



**PUBLIC COMMITTEE OF THE WHOLE**

**AGENDA PACKAGE**

**For the meeting of**

Date: Wednesday, March 10, 2021

Time: 6:00 p.m.

Place: Zoom

**AGENDA PACKAGE**  
**PUBLIC COMMITTEE OF THE WHOLE**

**Date: March 10, 2021**

**Time: 6:00 p.m.**

**ZOOM MEETING**

**1. CALL TO ORDER**

1.1 Roll Call

**2. ADMINISTRATIVE AND PROCEDURAL ISSUES**

2.1 Approval of Agenda

2.2 Delegations/ Presentations/ Petitions

**•Parrsboro Playground Committee – Matthew Brewer**

Matthew Brewer will provide Council with an overview/update on a proposed community playground/park located in Parrsboro.

**•Cumberland Energy Authority**

Ray Hickey, Executive Director of the Cumberland Energy Authority will present an update on the Geothermal Industrial Park. Studies and reports to support this presentation are included in your package.

**3. EXTERNAL REPORTS/COMMITTEE MINUTES**

3.1 Cumberland Regional Library Board

In your package you will find the February Report for the Cumberland Regional Library Board.

**4. INTERNAL REPORTS/COMMITTEE MINUTES**

4.1 In your package you will find a Tax Collection Report for January, 2021

4.2 In your package you will find a Tax Collection Report for February, 2021

4.3 Verbal Committee Updates (Councillors)

**5. INFORMATION ITEMS**

There are no Information Items for tonight's meeting

**6. ADJOURNMENT**



## Springhill Geothermal Business Park Summary Report

For Council March 10<sup>th</sup>, 2021

The Springhill Geothermal Business Park has been a longstanding goal of the community of Springhill. When the former coal mines ceased operation, they naturally flooded with water over time. This water is both large in volume – thanks to the expansive former mine workings – and relatively high in ambient temperature due to the depths of these mines. Since the late 1980's, both private and public efforts have been made to harness this energy resource with increasing success as technology, knowledge and need have advanced.

### History

In the early 2010's, the former Town of Springhill began working with the County of Cumberland and the Cumberland Regional Economic Development Agency (CREDA) to develop a business park using geothermal energy. A **Cumberland Regional Energy Strategy** was completed and in 2012 the Cumberland Energy Authority (CEA) was formed. Just prior to the dissolution of the Town of Springhill a Mineral Rights Lease was granted to the County of Cumberland to control further development of the Geothermal Resource. Several studies were commissioned to further assess the project potential and evaluate historical work. These include **Researching the Geothermal Potential of the Former Springhill Mine** by the Verschuren Centre at Cape Breton University, and a Management Without Borders research project through Dalhousie University.

### Investigations

Upon completion of these research studies, it was decided that the next steps would be to quantify the economic and environmental value of using minewater geothermal energy, and to further study the mineworkings to ensure they were harnessed properly. **The Energy Use Study** was completed in 2017 by Efficiency One. This project evaluated current geothermal users in Springhill and compared them with similar facilities elsewhere using traditional heating and cooling methods. Case studies included the Springhill Community Centre and Byway Packaging. It was found those using minewater geothermal used between **48-78% less energy**. The results were extremely encouraging and prompted support from both ACOA and Nova Scotia Business Inc. for business park development. A **Deep Mine Workings Review** was also completed in 2017 by CBCL, which verified the locations of mine workings below the surface, and suggested the best options for tapping into the minewater resource.

## Development

In 2019 the process began for designing a business park using minewater geothermal energy. A **Concept Pre-Design** was completed by Design Point outlining a business park design, a District Energy System to distribute heating and cooling to customers, and cost estimates. Draft reports are included. Final reports will be submitted this month, and include some optional work examining supplying geothermal energy to the downtown Springhill area.

## Next Steps

Moving forward, the next phase of work is to complete detailed designs for initial construction. The Pre-Design took into account that it is not fiscally responsible to complete an entire new business park prior to attracting business development. Initial detailed design work would be limited to constructing access to early building lots and a limited-scope District Energy System to supply these lots with geothermal energy. As building lots are sold, the park could be expanded in phases, eventually connecting with the highway connector, allowing commercial traffic to bypass local residential streets.

In addition to construction, there is also a need to do subsidence testing on the lands above the former mine workings to provide assurance to developers that there is little risk of sink holes or other mine-related issues. The risk is believed to be very low, but third party testing can confirm this. There is also need for an aggressive marketing plan to attract new businesses and policy work for potentially establishing a new energy utility to operate the District Energy System.

## Costs

Spending on the Geothermal Business Park to date has included studies, well drilling and a minor land purchase. The current Pre-Design phase of the park was budgeted at \$250,000, with the total to date at \$215,530 with one more invoice to come. The Deep Mineworkings Review totaled \$187,857.08, including two test wells. Both of these projects were funded 50% by ACOA. The cost of the Efficiency One Energy Use Study was \$60,785, and a small home was purchased at the potential new entry to the park near the highway connector for \$32,891.



**DALHOUSIE  
UNIVERSITY**

## **MANAGEMENT WITHOUT BORDERS**

**Cumberland Energy Authority**  
*Geothermal Green Industrial Park Initiative*

**Final Report**

MGMT 5000

Jasmine Chen, Andrew Hiscock, Jeff Janes, Scott Kraus, John Richards

December 11, 2015

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## EXECUTIVE SUMMARY

This report seeks to provide a comprehensive external/internal analysis and a preliminary communications plan to the Cumberland Energy Authority for the development of the Springhill Geothermal Green Industrial Park.

The Cumberland Energy Authority (CEA) is a joint municipality energy development initiative in the County of Cumberland, Nova Scotia. The authority's mandate is to promote, develop, and attract renewable and alternative energy in the region. The Springhill mine water geothermal resource is encompassed in the CEA's mandate for development.

The Springhill mine water resource is a now flooded former coal mine. The flooded mine workings allow for temperate water to be pumped to the surface and used for heating in the winter and cooling in the summer due to the heat differential below the surface. Since heat is extracted or transferred back into the water, the same water source can be used for heating or cooling, depending on the needs of the user.

This report consisted of examining existing data collected from various sources on the resource. An external analysis was conducted using a PESTEL and an internal/external analysis was conducted using a SWOT. A jurisdictional scan and communications plan were also developed.

Several recommendations have been proposed for advancing the Geothermal Industrial Park. A greater understanding into the capacity, integrity, and future development opportunities of the mine water resource must be achieved prior to proceeding with substantial marketing and communications. As the integrity of the system is directly proportional to the monitoring and control of its use, it is essential to communicate clear management of the resource to potential investors.

## INTRODUCTION

### PROJECT OVERVIEW

The potential for geothermal energy development in the Springhill area has been a topic of discussion since the 1980's, due to the abundance of abandoned coal mines within the region. In 1986, the first feasibility study was conducted for geothermal energy potential in the area. The results from drilling, pump tests, and chemical analysis revealed that there is major opportunity for development of this resource. This led to Ropak Can-Am Ltd., a packaging company located in Springhill, using geothermal energy as their main heating source for their facility for the last 26 years.

