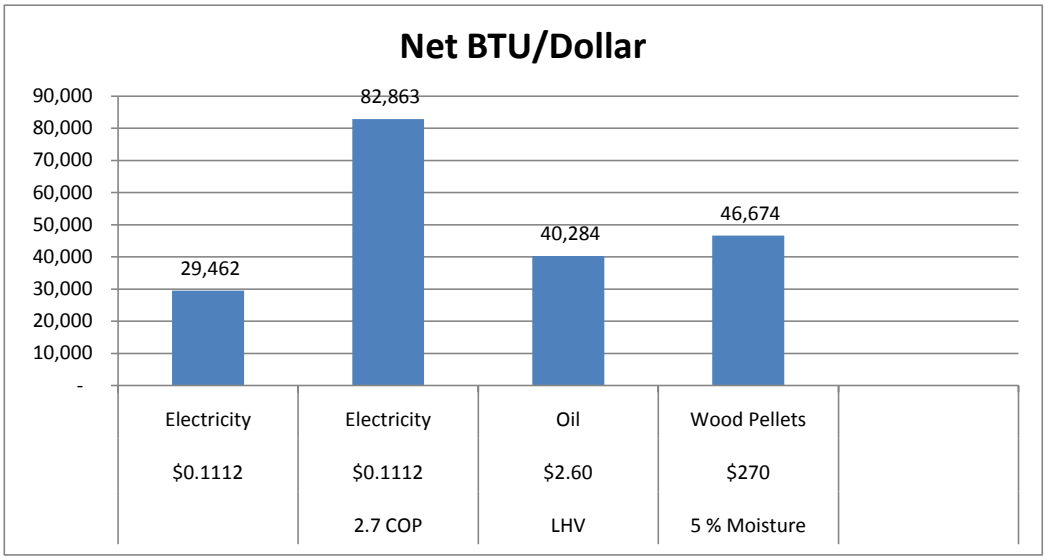
Fuel Source Price Comparison

Fuel	Electricity	Heat Pump Electricity	Oil	Wood Pellets
Bulk Price	$ 0.0897	$ 0.0897	$ 2.60	$ 270
Unit	kW	kW	Gal	2,000 lbs
Diesel Surcharge	$ 0.0175	$ 0.0175		
	kW	kW		
Demand Charge	$ 2.91	$ 2.91		
Per month	kWD	kWD		
Hours per month	720	720		
Ave $/kW for kWD	$ 0.0040	$ 0.0040		
Price	$ 0.1112	$ 0.1112	$ 2.60	$ 0.14
Unit	kW	kW	Gal	lb
Gross HV (BTU)	3,414	3,414	138,000	8,250
	BTU/kW	BTU/kW	BTU/Gal	BTU/lb dry
Moisture Content				5%
Btu Available	3,414	3,414	138,000	7,838
	BTU/kW	BTU/kW	BTU/Gal	BTU/lb wet
Latent Heat			(8,694)	(59)
Lower HV	3,414	3,414	129,306	7,779 Btu/lb LHV
				15,558,000 Btu/Ton LHV
		COP		
Firing Efficiency	96%	270%	81%	81%
Net useful Btu/unit	3,277	9,218	104,738	12,601,980
Net BTU/$	29,462	82,863	40,284	46,674
		2.7 COP	LHV	5 % Moisture
	$ 0.1112	$ 0.1112	$ 2.60	$ 270
	Electricity	Electricity	Oil	Wood Pellets



HMS Project No. 10082 (A)

CONCEPTUAL DESIGN SUBMITTAL
CONSTRUCTION COST ESTIMATE

ALTERNATIVE ENERGY STUDIES
KETCHIKAN AQUATIC CENTER
KETCHIKAN, ALASKA

PREPARED FOR:

AMC Engineers
701 East Tudor Road, Suite 250
Anchorage, Alaska 99503

June 14, 2010

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NOTES REGARDING THE PREPARATION OF THIS ESTIMATE

DRAWINGS AND DOCUMENTS

Level of Documents: (5) scenarios for alternative energy system
Date: June 3, 2010
Provided By: AMC Engineers of Anchorage, Alaska

RATES

Pricing is based on current material, equipment and freight costs.

