VILLAGE OF HAINES JUNCTION

GEOTHERMAL DISTRICT HEATING

BUSINESS CASE STUDY

Submitted to:

The Energy Solution Centre and the Village of Haines Junction Joint Venture

By:

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ESC Project: HJ/ESC-2003
LMP Project: 0303007001

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MOIR
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TABLE of CONTENTS

LIST of FIGURES

LIST of TABLES

GLOSSARY

AADD	Average annual daily demand
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
CAFN	Champagne-Aishihik First Nations
CBD	Central Business District
ESC	Energy Solutions Centre
IRR	Internal Rate of Return
LMP	Lessoway Moir Partners
NPV	Net Present Value
VHJ	Village of Haines Junction
CFM	Cubic feet per minute
BTU	British thermal unit
CO2	Carbon dioxide

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1 EXECUTIVE SUMMARY

In September 2002, the Village of Haines Junction (VHJ) constructed a water well to meet its average daily and future domestic water requirements. The well flows under artesian pressure and provides relatively warm water. VHJ recognized the potential for using the well water as an alternate energy heat source and commissioned a study to review the potential of the well to provide geothermal district heating.

A Resource Assessment was completed in late August 2003 to confirm the quality, reliability and long term capacity of the well to deliver water. The results indicated that the water was of high quality, the water temperature 16.6ºC and the long term yield in the order of 25.6 litres per second confirming the well's suitability as a geothermal source of heat.

Following the Resource Assessment, a Demand Side Study was undertaken to review the technical feasibility of using the well water for heating the Village buildings. The results of the study indicated that the use of well water for heat extraction and distribution to Village building heating systems could be implemented in a practical manner using geothermal heat pumps.

Additionally, heat extraction could be done without adversely affecting the temperature and quality of the village domestic supply water. Application of geothermal heating to the entire Village of Haines Junction could be possible due to the volume of well water available; however, provision of well water heat to the entire Village would require re-injection of the well water to the aquifer as the water volume for heating will exceed the domestic consumption. A second well for re-injection would be required with added pumping requirements and a system for the de-chlorination of the water returned to the aquifer.

The report recommended that the Village of Haines Junction undertake the application of Geothermal Heating for village in phases.

The initial phase would include the core Village buildings (Arena, Convention Centre, and School) interconnected by a re-circulation system utilizing the existing water distribution system to exchange and transfer heat energy.

The second phase would include the connection of the remaining buildings in the village of Haines Junction to an expanded water re-circulation system.

The third phase would be the connection of the Champagne-Aishihik first nations system and connection of the buildings to the water system.

Each phased application has been evaluated in the business case independently to determine the feasibility of the project.

From a long-term cost and benefit system or social cost system, switching all properties in the Village of Haines Junction and Champagne-Aishihik to geothermal heat makes sense.

In all stages, providing tightly controlled construction costs, favorable rates of return will be achieved. Considerable environmental benefit will be achieved through the reduction of CO_2 emissions in the order of 2124.16 Equivalent Tonnes per year and a reduction in consumed oil in the order of 111,000 litres per year for the core buildings. The viability of the project could be greatly enhanced through aggressive financing arrangements and by negotiating a suitable heating cost payment from YTG.

Assuming that the Yukon government would pay to the Village the current $44,000 per year for heating fuel to the school, and that the Village would cover the other costs associated with the School, the IRR would be 7.7%.

The internal rate of return to install geothermal heating in the Village is approximately 8.5% and for the Champagne-Aishihik First Nations district, the internal rate of return is in the order of 6.5%.

In consideration of the positive Social-Environmental impact and moderate financial benefits the conversion to Geothermal Heating in the Village of Haines Junction is warranted.

There are two primary benefits supporting the application of geothermal technology to Haines Junction.

The first is the quantified economic analysis, which suggests a reasonable return on investment by paying back incremental capital expenditures with substantially reduced operating costs.

The second is the significant positive impact geothermal technology has on the environment.

In short, applying a technology which saves money and has a positive environmental impact on reflects a commitment that is shared by the Yukon Territories and Canada.

It is recommended that study move forward to the next phase; preparation of a design report for the Core Buildings Geothermal District Heating.

2 INTRODUCTION

In September 2002, the Village of Haines Junction (VHJ) constructed water well No. 5 and installed a 150mm insulated waterline from well No. 5 to the existing pumphouse No. 2. Post construction evaluation indicated that the well flows under artesian pressure, produces a water volume capable of meeting the average daily water demand requirements of the Village, meets the Canadian Drinking water Quality Guidelines (CDWQG) and has an average temperature of 16ºC.

The Village of Haines Junction recognized the potential for using the well water as an alternate energy heat source and through a joint venture with Energy Solutions Centre (ECS) in Whitehorse initiated a study to determine the heat recovery potential of the ground water.

ESC and VHJ retained Lessoway Moir Partners (LMP) in June 2003 and their team of specialists including EBA Engineering Consultants (hydrologist), Quest Engineering Group (Civil engineering), Dorward Engineering Services Ltd. (Electrical Engineering), Luigi Zanasi Economist (economist), Access Consulting (regulatory and permitting issues) to review and study the potential of well No. 5 to provide geothermal district heating . The Firm of Lessoway Moir Partners is the prime consultant and the mechanical engineering consultant.

The study is divided into distinct phases including;

- Resource assessment;
- Water Distribution System and Demand Side Assessment;
- Business Case; and
- Preliminary Design and Design Brief Preparation .

The Resource Assessment was completed in late August 2003. The results indicated that the water quality was of high quality, the water temperature 16.6ºC and the long term yield in the order of 25.6 l/s.

The DRAFT Water Distribution and Demand Side Assessment report was completed in December 2003. The results indicated that heat could be extracted from the Village water distribution system to supplement the Core building heating systems using geothermal heat pumps.

For further information and background, the reader should reference the Resource Assessment and the Demand Side Assessment report.

This report presents the findings of the Business Case Analysis. There is no question that geothermal heating saves considerable amounts in fuel costs and in maintenance compared to oil or other forms of heat. However, provision of geothermal heating requires a large up-front investment. The essence of this Business Case study is to determine whether provision of a geothermal heating system is cost effective.

The economic or financial techniques used to answer that question are Net Present Value (NPV) or Internal Rate of Return (IRR) analysis. The two are very similar and in some ways mathematically identical. The basic idea behind the techniques is that they seek to determine whether a particular project is worth doing or whether a proponent is better off leaving their money in the bank. However, this technique is very sensitive to the assumptions made. A spreadsheet model was developed for this project that examined the differences between various sets of assumptions relating to capital costs, savings, inflation rates, etc.

An alternative method is to calculate the number of years it takes for the savings to pay back the initial investment. This is often referred to as “Simple Payback”. While it can be a useful tool to compare different investments, it does not provide a criterion by which to decide whether a project is worth doing. Nevertheless, that information is provided here.

Reduction of greenhouse gas emissions is another factor that could impact on the business case. Tradeable emission credits have been created, and there is serious consideration of developing a market for them. So, in theory, the Village of Haines Junction could also profit from selling the credits obtained by reducing greenhouse gas emissions. However, the market for emission credits is not developed yet, and the status of the Kyoto Agreement is now unclear.

3 BACKGROUND & METHODOLOGY

The method used in this analysis included calculating the capital and operating costs of three options for geothermal systems and comparing the overall costs with the costs of the current conventional heating systems currently in place in Haines Junction . As heating systems have a long life, the analysis is done for 30 years, which is the expected life of the individual operating components of a geothermal system.

The three options for geothermal heating systems evaluated in this analysis include:

1. Village Core buildings (i.e. Arena, School, Convention Centre)
2. Village residential and commercial loop
3. Champagne-Aishihik municipal water supply loop

Separate financial analyses were done on each of these options as they could constitute distinct separate systems.

3.1 Options for a geothermal system description

The following sections describe the proposed geothermal heating options . Reference figure 1 for the Village of Haines Junction overall site plan.

3.1.1 Village Core Buildings

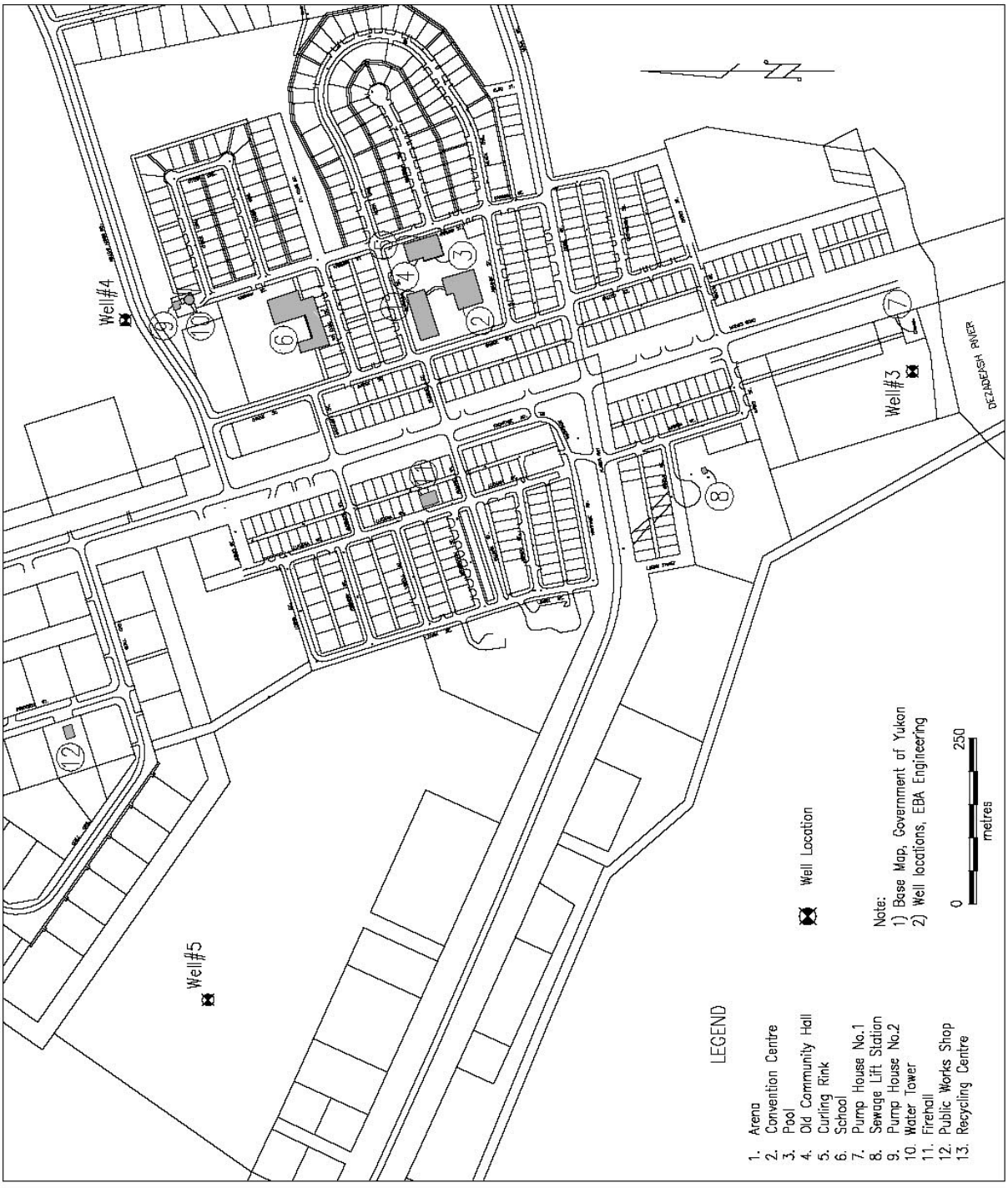
The Village core buildings consist of the Territorial School, the Village Arena, and the Village Convention Centre. The existing water system will be modified to operate as a re-circulation system and will transfer heat from the re-circulated domestic water via two heat exchangers (one located in the school and one located in the Convention Centre). Figure 2 shows the Core building geothermal heating system schematic. The heat exchangers would transfer heat from the domestic water to a secondary loop. The secondary heating loop will run below grade between the school and the arena, then above grade in the building structure between the arena and the convention centre. The arena ice plant will be connected to the secondary loop system to capture the waste heat from the ice plant. The captured heat will be reused in the heating process of the three buildings. Reference Demand Side Assessment Report for further details.