As there is an abundance of abandoned mine sites within the Springhill area, multiple studies have shown that there are opportunities for the development of geothermal resources within the area. The Cumberland Energy Authority (CEA) was formed in 2012 through an inter-municipal agreement between the Municipality of the County of Cumberland, the town of Parrsboro, and the former town of Springhill to promote renewable energy development within the region. As a result of this agreement, the CEA has a mandate that contains a number of objectives:

- The promotion, attraction, and development of renewable and alternative energy sources;
- The promotion and implementation of energy efficiency and conservation programs;
- The development of community sustainability through increased energy security, economic development, and environmental protection;
- The establishment of the municipalities as leaders in renewable energy use, and energy efficiency and conservation; and
- The planning, development, construction, and operation of special projects which include wind and solar unique to the Amherst area, tidal power in Parrsboro and geothermal mine water in Springhill.

The purpose of this project is to develop a communications plan for the CEA, which will be used to provide guidance on how to attract key investors and commercial industries to Springhill, that are interested in incorporating geothermal energy into their operations. This communications plan will aid a funding application that the CEA plans to prepare to facilitate the development of this geothermal industrial park.

### PROJECT SCOPE

The scope of this report involves creating a communications plan for the CEA that will outline and promote the economic development of Springhill and surrounding areas. The communications plan will identify and advertise the economic and environmental benefits that can be achieved by investing in geothermal energy. Likewise, this communications plan will aim to target key

investors and industries, which will have large economic and environmental incentives to integrate geothermal energy technologies into their operations.

## **METHODOLOGY**

The methodology for the development of this report and communications plan for the CEA consisted of a number of tools in order to better understand both the internal and external environmental factors surrounding the development of the geothermal park. The first objective was to complete an environmental analysis to identify the internal and external factors. This involved developing a SWOT analysis to determine the internal and external factors applicable to the geothermal park development. This was complimented by a PESTEL analysis to help further identify external factors in various environmental spheres.

The second deliverable from the methodology was to undertake a jurisdictional scan to get an understanding on what other regions are using, and have successfully developed and implemented industrial parks or district heating systems. This involved researching through academic and grey literature to find cases of geothermal developments in both North America, and throughout international regions. These developments were assessed to look for commonalities or trends that were deemed critical to the successful development of the geothermal system. This would allow the CEA to understand what methods or concepts they could consider adopting in order to further strengthen their position in developing their planned industrial park.

## PROPOSED COMMUNICATIONS PLAN

### PURPOSE

To encourage private investment and tenancy in a newly developed geothermal industrial park in Springhill Nova Scotia. The following communications plan is designed to market the town, and the geothermal industrial park primarily to businesses in Cumberland County. This communications plan is designed to identify potential targets for relocation to Springhill and to establish Springhill as a national and provincial leader in geothermal energy.

### BACKGROUND

The concept of geothermal technology is not a new phenomenon; it relies on the ability to draw warm water from deep within the Earth's surface. Abandoned mine shafts, such as those located in Springhill, serve as the perfect reservoirs for a geothermal heating system. In the Springhill resource, the flooded abandoned mine shafts can be used as reservoirs, significantly reducing the initial costs and lead time required to build a geothermal energy system.

The foundation for Springhill's geothermal capacity was laid in the late 1800's. With the creation of the Springhill Mining Company and the start of coal extraction from the Springhill area (Herteis, 2006). By 1910 Springhill had become a region known exclusively for coal mining, with mining activities being conducted across five coal seams. The Number 2 seam was the most extensively mined, and represents the seam that has been studied most for its geothermal heating capacity (Herteis, 2006). When the mine in Springhill closed in 1958, the No.2 seam had reached a length of 4,400m, and a total vertical depth 1,320m (Herteis, 2006). This now represents a large geothermal reservoir, flooded with ground water naturally heated from the Earth (Herteis, 2006). The high volume of water in this flooded mine shaft presents a great opportunity for the development of a geothermal industrial park.

The potential for geothermal energy development in the Springhill area has been a topic of discussion since the 1980's, due to the abundance of abandoned coal mines within the region. In 1986, the first feasibility study was conducted for geothermal energy potential in the area. The results from drilling, pump tests, and chemical analysis revealed that there is major opportunity for development of this resource. This led Ropak Can-Am Ltd., a packaging company currently located in Springhill, to use geothermal energy as their main heating source for their facility for the last 26 years.

As there is an abundance of abandoned mine sites within the Springhill area, there is opportunity to integrate this technology into the development of the Springhill industrial park. The purpose of this project is to develop a communications plan for the CEA, which will be used to attract key investors and commercial industries that are interested in incorporating geothermal energy into

their operations. This communications plan will help factor into a funding application that the CEA plans to prepare to facilitate the development of this park.

## ENVIRONMENTAL ANALYSIS

### SWOT ANALYSIS

A Strength, Weakness, Opportunities, and Threats (SWOT) analysis is an overview of both the macro and micro factors affecting an industry or business to achieving a strategic goal or mission. For this analysis, the subject being analyzed is the geothermal industrial park development proposed by the CEA. This analysis was designed to understand both the strengths and weaknesses that the CEA possesses in terms of their organization and the geothermal resource that they have, and also understanding the opportunities and threats that exist that could affect the park development. This section provides a overview of a few factors that were identified. For the complete SWOT analysis See Appendix F.

### STRENGTHS

The Springhill mine water geothermal industrial park has the advantage of extensive research existing on the resource and area since the 1980s. With the completion of the Verschuren Centre's report on the resource, the CEA will have an adequate amount of academic credibility when approaching potential corporate investment. Further defining the water quality from the mine will encourage investment.

In addition to academic research on the resource, there is an added benefit of existing manufacturing corporations utilizing the resource in a commercial environment. Proven usage examples such as Ropak and Surette Battery will be the pinnacle of a strong communications plan for potential investment. Water quality has also been shown to be of good quality, which is beneficial to attracting interest into utilization of the resource. Strong case studies of success that are currently using the geothermal resource in Springhill will demonstrate to certain industries that this is a positive investment to make.

Location relative to two Nova Scotia Community College locations is considered a strength for larger corporations seeking training and development facilities. In addition, there is the ability to develop curriculum to meet the labour requirements for potential local employment and long term sustainable staffing requirements surrounding the installation and maintenance of the geothermal resource. This will also be cost effective for industries who invest in the industrial park, as they will not have to outsource or bring in maintenance supplies and services from other parts of the province or throughout Canada. The capacity and capability for maintenance of the geothermal infrastructure can be developed within Cumberland County.

Another Strength that the CEA possesses is tied to the geothermal license that was awarded to the municipal government of Cumberland County by the provincial government. This license gives the municipality a level of autonomy over the promotion, development, and control of the geothermal resource. This separation from the provincial government will help give the CEA more flexibility in terms of how they plan to go about the development of this geothermal park, without any barriers from the provincial government.

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## WEAKNESSES

The long term viability of utilizing mine water in a geothermal system has not been tested. Although insight can be gained into usage patterns and maintenance from existing commercial users, there has not been definitive testing surrounding the effect of mine water on the systems. Due to the use of standard geothermal heat pumps in the systems, the effect on the internal components cannot be verified.

Oxidation of the mine water could cause chemical changes that have the potential to result in clogging of geothermal systems. It will be important to mitigate the risk of oxygen contamination from nearby water table activities to avoid any extra costs associated with maintenance, and to ensure the integrity of the water supply.

Although overall operating costs associated with geothermal are substantially lower, there is a large upfront cost associated with the purchase and installation of the geothermal system components, which may pose a barrier to entry for some companies. Communicating a viable economic payoff and future energy cost stability will be essential to garner interest for any business and will be examined later on in this report.