Labor Rates: A.S. Title 36

BIDDING ASSUMPTIONS

Contract: Standard construction contract without restrictive bidding clauses
Bidding Situation: Competitive bids assumed
Bid Date: Spring 2011
Start of Construction: Summer 2011
Months to Complete: Varies depending on a preferred scenario (this work to be done as a part of overall pool addition/building renovation project)

EXCLUDED COSTS

1. A/E design fees
2. Administrative and management costs
3. Pool addition and building renovation costs
4. Life cycle cost analysis (to be performed by AMC Engineers)

NOTES REGARDING THE PREPARATION OF THIS ESTIMATE (Continued)

GENERAL

When included in HMS Inc.'s scope of services, opinions or estimates of probable construction costs are prepared on the basis of HMS Inc.'s experience and qualifications and represent HMS Inc.'s judgment as a professional generally familiar with the industry. However, since HMS Inc. has no control over the cost of labor, materials, equipment or services furnished by others, over contractor's methods of determining prices, or over competitive bidding or market conditions, HMS Inc. cannot and does not guarantee that proposals, bids, or actual construction cost will not vary from HMS Inc.'s opinions or estimates of probable construction cost.

This estimate assumes normal escalation based on the current economic climate in Alaska. It is not possible to gauge the effect of the global economic down turn on construction costs in Alaska. HMS Inc. will continue to monitor these events and the resulting construction climate, and will adjust costs and contingencies as deemed prudent.

HMS Project No.: 10082 (A)

CONCEPTUAL DESIGN COST SUMMARY

	Total
CAPITAL COST ESTIMATE BASE CASE	
(3) Oil Fired Boilers	$ 494,552
Variation 1 - (2) Oil Fired Boilers and (1) Electric Boiler	$ 463,465
Variation 2 - (1) Oil Fired Boiler and (2) Electric Boilers	$ 447,271
ALTERNATIVE ENERGY WOOD PELLET BOILER	
(1) Oil and (1) Electric Boiler	$ 1,678,477
ALTERNATIVE ENERGY GROUND SOURCE HEAT PUMP	
(1) Oil and (1) Electric Boiler	$ 2,574,816
ALTERNATIVE ENERGY AIR SOURCE HEAT PUMP	
(1) Oil and (1) Electric Boiler	$ 1,156,833

CAPITAL COST ESTIMATE BASE CASE ***(3) Oil Fired Boilers***	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE *$*	*TOTAL* *$*	*RATE* *$*	*TOTAL* *$*	*UNIT RATE* *$*	*MATERIAL/LABOR* *$*
Note: Labor at $75/hour.								
1,700 MBH oil fired boilers	3	EA	21000.00	63,000	12500.00	37,500	33500.00	100,500
Boiler control panel	1	EA	3000.00	3,000	1800.00	1,800	4800.00	4,800
Boiler stacks and caps	3	EA	7500.00	22,500	3200.00	9,600	10700.00	32,100
Primary pumps with VFD	3	EA	4500.00	13,500	1250.00	3,750	5750.00	17,250
Boiler and pumps manifold piping, valves and gauges	3	LOTS	5000.00	15,000	8000.00	24,000	13000.00	39,000
50 gallon fuel day tank, pump, piping, floats, etc.	1	EA	6500.00	6,500	2300.00	2,300	8800.00	8,800
Fuel oil piping, valves and connections to burners	3	LOTS	500.00	1,500	1200.00	3,600	1700.00	5,100
Boiler and pump controls	6	LOTS	900.00	5,400	1200.00	7,200	2100.00	12,600
600 amp service and transformer	1	LOT						With Building Cost
Boiler pump power and connections	3	LOTS	400.00	1,200	1200.00	3,600	1600.00	4,800
Boiler burner motor power and connections	3	EA	300.00	900	700.00	2,100	1000.00	3,000
6" concrete pad for fuel tank	240	SF	5.20	1,248	6.50	1,560	11.70	2,808
6" pipe bollards and bases	10	EA	395.00	3,950	275.00	2,750	670.00	6,700