3.1.2 Village Residential and Commercial loop

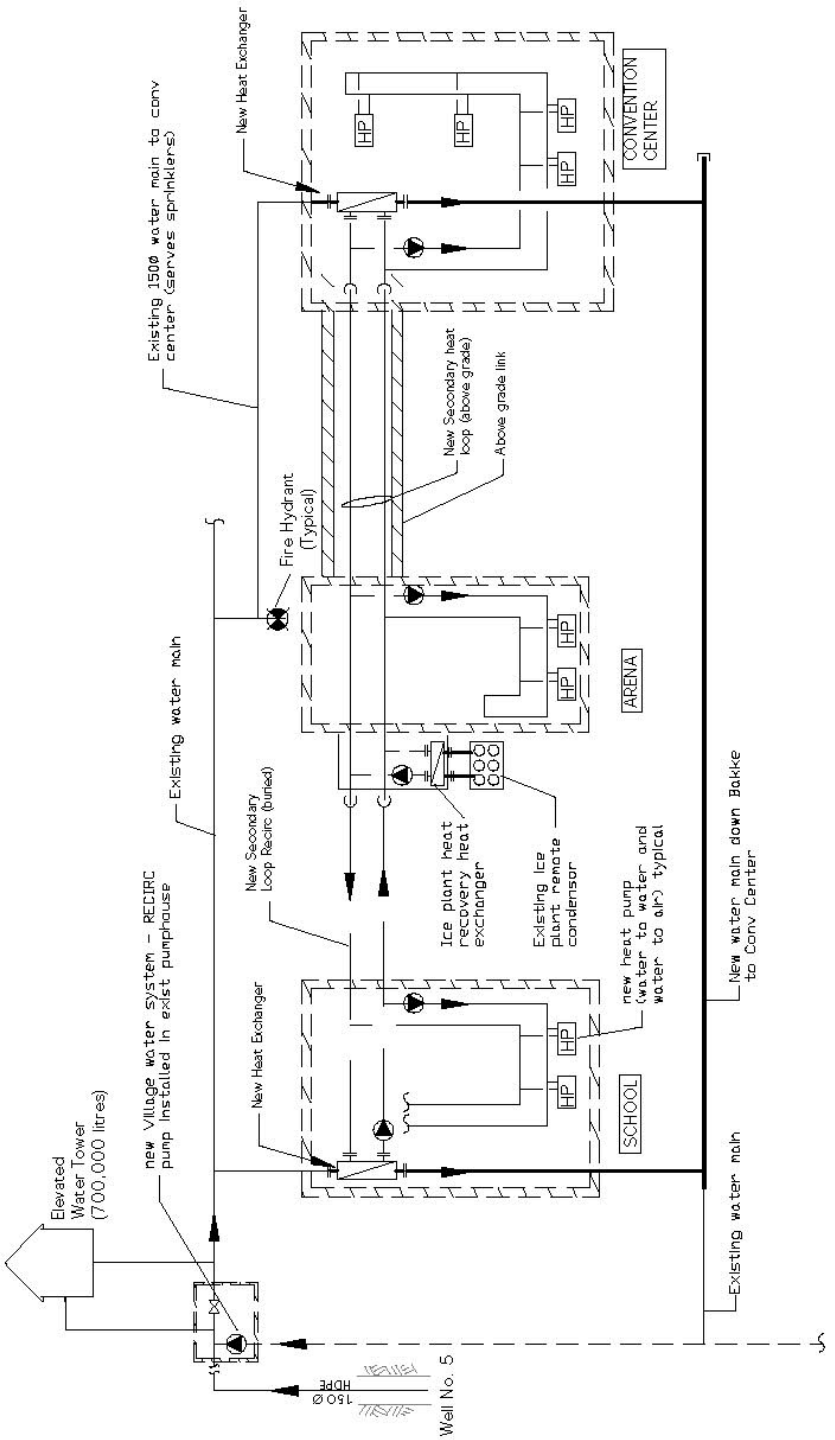
The full Village system will require the use of more domestic water then the average domestic water daily demand for the Village. Consequently, additional water wells and increased water supply from well # 5 will be required. An upgrade of the existing water delivery system will be required in some locations in the Village and the addition of a re-circulation system will be built in the water system. This will maintain the water temperature in the delivery system to ensure that the load on the heating demand side of the Village does not exceed the source side (well no. 5) of the system.

The number of residential and commercial properties in the location of the re-circulation system was determined using the average size of the properties from a previous study of the Village by the Yukon Housing Corporation in 1999. The approximate heat pump capacity per property (tons) required to heat these properties was determined assuming average building construction and average floor area of 158m2. From this it was determined that the water lines into each building required an increase in size and the installation of a return line to allow circulation of the water back into the delivery system after being used by the heat pump.

The excess water will then be discharged out of the domestic water system through injection well(s).



LESSOWAY MOIR PARTNERS 101, 204 Black Street Whitehorse, Yukon Y1A 2M9 Phone (867)393-2905 Fax (867)667-7005	Project: Haines Junction District Geothermal Heating Evaluation	Project No: 0303007001 Date: September 2003
	Drawing Title: Village Site Plan	Dwg. No. Figure 1



LESSOWAY MOIR PARTNERS 101, 204 Black Street Whitehorse, Yukon Y1A 2M8 Phone (867)393-2905 Fax (867)667-7005	Project: Haines Junction District Geothermal Heating Evaluation	Project No: 0303007001 Date: October 2003
	Drawing Title: District Heating -secondary loop schematic	Dwg. No. Figure 2

3.1.3 Champagne-Aishihik system loop

The Champagne – Aishihik system will be built using the existing water supply system, recalculating the system and closing off any open ended loop for recalculation. The system would be built in the same manor as the Village of Haines Junction loop system with the individual properties replacing the existing water supply line into the property and adding the return line back the main water supply system closing the loop . This loop requires less infrastructure to make a geothermal heating system operational as the existing water lines have a greater capacity and the loop is smaller than the Village, also the heating load and the heat pump quantity is less than the Village.

3.2 Present value method

"Present Value" or "Net Present Value" is the standard economic and financial technique used in evaluating investments whose return will occur over a period of years. It is based on the idea that the alternative to spending money on an investment is to leave it in the bank or investing it elsewhere. It looks at the costs and savings of each action and discounts future savings and costs. It estimates what the action is worth in today's dollars, hence the name "present value". Future savings or costs are "discounted" using a discount or interest rate. Another name for this type of analysis is "Discounted cash flow analysis".

The Net Present Value of the existing system was determined by calculating the replacement costs of the existing equipment and schedule thereof, continued fuel oil consumption and continued maintenance calculated over a thirty year life.

It should be noted that present value calculations are generally very sensitive to the discount rate selected. At high discount rate, an investment might have a negative present value (i.e. it is not worth doing) while it would be feasible at a lower discount rate.

To obviate the difficulty of selecting an appropriate discount rate, we also calculate the "Internal Rate of Return" (IRR) rate. This can be interpreted as the rate of return on the investment and can be compared with other potential investments.

A spreadsheet model was developed to calculate the present value. The present value calculation is done over 30 years, which is the expected life of a geothermal heating

system. The model compares cash flows for all costs (fuel/power, maintenance, capital, replacement) for the existing system and for a geothermal system. Separate worksheets have been developed for the three options.

The present value model allows changing a number of assumptions (capital costs, inflation rates, discount rates, etc.). The model takes into account operating costs (fuel and electricity), maintenance costs, initial capital costs, as well as replacement costs for new or existing equipment. Separate calculations are done for the existing system and for a new geothermal system. For the residential/commercial Town-site and Champagne-Aishihik loops, the installation of the new geothermal systems is assumed to occur when the existing system needs replacement.

A Community Housing Needs Survey done by the Yukon Housing Corporation in 1999 provides an indication of the age of existing heating systems in Haines Junction, and so provides the information needed to calculate when residential or commercial building systems can be replaced.

3.2.1 Calculation of operating cost savings of new system

Operating costs of the new geothermal hybrid heating system were calculated using the heating and cooling loads of the three core Village buildings (i.e. School, Arena, and the Convention Centre). Using the loads determined for these building, the local weather conditions, the water supply temperature, and the local fuel costs, the operating costs were determined using a modeling software developed by the geothermal heat pump manufacture Waterfurnace. The software used was WFEA 7.1. The calculations were cross-checked using an earlier software version, i.e. WFEA 5.3. The two software models produced results within 10% of each other so the average of the two was used as the operational cost of the buildings.

These operational costs were extended throughout the Village to model the full system .

Maintenance costs of the new system were determined using the ASHRAE report TO-98-7-4 where 342 Buildings were studied using geothermal and conventional heating systems. The report found that maintenance costs of the conventional equipment was $0.3041 per sq ft U.S. and the geothermal equipment at $0.0732 per sq ft U.S. These values were used for this report.

The annual fuel oil consumption for the Village Core Buildings (School, Arena, and Convention Centre) is approximately 130,500 litres. Provision of geothermal heating will reduce the annual fuel oil consumption by approximately 111,000 litres. Maintenance costs and life cycle costs will decrease as the new geothermal equipment is installed. Electrical consumption will increase in the order of 260 MWh. The estimated annual cost savings for the Core Village buildings will be approximately $39,000.00.

3.2.2 Discount rate and inflation assumptions

Present value calculations are extremely sensitive to the discount rate used in the calculation, and which discount rate to use is often subject to controversy. For public investments, the government of Canada long-term bond yield rate is often used, as it represents a risk-free long-term rate of return that can be obtained by anyone. While federal government bonds are not entirely risk free, the federal government can always pay back its obligations by creating more money.

If a project proponent needs to borrow money, the borrowing interest rate would be a more appropriate discount rate. In this case, preferential interest rates below the Government of Canada Bond rate may be available from the Federation of Canadian Municipalities' "Green Municipal Funds" program, so using the Bond rate is appropriate.

In theory, markets ensure that bond yields incorporate a premium for expected inflation. Long-term inflation rates are particularly important in this project given the long life of the systems proposed, especially the difference between the cost of fuel and that of electricity. Geothermal systems reduce the consumption of fuel, but the pumps, heat exchangers and other equipment consume more electric power. The model does include separate assumptions for general inflation, fuel price inflation and electric power inflation. Fuel and electricity prices are very likely to behave very differently in the Yukon context. Fuel prices are subject to the vagaries of international markets, while the price of electricity in the Yukon is dominated by the large, regulated low cost hydro-electric installations. Increases in fuel prices only have a small effect on electricity prices because most of the electricity is produced by the Whitehorse Rapids and Aishihik hydro plants. The price of electricity is regulated and fixed based on the costs of generation, which are dominated by the low-cost and generally stable cost of producing hydro power. So fuel prices are likely to increase faster than electricity generating costs.

However, using inflation rates in the model makes the use of bond yield rates inappropriate, as the inflation would then be double counted. “Real” discount rates need to be used . The word “real” used in economic analysis simply means adjusted for inflation. Fortunately, the government of Canada has “real” yield bonds which give the bondholder a return equal to a “real” yield plus the inflation rate.

Bond yields are available from the Bank of Canada and other financial publications and are published on the internet at the Bank of Canada’s web site: www.bankofcanada.ca/en/bonds.htm. The discount rates used in the analysis are those in effect around March 30, 2004: 4.9% per year for long term bonds and 2.4% for “real return” bonds. The difference between these two rates is an indication of the expected long-term inflation rate. The bond market expects that the long-term inflation rate will be about 2.4% per year.

For the purposes of the analysis presented here, the following are the inflation and discount rate assumptions for the base scenario. Other inflation and discount rate assumptions are also used to test the model.