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## OPPORTUNITIES

Investment in geothermal for commercial heating and cooling may not have previously been an option for many corporations due to inadequate performance of existing systems. The mine water geothermal system offers the ability to move large volumes of water without losing efficiency. The ability to move larger volumes of water in comparison to a simple water table well drilled geothermal system is a key benefit that is offered by the mine water resource.

The Springhill area is largely underdeveloped. Furthermore, there is a current societal trend globally, and within Nova Scotia, towards operating in a sustainable manner. All levels of government are interested in promoting the use of green technologies. The new federal government is specifically concerned with offering financial assistance to companies who are able to use green technologies and ultimately create greener jobs. The municipality and the provincial government are both encouraging investment in the area, and the undeveloped land provides many opportunities to design this park to achieve peak utilization of this renewable resource.

With regards to the mine itself, only the upper levels have been tapped, thus showing only a fraction of the geothermal potential and capacity in Springhill. With much more unexplored areas of the mineshaft, there is opportunity for even more capacity of mine water, and consequently, more opportunity for development. Finally, the low cost of operating through geothermal energy is much more efficient than fossil fuels. Although there is a higher upfront cost associated with installation, there is a relatively quicker payback period than using typical non renewable resources such as coal. This creates an opportunity for companies and industries that rely heavily on heating and cooling as part of their every day business activities.

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## THREATS

There is inconsistent data regarding the long term usage of the mine water as data has only been collected in varying intervals. Further tests are currently being conducted into the mine water quality at lower levels, and the structural composition of other areas of the mine. Geothermal wells can only be drilled where the mine shaft is supported by a ‘room and pillar’ structure, it is unknown yet how many potential wells can be drilled based on this requirement. Furthermore, the long term viability of using the mine water has not yet been definitively determined. There is also potential for lower quality mine water in the deeper portion of the mine shafts as these shafts have yet to be explored in detail in their entirety.

The geothermal opportunity in Springhill is vulnerable to further mining activities. There is currently a proposal for a strip mine to be developed in the local area. If this mine comes to fruition, there is a significant risk that these aggressive mining activities will pollute and degrade the high quality mine water found in the system. This pollution would come from oxidization, as ground water could find its way into the mine shaft. If the mine water oxidizes, the water could clog well and heat pumps, thus lowering efficiency and most likely increasing maintenance costs. Additionally, future mining activities could cause the height of the mine water to drop, this would increase initial investment as larger pumps and wells would be needed to reach the deeper mine water (MacAskill, 2015).

Finally, the long term economic feasibility regarding the existing infrastructure has yet to be determined. The ambiguity surrounding the quality and longevity of the mine water poses potential threats to the economic sustainability of the project.

## PESTEL

A PESTEL analysis was conducted to help compliment the original SWOT analysis, and looked at external factors from the political, economic, social, technological, environmental, and legal aspects. This was done in order to help get a more in depth understanding of the factors that

could potentially influence the ability of the CEA both, positively and negatively, in developing the geothermal industrial park.

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## POLITICAL

There are several incentives brought through political action that increase the attractiveness for establishing business entities in Nova Scotia. Communicating these benefits adds additional value to attraction plans, especially for corporations foreign to Nova Scotia business.

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## FEDERAL PERSPECTIVE

The Liberal Party of Canada has made significant commitments to creating green jobs across Canada. According to Prime Minister Trudeau's platform, his party intends to invest \$100 million more each year in clean technology (Liberal Party of Canada, 2015). Furthermore, the Liberal Party promises to invest \$200 million more per year in order to support clean technologies in the agricultural sector (Liberal Party of Canada, 2015). The potential extra funding for agricultural products forms a special incentive for the business park to attempt to attract aquaculture businesses, such as those found in Truro. These platform promises demonstrate that there appears to be a willing federal partner in Ottawa interested in helping Canadian communities pursue green jobs, and greener technologies. A willing federal partner is a precursor for any strong economic development in the province of Nova Scotia (Nova Scotia Commission for Building Our New Economy, 2014).

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## PROVINCIAL INCENTIVES

The provincial government of Nova Scotia is also committed to rural economic development and the growth of the green technology sector. In 2010 the government of Nova Scotia released their "Renewable Electricity Plan" outlining their strategic plan to move away from fossil fuel energy sources and to become 40% renewable by 2040 (Department of Energy, 2010). The following business incentives reinforce the province's demand for development and to attract businesses to the province.

### *Scientific Research and Experimental Development Tax Credits (NSBI, 2014)*

- Depending on the size and nature of the business, federal SR&ED tax credits can be either 20% or 35% of the eligible expenditures.
- A portion of these credits may be eligible for cash payout.

### *Payroll Rebate (NSBI, 2014)*

- Corporations are eligible for a payroll rebate for up to a five-year period. This rebate is based on the number of jobs created and average annual salaries. Minimum job eligibility is 20 full time positions.

### *Nova Scotia Unlimited Liability Companies (NSBI, 2014)*

- A US taxpayer may be able to use losses from its Canadian business as a deduction against its income for US income tax purposes.
- A US taxpayer could use the NSULC to limit transfer pricing (internal goods and services movements) issues to Canada.
- A US individual could have a local corporate presence in Canada while at the same time having the benefit of a flow-through entity for US income tax purposes.
- NSULCs do not have residency requirements for directors of Nova Scotia companies.

Currently, while Efficiency Nova Scotia offers an installation rebate of up to \$2,500 dollars for residential home owners to install geothermal heat pumps (Nordic, 2015), there does not seem to be any federal or provincial rebate program for industrial geothermal heat pump installations.

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## ECONOMIC

Cumberland County is located in eastern Nova Scotia, towards the border of New Brunswick. The provincial economy, and the Cumberland area have interesting trends. As such, it is important to consider the economic environment at both levels. Economic factors to be considered are economic growth (both provincially and nationally), and national interest rates.

The provincial economy has steadily increased since rebounding after the financial crisis. The Nova Scotian GDP across all industries has increased from a low of \$1.25 trillion dollars in 2009 to \$1.65 trillion in 2015 (Province of Nova Scotia, 2015). However, most of this growth can be attributed to the transition towards urban centres, primarily Halifax (Rashti, Koops, & Covey, 2015). The local Halifax economy has been stagnant in the past few years. However, the economy has shown improvements and is expected to expand 3.1 per cent in 2015, and 2.8 per cent in 2016 (Taylor, 2015).

The economic impact of interprovincial migration is such that there is less capital, both invested and disposable, available in rural areas. This is evident through the economic cycle. Fewer residents in an area like Cumberland County results in lower labour requirements which then reduces disposable income. Lower disposable income lowers the demand for goods and services, which in turn reduces corporate investment in the area. However, Appendix F details cost of labour requirements across the country (KPMG, 2014). Truro is the closest representation of Cumberland in this study, and it is shown in comparison to both Halifax and Canada as having the lowest labour costs.

The Canadian economy is in a much more precarious position, as it is primarily based on resource extraction and exportation. Oil is a driver of gross domestic product growth, and the global downturn in oil prices has caused a downturn in the Canadian economy. The economy is currently in a recession after two consecutive quarters of negative growth. As a result, unemployment has increased to 7.1 per cent (Isfeld, 2015). The current economic situation has pros and cons. First,

high unemployment means a high supply of skilled and unskilled labour. Conversely, it means less disposable income in the system, which would result in less demand for goods and services, as outlined above.