CAPITAL COST ESTIMATE BASE CASE ***(3) Oil Fired Boilers***	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
7,500 gallon double wall fuel tank complete with accessories, alarms, ladders, labels, etc.	1	EA	39500.00	39,500	8500.00	8,500	48000.00	48,000
Fuel oil piping and valves to building	1	LOT	1500.00	1,500	2500.00	2,500	4000.00	4,000
Fuel for testing equipment	1,000	GALS	6.50	6,500			6.50	6,500
Miscellaneous cut and patch at roof and walls for flues and piping	1	LOT	1500.00	1,500	3500.00	3,500	5000.00	5,000
Test and commission systems	1	LOT	500.00	500	4500.00	4,500	5000.00	5,000
SUBTOTAL:				*$ 187,198*		*$ 118,760*		*$ 305,958*
Premium time (6/10s)	16.70%					19,833		19,833
SUBTOTAL:				*$ 187,198*		*$ 138,593*		*$ 325,791*
Subcontractor's Overhead and Profit on Materials and Labor	20.00%			37,440		27,719		65,159
SUBTOTAL:								*$ 390,950*
Prime's Mark-Up	15.00%							58,643
Estimator's Contingency	10.00%							44,959

Note: Owner and A/E cost and project contingency is excluded.

TOTAL ESTIMATED COST:	***$ 494,552***

CAPITAL COST ESTIMATE BASE CASE Variation 1 - (2) Oil Fired Boilers and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE*	*TOTAL MATERIAL/LABOR*
			RATE	*TOTAL*	*RATE*	*TOTAL*		
			$	*$*	*$*	*$*	*$*	*$*
Note: Labor at $75/hour.								
1,700 MBH oil fired boilers	2	EA	21000.00	42,000	12500.00	25,000	33500.00	67,000
520 KW electric boiler	1	EA	22250.00	22,250	7500.00	7,500	29750.00	29,750
Boiler control panel	1	EA	3000.00	3,000	1800.00	1,800	4800.00	4,800
Boiler stacks and caps	2	EA	7500.00	15,000	3200.00	6,400	10700.00	21,400
Primary pumps with VFD	3	EA	4500.00	13,500	1250.00	3,750	5750.00	17,250
Boiler and pumps manifold piping, valves and gauges	3	LOTS	5000.00	15,000	8000.00	24,000	13000.00	39,000
50 gallon fuel day tank, pump, piping, floats, etc.	1	EA	6500.00	6,500	2300.00	2,300	8800.00	8,800
Fuel oil piping, valves and connections to burners	2	LOTS	500.00	1,000	1200.00	2,400	1700.00	3,400
Boiler and pump controls	6	LOTS	900.00	5,400	1200.00	7,200	2100.00	12,600
Upgrade 600 amp service to 1,600 amp service and larger transformer	1	LOT	10000.00	10,000	7500.00	7,500	17500.00	17,500
Boiler pump power and connections	3	LOTS	400.00	1,200	1200.00	3,600	1600.00	4,800
Boiler burner motor power and connections	2	EA	300.00	600	700.00	1,400	1000.00	2,000
520 KW boiler power and connections	1	EA	1650.00	1,650	2500.00	2,500	4150.00	4,150

CAPITAL COST ESTIMATE BASE CASE Variation 1 - (2) Oil Fired Boilers and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
6" concrete pad for fuel tank	200	SF	5.20	1,040	6.50	1,300	11.70	2,340
6" pipe bollards and bases	8	EA	395.00	3,160	275.00	2,200	670.00	5,360
4,000 gallon double wall fuel tank complete with accessories, alarms, ladders, labels, etc.	1	EA	22500.00	22,500	6500.00	6,500	29000.00	29,000
Fuel oil piping and valves to building	1	LOT	1200.00	1,200	2200.00	2,200	3400.00	3,400
Fuel for testing equipment	700	GALS	6.50	4,550			6.50	4,550
Miscellaneous cut and patch at roof and walls for flues and piping	1	LOT	1000.00	1,000	3000.00	3,000	4000.00	4,000
Test and commission systems	1	LOT	500.00	500	4500.00	4,500	5000.00	5,000
SUBTOTAL:				*$ 171,050*		*$ 115,050*		*$ 286,100*
Premium time (6/10s)	16.70%					19,213		19,213
SUBTOTAL:				*$ 171,050*		*$ 134,263*		*$ 305,313*
Subcontractor's Overhead and Profit on Materials and Labor	20.00%			34,210		26,853		61,063
SUBTOTAL:								*$ 366,376*

CAPITAL COST ESTIMATE BASE CASE Variation 1 - (2) Oil Fired Boilers and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE* $	*TOTAL MATERIAL/LABOR* $
			RATE $	*TOTAL* $	*RATE* $	*TOTAL* $		
Prime's Mark-Up	15.00%							54,956
Estimator's Contingency	10.00%							42,133

Note: Owner and A/E cost and project contingency is excluded.