Parameter		**Source**
Real Discount rate	2.4%	Gov’t of Canada Real return Bond yield
Nominal Discount rate	4.9%	Gov’t of Canada long-term Bond yield, used only in zero inflation scenario
General Inflation Rate	2.5%	Difference between nominal & real bond yields
Fuel price inflation	2.5%	Same as general inflation
Electricity Price Inflation	1.5%	1 percentage point less than the general inflation rate

TABLE 1 - Inflation and Discount Rate Assumptions

3.3 Capital costs

The Class D (+/-25%) opinion of probable cost to provide a geothermal system for the Core Village Buildings and the entire Village is in the order of $1.85 million for the Core buildings. A detailed breakdown is presented in the attached appendices.(appendices 1.3.5 &1.3.7)

The class D (+/-25%) opinion of probable cost to provide a geothermal system for the Townsite and Champagne-Aishihik loops is in the order of $14,262,500. A detailed breakdown is presented in the attached appendices.(appendices 1.3.5 &1.3.7)

3.4 Replacement costs

Replacement costs differ between the current and proposed geothermal system in a number of respects . To ensure redundancy, a large part of the current system will have to remain in place. However, since the components will not be used as much, their expected life will be longer. As well, some components can be removed.

Remaining life of the existing heating and ventilation equipment in the Village Core buildings was estimated based on ASHRAE TC 1.8 – Equipment Service Life data.

Replacement costs for the main systems in the three core buildings were calculated based on – order of magnitude estimating, e.g. $/cfm for ventilation and $/btu for heating.

A summary of the replacement costs and replacement life is presented in the attached appendices.

(See appendices 1.3.1 , 1.3.2 & 1.3.3)

3.5 $C0_2$ Emissions

As the market for Greenhouse Gas Emission Credits is not developed, the amount that could be potentially obtained from these is not accounted for in the financial modelling. Currently, prices for GHG emission credits are estimated anywhere between $0.50 to $20.00 per tonne of CO_2 .

Using CO_2 emissions estimating software developed by 'Energy Sector, Natural Resources Canada ('Canada's Emissions Outlook, An "Events-Based" Update for 2010,

Canada's Emissions Outlook: Update, Energy Policy Branch, Natural Resources Canada '- Registration Guide 1999, Canada's Climate Change Voluntary Challenge and Registry Inc) The estimated CO_2 Equivalent Savings generated for the entire system are in the order of 2124.16 Equivalent Tonnes per year. The core village Townsite at 128.8 Equivalent Tonnes per year, village at 1686.23 Equivalent Tonnes per year and Champagne-Aishihik at 309.11 Equivalent Tonnes per year.

Estimated greenhouse emission reduction amounts are presented in the attached appendices

(See appendices 1.3.4)

4 VILLAGE CORE BUILDINGS

The village core buildings include the Bill Brewster Arena, the St. Elias Visitor and Convention Centre and the St. Elias Community School. The three buildings could be served by a single water service loop with heat exchangers in each building. The business case analysis compares the costs of the current system and a potential geothermal system. The costs considered in the analysis include:

- operating costs (fuel for the current system and additional electricity for the geothermal system),
- maintenance costs.
- required improvements to current system (water pressure for fire-fighting),
- capital costs for geothermal system and
- replacement costs for existing equipment.

4.1 Required improvements

The Village indicated that the existing water supply system pressure at the school was inadequate for proper fire protection and that the Territorial government has been intending to install a diesel driven fire pump to increase supply pressure. If the geothermal system is installed and the Village water distribution system is revised to create a recirculation system, provision of a fire pump will not be required because water pressure and water flow will be increased . An allowance for offset cost of the fire pump was included in the calculations. A class D option of probable cost for the fire pump installation is included in the attached appendices.(See appendices 1.2.9)

4.2 Financial modelling

There is no question that a geothermal system for the Village Core buildings would save money compared to current operating, maintenance, and replacement costs. In other words, under most assumptions a geothermal system would yield a positive rate of return on investment. The purpose of this analysis is to determine under what conditions the substantial capital investment makes those savings worthwhile.

The following table presents the results of the financial analysis, using a mid-range scenario; i.e. the inflation rates specified in the assumptions section and the middle of the capital cost estimates. “NPV” refers to the net present discounted value of the costs.

What the NPV means is that if the Village of Haines Junction put about $5.3 million dollars in Government of Canada Real Return Bonds, it could pay for all heating system costs (operating and capital) for the next 30 years using the existing system. A geothermal system would require about $4.6 million . The Internal Rate of Return (IRR) of 5% . This rate of return is calculated on the $1,848,000 capital cost.

Mid-range Scenario	
Capital costs	$1,848,000
General Inflation Rate	2.50%
Electricity Inflation Rate	1.50%
Discount Rate	2.4%
NPV of costs - Existing system	**$5,289,183**
NPV of costs - Geothermal system	**$4,792,192**
IRR	**5.0%**
Simple payback	23.2 years

Table 2 – Core Building Summary Financial Model– Mid Range Scenerio

These results are not spectacular, but do indicate that a geothermal system is worth doing, based on the specified assumptions.

Note that the costs do include the costs of heating the school. From the Village's perspective, the results could be better depending on what could be negotiated with the Yukon government for the school's heating costs. In Watson Lake, where the school is using heat from a district heating system owned by the municipality, the Yukon Government is remitting to the Town the same amount it would pay for heating with fuel oil. Assuming that the Yukon government would pay to the Village the current $44,000 per year for heating fuel to the school, and that the village would cover the other costs associated with the School, the IRR would rise to 7.7% . The net present value of those payments minus the costs the village would incur for the school would amount to $511,674. So the NPV of the costs for the geothermal system would be reduced by that amount.

4.3 Sensitivity analysis

The results presented in Section 4.2 above are very dependent on the assumptions made. In particular, capital costs and inflation rates can considerably affect the viability of the project.

4.3.1 Capital Costs

As noted above, capital costs for the new system could be within ±25% of the estimated $1,848,000, ranging from 1,386,000 to $2,310,000 . The following table presents the results for those two scenarios.

	Low Capital Cost Scenario	**High Capital Cost Scenario**
Capital costs	$1,386,000	$2,310,000
General Inflation Rate	2.50%	2.50%
Electricity Inflation Rate	1.50%	1.50%
Discount Rate	2.40%	2.40%
NPV of costs - Existing system	$5,289,183	$5,289,183
NPV of costs - Geothermal system	$4,339,066	$5,241,318
IRR	8.81%	2.61%
Simple payback	15.8 years	30.6 years

Table 3 – Core Building Capital Cost Sensitivity

Reducing capital costs would undoubtedly make the project much more viable . At the low end, the rate of return could increase to 8.8% . Even at the high end, the project is still viable but marginal . A capital cost of $1,900,000 would obtain the same rate of return (4.9%) as investing in Government of Canada Bonds.

4.3.2 Inflation

Inflation is another factor potentially affecting the viability of the project . The key here is the difference between the inflation in the cost of fuel and that of electric power . Arguments about why electricity costs should not increase as fast as general inflation and fuel prices have been presented in Section 3.2.2 above, but are worth reiterating here . Essentially, electricity prices are regulated and are dominated by the cost of

producing hydro-electricity, which is very cheap. So it is unlikely that they will increase as fast as the prices of other goods.

The following table presents the results of testing a number of inflation assumptions. A large number of other ones were also considered. The basic conclusion is that the higher the inflation rate will be in the future, the more viable the project becomes. Note that the zero inflation scenario uses a 4.9% discount rate, so the project is very marginal. Even at 1% inflation, the project is still marginal and does not quite reach the 4.9% rate of return.

	Base Scenario	Zero inflation Scenario	Equal 2.5% inflation Scenario	Equal 1% inflation Scenario	10% inflation Scenario
Capital costs	$1,848,000	$1,848,000	$1,848,000	$1,848,000	$1,848,000
General Inflation Rate	2.50%	0.00%	2.50%	1.00%	10.00%
Electricity Inflation Rate	1.50%	0.00%	2.50%	1.00%	10.00%
Discount Rate	2.40%	4.90%	2.40%	2.40%	2.40%
NPV of costs - Existing system	$5,289,183	$2,959,366	$5,342,698	$4,417,781	$16,888,223
NPV of costs - Geothermal system	$4,790,192	$3,296,938	$4,917,404	$4,284,702	$13,649,082
IRR	5.00%	2.21%	4.70%	3.20%	12.19%

Table 4 – Core Building Inflation Sensitivity

If electricity prices were to be assumed to increase at the same rate as fuel price and general inflation rates, the rates of return on the project go down slightly. However, the viability of the project does not depend on the difference between inflation in electricity and fuel prices.

4.4 C02 emissions & credits

The core buildings have an estimated CO_2 equivalent savings of 128.8 tonnes. (See 3.5 and appendix 1.3.4)

4.5 Issues relating to financing and covering costs

It could be argued that the discount rate used in this analysis is too low. However, it is closely related to the borrowing rates that the Village of Haines Junction could expect. As was mentioned above, the Federation of Canadian Municipalities' "Green Municipal Funds" program offers publicly two options that could be used in this project.

The $200 million Green Municipal Investment Fund (GMIF) funds innovative environmental infrastructure projects. Municipal governments can borrow at preferred interest rates of 1.5 per cent below the Bank of Canada bond rate. GMIF finances up to 15 per cent of the capital costs of a qualifying project.

It is also possible to obtain grant funding for pilot projects that are highly innovative, but have a loan payback period in excess of 10 years. Up to 50% of the cost of a project could be financed in this manner.

As well, it may be possible to negotiate different terms with the FCM.

As was noted above, project viability could be further improved by negotiating an agreement with YTG on the School's heating costs. This could take any number of forms. One option is an inflation-adjusted annual or monthly payment. That amount could be for the savings realized for YTG, or for what YTG would have to pay if they remained on fuel oil heat, and could cover both fuel and capital/replacement cost savings. It might also be possible to negotiate a lump sum amount up-front from the Yukon government to cover the school's long-term heating costs.

One final concern that should be noted is the possibility of natural gas becoming available to Haines Junction if and when an Alaska Highway pipeline is built. This should not affect the viability of the project for a number of reasons. First, piping natural gas to the town centre would require fairly large infrastructure costs. Secondly, the viability of an Alaska Highway natural gas pipeline requires fairly high natural gas prices, so the savings in fuel costs compared to fuel oil would not be that great. Other studies, notably the major pipeline economic impact conducted by Informetrica in 2001, showed that heating cost savings using natural gas compared to fuel would be in the order of 25%, considerably less than that afforded by a geothermal system. The more important impact would be to use natural gas to generate electricity and possibly using the waste heat from the electrical generation in a district heating system. Again, this type of

cogeneration system would also entail fairly high infrastructure costs. Further, gas-fired generated electrical power generation would cost more than hydro (albeit less than diesel), so it would only be used at peak times.

4.6 Conclusions

While a new geothermal heating system for the town centre buildings does not produce spectacular financial results and the payback time is rather long, it certainly appears to be worth doing. The only caveat is to ensure that capital costs do not get out of control. The viability of the project could be greatly improved through different financing arrangements, notably by obtaining a grant for the FCM's Green Municipal Investment Fund and by negotiating a suitable heating cost payment from YTG.

5 RESIDENTIAL AND COMMERCIAL BUILDINGS

Two of the options relate residential and commercial buildings in Haines Junction. As they are served by different loops starting at the pumping station, geothermal systems could be installed for each one separately. It is assumed that property owners would change their system to a geothermal one only at the end of the useful life of their current system, as changing it immediately might not make economic sense if the existing heating system is relatively new.

5.1 Current Operating costs

Operating costs for residential buildings were obtained from a Community Housing survey done in Haines Junction by the Yukon Housing Corporation in 1999. The 69 respondents of that survey were asked how much they spent on heating fuel in the previous year as well as the square footage of their dwelling (including the basement). In 1999, the average cost for heating fuel per square foot was $0.72 . However, increases in heating fuel prices since that time increase the cost of heating to $1.17 per square foot. Average dwelling size in Haines Junction was 1,750 square feet, including basement area that needs to be considered in estimating heating costs.

5.2 Infrastructure costs

Average infrastructure upgrade costs was estimated per building based on the following upgrades;

1. A new water service supply line into each building,
2. a new return line from each building back to the water main, and
3. a new recirculation pump in each building.
4. Also, a provision was included for Village distribution upgrade, e.g. new pumps, valves, etc.