Interest rates are one of the determinants of cost of capital. When interest rates are low, funding projects becomes easier as capital costs are lower. As expected within a sluggish economy, the Canadian interest rates are low in an effort to stimulate and encourage investment. As of October 13, 2015, the Canadian interest rate was a low of 0.50 per cent. This has a positive impact on the industry as companies would be more willing to invest in projects in the area, as the cost of capital is low.

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## SOCIAL

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### PROVINCIAL SOCIAL OUTLOOK:

The release of the final report by the Nova Scotia Commission on Building our New Economy, commonly called the “Ivany Report”, has painted a bleak picture for the future of Nova Scotia’s economy and social demographics if change is not made. They state “Nova Scotia hovers on the brink of an extended period of decline mainly due to an aging and shrinking population” (Nova Scotia Commission for Building Our New Economy, 2014). In July of 2014, Nova Scotia posted an estimated population of 942,668 people. This represented a decrease of 0.03% (262 people) from 2013. This is not a new trend, and Nova Scotia’s population growth has been stagnant. According to Statistics Canada (2012), between the census years of 2006 and 2012, Nova Scotia’s population increased by 0.9%. This was the second lowest growth rate out of all the provinces and territories (Appendix B).

It is also noteworthy to see the demographic shifts that are occurring within the province. In 2011, it was estimated that 43% of the province’s population lived within rural areas, double the Canadian average at the time (Gibson et al., 2015). However, this has begun to shift, and between 2010-2014 only the counties of Halifax and Hants saw any type of population growth (Appendix C); the rest all suffered declines. Out-migration is another issue that rural areas of Nova Scotia are facing (Appendix D). As of July 1st, 2015, Nova Scotia saw a net outmigration of 1,286 people (Department of Finance, 2015). This was less than the 2,172 totals posted from 2014, but the province has been on a decline for some time. These trends are resulting in rural depopulation and many people moving towards the more urban centres of the province, and out of the province. This can present large issues to those left in rural communities regarding succession planning and maintaining the community’s economic viability.

The aging demographic of Nova Scotia has also presented a challenge to the province. Currently, Nova Scotia is the second oldest province in the country, trailing only Newfoundland and Labrador in median age (Nova Scotia Commission for Building Our New Economy, 2014). In 2014, The Canadian portion of the population 65 years and older was at 15.7%. Nova Scotia ranked the

highest in all Atlantic Provinces with 18.3% of the population aged 65 and older (Statistics Canada, 2014). This aging population is expected to continue as the baby boomer generation moves closer into retirement.

#### REGIONAL SOCIAL OUTLOOK: CUMBERLAND COUNTY

Cumberland County is facing a situation similar to many other rural counties within Nova Scotia. The provincial government released a population estimate in 2015 that showed Cumberland County with a population of 30,835 (Department of Finance, 2015). This marks a 1.7% decrease from their 2011 census population of 31,353 people (Statistics Canada, 2012). This is in part due to the out-migration problem that rural communities in the province have been facing (Appendix D). Cumberland County is no exception to this, and between 2013 and 2014 it lost 194 people to this problem.

Likewise, the age demographic issues in rural regions are extrapolated compared to the province as a whole. For example, Nova Scotia had an estimated 18.3% of its population were above the age of 65, but many rural regions had higher ratios. Cumberland County in particular has an aging population (Appendix E), with just under 25% over the age of 65. Likewise, the population between 18 and 64 in Cumberland is also lower than the provincial average (Appendix E). This shows the challenging demographic situation that Cumberland County finds itself in, and highlights the importance of attracting industries to the geothermal park that can bring more workers into the region to increase the county's resiliency and economic prosperity.

#### EMPLOYMENT AND EDUCATION WITHIN CUMBERLAND COUNTY:

According to statistics from the 2011 National Household Survey, Cumberland County had an employment rate of 48.9% and an unemployment rate of 11.4% (Statistics Canada, 2015). This is slightly below the provincial average unemployment rate of 10% (Statistics Canada, 2013). Manufacturing is one of the most prominent industries in the region with approximately 1,855 related occupations. This is second only to healthcare and social assistance with 1,915 positions (Statistics Canada, 2013).

There is a good percentage of education within Cumberland County, and this can be partially attributed to the presence of Nova Scotia Community College Campuses located in Amherst and Springhill. Out of the population aged 25-64 (16,290 individuals), about half (8,870) have a post-secondary certificate, diploma, or degree. Approximately 2,305 people have either a trade or apprenticeship, while 2,085 have a degree at the bachelor level or higher (Statistics Canada, 2013).

#### SOCIAL PERCEPTIONS IN NOVA SCOTIA

As documented in the Ivany report along with several other news publications, Nova Scotia, and particularly rural Nova Scotia, has a prominent negative connotation toward change of their

traditional lifestyle (Nova Scotia Commission for Building Our New Economy, 2014; Ibbitson, J., 2015). This may prove to be a large barrier to implementation of a geothermal initiative in the town of Springhill. Although the resource is an existing part of the coal mining industry that the province relied on for generations, this reluctance to deviate away from cultural identity or tradition (Dukeshire & Thurlow, 2002) could pose as a barrier of entry to some companies that may want to establish a business in the local community. As such, communication to the local community will be critical in establishing a plan for development of the geothermal resource and subsequent industrial park. However, there has been no formal protest or community opposition towards the geothermal development that the team has discovered, which could pose well for the project moving forward.

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## TECHNOLOGY

Technological developments play a big role in reducing the cost in developing and operating geothermal energy, and identifying the capacity of the resources, therefore making the industrial park more appealing to its investors and clients (Björnsson et al. 2012).

When it comes down to the specific geothermal technologies, geothermal drilling generally involves dealing with hard rock, high temperatures and corrosive fluids (Coles 2009), and accounts for a considerable part of geothermal projects (Barbier, 2002). The expense of the drilling to create the geothermal exchange field is usually a big cause for the high installation costs for geothermal projects (Michigan Technological University, 2013). In the context of Springhill, the technology for drilling boreholes for low temperature geothermal systems is much more simple compared to the ones for drilling water wells (Coles, 2009). Therefore, the reuse of existing mineshafts significantly reduces the drilling cost, thus results in considerable overall project savings (Michigan Technological University, 2013).

Regular heat exchangers and heat pumps have been used for energy transfer from the geothermal mine water in Springhill since its first commercial utilization (Michel, 2007). The technology is reliable, stable and widely available. The coefficient of performance (COP) is a measure of heat pump efficiency: the heat output divided by the energy input. The estimated COP for the system in Springhill was 3.6 (Watzlaf & Ackman, 2006), which falls into the typical COPs range for heat pumps 3-4.5 (Coles, 2009), therefore can be considered as efficient.

Geographical Information System (GIS) is a computerized approach that is able to determine the spatial associations by combing multiple evidence layers in the area of interest (Noorollahi et al. 2007). It is an important tool in the identification and development of geothermal resources, as it allows the analysis of data by combining various sets of geoscientific data (Noorollahi et al. 2007). GIS has been widely used to evaluate geothermal systems (Coolbaugh et al. 2002), and identify promising areas for geothermal exploration (Noorollahi et al. 2007). In Springhill, except for No.2 Seam, the evaluation of which has been completed, each of the other seams requires further investigation to estimate the identification and location of potential geothermal resources (Michel,

2007). The application of GIS in investigating these seams will permit accurate identification and location of potential drill targets, therefore allow estimating the capacity and future development.