TOTAL ESTIMATED COST: ***$ 463,465***

CAPITAL COST ESTIMATE BASE CASE Variation 2 - (1) Oil Fired Boiler and (2) Electric Boilers	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE*	*TOTAL MATERIAL/LABOR*
			RATE	*TOTAL*	*RATE*	*TOTAL*		
			$	*$*	*$*	*$*	*$*	*$*
Note: Labor at $75/hour.								
1,700 MBH oil fired boiler	1	EA	21000.00	21,000	12500.00	12,500	33500.00	33,500
520 KW electric boiler	2	EA	22250.00	44,500	7500.00	15,000	29750.00	59,500
Boiler control panel	1	EA	3000.00	3,000	1800.00	1,800	4800.00	4,800
Boiler stack and cap	1	EA	7500.00	7,500	3200.00	3,200	10700.00	10,700
Primary pumps with VFD	3	EA	4500.00	13,500	1250.00	3,750	5750.00	17,250
Boiler and pumps manifold piping, valves and gauges	3	LOTS	5000.00	15,000	8000.00	24,000	13000.00	39,000
30 gallon fuel day tank, pump, piping, floats, etc.	1	EA	4500.00	4,500	1800.00	1,800	6300.00	6,300
Fuel oil piping, valves and connections to burners	1	LOT	500.00	500	1200.00	1,200	1700.00	1,700
Boiler and pump controls	6	LOTS	900.00	5,400	1200.00	7,200	2100.00	12,600
Upgrade 600 amp service to 2,000 amp service and larger transformer	1	LOT	15000.00	15,000	10000.00	10,000	25000.00	25,000
Boiler pump power and connections	3	LOTS	400.00	1,200	1200.00	3,600	1600.00	4,800
Boiler burner motor power and connections	1	EA	300.00	300	700.00	700	1000.00	1,000
520 KW boilers power and connections	2	EA	1650.00	3,300	2500.00	5,000	4150.00	8,300

CAPITAL COST ESTIMATE BASE CASE Variation 2 - (1) Oil Fired Boiler and (2) Electric Boilers	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
6" concrete pad for fuel tank	200	SF	5.20	1,040	6.50	1,300	11.70	2,340
6" pipe bollards and bases	8	EA	395.00	3,160	275.00	2,200	670.00	5,360
4,000 gallon double wall fuel tank complete with accessories, alarms, ladders, labels, etc.	1	EA	22500.00	22,500	6500.00	6,500	29000.00	29,000
Fuel oil piping and valves to building	1	LOT	1000.00	1,000	2000.00	2,000	3000.00	3,000
Fuel for testing equipment	500	GALS	6.50	3,250			6.50	3,250
Miscellaneous cut and patch at roof and walls for flues and piping	1	LOT	1000.00	1,000	3000.00	3,000	4000.00	4,000
Test and commission systems	1	LOT	500.00	500	4500.00	4,500	5000.00	5,000
SUBTOTAL:				*$ 167,150*		*$ 109,250*		*$ 276,400*
Premium time (6/10s)	16.70%					18,245		18,245
SUBTOTAL:				*$ 167,150*		*$ 127,495*		*$ 294,645*
Subcontractor's Overhead and Profit on Materials and Labor	20.00%			33,430		25,499		58,929
SUBTOTAL:								*$ 353,574*

CAPITAL COST ESTIMATE BASE CASE Variation 2 - (1) Oil Fired Boiler and (2) Electric Boilers	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE* $	*TOTAL MATERIAL/LABOR* $
			RATE $	*TOTAL* $	*RATE* $	*TOTAL* $		
Prime's Mark-Up	15.00%							53,036
Estimator's Contingency	10.00%							40,661

Note: Owner and A/E cost and project contingency is excluded.