The number of commercial and residential buildings were estimated based on the site plan provided in the original request for proposal and cross-checked with the latest census data.

A cost to provide additional supply and injection wells was estimated based on the total additional heating load in tons for the Village.

A breakdown is presented in the attached appendices. (See appendices 1.2.5 ,1.2.6 ,1.2.7 ,1.2.1 & 1.3.7)

5.3 Capital costs for individual buildings

Capital costs per building included provision of new heat pump . For the purpose of this study, it was assumed that the average residential building requires a three (3) ton water to air heat pump and each commercial building requires a 12 ton commercial water to air heat pump.

5.4 Operating costs of geothermal system

Reference Section 3.2.1. The operational costs were determined using the average square foot of the buildings and extrapolating the number obtained off the core building costs.

5.5 Replacement costs

Replacement cost for residential heating systems is estimated at $6,000. It is assumed that property owners would change to a geothermal system only when existing systems need replacing. While there is no data on the age of existing systems in Haines Junction, a residential energy use survey conducted for the Energy Solutions Centre in 2001 revealed the following distribution of age of heating systems across the Yukon:

1 to <5 years	36.5%
5 to <10 years	28.9%
10 to <20 years	16.2%
20+ years	18.4%
	100.0%

Table 5 – Average Age of VHJ Residential Heating System

For the purposes of this analysis, it is assumed that both residential and commercial buildings in Haines Junction follow this pattern. So, about 18% of heating systems will need replacing in the next five years, assuming a 25 year life, 16% between 5 and 15 years from now, and so on .

5.6 Financial modelling

The following table presents the overall results of putting the entire town on a geothermal heating system. The table shows that a town-wide system could be viable. The CAFN loop is interesting in that it would require much less capital investment although it has a lower potential rate of return. The low return on the CAFN loop is mainly due to the relatively young age of the existing systems in the non-residential buildings, where the savings would only start kicking in after 15 year estimated life. However, a geothermal system serving the entire Village would have to address a number of environmental issues related to releasing large amounts of warm water.

	Total Residential & Commercial	**Town Site Loop**	**CAFN Loop**
General Inflation Rate	2.50%	2.50%	2.50%
Electricity Inflation Rate	1.50%	1.50%	1.50%
Discount Rate	2.40%	2.40%	2.40%
30-year new Residential units	15 dwellings	15 dwellings	5 dwellings
30-year new commercial bldgs.	5 buildings	5 buildings	0 buildings
NPV of costs - Existing system	$36,632,709	$31,846,336	$5,665,558
NPV of costs - Geothermal system	$30,625,093	$25,342,818	$5,282,275
IRR	8.48%	8.66%	6.46%

Table 6 – Financial Model – All Village Geothermal Heating System

Although a geothermal system would be viable from a total or social cost perspective, the distribution of benefits and costs needs to be considered. Many of the costs would be borne by the Village or whatever entity builds the infrastructure, while the savings would accrue to the property owners. On the other hand, the property owners would also be faced with very high initial capital costs, considerably higher than simply replacing a furnace when it reaches the end of its life. For dwelling units, it is estimated that the cost of replacing an oil-fired boiler or furnace is about $6,000, while a geothermal system would cost about $7,800 inside the house. In addition the property would require a larger

water supply, so this would mean another $8,000 to replace the water supply line from the main service to the house.

When faced with such high initial costs, many property owners would balk, even if the long-term savings justify it. One solution to this problem is to have a utility lease the infrastructure and equipment to the property owner. However, to cover the $15,800 cost of providing geothermal heat to a house would require a minimum lease payment of $1,010 per year. This amount would amortize the $15,800 over 30 years at the 4.9% long term interest rate use and would not cover the other infrastructure costs to increase flows within the existing water mains, recirculation loops, and additional wells. That $1,010 payment compares with estimated average cost savings of $1,122 in heating fuel costs by switching to a geothermal system. So, from the property owner's perspective, the benefits of switching to geothermal under these conditions would be marginal, although they are quite good from a 30 year lifetime perspective.

5.7 Sensitivity analysis

As with the town centre system, putting residences and commercial buildings on a geothermal system is sensitive to capital costs, and expected inflation rates. The results of simulations using different capital costs and inflation rates are quite similar. Higher capital costs reduce the viability, while higher inflation rates improve it.

The numbers presented above assume 10% construction. Assuming one half a new housing unit per year over the next 30 years, should this rate of construction be 0% the Internal Rate of Return would drop from 8.5% to 8.29%.

5.8 C02 emissions & credits

Reference Section 3.5 .

5.9 Conclusions

While from a long-term total or social cost system, switching all properties in the Village of Haines Junction to geothermal heat makes sense, a number of obstacles need to be overcome. The first set are the environmental ones, which can be solved by dechlorinating and reinjecting the water. There are a number of financial and operational issues that need to be addressed, especially as to who pays the costs and who gains

from the savings that the system affords. The recommendation made in the Demand Assessment that a phased approach be taken also is valid from the business case perspective. Providing geothermal heat to the entire Village necessitates very large capital investments. The estimated savings come from models and need to be validated by actual experience. So moving to a geothermal system for the entire Village is risky without better information. Building the Town Centre system first would provide better information on the actual potential savings.

6 SUMMARY & CONCLUSIONS

We recommend a three phased approach:

1. Town Centre (Phase 1)

2. Village loop. (Phase 2)

3. CAFN loop (Phase 3)

7 REFERENCES

Canada's Emissions Outlook, An "Events-Based" Update for 2010,

Energy Sector, Natural Resources Canada

- Canada's Emissions Outlook: Update, Energy Policy Branch, Natural Resources Canada

- Registration Guide 1999, Canada's Climate Change Voluntary Challenge and Registry Inc

CO2 emissions estimating software

Waterfurnace International WFI Industries

Engineering Manual wf1400

Waterfurnace International WFI Industries

WFEA 7.1 Software

WFEA 5.3 Software

ASHRAE report TO-98-7-4 Geothermal Heat Pump Consortium, Inc.,

under United States Department of Energy Contract DE-FG07-95ID13347

Community Housing Needs Survey done by the Yukon Housing Corporation in 1999

Survey conducted for the Energy Solutions Centre in 2001

Bank of Canada

8 APPENDICES

List of appendices

3-Year Fuel Costs by Facility

	Convention Centre		Community Hall		Curling Rink		Swimming Pool		(Propane)	Arena - Rink		Arena - Ice Plant		Arena - Zamboni Room	
	Charge	# of litres	Charge	# of litres	Charge	# of litres	Charge	# of litres	# of litres	Charge	# of litres	Charge	# of litres	Charge	# of litres
1999	$ 14,703.27	38,916	$ 5,743.69	15,121	$ 2,564.96	6,862	$ 8,550.43		20,655	$ 5,999.93	15,557	$ 1,438.41	3,697	$ 2,185.94	5,692
2000	$ 17,169.45	35582	$ 8,148.01	17090	$ 3,233.36	6693	$ 9,167.04	2347	17663	$ 7,069.20	14658	$ 2,413.70	4883	$ 3,103.37	6389
2001	$ 17,745.39	31432	$ 7,857.98	13807	$ 3,076.11	5397	$ 12,991.25	17075	4809	$ 7,892.79	13843	$ 2,423.23	4246	$ 3,280.81	5767
2002	$ 13,368.02	25158	$ 5,346.42	10004	$ 2,151.53	4044	$ 6,131.70	11665	0	$ 6,672.57	12528	$ 2,493.11	4674	$ 2,284.23	4302
Tot	$ 62,986.13	131,088	$ 27,096.10	56,022	$ 11,025.96	22,996	$ 36,840.42	31,087	43,127	$ 27,634.49	56,586	$ 8,768.45	17,500	$ 10,854.35	22,150
Price 1999		$ 0.38		$ 0.38		$ 0.37		$ 0.63	13679.88		$ 0.39		$ 0.39		$ 0.38
2000		$ 0.48		$ 0.48		$ 0.48		$ 0.65	14045.27		$ 0.48		$ 0.49		$ 0.49
2001		$ 0.56		$ 0.57		$ 0.57		$ 0.64	20260.02		$ 0.57		$ 0.57		$ 0.57
2002		$ 0.53		$ 0.53		$ 0.53		$ 0.53	11665.00		$ 0.53		$ 0.53		$ 0.53
AVG Price		$ 0.48		$ 0.48		$ 0.48		$ 0.62			$ 0.49		$ 0.50		$ 0.49
AVG	$ 15,746.53	32772	$ 6,774.03	14006	$ 2,756.49	5749	$ 9,210.11		14913	$ 6,908.62	14147	$ 2,192.11	4375	$ 2,713.59	5538
MAX	$ 17,745.39	38916	$ 8,148.01	17090	$ 3,233.36	6862	$ 12,991.25		20260	$ 7,892.79	15557	$ 2,493.11	4883	$ 3,280.81	6389

	Public Works Shop		Recycle Centre		Pumphouse		Water Tower		Lift Station		Fire Hall		Mezzanine	(Propane)
	Charge	# of litres	Charge	# of litres	Charge	# of litres	Charge	# of litres	Charge	# of litres	Charge	# of litres	Charge	# of litres
1999	$ 5,168.38	13413	$ -	0	$ 2,572.78	6560	$ 3,988.47	10320	$ 3,573.34	9436	$ -	0	$ 12,191.71	28,904
2000	$ 6,136.32	12695	$ -	0	$ 4,078.05	8602	$ 6,798.96	14612	$ 2,715.91	5711	$ 5,767.43	10762	$ 6,507.34	11,757
2001	$ 6,295.24	11121	$ 1,126.30	2101	$ 4,103.75	7154	$ 5,663.11	10043	$ 3,246.52	5703	$ 11,284.81	19793	$ 7,258.20	12,163
2002	$ 4,610.94	9004	$ 1,209.38	2309	$ 3,723.65	6902	$ 4,002.57	7479	$ 2,728.74	5159	$ 7,726.67	14754	$ 5,458.41	10,249
Tot	$ 22,210.88	46,233	$ 2,335.68	4,410	$ 14,478.23	29,218	$ 20,453.11	42,454	$ 12,264.51	26,009	$ 24,778.91	45,309	$ 31,415.66	63,073
Price 1999		$ 0.39				$ 0.39		$ 0.39		$ 0.38				$ 0.42
2000		$ 0.48				$ 0.47		$ 0.47		$ 0.48		$ 0.54		$ 0.55
2001		$ 0.57		$ 0.54		$ 0.57		$ 0.56		$ 0.57		$ 0.57		$ 0.60
2002		$ 0.51		$ 0.52		$ 0.54		$ 0.54		$ 0.53		$ 0.52		$ 0.53
AVG Price		$ 0.48		$ 0.53		$ 0.50		$ 0.48		$ 0.47		$ 0.55		$ 0.50
AVG	$ 5,552.72	11558	$ 583.92	1103	$ 3,619.56	7305	$ 5,113.28	10614	$ 3,066.13	6502	$ 6,194.73	11327	$ 7,853.92	15768
MAX	$ 6,295.24	13413	$ 1,209.38	2309	$ 4,103.75	8602	$ 6,798.96	14612	$ 3,573.34	9436	$ 11,284.81	19793	$ 12,191.71	28904

	Territorial School	
	Charge	# of litres
1999		85,939
2000		84,332
2001		72,002
2002		66,747
2003		58,663
Tot		367,683
AVG		73,537
MAX		85,939

Project: HJ district Heating

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
Prepared By: Lessoway Moir Partners
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1.3 construction factor. Allows for freight, hotel, increased cost of construction