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## ENVIRONMENTAL

The coal mining industry in Springhill started in 1872, and thrived until 1958, after which the mines were allowed to be flooded with water (Jessop, 1995). In 1980s the idea of utilizing the mine water for space heating/cooling in Springhill was concluded feasible, and then the town began the commercialization of its geothermal resources (Jessop, 1995). The capacity of No.2 Mine is estimated to be of between 4,350,000 m<sup>3</sup> and 5,500,000 m<sup>3</sup> of mine water (MacAskill, 2015). While other mines have not been investigated to this level, it is safe to say that the abandoned mine workings are capable of providing substantial renewable energy resources. The industrial park is located in the western part of Springhill, directly over the mine workings, therefore benefits from the steady massive renewable mine water resources.

Geothermal is a sustainable replacement for fossil fuel energy. Switching to geothermal results in a reduction of fossil fuels required for oil heating and conventional cooling, thereby reducing pollutants and greenhouse gas (GHG) emissions. Even though it is a small quantity compared to the GHG and air pollutants emissions nationally or globally, using geothermal is environmentally responsible, and could potentially contribute to climate change mitigation (Jessop, 1995). The heat pumps that are driven by electricity, however, lead to GHG emissions. On average, the electrically driven heat pump reduces GHG emission by 45% compared to an oil boiler (Fridleifsson et al. 2008). In Nova Scotia, 75% of the electricity in 2014 was generated from coal, natural gas, and oil (Nova Scotia Power, 2015).

One of the environmental concerns regarding geothermal energy is that the water contains a variety of pollutant gases, like nitrogen and carbon dioxide (CO<sub>2</sub>). However, the gas emissions from low-temperature geothermal energy is normally at low levels compared to those from high-temperature ones. Emissions like CO<sub>2</sub> are usually negligible in low-temperature geothermal production (Fridleifsson et al. 2008). Since the geothermal system in Springhill is a closed loop, the emissions and chemicals go back into drill-holes, and are not released in to the environment. The system generates little negative impacts on the local environment when it is in routine use (Jessop, 1995).

Mine water quality is an essential component to sustainable operation. In the context of Springhill, the levels of metals, such as Iron, Manganese and Zinc, are higher than Canadian Drinking Water Quality and Freshwater Aquatic Life Guidelines, although, lower than the concentrations observed in other coal mine waters (MacAskill, 2015). Most of these problems have negative impacts on the system efficiency, such as clogging of heat pumps and system corrosion, rather than resulting in environmental contamination (Grasby et al. 2012).

Another concern is the possibility of a mine collapse when the shaft is not entirely filled with water. To prevent collapse, all water needs to be returned to the subsurface in order to minimize

pressure differentials. Issues with collapse and surface subsidence need to be taken into consideration when designing, constructing and operating the system (Michel, 2007).

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## LEGAL

The mine water resource found in the Springhill mine is subject to *Special Mineral Lease 13-01; Springhill Area* granted by Nova Scotia Natural Resources in December 2013 (Herteis, 2014). This effectively transfers management and coordination of the resource to the CEA.

The Nova Scotia government has enacted legislation mandating the use of renewable energy sources for load serving entities, increasing renewable energy to above 25% of total energy provided. By 2020, this goal is set for 40% of total energy usage (Efficiency NS, 2014). Communicating the “green value” of Nova Scotia will be essential to developing strong business cases for relocation and development.

In addition, Nova Scotia seeks to enhance the building code surrounding energy efficiency. By 2018, the NS building code will include energy performance requirements that are 15% improved over the National building code. (Efficiency NS, 2014). Utilization of geothermal energy will result in an overall net energy usage score lower than that of conventional heating and cooling methods. Nova Scotia businesses have demonstrated that the overall savings on energy efficiency programs far exceed the costs of implementation of these programs (Appendix G).

## ANALYSIS/SYNTHESIS

The rural economy in Nova Scotia is struggling, and is expected to continue to struggle moving forward. The interprovincial migration is having negative impacts on the labour pool. As such, There is lower demand for skilled workers in rural areas. This exacerbates the situation because the economy cannot improve without an influx of capital, either financial or human. The change in demographics and social trends is forcing capital out of these rural areas. This poses a significant challenge as it will have to evaluate the potential to shift capital back into the rural area. This industrial park project has the potential to create multiple jobs within Springhill and Cumberland county, and therefore inject valuable economic activity into the region that the County can use to help fosters its long term development. the strength of having two educational institutions within Cumberland county also means that some of these jobs in geothermal maintenance and installation can be produced within the region. Education and training programs will be able to help community members gain meaningful employment and to stay within Cumberland County.

One critical issue that could threaten the future development of the industrial park is the level of uncertainty surrounding the mine shaft. While there has been extensive research conducted to date, this has focused mainly on the no. 2 mine shaft, and typically mine water in the shallower areas of the mine shaft. This leaves six more mine seams that need to be researched more extensively in

order to determine their characteristics and long term viability. When attempting to attract investors, more tests need to be done in order to determine capacity, and integrity of the mine shafts to remain intact, thus reducing risk for companies who are interested in investing in geothermal energy.

In saying that, there are many strengths that the CEA has moving forward. They have a breadth of research conducted on the no. 2 mine seam, all of which have yielded positive results. Another major asset moving forward with the development of the industrial park are the two cases of major success in Ropak and Surette, who have been using the resource extensively for decades with little issues. This will be a good showcase to show that the benefits from geothermal are tangible and real, creating a positive outlook for future investors. The acquisition of the special mineral lease from the provincial government is also a strong asset to have. This releases the CEA from some of the restrictions that may have been involved with the provincial government processes, and they now have autonomy on how they want to go about developing the industrial park.

#### COMMUNICATIONS OBJECTIVES

<b>Objective:</b>	<b>Measurable:</b>	<b>Outcome:</b>
<b>Secure businesses for Springhill's geothermal industrial park</b>	<ol style="list-style-type: none"> <li>1. Number of businesses who lease space in the geothermal industrial park</li> <li>2. Number of businesses interested in leasing space in the Springhill geothermal industrial park.</li> </ol>	<ol style="list-style-type: none"> <li>1. Long term economic development of Springhill</li> <li>2. Increase employment in Springhill</li> <li>3. Establishment of Springhill as a provincial and national leader in geothermal heating/cooling</li> </ol>
<b>Create housing/apartment developments which use geothermal heating/cooling</b>	<ol style="list-style-type: none"> <li>1. Number of companies interested in building houses with geothermal heating/cooling</li> <li>2. Number of houses built using geothermal heating/cooling</li> </ol>	<ol style="list-style-type: none"> <li>1. Increased migration to Springhill</li> <li>2. Revival of the town of Springhill</li> <li>3. Economic development of the town of Springhill</li> <li>4. Establishing Springhill as a provincial and national leader in residential geothermal heating</li> </ol>

<p><b>Springhill becomes a specialist in geothermal heating/cooling in Cumberland county</b></p>	<ol style="list-style-type: none"> <li>1. Number of times Springhill is consulted/cited as a case study for geothermal heating/cooling</li> <li>2. Media coverage of the geothermal park</li> <li>3. Cost savings for residents of the geothermal park (commercial and residential)</li> </ol>	<ol style="list-style-type: none"> <li>1. Springhill's geothermal capacity can be leveraged as part of a broader tourist strategy</li> <li>2. Springhill becomes a provincial and national leader in geothermal heating/cooling</li> <li>3. Companies migrate to Springhill in order to take advantage of geothermal capacity.</li> </ol>
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## STRATEGIC CONSIDERATIONS

One of the strongest strategic considerations concerning the development of a geothermal industrial park is the required community buy-in. The project is expected to be broadly supported by community stakeholders. This limits the potential pushback from the community, and will ensure smooth progression when the project moves into the public consultation phase.