TOTAL ESTIMATED COST: ***$ 447,271***

ALTERNATIVE ENERGY WOOD PELLET BOILER ***(1) Oil and (1) Electric Boiler***	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
Wood pellet silo concrete foundations	10	EA	850.00	8,500	600.00	6,000	1450.00	14,500
Silo and feed auger system	1	LOT						See Below
540 KW wood pellet boiler complete system	1	LOT						See Below
Stack	1	EA						See Below
Power connections	1	LOT						See Below
Primary pumps and piping	1	LOT						See Below
Supply, install and commission above equipment (Synergy Systems quote)	1	LOT	847000.00	847,000		Included	847000.00	847,000
Interface wood burning boiler with Boilers 2 and 3	1	LOT	10000.00	10,000	7500.00	7,500	17500.00	17,500
Note: Labor at $75/hour.								
1,700 MBH oil fired boiler	1	EA	21000.00	21,000	12500.00	12,500	33500.00	33,500
520 KW electric boiler	1	EA	22250.00	22,250	7500.00	7,500	29750.00	29,750
Boiler control panel	1	EA	3000.00	3,000	1800.00	1,800	4800.00	4,800
Boiler stack and cap	1	EA	7500.00	7,500	3200.00	3,200	10700.00	10,700
Primary pumps with VFD	2	EA	4500.00	9,000	1250.00	2,500	5750.00	11,500

ALTERNATIVE ENERGY WOOD PELLET BOILER ***(1) Oil and (1) Electric Boiler***	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
Boiler and pumps manifold piping, valves and gauges	2	LOTS	5000.00	10,000	8000.00	16,000	13000.00	26,000
30 gallon fuel day tank, pump, piping, floats, etc.	1	EA	4500.00	4,500	1800.00	1,800	6300.00	6,300
Fuel oil piping, valves and connections to burners	1	LOT	500.00	500	1200.00	1,200	1700.00	1,700
Boiler and pump controls	4	LOTS	900.00	3,600	1200.00	4,800	2100.00	8,400
Upgrade 600 amp service to 1,600 amp service and larger transformer	1	LOT	10000.00	10,000	7500.00	7,500	17500.00	17,500
Boiler pump power and connections	2	LOTS	400.00	800	1200.00	2,400	1600.00	3,200
Boiler burner motor power and connections	1	EA	300.00	300	700.00	700	1000.00	1,000
520 KW boiler power and connections	1	EA	1650.00	1,650	2500.00	2,500	4150.00	4,150
6" concrete pad for fuel tank	200	SF	5.20	1,040	6.50	1,300	11.70	2,340
6" pipe bollards and bases	8	EA	395.00	3,160	275.00	2,200	670.00	5,360
4,000 gallon double wall fuel tank complete with accessories, alarms, ladders, labels, etc.	1	EA	22500.00	22,500	6500.00	6,500	29000.00	29,000
Fuel oil piping and valves to building	1	LOT	1000.00	1,000	2000.00	2,000	3000.00	3,000
Fuel for testing equipment	500	GALS	6.50	3,250			6.50	3,250

ALTERNATIVE ENERGY WOOD PELLET BOILER ***(1) Oil and (1) Electric Boiler***	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
Miscellaneous cut and patch at roof and walls for flues and piping	1	LOT	1000.00	1,000	3000.00	3,000	4000.00	4,000
Test and commission systems (excludes wood boiler)	1	LOT	500.00	500	4500.00	4,500	5000.00	5,000
SUBTOTAL:				*$ 992,050*		*$ 97,400*		*$ 1,089,450*
Premium time (6/10s)	16.70%					16,266		16,266
SUBTOTAL:				*$ 992,050*		*$ 113,666*		*$ 1,105,716*
Subcontractor's Overhead and Profit on Materials and Labor	20.00%			198,410		22,733		221,143
SUBTOTAL:								*$ 1,326,859*
Prime's Mark-Up	15.00%							199,029
Estimator's Contingency	10.00%							152,589

Note: Owner and A/E cost and project contingency is excluded.

TOTAL ESTIMATED COST:	***$ 1,678,477***

ALTERNATIVE ENERGY GROUND SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE*	*TOTAL MATERIAL/LABOR*
			RATE	*TOTAL*	*RATE*	*TOTAL*		
			$	*$*	*$*	*$*	*$*	*$*
1,200 MBH heat pump system	1	EA	195000.00	195,000	35000.00	35,000	230000.00	230,000
1" to 3/4" loop field piping, excavation and backfill	40,000	LF	10.00	400,000	16.00	640,000	26.00	1,040,000
Loop field pumps and piping in boiler room	1	LOT	10000.00	10,000	12000.00	12,000	22000.00	22,000
Thermal conductivity test	1	LOT	25000.00	25,000		Included	25000.00	25,000
Increase size of heating coil	1	LOT	40000.00	40,000		Included	40000.00	40,000
Note: Labor at $75/hour.								
1,700 MBH oil fired boiler	1	EA	21000.00	21,000	12500.00	12,500	33500.00	33,500
520 KW electric boiler	1	EA	22250.00	22,250	7500.00	7,500	29750.00	29,750
Boiler control panel	1	EA	3000.00	3,000	1800.00	1,800	4800.00	4,800
Boiler stack and cap	1	EA	7500.00	7,500	3200.00	3,200	10700.00	10,700
Primary pumps with VFD	2	EA	4500.00	9,000	1250.00	2,500	5750.00	11,500
Boiler and pumps manifold piping, valves and gauges	2	LOTS	5000.00	10,000	8000.00	16,000	13000.00	26,000
30 gallon fuel day tank, pump, piping, floats, etc.	1	EA	4500.00	4,500	1800.00	1,800	6300.00	6,300
Fuel oil piping, valves and connections to burners	1	LOT	500.00	500	1200.00	1,200	1700.00	1,700