SUMMARY

CLASS D minus Order of Magnitude

			Material		Labour					
Description	No.	unit	cost	factored $	mhrs	mhr cost	Sub-TOTAL	contingency	Engineering	TOTAL
		ea.		$0.00		$0.00	$0.00	$0.00	$0.00	$0.00
School	1	ea.	$304,680.52	$396,084.67		$112,395.69	$508,480.36	$0.00	$59,543.05	$568,023.41
Arena	1	ea.	$82,761.00	$107,589.30		$21,728.20	$129,317.50	$0.00	$15,143.08	$144,460.58
convention center	1	ea.	$123,828.00	$160,976.40		$30,591.60	$191,568.00	$0.00	$22,432.61	$214,000.61
Pumphouse No. 2 modifications	1	ea.	$103,450.00	$134,485.00		$260.00	$134,745.00	$0.00	$15,778.64	$150,523.64
Secondary heating loop	1	ea.	$275,355.62	$357,962.30		$0.00	$357,962.30	$0.00	$41,917.39	$399,879.69
Water System Upgrade	1	ea.	$255,382.50	$331,997.25		$0.00	$331,997.25	$0.00	$38,876.88	$370,874.13
		ea.		$0.00		$0.00	$0.00	$0.00	$0.00	
SUBTOTAL		**ea.**		**$1,489,094.92**		**$164,975.49**	**$1,654,070.41**			
Contingency Allowance	0%			$0.00		$0.00	$0.00			
SUBTOTAL				**$1,489,094.92**		**$164,975.49**	**$1,654,070.41**			
Engineering Fees	11.71%			$174,373.02		$19,318.63	$193,691.65			
TOTAL		**ea.**		**$1,663,467.94**		**$184,294.12**	**$1,847,762.06**	**$0.00**	**$193,691.65**	**$1,847,762.06**

Project: HJ district Heating

SCHOOL

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
CLASS D minus Order of Magnitude
Prepared By: Lessoway Moir Partners, Dorward Engineering Services
Mhr. rate: $65.00 /hr ave labour rate
Construction factor: 1 construction factor. Allows for freight, hotel, increased cost of construction

			Material		Labour			
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**	
WATER to AIR HEAT PUMP		ea.		$0.00		$0.00	$0.00	
water to air heat pump installed	23	ea.	$4,539.00	$104,397.00	41.82	$62,520.90	$166,917.90	see sub-sheet for detailed breakdc
console units	3	ea.	$2,000.00	$6,000.00	10	$1,950.00	$7,950.00	
HW loop - 6" dia w/ insul	0	ft	$60.00	$0.00		$0.00	$0.00	
HW loop - 4" dia w/ insul	0	ft	$45.00	$0.00		$0.00	$0.00	
HW loop - 3" dia w/ insul, sch 40	571.5	ft	$35.00	$20,003.28		$0.00	$20,003.28	
HW loop -2" dia w/ insul	571.5	ft	$30.00	$17,145.67		$0.00	$17,145.67	
pipe hangers	114.3	ea.	$15.00	$1,714.57	1	$7,429.79	$9,144.36	1 hanger per pipe @ 10 ft spacing
fill system - glycol	1	LS	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
heat pump recirc pump S-P3	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
heat pump recirc pump S-P4	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
WATER to WATER HEAT PUMP								
water to water heat pump	2	ea.	$15,000.00	$30,000.00		$0.00	$30,000.00	
new pre-heat coil on each AHU	4	ea.	$750.00	$3,000.00	10	$2,600.00	$5,600.00	
duct modifications for each preheat coil	4	ea.	$500.00	$2,000.00	10	$2,600.00	$4,600.00	
water recirc pumps S-P5	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
water recirc pumps S-P6	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
HW pipe between water to water HP and preheat coil	4	ea.	$750.00	$3,000.00	20	$5,200.00	$8,200.00	
preheat coil controls	4	ea.	$500.00	$2,000.00	8	$2,080.00	$4,080.00	
controls on water to water heat pump	2	ea.	$500.00	$1,000.00	8	$1,040.00	$2,040.00	
VILLAGE GEOTHERMAL WATER				$0.00		$0.00	$0.00	
heat exchanger	1	ea	$23,000.00	$23,000.00	30	$1,950.00	$24,950.00	
6" dia water main	30	ft	$150.00	$4,500.00		$0.00	$4,500.00	
insulation	1	LS	$2,500.00	$2,500.00		$0.00	$2,500.00	
concrete base	1	LS	$1,500.00	$1,500.00		$0.00	$1,500.00	
4" valves, fittings	10	ea	$500.00	$5,000.00	10	$6,500.00	$11,500.00	
4" water line (inside building)	1	LS	$2,500.00	$2,500.00		$0.00	$2,500.00	
primary water recirc pump S-P1	1	ea	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
primary water recirc pump S-P2	1	ea	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
Hot side flow pump S-P7	1	ea	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
				$0.00		$0.00	$0.00	
MISCELLANEOUS				$0.00		$0.00	$0.00	
remove existing equipment in mechanical rm	1	LS	$1,500.00	$1,500.00		$0.00	$1,500.00	
				$0.00		$0.00	$0.00	
ELECTRICAL				$0.00		$0.00	$0.00	
Heat pumps (Water - Air)	23	ea.	$500.00	$11,500.00	4	$5,980.00	$17,480.00	
Console units	3	ea.	$500.00	$1,500.00	3	$585.00	$2,085.00	
Pumps	7	ea.	$500.00	$3,500.00	4	$1,820.00	$5,320.00	
Heat pumps (Water - Water)	2	ea.	$500.00	$1,000.00	4	$520.00	$1,520.00	
YECL Costs for Upgrade	1	ea.	$4,482.00	$4,482.00		$0.00	$4,482.00	
YECL Investment	1	ea.	-$4,482.00	-$4,482.00		$0.00	-$4,482.00	
Overhead Connection to Service Entrance	1	ea.	$2,400.00	$2,400.00	8	$520.00	$2,920.00	
Service Entrance, Distribution and MCC	1	ea.	$33,000.00	$33,000.00	40	$2,600.00	$35,600.00	
Re-connect Existing Service to New	1	ea	$4,020.00	$4,020.00	16	$1,040.00	$5,060.00	
Demolition of Existing Service Entrance	1	ea.	$0.00	$0.00	4	$260.00	$260.00	
Permit	1	ea.	$1,000.00	$1,000.00		$0.00	$1,000.00	
O+M Manual	1	ea.	$500.00	$500.00		$0.00	$500.00	
Mobilization	1	ea.	$1,000.00	$1,000.00		$0.00	$1,000.00	
				$0.00		$0.00	$0.00	
				$0.00		$0.00	$0.00	
TOTAL				**$304,680.52**		**$112,395.69**	**$417,076.21**	

Project: HJ district Heating

Arena

LMP No: 0303007001.C01

Date Prepared: February 11, 2004

CLASS D minus Order of Magnitude

Prepared By: Lessoway Moir Partners, Dorward Engineering Services

Mhr: rate: $65.00 /hr ave labour rate

Construction factor: 1 construction factor. Allows for freight, hotel, increased cost of construction

			Material		Labour			
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**	
		ea.		$0.00		$0.00	$0.00	
WATER to AIR HEAT PUMPS		ea.		$0.00		$0.00	$0.00	
water to air heat pump installed	4	ea.	$4,539.00	$18,156.00	41.82	$10,873.20	$29,029.20	see sub-sheet for detailed breakdc
console units	0	ea.	$2,000.00	$0.00	10	$0.00	$0.00	
HW loop - 6" dia w/ insul	0	ft	$60.00	$0.00		$0.00	$0.00	
HW loop - 4" dia w/ insul	0	ft	$45.00	$0.00		$0.00	$0.00	
HW loop - 3" dia w/ insul	0	ft	$35.00	$0.00		$0.00	$0.00	
HW loop -2" dia w/ insul	250	ft	$30.00	$7,500.00		$0.00	$7,500.00	
pipe hangers	25	ea.	$15.00	$375.00	1	$1,625.00	$2,000.00	1 hanger per pipe @ 10 ft spacing
fill system - glycol	1	LS	$750.00	$750.00	10	$650.00	$1,400.00	
heat pump recirc pump A-P1	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	2 pumps @ lead/lag
heat pump recirc pump A-P2	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
ICE PLANT HEAT RECOVERY								
refrigerant-water HEX	1	ea.	$7,500.00	$7,500.00		$0.00	$7,500.00	
Chiller plant heat recovery pump A-P3	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
Chiller plant heat recovery pump A-P4	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
pipe modifications	1	LS	$2,500.00	$2,500.00		$0.00	$2,500.00	
glycol	1	LS	$750.00	$750.00		$0.00	$750.00	
Controls	1	LS	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
MISCELLANEOUS				$0.00		$0.00	$0.00	
				$0.00		$0.00	$0.00	
ELECTRICAL				$0.00		$0.00	$0.00	
Heat pumps (Water - Air)	4	ea.	$500.00	$2,000.00	4	$1,040.00	$3,040.00	
Console units	0	ea.	$500.00	$0.00	3	$0.00	$0.00	
Pumps	5	ea.	$500.00	$2,500.00	4	$1,300.00	$3,800.00	
Heat pumps (Water - Water)	0	ea.	$500.00	$0.00	4	$0.00	$0.00	
YECL Costs for Upgrade	1	ea.	$3,420.00	$3,420.00		$0.00	$3,420.00	
YECL Investment	1	ea.	-$3,420.00	-$3,420.00		$0.00	-$3,420.00	
Overhead Connection to Service Entrance	1	ea.	$2,000.00	$2,000.00	8	$520.00	$2,520.00	
Service Entrance, Distribution and MCC	1	ea.	$26,830.00	$26,830.00	30	$1,950.00	$28,780.00	
Re-connect Existing Service to New	1	ea	$400.00	$400.00	4	$260.00	$660.00	
Demolition of Existing Service Entrance	1	ea.	$0.00	$0.00	4	$260.00	$260.00	
Permit	1	ea.	$500.00	$500.00		$0.00	$500.00	
O+M Manual	1	ea.	$500.00	$500.00		$0.00	$500.00	
Mobilization	1	ea.	$1,000.00	$1,000.00		$0.00	$1,000.00	
TOTAL				**$82,761.00**		**$21,728.20**	**$104,489.20**	

Project: HJ district Heating

Convention Center

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
Prepared By: Lessoway Moir Partners, Dorward Engineering Services
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1 construction factor. Allows for freight, hotel, increased cost of construction