Geothermal heating requires significant initial costs in order to establish the capacity for heating and cooling. Heat pumps and the other required infrastructure is expensive to purchase initially and this can be a significant deterrent to finding businesses to develop in the park or relocate to Springhill. In order to mitigate this concern, there can be several government grants and programs available to corporations. However, these programs demand cooperation from multiple levels of government with the private sector. This level of collaboration can be inherently tenuous and difficult to maintain. Therefore, it is recommended that the CEA play a liaison role between potential industrial park residents and the levels of government. Managing the relationship between government and the private sector will be a key to the success of the industrial park.

It is important to address the relative uncertainty facing the geothermal project in Springhill. This uncertainty is present in both a legal context, and in a qualitative context. Legally there are concerns as to who owns the mine water, and while it is on a special lease from the province, there is a risk that this lease could be renegotiated. There also needs to be development of specific geothermal by-laws that regulate the pumping of the mine water out of the mine, and back into the mine in order to maintain the integrity of the open loop system. There is further uncertainty into how much geothermal potential is actually present in the mine. Currently, only a small fraction of the mine has been surveyed and studied, this leaves a lot of uncertainty for potential investors if it remains unknown the entire quality of mine water, and more importantly what flow rates can be achieved on a consistent basis. Higher flow rates are needed for larger and larger applications,

however there could be a question into how such how flow rates can be sustained, and what kinds of flow rates can be achieved. This qualitative data would need to be known with confidence in order to begin marketing the industrial park to potential investors.

## KEY AUDIENCES (TARGET MARKETS)

### MARKETING MIX

While identifying a target market is the one of the initial steps in developing a marketing strategy, utilizing the marketing mix framework allows for better customization of marketing strategies. The fundamentals of the marketing mix include identification and communication of the 4 P's of marketing: Product, Price, Promotion, and Place.

### PRODUCT

Springhill Mine Water Geothermal Industrial Park. Outlining the benefits and features of the product is the foundation of the market mix. The lifecycle of the product must also be taken into consideration when identifying product attributes. Product lifecycle stages are identified in appendix I. The Springhill Mine water resource has been utilized by several local establishments for over 20 years, however, tangible data and reporting of this use has not been consistently collected. Due to the lack of consistent usage data, and the relatively few users as compared to traditional geothermal, the primary consumers of the resource will be “Early Adopters” and “Innovators”. In addition, diversifying the product line can offer perceived value to consumers. While the product as a whole can be described as the mine water resource, it can be further diversified into several product components with different target markets. For example, a manufacturer of LCD TV panels can diversify a product line through commercial large screens and domestic consumer TVs. Identifying the product lines available will assist in forming a message that is tailored to specific markets. Initially, the CEA may focus on segmenting the product into residential/small business use and larger scale commercial use.

### PRICE

Outline the economic benefits and feasibility of the geothermal resource. Any fees, incentives, and applicable financial factors should be outlined. Marketing price should be in line with what the customer views as the perceived value of the product. Perceived value of the mine water resource is not only the economic savings from conventional energy usage, but also the corporate social responsibility influence which are often less tangible.

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## PROMOTION

How the product is promoted to the target market and potential users. This can be through several methods as identified in the attached communications plan. Utilizing the benefits of web 2.0, or the interconnections of social media, is seen as a modern incarnation of ‘word of mouth’ and is essential to testimonial and public relations.

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## PLACE

How the consumer can obtain the product through distribution methods. In the case of the geothermal mine water, this involves the use of intermediaries between the CEA and potential investors/developers. Intermediaries consist of independent organizations that make the product available for consumption for the end user.

## MARKET STRATEGY

Marketing strategy is centered around problem resolution for multiple stakeholders. The Geothermal Industrial Park requires development of marketing strategy encompassing the Community, Investors, and Geothermal expertise.



## TARGET MARKET

As examined in previously collected data, the Springhill mine water resource is typically cooler than traditional geothermal uses for high heating requirements. Due to the open loop/removal-return system operation, overall the resource can be compared to similar case studies that utilize underground aquifers, where water is of comparably cooler temperatures. This increases the potential for identifying target customers with heating requirements, but also significant cooling requirements as well.

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## AGRICULTURE/AQUACULTURE

Worldwide, agriculture/aquaculture is the second largest use for geothermal energy. The ability to cost effectively control temperature control allows for production capabilities in seasons that would otherwise not be feasible from standard heating/cooling methods. Appendix M is an example of geothermal agri/aquaculture uses in Europe (Duffield, 2012).

In agriculture, there are several applications of geothermal energy that can be used to regulate the temperature within the system. Methods of temperature regulation will be case specific and will involve external consultation of equipment available. Temperature regulation is essential in on land aquaculture. In a fish farming plant the growth rate of the fish can be increased by 50 to 100% by controlling temperatures (Ragnarsson, 2014). The water temperature depends on the species involved, any typically ranging from 13 to 30°C.

Locally, facilities such as Oxford Frozen Foods could greatly benefit from the ability to utilize water to water geothermal cooling. In addition, Truro Herbal Co., a medicinal marijuana production company, is currently in the approval process for a manufacturing/warehouse facility in the Truro Industrial Park. In a recent article in the Chronicle Herald, 2015, the organization has indicated potential expansion in the near future, and may benefit from the cost reduction in large scale geothermal application

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## DATA CENTERS

Canada is increasingly becoming a “hot spot” for data centers due to the abundance of ambient cold weather (Globe and Mail, 2012). With cooling costs being one of the largest cost requirements for data centers, it is an attractive proposition to relocate to cooler climates. The feasibility of data center construction would also rely on connecting to data communication networks to flow data to surrounding geographical locations. Appendix K is a network connectivity example from Telus, demonstrating the existence of nodes and connections that may influence the location of a data hub.

The relatively lower temperature of the mine water provides an optimal source for cooling. The Telicentre datacenter in Amsterdam is an existing case study of the potential for large scale

geothermal temperature regulation. The facility uses an underground aquifer as a heat sink, pumping heat during the summer into the underground reservoir, and using a combination of surface air cooling in the winter to manipulate the temperature of the reservoir in preparation for the next summer cooling requirements (Geere, 2012).

While data centers require short term employment related to construction and infrastructure, the overall job creation would be lower than a comparatively sized manufacturing facility. Data center staffing requirements are typically focused on maintenance, security, and overall facility upkeep. Utilizing the local community college infrastructure would benefit training for the IT services programs.

Locally, IBM has recently established a corporate location in Bedford. This facility is currently still in the hiring/expansion phase. Globally, IBM is a proponent of corporate social responsibility initiatives, and environmentally sustainable practices.

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## MANUFACTURING

Industrial manufacturing applications offer the ability to use the geothermal resource in both space heating of large production/warehouse floors and also in production processes. Utilizing the case studies of Ropak and Surette Battery will be essential for proof of concept in both space heating and business processes. Economic development and sustainability in the area would greatly benefit from the addition of a greater amount of jobs in manufacturing.