ALTERNATIVE ENERGY GROUND SOURCE HEAT PUMP ***(1) Oil and (1) Electric Boiler***	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL*	*TOTAL*
			RATE	*TOTAL*	*RATE*	*TOTAL*	*UNIT RATE*	*MATERIAL/LABOR*
			$	*$*	*$*	*$*	*$*	*$*
Boiler and pump controls	4	LOTS	900.00	3,600	1200.00	4,800	2100.00	8,400
Upgrade 600 amp service to 1,600 amp service and larger transformer	1	LOT	10000.00	10,000	7500.00	7,500	17500.00	17,500
Boiler pump power and connections	2	LOTS	400.00	800	1200.00	2,400	1600.00	3,200
Boiler burner motor power and connections	1	EA	300.00	300	700.00	700	1000.00	1,000
520 KW boiler power and connections	1	EA	1650.00	1,650	2500.00	2,500	4150.00	4,150
6" concrete pad for fuel tank	200	SF	5.20	1,040	6.50	1,300	11.70	2,340
6" pipe bollards and bases	8	EA	395.00	3,160	275.00	2,200	670.00	5,360
4,000 gallon double wall fuel tank complete with accessories, alarms, ladders, labels, etc.	1	EA	22500.00	22,500	6500.00	6,500	29000.00	29,000
Fuel oil piping and valves to building	1	LOT	1000.00	1,000	2000.00	2,000	3000.00	3,000
Fuel for testing equipment	500	GALS	6.50	3,250			6.50	3,250
Miscellaneous cut and patch at roof and walls for flues and piping	1	LOT	1000.00	1,000	3000.00	3,000	4000.00	4,000
Test and commission systems (excludes ground source heat pump)	1	LOT	500.00	500	4500.00	4,500	5000.00	5,000
SUBTOTAL:				*$ 796,550*		*$ 770,900*		*$ 1,567,450*

HMS Project No.: 10082 (A)

ALTERNATIVE ENERGY GROUND SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE* $	*TOTAL MATERIAL/LABOR* $
			RATE $	*TOTAL* $	*RATE* $	*TOTAL* $		
Premium time (6/10s)	16.70%					128,740		128,740
SUBTOTAL:				*$ 796,550*		*$ 899,640*		*$ 1,696,190*
Subcontractor's Overhead and Profit on Materials and Labor	20.00%			159,310		179,928		339,238
SUBTOTAL:								*$ 2,035,428*
Prime's Mark-Up	15.00%							305,314
Estimator's Contingency	10.00%							234,074

Note: Owner and A/E cost and project contingency is excluded.

TOTAL ESTIMATED COST: ***$ 2,574,816***

ALTERNATIVE ENERGY AIR SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE*	*TOTAL MATERIAL/LABOR*
			RATE	*TOTAL*	*RATE*	*TOTAL*		
			$	*$*	*$*	*$*	*$*	*$*
840 MBH heat pump systems	2	EA	180000.00	360,000	35000.00	70,000	215000.00	430,000
HP pumps and piping in boiler room	2	LOT	10000.00	20,000	12000.00	24,000	22000.00	44,000
Increase size of heating coil	1	LOT	40000.00	40,000		Included	40000.00	40,000
Note: Labor at $75/hour.								
1,700 MBH oil fired boiler	1	EA	21000.00	21,000	12500.00	12,500	33500.00	33,500
520 KW electric boiler	1	EA	22250.00	22,250	7500.00	7,500	29750.00	29,750
Boiler control panel	1	EA	3000.00	3,000	1800.00	1,800	4800.00	4,800
Boiler stack and cap	1	EA	7500.00	7,500	3200.00	3,200	10700.00	10,700
Primary pumps with VFD	2	EA	4500.00	9,000	1250.00	2,500	5750.00	11,500
Boiler and pumps manifold piping, valves and gauges	2	LOTS	5000.00	10,000	8000.00	16,000	13000.00	26,000
30 gallon fuel day tank, pump, piping, floats, etc.	1	EA	4500.00	4,500	1800.00	1,800	6300.00	6,300
Fuel oil piping, valves and connections to burners	1	LOT	500.00	500	1200.00	1,200	1700.00	1,700
Boiler and pump controls	4	LOTS	900.00	3,600	1200.00	4,800	2100.00	8,400
Upgrade 600 amp service to 2,000 amp service and larger transformer	1	LOT	15000.00	15,000	10000.00	10,000	25000.00	25,000