CLASS D minus Order of Magnitude

			Material		Labour			
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**	
WATER to AIR HEAT PUMPS		ea.		$0.00		$0.00	$0.00	
water to air heat pump installed	2	ea.	$4,539.00	$9,078.00	41.82	$5,436.60	$14,514.60	see sub-sheet for detailed breakdc
console units	3	ea.	$2,000.00	$6,000.00	10	$1,950.00	$7,950.00	
HW loop - 6" dia w/ insul	0	ft	$60.00	$0.00		$0.00	$0.00	
HW loop - 4" dia w/ insul	0	ft	$45.00	$0.00		$0.00	$0.00	
HW loop - 3" dia w/ insul	100	ft	$35.00	$3,500.00		$0.00	$3,500.00	
HW loop -2" dia w/ insul	100	ft	$30.00	$3,000.00		$0.00	$3,000.00	
pipe hangers	20	ea.	$15.00	$300.00	1	$1,300.00	$1,600.00	1 hanger per pipe @ 10 ft spacing
fill system - glycol	**1**	**LS**	**$750.00**	**$750.00**	**10**	**$650.00**	**$1,400.00**	
heat pump recirc pump C-P3	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
heat pump recirc pump C-P4	**1**	**ea.**	**$2,000.00**	**$2,000.00**	**10**	**$650.00**	**$2,650.00**	
WATER to WATER HEAT PUMPS								
water to water heat pump	2	ea.	$15,000.00	$30,000.00		$0.00	$30,000.00	
connect to exist Dx coil	2	ea.	$1,500.00	$3,000.00	10	$1,300.00	$4,300.00	
water recirc pumps S-P5	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
water recirc pumps S-P6	1	ea.	$2,000.00	$2,000.00	10	$650.00	$2,650.00	
preheat coil controls	4	ea.	$500.00	$2,000.00	8	$2,080.00	$4,080.00	
controls on water to water heat pump	2	ea.	$500.00	$1,000.00	8	$1,040.00	$2,040.00	
VILLAGE GEOTHERMAL WATER				$0.00		$0.00	$0.00	
heat exchanger	1	ea	$23,000.00	$23,000.00	30	$1,950.00	$24,950.00	
6" dia water main	40	ft	$150.00	$6,000.00		$0.00	$6,000.00	
insulation	1	LS	$2,500.00	$2,500.00		$0.00	$2,500.00	
concrete base	1	LS	$1,500.00	$1,500.00		$0.00	$1,500.00	
4" valves, fittings	10	ea	$500.00	$5,000.00	10	$6,500.00	$11,500.00	
4" water line (inside building)	1	LS	$2,500.00	$2,500.00		$0.00	$2,500.00	
primary water recirc pump CP1	1	ea	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
primary water recirc pump C-P2	1	ea	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
Hot side flow pump C-P5	1	ea	$1,500.00	$1,500.00	10	$650.00	$2,150.00	
				$0.00		$0.00	$0.00	
MISCELANEOUS				$0.00		$0.00	$0.00	
relocate existing equipment in mechanical rm	1	LS	$1,500.00	$1,500.00		$0.00	$1,500.00	
				$0.00		$0.00	$0.00	
ELECTRICAL				$0.00		$0.00	$0.00	
Heat pumps (Water - Air)	2	ea.	$500.00	$1,000.00	4	$520.00	$1,520.00	
Console units	3	ea.	$500.00	$1,500.00	3	$585.00	$2,085.00	
Pumps	7	ea.	$500.00	$3,500.00	4	$1,820.00	$5,320.00	
Heat pumps (Water - Water)	2	ea.	$500.00	$1,000.00	4	$520.00	$1,520.00	
YECL Costs for Upgrade	1	ea.	$0.00	$0.00		$0.00	$0.00	
YECL Investment	1	ea.	$0.00	$0.00		$0.00	$0.00	
Overhead Connection to Service Entrance	1	ea.	$0.00	$0.00	0	$0.00	$0.00	
Service Entrance, Distribution and MCC	1	ea.	$1,800.00	$1,800.00	6	$390.00	$2,190.00	
Re-connect Existing Service to New	1	ea	$0.00	$0.00	0	$0.00	$0.00	
Demolition of Existing Service Entrance	1	ea.	$0.00	$0.00	0	$0.00	$0.00	
Permit	1	ea.	$400.00	$400.00		$0.00	$400.00	
O+M Manual	1	ea.	$500.00	$500.00		$0.00	$500.00	
Mobilization	1	ea.	$1,000.00	$1,000.00		$0.00	$1,000.00	
TOTAL				**$123,828.00**		**$30,591.60**	**$154,419.60**	

Project: HJ district Heating

Pumphouse No. 2 modifications

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
CLASS D minus Order of Magnitude
Prepared By: Lessoway Moir Partners, Dorward Engineering Services
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1 rt, hotel, increased cost of construction

			Material		Labour		
Description	No.	unit	cost	factored $	mhrs	mhr cost	TOTAL
PIPE MODIFICATIONS							
Pipe modifications outside pumphouse	1	LS	$15,000.00	$15,000.00		$0.00	$15,000.00
Pipe modifications inside pumphouse	1	LS	$20,000.00	$20,000.00		$0.00	$20,000.00
Provide 2 10 kW recirc pumps	1	LS	$20,000.00	$20,000.00		$0.00	$20,000.00
Provide motorized control valves	2	ea.	$10,000.00	$20,000.00		$0.00	$20,000.00
Provide instrumentation and controls	1	LS	$15,000.00	$15,000.00		$0.00	$15,000.00
Control Valves and Flow Meters	1	LS	$10,000.00	$10,000.00		$0.00	$10,000.00
misc. (2%)	1	ea.		$2,000.00		$0.00	$2,000.00
		ea.		$0.00		$0.00	$0.00
ELECTRICAL		ea.		$0.00		$0.00	$0.00
Heat pumps (Water - Air)	0	ea.	$500.00	$0.00	0	$0.00	$0.00
Console units	0	ea.	$500.00	$0.00	0	$0.00	$0.00
Pumps	1	ea.	$500.00	$500.00	4	$260.00	$760.00
Heat pumps (Water - Water)	0	ea.	$500.00	$0.00	0	$0.00	$0.00
YECL Costs for Upgrade	1	ea.	$0.00	$0.00	0	$0.00	$0.00
YECL Investment	1	ea.	$0.00	$0.00	0	$0.00	$0.00
Overhead Connection to Service Entrance	1	ea.	$0.00	$0.00	0	$0.00	$0.00
Service Entrance, Distribution and MCC	1	ea.	$0.00	$0.00	0	$0.00	$0.00
Re-connect Existing Service to New	1	ea	$0.00	$0.00	0	$0.00	$0.00
Demolition of Existing Service Entrance	1	ea.	$0.00	$0.00	0	$0.00	$0.00
Permit	1	ea.	$200.00	$200.00	0	$0.00	$200.00
O+M Manual	1	ea.	$250.00	$250.00	0	$0.00	$250.00
Mobilization	1	ea.	$500.00	$500.00	0	$0.00	$500.00
TOTAL				**$103,450.00**		**$260.00**	**$103,710.00**

Project: HJ district Heating

Secondary Heating Water Loop

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
Prepared By: Lessoway Moir Partners, Quest Engineering Services
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1 it, hotel, increased cost of construction

CLASS D minus Order of Magnitude

			Material		Labour		
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**
		ea.		$0.00		$0.00	$0.00
6" water main (insulated), 1000 ft buried, 2000 ft above grade	3000	ft	$50.00	$150,000.00		$0.00	$150,000.00
hangers	200	ea.	$50.00	$10,000.00		$0.00	$10,000.00
trenching/backfill	1000	ft	$35.00	$35,000.00		$0.00	$35,000.00
road patch (pavement)	40	ft	$150.00	$6,000.00		$0.00	$6,000.00
clean/flush lines	1	LS	$10,000.00	$10,000.00		$0.00	$10,000.00
fill lines with Glycol	97.91	bbl	$500.00	$48,956.49		$0.00	$48,956.49
misc (connection at building)	4	ea.	$2,500.00	$10,000.00		$0.00	$10,000.00
	0	ea.	$0.00	$0.00		$0.00	$0.00
misc (2%)	0	ea.	$0.00	$5,399.13		$0.00	$5,399.13
				$0.00		$0.00	$0.00
TOTAL				**$275,355.62**		**$0.00**	**$275,355.62**

Project: HJ district Heating

Water System Upgrade

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
Prepared By: Quest Engineering Services
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1 ıt, hotel, increased cost of construction

CLASS D minus Order of Magnitude

			Material		Labour		
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**
		ea.		$0.00		$0.00	$0.00
10" water main (insulated)	1800	ft	$60.00	$108,000.00		$0.00	$108,000.00
Tie-ins to existing mains	3	ea.	$5,000.00	$15,000.00		$0.00	$15,000.00
trenching/backfill	2075	ft	$35.00	$72,625.00		$0.00	$72,625.00
road patch (BST)	40	ft	$150.00	$6,000.00		$0.00	$6,000.00
clean/flush lines	1	LS	$2,500.00	$2,500.00		$0.00	$2,500.00
6" watermain (insulated)	275	ft	$50.00	$13,750.00		$0.00	$13,750.00
misc (connection at building)	2	ea.	$5,000.00	$10,000.00		$0.00	$10,000.00
Hydrants and valves	3	ea.	$7,500.00	$22,500.00		$0.00	$22,500.00
misc (2%)	0	ea.	$0.00	$5,007.50		$0.00	$5,007.50
				$0.00		$0.00	$0.00
TOTAL				**$255,382.50**		**$0.00**	**$255,382.50**

Project: HJ district Heating

water to Air HP, ducted, installed in crawlspace

LMP No: 0303007001.C01
Date Prepared: February 11, 2004
Prepared By: Lessoway Moir Partners
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1 ght, hotel, increased cost of construction

CLASS D minus Order of Magnitude

			Material		Labour			
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**	
		ea.		$0.00		$0.00	$0.00	
Heat pump (water to air)	1	ea.	$2,500.00	$2,500.00		$0.00	$2,500.00	
ductwork	1	LS	$350.00	$350.00	10	$650.00	$1,000.00	
floor cut and patch	5	ea.	$50.00	$250.00	1	$325.00	$575.00	3 S/A, 2 R/A through floor, opposite side of room
hang heat pump	1	ea.		$0.00	4	$260.00	$260.00	includes moving HP into & through crawlspace,
siemic restraint	1	ea.	$100.00	$100.00	3	$195.00	$295.00	
controls	1	ea.	$500.00	$500.00	5	$325.00	$825.00	
isolation valves	2	ea.	$50.00	$100.00	1	$130.00	$230.00	
1" branch pipe w/ insul	20	ft	$15.00	$300.00	0.3	$390.00	$690.00	
solenoid valve	1	ea	$250.00	$250.00	1	$65.00	$315.00	
flex connection	2	ea.	$50.00	$100.00	0.5	$65.00	$165.00	
commisioning	1	LS	$0.00	$0.00	4	$260.00	$260.00	
	0	ea.	$0.00	$0.00	0	$0.00	$0.00	
	0	ea.	$0.00	$0.00	0	$0.00	$0.00	
	0	ea.	$0.00	$0.00	0	$0.00	$0.00	
misc (2%)	1	ea.	$0.00	$89.00	0	$53.30	$142.30	
				$0.00		$0.00	$0.00	
Heat Pump Total			**$3,865.00**	**$4,539.00**	**41.8hrs**	**$2,718.30**	**$7,257.30**	

Project: HJ district Heating
LMP No: 0303007001.C01
Date Prepared: February 13, 2004
Prepared By: Lessoway Moir Partners
Mhr: rate: $65.00 /hr ave labour rate
Construction factor: 1.3 construction factor. Allows for freight, hotel, increased cost of construction

New diesel driven fire pump @ school

CLASS D minus Order of Magnitude

			Material		Labour		
Description	**No.**	**unit**	cost	factored $	mhrs	mhr cost	**TOTAL**
		ea.		$0.00		$0.00	$0.00
Diesel fire pump package	1	ea.	$34,000.00	$44,200.00	40	$2,600.00	$46,800.00
flow meter	1	ea.	$2,000.00	$2,600.00	10	$650.00	$3,250.00
bulding and foundation for new new fire pump (rated and attached to existing school)	1	LS	$30,000.00	$39,000.00		$0.00	$39,000.00
building power and lighting	1	LS	$5,000.00	$6,500.00		$0.00	$6,500.00
building heat (U/H)	1	LS	$1,500.00	$1,950.00		$0.00	$1,950.00
upgrade existing fire alarm panel	1	LS	$50,000.00	$65,000.00		$0.00	$65,000.00
connect to existing sprinkler system	1	LS	$15,000.00	$19,500.00		$0.00	$19,500.00
install muffler (muffler by others)	1	LS	$500.00	$650.00	10	$650.00	$1,300.00
siesmic	1	LS	$1,000.00	$1,300.00	10	$650.00	$1,950.00
sitework	1	LS	$5,000.00	$6,500.00		$0.00	$6,500.00
subtotal		ea.		$180,700.00		$0.00	$191,750.00
contingency @ 15%		ea.		$0.00		$0.00	$28,762.50
engineering @ 10%		ea.		$0.00		$0.00	$22,051.25
total		**ea.**		**$0.00**		**$0.00**	**$242,563.75**

Project: HJ district Heating
LMP No: 0303007001.C01
Date Prepared: February 13, 2004
Prepared By: Lessoway Moir Partners