Locally, LED Roadway lighting is a significant employer in the Amherst region. Locating an expansion relatively close to existing facilities would be advantageous for distribution efficiencies.

## KEY MESSAGES

The following are some general key messages that could be used by the CEA when marketing the geothermal industrial park to potential investors:

1. Geothermal heating is extremely efficient, costing approximately 1.9 cents/kWh compared to electric heating at 1.92 cents/kWh and diesel heating at 1.96 cents/kWh. With this efficiency, Ropak manufacturing has been able to cut their heating and cooling costs by \$160,000 per year. The Springhill community centre has been able to achieve similar cost savings, but on a much smaller scale. The community centre generates annual cost savings of \$50,000 – \$80,000 per year.
2. Springhill's geothermal potential is nearly unlimited with an open loop system it is possible to pump massive amounts of mine water for any heating and cooling application. This positions the geothermal industrial park as a logical destination for large scale industrial operations such as manufacturing, food processing, and agri/aqua culture. Springhill can offer a green heating solution with unmatched volume and scale.

3. Geothermal heating and cooling is quickly becoming a widely used resource. Ropak and Surette have been using geothermal heating and cooling in Springhill for over two decades without any issues. It is reliable, and easily transferrable to multiple applications, as the community centre also uses geothermal heating to achieve massive cost savings. Geothermal heating is a clean alternative that is more efficient and more environmentally friendly than conventional heating and cooling methods.
4. The geothermal industrial park in Springhill is a green clean energy resource. It builds off of the town's existing network of abandoned coal mines to create a cleaner energy resource. The once 'dirty' coal mines, are now able to provide a cleaner and greener energy alternative that connects the town's cultural past to its economic future. The development of the geothermal industrial park creates a new renewable resources from the non-renewable infrastructure of the Springhill coal mines. Investment in this park provides an opportunity to connect with the towns past, while also provide for its future.

## **COMMUNICATIONS ACTIVITIES/TOOLS**

It is recommended that the CEA engage in the following communications activities:

1. Social media campaign showcasing the cost savings experiences by industries using the geothermal resource in the area. These advertisements should provide both quantitative data, in terms of cost savings, efficiencies, and flow rates required. The advertisements should also include the qualitative data describing the consistency of the heating/cooling and the overall experience in geothermal heating/cooling.
2. Begin to start marketing the geothermal park at industry tradeshow. Demonstrate to manufacturers and companies in Cumberland County the advantages of moving to the industrial park and how geothermal heating is perfect for their particular application, and offers a competitive advantage for them because of the cost savings associated with geothermal heating.
3. Partnerships with the local Chamber of Commerce in order to market and advertise the benefits of Cumberland county including the lax land development by-laws, the geothermal capacity, the industrial park as a whole, and the expected cost savings that can be achieved.
4. Engagements with communities in Atlantic Canada who also seek to develop energy management initiatives within their community in an effort to unify best practices and collaborative initiatives.

## **EVALUATION**

Evaluation strategies for the communications plan are somewhat limited, as it is difficult for the CEA to really gain insight into how public opinion is towards the development of the industrial

park this early in the project development. It is important to set a benchmark of how the industrial park is currently perceived before beginning any of the communications activities. Evaluation mechanisms such as social media analysis, and a broader local media scan should be conducted a few months after an initial benchmark of opinion is established, and a few months after the communications activities have commenced. This data can be used to understand the ways in which public opinion towards the industrial park has changed over time. This change should be noted as a relationship between the key messages, and how aware the target audiences are of the key messages and the main advantages the geothermal industrial park can offer. The main evaluation strategy for the communications plan will be determining how many investors are reached by the communications plan, and how many investors become actively interested in investing the geothermal park. This data could be collected through tracking web-traffic on the social media sites, or on the CEA website as a whole. Furthermore, the CEA could keep track of the amount of visits to their booth during tradeshows or the number of people who are asking questions about the geothermal park and seem to have a genuine interest in becoming part of the project.

## **JURISDICTIONAL SCAN**

In order to better understand the potential geothermal applications that could be viable in Springhill, it is important to look internationally at successful geothermal projects. Two examples from North America, as well as two examples from the International community are analyzed in order to determine the best practices, and potential challenges that may present themselves when developing the geothermal industrial park.

### **NORTH AMERICA**

#### **KLAMATH FALLS, OREGON, USA.**

The Klamath County geothermal agricultural industrial park was a geothermal development in Klamath County, Oregon that was directed by the South Central Oregon Economic Development District (SCOEDD) to help develop the existing geothermal resource. Klamath County, Oregon, fits a similar description to that of Cumberland County in Nova Scotia. Likewise, the town of Paisley within Klamath can draw similar comparisons to that of Springhill.

Paisley is a rural community that was heavily reliant on the timber and forestry industry for generations before the downturn in public lands logging (SCOEDD, 2011). Likewise, Springhill also has a long history of resource dependence, as coal mining is such a large part of the town's history. The idea behind the geothermal development at Klamath Falls bears a similar idea from the CEA as well. The vision is for industries "to be able to utilize a resource while also enhancing development opportunities in rural distressed areas" (SCOEDD, 2011). For areas such as Paisley

and Springhill, this geothermal resource represents a new economic future that could help maintain and grow these towns into vibrant and thriving communities.

Klamath County is considered a rural area, and their goal was to attract new businesses to their business park development. As a result of their separation from major community hubs, they had a specific focus on aquaculture and agriculture related businesses. This was also in part to a lease agreement that was signed between Green Fuels of Oregon Inc. and Liskey Farms to develop a biodiesel manufacturer on the existing facility. As a result of this, the farm began to transition itself into an agro-industrial park.

The overall goal was to establish a functional producing geothermal well on a property that could then be leased or purchased by businesses that were looking to expand into the area for geothermal use. Establishing a system for lease or purchase will help reduce some of the regulatory, drilling, awareness, and engineering challenges that may otherwise slow down or halt progress of development and securing tenants (SCOEDD, 2011).

The development of the park was based on a 4 phase system, with the first being a land parceling system, whereby areas of productive geothermal activity would be identified through the collection of data and tests. These parcels would then be evaluated and chosen as the site for the park development. This would involve looking at existing geothermal wells next to adjacent land, water availability, utilities, zoning, land access, land-use bylaws, etc. Through this, they were able to come up with a legitimate area of land to be used as a geothermal industrial park.

The second phase of this development was accessing the necessary land available for a geothermal development. Within Klamath County, this involved discussions with Liskey Farms in order to allow the SCOEDD to purchase the land needed in order to expand the geothermal operation and create an agro-industrial park development. As a result of this, a model-leasing program was created between Liskey Farms and potential lessees that allowed the use of property and geothermal water for heating and cooling of buildings, irrigation of crops, warming of water, and other terms consistent with the lease.

Once leases and terms of agreement were finalized, developments on the properties would begin, starting out by drilling a well and pump testing to prove the resource and its capacity is productive and reliable. Once the functioning well was established, any water rights or regulatory requirements would be enacted to reduce the burden on the developer. The expected outcome from these three stages was to establish a proven functioning well on an identified parcel of land that has been transferred to the developer.