ALTERNATIVE ENERGY AIR SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE*	*TOTAL MATERIAL/LABOR*
			RATE	*TOTAL*	*RATE*	*TOTAL*		
			$	*$*	*$*	*$*	*$*	*$*
Boiler pump power and connections	2	LOTS	400.00	800	1200.00	2,400	1600.00	3,200
Boiler burner motor power and connections	1	EA	300.00	300	700.00	700	1000.00	1,000
520 KW boiler power and connections	1	EA	1650.00	1,650	2500.00	2,500	4150.00	4,150
6" concrete pad for fuel tank	200	SF	5.20	1,040	6.50	1,300	11.70	2,340
6" pipe bollards and bases	8	EA	395.00	3,160	275.00	2,200	670.00	5,360
4,000 gallon double wall fuel tank complete with accessories, alarms, ladders, labels, etc.	1	EA	22500.00	22,500	6500.00	6,500	29000.00	29,000
Fuel oil piping and valves to building	1	LOT	1000.00	1,000	2000.00	2,000	3000.00	3,000
Fuel for testing equipment	500	GALS	6.50	3,250			6.50	3,250
Miscellaneous cut and patch at roof and walls for flues and piping	1	LOT	1000.00	1,000	3000.00	3,000	4000.00	4,000
Test and commission systems (excludes ground source heat pump)	1	LOT	500.00	500	4500.00	4,500	5000.00	5,000
SUBTOTAL:				*$ 551,550*		*$ 180,400*		*$ 731,950*
Premium time (6/10s)	16.70%					30,127		30,127
SUBTOTAL:				*$ 551,550*		*$ 210,527*		*$ 762,077*
Subcontractor's Overhead and Profit on Materials and Labor	20.00%			110,310		42,105		152,415

ALTERNATIVE ENERGY AIR SOURCE HEAT PUMP (1) Oil and (1) Electric Boiler	*QUANTITY*	*UNIT*	*MATERIAL*		*LABOR*		*TOTAL UNIT RATE* $	*TOTAL MATERIAL/LABOR* $
			RATE $	*TOTAL* $	*RATE* $	*TOTAL* $		
SUBTOTAL:								*$ 914,492*
Prime's Mark-Up	15.00%							137,174
Estimator's Contingency	10.00%							105,167

Note: Owner and A/E cost and project contingency is excluded.

TOTAL ESTIMATED COST:	***$ 1,156,833***

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Synergy Systems
A Sealaska Diversity Solution

May 24, 2010

AMC Engineers
701 East Tudor Road
Anchorage, AK 99503

Attention: Boyd Morgenthaler

Re: Ketchikan Pool Bioenergy Project
Synergy Budget Proposal KET-210 R1

Dear Boyd:

As discussed please find enclosed our budget estimate for the proposed biomass boiler system in the Ketchikan Pool project. Our estimate includes pricing for all equipment, engineering; and installation of the boiler components, training and commissioning as specified. Please refer to the attached proposal for more details.

We trust that this etimate meets with your approval and look forward to working with you on this project. Should you have any questions, please don't hesitate to call us.

Sincerely,

Synergy Systems, Inc.