SCHOOL

Replacement Costs

Equipment	Age	Existing system Ave life	Existing system Life left	Existing system Replacement Cost, 2004	Geothermal system Life left	Geothermal system Replacement Cost, 2004	notes	Comments
HEATING PLANT								
boiler B1	10 yrs	30 yrs	20 yrs	$20,000.00	30 yrs	$20,000.00		does not include demo (if req), chimney, controls
boiler B2	25 yrs	30 yrs	5 yrs	$20,000.00	15 yrs	$20,000.00		does not include demo (if req), chimney, controls
boiler B3	25 yrs	30 yrs	5 yrs	$20,000.00		$0.00	scrap	does not include demo (if req), chimney, controls
recirc pumps	15 yrs	20 yrs	5 yrs	$8,000.00	5 yrs	$8,000.00		assume 4 primary HW pumps. Replace 2 within 5 yrs, 2 within 10 yrs
Fuel Oil system	30 yrs	30 yrs	1 yrs	$40,000.00	30 yrs	$40,000.00		assumes above grade double walled tank, transfer pumps, auxilliary day tank, controls
VENTILATION								
AHU-1 (gym)	25 yrs	25 yrs	1 yrs	$18,000.00	1 yrs	$18,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
AHU-2 (gym and offices)	25 yrs	25 yrs	1 yrs	$18,000.00	1 yrs	$18,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
AHU-3 (1979 class wing)	10 yrs	25 yrs	15 yrs	$47,000.00	15 yrs	$47,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
AHU-4 (1993 addn)	10 yrs	25 yrs	15 yrs	$27,000.00	15 yrs	$27,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
DOMESTIC WATER								
domestic hot water tank w/ HEX	25 yrs	30 yrs	5 yrs	$25,000.00	5 yrs	$25,000.00		suggest review of DHW demand, could down size tank
				$243,000.00		$223,000.00		

Project: HJ district Heating
LMP No: 0303007001.C01
Date Prepared: February 13, 2004
Prepared By: Lessoway Moir Partners

ARENA

Replacement Costs

			Existing system			Geothermal system			
Equipment	**Age**	**Ave life**	**Life left**	**Replacement Cost, 2004**	**Life left**	**Replacement Cost, 2004**	**notes**	**Comments**
HEATING PLANT/ VENTILATION								
Furnaces FRN-1	15 yrs	18 yrs	3 yrs	$15,000.00		$0.00	scrap	does not include chimney, controls
Furnaces FRN-2	15 yrs	18 yrs	3 yrs	$15,000.00		$0.00	scrap	does not include chimney, controls
Furnaces FRN-3	15 yrs	18 yrs	3 yrs	$15,000.00		$0.00	scrap	does not include chimney, controls
Furnaces FRN-4	15 yrs	18 yrs	3 yrs	$15,000.00		$0.00	scrap	does not include chimney, controls
Propane Roof top unit	10 yrs	15 yrs	5 yrs	$20,000.00		$0.00	scrap	
Oil tank	15 yrs	30 yrs	15 yrs	$40,000.00	15	$5,000.00	Small tank required for DHW & zamboni room only	assumes above grade double walled tank, transfer pumps, auxilliary day tank, controls
hot water maker - zamboni room	10 yrs	25 yrs	15 yrs	$10,000.00	15	$10,000.00		includes boiler only - does not incl. DHW tank and HEX
DOMESTIC WATER								
oil fired domestic hot water tank	10 yrs	15 yrs	5 yrs	$5,000.00	5	$2,000.00	smaller tank	does not include chimney, controls
				$135,000.00		$17,000.00		

Project: HJ district Heating
LMP No: 0303007001.C01
Date Prepared: February 13, 2004
Prepared By: Lessoway Moir Partners

CONVENTION CENTER

Replacement Costs

Equipment	Age	Existing system Ave life	Existing system Life left	Existing system Replacement Cost, 2004	Geothermal system Life left	Geothermal system Replacement Cost, 2004	notes	Comments
HEATING PLANT								
boiler B1	10 yrs	30 yrs	20 yrs	$20,000.00	30 yrs	$20,000.00		does not include chimney, controls
boiler B2	15 yrs	30 yrs	15 yrs	$20,000.00	30 yrs	$20,000.00		does not include chimney, controls
boiler B3	15 yrs	30 yrs	15 yrs	$20,000.00		$0.00	scrap	does not include chimney, controls
recirc pumps	10 yrs	20 yrs	10 yrs	$8,000.00	10 yrs	$8,000.00		assume 4 primary HW pumps.
Fuel Oil system	10 yrs	30 yrs	20 yrs	$40,000.00	30 yrs	$40,000.00		assumes above grade double walled tank, transfer pumps, auxilliary day tank, controls
VENTILATION								
AHU-1 (2nd fl offices)	10 yrs	25 yrs	15 yrs	$34,000.00	15 yrs	$34,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
AHU-2 (theatre)	10 yrs	25 yrs	15 yrs	$48,000.00	15 yrs	$48,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
AHU-3 (main floor)	10 yrs	25 yrs	15 yrs	$43,000.00	15 yrs	$43,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
AHU-4 (front lobby area)	10 yrs	25 yrs	15 yrs	$30,000.00	15 yrs	$30,000.00		includes demo, no upgrade or new duct. Incl allowance for tough demo work
DOMESTIC WATER								
domestic hot water tank	10 yrs	10 yrs	1 yrs	$2,500.00	15 yrs	$2,500.00		
CHECKSUM				$265,500.00		$245,500.00		

Canada's Emissions Outlook, An "Events-Based" Update for 2010,
Energy Sector, Natural Resources Canada
- Canada's Emissions Outlook: Update, Energy Policy Branch, Natural Resources Canada
- Registration Guide 1999, Canada's Climate Change Voluntary Challenge and Registry Inc

CO2 Emissions CO2 emissions estimating software

Proposed	Core buildings	Tonnes
CO2 Emissions (tonnes) existing		
	CO2 (tonnes)	227.12
	N2O (tonnes)	0.30
	CH4 (tonnes)	0.09
	Total CO2 Equiv. (tonnes)	227.50
CO2 Emissions geo		
	CO2 (tonnes)	98.38
	N2O (tonnes)	0.28
	CH4 (tonnes)	0.03
	Total CO2 Equiv. (tonnes)	98.69
CO2 Savings		
	CO2 (tonnes)	128.74
	N2O (tonnes)	0.02
	CH4 (tonnes)	0.06
	Total CO2 Equiv. (tonnes)	**128.82**

Town System		
CO2 Emissions (tonnes) existing		
	CO2 (tonnes)	3104.668
	N2O (tonnes)	4.04913
	CH4 (tonnes)	1.265981
	Total CO2 Equiv. (tonnes)	3109.983
CO2 Emissions geo		
	CO2 (tonnes)	1419.051
	N2O (tonnes)	4.252429
	CH4 (tonnes)	0.440896
	Total CO2 Equiv. (tonnes)	1423.755
CO2 Savings		
	CO2 (tonnes)	1685.62
	N2O (tonnes)	-0.20
	CH4 (tonnes)	0.83
	Total CO2 Equiv. (tonnes)	**1686.23**

Champagne system		
CO2 Emissions (tonnes) existing		
	CO2 (tonnes)	565.1765
	N2O (tonnes)	0.737107
	CH4 (tonnes)	0.23046
	Total CO2 Equiv. (tonnes)	566.144
CO2 Emissions geo		
	CO2 (tonnes)	256.2292
	N2O (tonnes)	0.760787
	CH4 (tonnes)	0.080824
	Total CO2 Equiv. (tonnes)	257.0308
CO2 Savings		
	CO2 (tonnes)	308.95
	N2O (tonnes)	-0.02
	CH4 (tonnes)	0.15
	Total CO2 Equiv. (tonnes)	**309.11**

total project co2 savings	
Total CO2 Equiv. (tonnes)	**2124.16 per year**

Arena

WaterFurnace Energy Analysis
Ground Source System Performance

Company	Customer
Notes:	Notes:

System Design-				**Annual Operating Costs-**		
WaterFurnace Unit:		Versatec		Arena		
Total Series Tons:	16	N/A				
Loop Source:		Water		**Heating-**		
Soil Type:		Water		Load:	485.4	million btu
Average Depth:	12	Feet		WF Unit:	35,367	kwh
Trench/Bore:		Autosize		fuel oil	770	gals
Hot Water:		Fuel Oil		Average COP:	3.98	btu/btu
Fossil Fuel Backup:		Fuel Oil			74.9%	By heatpump
Loop Temp Min-Max:	60	100	° F	Cost of Operation:	**$5,999**	
Elec Rate Htg - Clg:	0.125	0.125				
Fossil Fuel Rate:	2.500	Efficiency:	0.85	**Cooling-**		
Design Data-				Load:	25.8	million btu
Heating Load:		207520	btu/hr	WF Unit:	0	kwh
Heating Temp Diff:	115	° F		Average EER:	15.7	btu/watt
Cooling Load:	40000	btu/hr		Cost of Operation:	**$18**	
Cooling Temp Diff:	5	° F				
DHW Temp Setting:	120	° F				
DHW Users:		People				
Constant Fan:		No				
Internal Gains:	15,853	btu/hr				
Comfort Conditions-						
Heating Setpoint:	70	° F				
Cooling Setpoint:	75	° F				
Start Cooling Temp:	75	° F				
Weather Location:	HainesJunction Yukon			**Annual Cost:**	**$6,017**	

Ground Source System Analysis-					
WaterFurnace Model:	**versatec**		Summer Peak Demand:	14.8	kw
min water flow	**24**	gpm	Winter Peak Demand:	19.5	kw
Auxiliary Heat Required:	170,012	btuh	Max Loop Extreme:	55.0	° F
Opt. Emergency Heat Size:		kw	Min Loop Extreme:	55.0	° F
Max. System Balance Point:	-3	° F	Avg Loop Temp Cooling:	55.0	° F
Avg. System Balance Point:	-3	° F	Avg Loop Temp Heating:	55.0	° F
			WF Unit Cooling Run Time:	10	hours
			WF Unit Heating Run Time:	2,899	hours

Convention Centre

WaterFurnace Energy Analysis
Ground Source System Performance

Company	Customer
Notes:	Notes:

System Design-			
WaterFurnace Unit:		Versatec	
Total Series Tons:	24	N/A	
Loop Source:		Water	
Soil Type:		Water	
Average Depth:	12	Feet	
Trench/Bore:		Autosize	
Hot Water:		Fuel Oil	
Fossil Fuel Backup:		Fuel Oil	
Loop Temp Min-Max:	60	100	° F
Elec Rate Htg - Clg:	0.125	0.125	
Fossil Fuel Rate:	2.500	Efficiency:	0.85
Design Data-			
Heating Load:		531923	btu/hr
Heating Temp Diff:	115	° F	
Cooling Load:	130000	btu/hr	
Cooling Temp Diff:	5	° F	
DHW Temp Setting:	120	° F	
DHW Users:		People	
Constant Fan:		No	
Internal Gains:	40,636	btu/hr	
Comfort Conditions-			
Heating Setpoint:	70	° F	
Cooling Setpoint:	75	° F	
Start Cooling Temp:	75	° F	
Weather Location:	HainesJunction Yukon		

Annual Operating Costs-		
convention centre		
Heating-		
Load:	1,240.6	million btu
WF Unit:	95,609	kwh
fuel oil	460	gals
Average COP:	3.98	btu/btu
	64.5%	By heatpump
Cost of Operation:	**$13,876**	
Cooling-		
Load:	25.8	million btu
WF Unit:	0	kwh
Average EER:	15.7	btu/watt
Cost of Operation:	**$679**	
Annual Cost:	**$14,555**	

Ground Source System Analysis-					
WaterFurnace Model:	**versatec**		Summer Peak Demand:	21.6	kw
min water flow	**36**	gpm	Winter Peak Demand:	28.9	kw
Auxiliary Heat Required:	435,769	btuh	Max Loop Extreme:	55.0	° F
Opt. Emergency Heat Size:		kw	Min Loop Extreme:	55.0	° F
Max. System Balance Point:	-3	° F	Avg Loop Temp Cooling:	55.0	° F
Avg. System Balance Point:	-3	° F	Avg Loop Temp Heating:	55.0	° F
			WF Unit Cooling Run Time:	22	hours
			WF Unit Heating Run Time:	3,637	hours

School

WaterFurnace Energy Analysis
Ground Source System Performance

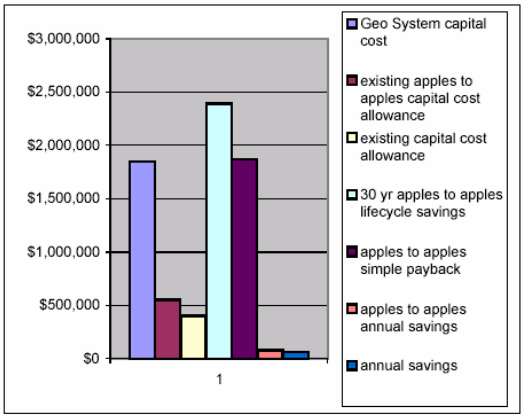
Company				Customer			
Notes:				Notes:			
System Design-				**Annual Operating Costs-**			
WaterFurnace Unit:		Versatec		school			
Total Series Tons:	66	N/A					
Loop Source:		Water		**Heating-**			
Soil Type:		Water		Load:	2,465.1	million btu	
Average Depth:	12	Feet		WF Unit:	194,835	kwh	
Trench/Bore:		Autosize		fuel oil	1,142	gals	
Hot Water:		Fuel Oil		Average COP:	3.98	btu/btu	
Fossil Fuel Backup:		Fuel Oil			66.0%	By heatpump	
Loop Temp Min-Max:	60	100 ° F		Cost of Operation:	**$28,289**		
Elec Rate Htg - Clg:	0.125	0.125					
Fossil Fuel Rate:	2.500	Efficiency:	0.85	**Cooling-**			
Design Data-				Load:	0.0	million btu	
Heating Load:		1056937	btu/hr	WF Unit:	0	kwh	
Heating Temp Diff:	115	° F		Average EER:	0.0	btu/watt	
Cooling Load:	300000	btu/hr		Cost of Operation:	**$0**		
Cooling Temp Diff:	5	° F					
DHW Temp Setting:	120	° F					
DHW Users:		People					
Constant Fan:		No					
Internal Gains:	80,745	btu/hr					
Comfort Conditions-							
Heating Setpoint:	70	° F					
Cooling Setpoint:	75	° F					
Start Cooling Temp:	75	° F					
Weather Location:	HainesJunction Yukon			**Annual Cost: $28,289**			

Ground Source System Analysis-				
WaterFurnace Model:	**versatec**		Summer Peak Demand:	59.9 kw
min water flow	**99** gpm		Winter Peak Demand:	80.2 kw
Auxiliary Heat Required:	865,903 btuh		Max Loop Extreme:	55.0 ° F
Opt. Emergency Heat Size:	kw		Min Loop Extreme:	55.0 ° F
Max. System Balance Point:	-3 ° F		Avg Loop Temp Cooling:	55.0 ° F
Avg. System Balance Point:	-3 ° F		Avg Loop Temp Heating:	55.0 ° F
			WF Unit Cooling Run Time:	0 hours
			WF Unit Heating Run Time:	2,686 hours

30 year lifecycle cost

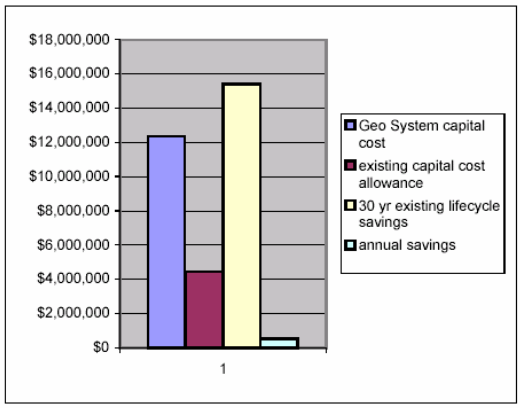
Core Building System

Geo System capital cost	**$1,847,813**	
existing apples to apples capital cost allowance	$549,500	
existing capital cost allowance	**$399,500**	
30 yr apples to apples lifecycle savings	$2,393,791	
30 yr existing lifecycle savings	**$1,871,191**	
apples to apples annual savings	$79,793	
annual savings	**$62,373**	
apples to apples simple payback	16.27	years
simple payback	**23.22**	**years**
co2 savings annually Equiv co2 tonnes	**128.8**	



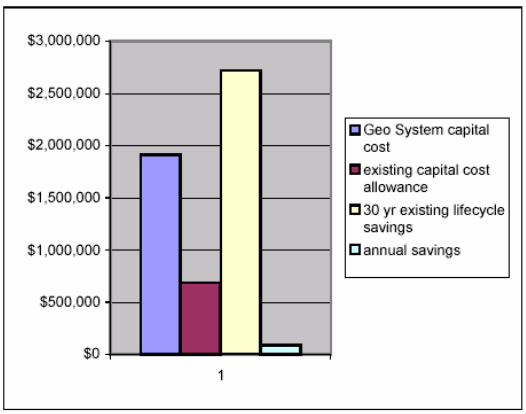
Town Site System

Geo System capital cost	$12,352,320	
existing capital cost allowance	$4,446,835	
30 yr existing lifecycle savings	**$15,388,571**	
annual savings	$512,952	
simple payback	**15.4**	**years**
co2 savings annually Equiv co2 tonnes	**1,686.2**	



Champagne system

Geo System capital cost	$1,910,160	
existing capital cost allowance	$687,658	
30 yr existing lifecycle savings	**$2,721,359**	
annual savings	$90,712	
simple payback	**13.5**	**years**
co2 savings annually Equiv co2 tonnes	**309.1**	



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Waterfurnace International WFI Industries
Engineering Manual wf1400

Waterfurnace International WFI Industries
WFEA 7.1 Software
WFEA 5.3 Software

ASHRAE report TO-98-7-4 Geothermal Heat Pump Consortium, Inc.,
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Community Housing Needs Survey done by the Yukon Housing Corporation in 1999

Survey conducted for the Energy Solutions Centre in 2001

Town Site and CAFN Capital Cost Estimate

	town site existing	growth	champagne existing	growth
commercial properties	45	49.5	4	4.4
residential properties	150	165	50	55
estimated tons per property				
commercial properties avg	12	12	10	10
residential properties	3	3	3	3
total tons				
commercial properties	540	594	40	44
residential properties	450	495	150	165
sub total	990	99	190	19
total		1089		209
estimated capital cost per ton				
commercial properties	$4,000	$4,000	$4,000	$4,000
residential properties	$2,600	$2,600	$2,600	$2,600
total cost				
commercial properties	$2,160,000	$216,000	$160,000	$16,000
residential properties	$1,170,000	$117,000	$390,000	$39,000
total	$3,330,000	$333,000	$550,000	$55,000
estimated infrastructure cost per property				
commercial properties	$10,000	$10,000	$10,000	$10,000
residential properties	$8,000	$8,000	$8,000	$8,000
water system upgrade	$12,000		$500	
new well system (Per tonne)	$2,400		$2,400	
total cost infrastructure				
commercial properties	$450,000	$45,000	$40,000	$4,000
residential properties	$1,200,000	$120,000	$400,000	$40,000
water system upgrade	$2,340,000		$27,000	
new well system	$2,376,000		$456,000	
sub total	$9,696,000	$597,600	$1,473,000	$118,800
current projects total	$13,402,800			
additional for future growth	$859,680			
Total	$14,262,480			

Town Site and CAFN operational and maintenance Estimate

operational fuel costs	avg sq ft	existing cost /sq ft	geo cost /sq ft	town site existing	geo	savings	champagne existing	geo	savings	Total 30 year savings
commercial properties	6000	$1.86	$0.81	$551,333	$240,866	$310,467	$49,007	$21,410	$27,597	
residential properties	1750	$1.17	$0.58	$336,600	$168,300	$168,300	$112,200	$56,100	$56,100	
total				**$887,933**	**$409,166**	**$478,767**	**$161,207**	**$77,510**	**$83,697**	
total project				$1,049,141	$486,676	$562,464				**$16,873,926**
commercial properties										
30 yr lifecycle cost savings										
repairs maintenance				$374,220	$133,650		$33,264	$11,880		
replacement				$1,202,850	$905,850		$106,920	$80,520		
total				$1,577,070	$1,039,500	$537,570	$140,184	$92,400	$47,784	
savings										
residential properties										
30 yr lifecycle cost savings										
repairs maintenance				$291,638	$92,400		$97,213	$30,800		
replacement				$880,688	$591,938		$293,563	$197,313		
total				$1,172,325	$684,338	$487,988	$390,775	$228,113	$162,663	
total savings										
repairs maintenance				$665,858	$226,050		$130,477	$42,680		
replacement				$2,083,538	$1,497,788		$400,483	$277,833		
total				$2,749,395	$1,723,838	**$1,025,558**	$530,959	$320,513	**$210,447**	**$1,236,004**
savings										
Total										**$18,109,930**

RESULTS

	Existing	Geothermal					
Village Core Buildings							
		Base Scenario	Base Scenario without secondary loop	Zero inflation Scenario	Equal 2.5% inflation Scenario	Equal 1% inflation Scenario	10% inflation Scenario
Capital costs	$1,847,813	$1,847,813	$1,536,000	$1,847,813	$1,847,813	$1,847,813	$1,847,813
General Inflation Rate	2.50%	2.50%	2.50%	0.00%	2.50%	1.00%	10.00%
Electricity Inflation Rate	1.50%	1.50%	1.50%	0.00%	2.50%	1.00%	10.00%
Discount Rate	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%
NPV of costs - Existing system	$5,289,183	$5,289,183	$5,289,183	$3,924,492	$5,342,695	$4,417,781	$16,888,223
NPV of costs - Geothermal system	$4,790,192	$4,790,192	$5,129,089	$3,954,384	$4,917,404	$4,284,702	$13,649,082
IRR	5.00%	5.00%	3.64%	2.21%	4.70%	3.20%	12.19%
Simple payback	23.2 years	23.2 years	29.5 years	23.2 years	23.2 years	23.2 years	23.2 years

		Base Scenario	Zero inflation Scenario	Equal 2.5% inflation Scenario	Equal 1% inflation Scenario	10% inflation Scenario	
Total Residential & Commercial							
General Inflation Rate	2.50%	2.50%	0.00%	2.50%			
Electricity Inflation Rate	1.50%	1.50%	0.00%	2.50%			
Discount Rate	2.40%	2.40%	4.90%	2.40%			
NPV of costs - Existing system	$36,632,709	$36,632,709	$18,004,083	$36,632,709			
NPV of costs - Geothermal system	$30,625,093	$30,625,093	$19,394,057	$33,026,660			
IRR	8.48%	8.48%	4.05%	6.85%			
Simple payback	23.6 years	23.6 years	23.6 years	23.6 years			
Town Site Loop							
30-year new Residential units	15 dwellings	15 dwellings	15 dwellings	15 dwellings			
30-year new commercial bldgs.	5 buildings	5 buildings	5 buildings	5 buildings			
NPV of costs - Existing system	$31,846,336	$31,846,336	$16,018,580	$31,846,336			
NPV of costs - Geothermal system	$25,342,818	$25,342,818	$16,325,904	$27,404,880			
IRR	8.66%	8.66%	4.34%	7.15%			
CAFN Loop							
30-year new Residential units	5 dwellings	5 dwellings	5 dwellings	5 dwellings			
30-year new commercial bldgs.	0 buildings	0 buildings	0 buildings	0 buildings			
NPV of costs - Existing system	$5,685,558	$5,685,558	$2,867,882	$5,685,558			
NPV of costs - Geothermal system	$5,282,275	$5,282,275	$3,068,553	$5,821,781			
IRR	6.46%	6.46%	2.31%	2.98%			

Total Residential & Commercial	
General Inflation Rate	2.50%
Electricity Inflation Rate	1.50%
Discount Rate	2.40%
NPV of costs - Existing system	$36,632,709
NPV of costs - Geothermal system	$30,625,093
IRR	8.48%
Simple payback	23.6 years
Town Site Loop	
30-year new Residential units	15 dwellings
30-year new commercial bldgs.	5 buildings
NPV of costs - Existing system	$31,846,336
NPV of costs - Geothermal system	$25,342,818
IRR	8.66%
CAFN Loop	
30-year new Residential units	5 dwellings
30-year new commercial bldgs.	0 buildings
NPV of costs - Existing system	$5,685,558
NPV of costs - Geothermal system	$5,282,275
IRR	6.46%