Robert Wysocki
General Manager

5425 Antioch Drive
Suite 400
Merriam, KS 66202
913.928.6730

Synergy Systems
A Sealaska Diversity Solution

Ketchikan Pool Project
Synergy Budget Proposal KET-210 R1
May 24, 2010

SYSTEM DESCRIPTION:

Synergy Systems Inc., propose to design, supply, engineer and install (see below) a bioenergy heating system for the Ketchikan Pool Project. The proposed system will consist of a single Viessmann/KOB Pyrot 540 biomass boiler plant producing a nominal 540 kW or 1,842,480 BTH of heat output along with a high efficiency metal mesh filter for flue gas particulate reduction to 20mg/Nm³. The boiler and necessary components will come pre-assembled. Component installations like screw augers, ash augers, fuel silo, piping, etc. as well as the start-up and commissioning of the system will be completed on site. The system is complete with a proprietary control system, which can be interfaced with an existing building control system by others.

A nom. 63 Tonne pellet storage silo would be installed beside and approximately 30 feet off the boiler room by others. Please refer to the section below for work not included in our proposal.

Electrical Data and Consumption (see attachment for full details)

Power source	208/3/60
Total Connected Load	3.63 kW
Power Consumption at full load	1.75 kW
Power Consumption at partial load	0.46 kW

Boiler Annual Maintenance Costs

The biomass boiler requires 2 full day shut downs for cleaning and maintenance per year along with 1.5 hours per week for regular maintenance checks and ash removal.

Shut downs	16 hours
Regular Maintenance	76 hours
Total	92 hours @ $ 100.00/hr = $ 9,200.00 per year

Boiler Annual Repair Parts

This value can be stated at $ 500.00 per year

The following items are included in the limit of supply for the proposed pricing:

- Mechanical design and engineering, including flow schematic, boiler room plan and elevation drawings
- Boiler and boiler components, supply and installation
- Boiler piping (boiler to accumulator tank only), supply and installation.
- Chimney and breaching supply and installation
- Electrical and controls wiring from control panel to boiler components, supply and installation.
- Automatic ash removal system supply and installation
- Automatic tube cleaning system compressor and piping, supply and installation.
- Proprietary control system
- Remote access control option
- Silo and feed auger system supply and installation
- Commissioning, start-up and training

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Ketchikan Pool Project
Synergy Budget Proposal KET-210 R1
May 24, 2010

The following items are not included in our proposal:
- Local civil and structural engineering/work including seismic, concrete foundations, pipe supports, etc.
- Local mechanical engineering
- Excavation and backfilling.
- Architectural, building modifications, enclosure etc.
- Local electrical design, engineering
- External controls, design and wiring
- External piping, installation and insulation
- Permits
- Expansion tank and air separator

PRICES, TERMS AND CONDITIONS:

Our price to design, engineer, supply and install the specified BMB system, would be: **USD $847,000.00**

All applicable taxes extra.
Prices firm for 30 days.
Delivery: Approximately five (5) months
Payment terms:
- 30% with purchase order of boiler price only, (USD 254,100.00), payable upon receipt
- 20% upon submittal of drawings "issued for construction", net 30 days
- 40% upon delivery of equipment, progress billing, net 30 days
- 10% upon start-up, net 30 days

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Synergy Systems
A Sealaska Diversity Solution

Ketchikan Pool Project
Ventek Budget Proposal KET-210 R1
May 24, 2010

SPECIFICATIONS:

1 – only, Viessmann/ KOB Pyrot 540, 30 PSIG ASME/CSA Biomass Heating System Boiler Plant, c/w Pyrot Ecotronic Controls and operating panel, remote visualization, automatic ignition, automatic heat exchanger tube cleaning system, automatic ash removal system, thermal safety valve, safety slide gate for fuel feed, and accumulator management system. Capacity: Nom. 540 kW or 1,842,480 BTH output.

1 – only, Boiler Pump

1 – only, Motorized 3-way Mixing Valve

1 – only, Boiler Accessory Spool including relief valve, temperature and pressure gauges, low water cut-off

1 – only, 1500 gal Accumulator Tank w/ 5" insulation and metal clad casing

1 – only, De-ashing into Ash Bin 240 L

1 – only, Reserve Ash Container 240 L

1 – only, Pneumatic boiler tube cleaning system

1 – only, Flue gas re-circulation

1 – only, Flue gas I.D. fan

1 – only, Pyrot Ecotronic Control Unit

1 – only, Accumulator management system

1 – only, Automatic ignition system

1 – only, Sluice valve

1 – only, Thermal safety valve

1 – only, In-feed Auger from the pellet silo to the boiler nom.30 feet long c/w drive unit

1 – only, 63 tonne, nominal capacity pellet storage silo.

1 – only metal mesh particulate filter and control system