The final phase of the development was to include an outreach program in order to further publicize and promote the geothermal resource in Klamath County. This involved targeting specific industries that they wanted to attract to their county, and attending various industry conferences and trade shows from multiple organizations that relate to the types of target industries that the SCOEDD wanted to bring to Klamath County.

As a result of this system, the SCOEDD was able to expand the geothermal resource to companies such as “Gone Fishing” farms, which uses heated wastewater from the Liskey Farm greenhouses in a cold pond to create water roughly 27 degrees Celsius. A pond of this temperature is required to grow tropical fish for aquariums, and tilapia for the consumer market.

Another company that has taken advantage of this resource is Biotactics, which supplies augmentative biological controls for spider mite pests. The company farms eight different species of predatory mites for various climates, and switching to geothermal helped them reduce their utility costs and reduce reliance on propane for heating. The company currently employs about 11 full time positions and is planning expansion in the near future.

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#### ELKO HEAT COMPANY, ELKO, NEVADA, USA.

Located in Elko Nevada, the Elko Heat Company has been operating a geothermal district heating system (DHS) since 1982 and supplies heating services to various clients throughout the community (Oregon Institute of Technology, 2006). The original layout of the geothermal system provided services to three companies. Two companies primarily use the system for space heating and hot water heating. These companies also make use of the return water for melting snow and ice on walkways during the winter months. The third company is a laundry facility. This facility is actually softening the hot water and using it directly for wash and rinse water in their laundry machines (Lund, 2001). However, there are now 17 companies making use of Elko's geothermal capacity. Users of geothermal energy in Elko include: the Bank of America, Wells Fargo, the Elko County Courthouse, a casino, and Nevada Energy, which is actually the local electric utility of the county (Sabo, 2010).

This system differs from many other geothermal systems observed as it runs on an open loop circuit. Instead of being re-injected back into the groundwater source after use. The return water is sent through a separate un-insulated return pipe to be discharged to a cooling pond, followed by a discharge into a wetland adjacent to the Humboldt River. The quality of the return water is such that cooling is the only necessary step required in the discharge process (Lund, 2001). The open loop system was chosen as the preferred design by the Elko Heat Company because it has many advantages over a closed loop structure. First, open loop systems reduce the up-front capital costs associated with system installation; second, it allowed for a more efficient use of geothermal fluids, such as the Laundromat being able to use the water for their operations; and third, it allows the company to charge a user fee for the service based on the volume of geothermal fluid consumed. (Lattin & Hoppe, 1983).

One element that was highlighted as a critical factor in the initial development of the Elko park was the partnership between Elko Heat Company and the Department of Energy (DOE) in providing much of the start up costs to the original geothermal developments. The cost structure was broken down so that the DOE would provide funding for all the high risk start up costs and the Elko Heat Company's costs would increase as the probability of a successful well increased.

The end-user companies only had to pay for the retrofitting of their buildings to accommodate the system (Lattin & Hoppe, 1983). In total, the original development of the Elko DHS cost roughly \$1,398,269 USD. \$827,504 USD was provided by the DOE. While amount of \$289,765, and \$281,000 were split between the three end-users (Lattin & Hoppe, 1983). Without this federal funding from the DOE to Elko, their smaller capital base would have provided a repayment window of 25.6 years. This long repayment period would have made the project economically unfeasible from the beginning. With the government funding, Elko calculated that its estimated payback period would be 6-7 years. (Lattin & Hoppe, 1983).

Based on Elko's experience, they created a strategy and list of conditions that need to be realized in order to successfully attract new users to adopt geothermal energy. These conditions could be modified and applied in part of a marketing strategy for the Springhill Geothermal industrial park. The conditions are:

1. The geothermal system has to be in operation and have a proven track record of reliable and efficient operation over a number of years. This includes consistent flow rate data, as well as temperature and water quality data.
2. Any user or potential user has to be able to analyze the benefits of geothermal energy and determine the potential cost savings.
3. Any user or potential user has to be able to determine what will be required in the way of geothermal retrofits for their building/specific application and determine what the associated costs will be.
4. Every geothermal application needs to determine the financial structure that works best for them. Considering the open-loop nature of the system Elko Heat Company has, user fees based on the volume of consumption (in gallons) is the most effective cost structure.
5. To be successful in getting new customers, a well-organized sales program is necessary. Potential customers have to be sold on the benefits, both qualitative and quantitative of geothermal energy. (Lattin & Hoppe, 1983).

The Elko system followed a leasing standard common to other jurisdictions, but they had various incentives to help entice companies to adopt geothermal energy. One option was to have Elko charge only 50% of the normal rate for the first three years of the contract, free geothermal use for two years and/or Elko Heat Company paying for retrofit and the customers pay the rate they were paying for conventional fuel over the next five years (Lund, 2001). These incentives serve as an extra push and motivation for companies that may have difficulty making the commitment to switch to geothermal energy.

The next example of geothermal application comes from a Canadian example in Îlees-Chênes, District Heating System, Manitoba, Canada.

Île-des-Chênes is a small community of about 1,200 people located near Winnipeg, Manitoba. It is within the municipality of Richot and has been operating a small DHS within the region since

2011. Île-des-Chênes has similar problems to Springhill and because of the limited property tax base, Île-des-Chênes has struggled to maintain a modern infrastructure and amenities. By the early 2000s, its town hall, which was housed in a 60-year-old schoolhouse, existed solely on subsidies from the regional municipality. Likewise, the local hockey arena was losing revenue because of the inability to book a full season, caused by a failing ice plant and an uneven concrete ice subsurface that was slowly collapsing (FCM, 2012).

The regional municipality adopted a green policy in 2009 and decided to renovate the town hall with a new community centre that would achieve LEED certification, and one of the ways the municipality wanted to achieve this certification was through the creation of a geothermal system. The regional municipality applied for and received funding from the federal Infrastructure Stimulus Program, Community Adjustment Fund (FCM, 2012).

After the community centre was addressed, the community looked towards its aging hockey rink and fire hall as potential candidates to link into the geothermal system. The federal funding provided enough funding to secure the geothermal system for the community centre, so the community applied for further funding and received it from the provincial government to install a geothermal system into the arena and into the fire hall as well (FCM, 2012).

As a result of this installation of a DHS, the rink estimates that it saves \$15,000 per year in heating costs compared to their traditional system. Cost savings have also been recognized in both the fire hall and the community centre. Along with this, the community is also significantly reducing its emissions, and has created new local jobs from the system (CDEM, 2014). The successful application of a geothermal energy system has helped re-energize the town, and reduce its emissions significantly.

## INTERNATIONAL

### HEERLEN, NETHERLANDS

Heerlen is a municipality located in the southeast of the Netherlands. Similar to Springhill, Heerlen also had a history in the coal mining industry. Heerlen had been thriving off of coal mining for a long period of time before the production diminished and mines shut down. The abandoned and flooded mines under Heerlen present a great potential for geothermal mine water applications. The top layers of the mines in Heerlen (approx. 200m in depth) contain water ranging in temperature between 15- 20 degrees Celsius. The deeper layers (approx. 700– 800m in depth) have water ranging in temperature between 30 – 35 degrees Celsius. (Op ‘t Veld & Demollin-Schneider 2007). The mine water in Heerlen provides similar geothermal potential as to what is found in Springhill.

The municipality realized that the utilization of the geothermal mine water has the potential to lead to economic and community rehabilitation (Op ‘t Veld & Demollin-Schneider 2007). In 2011, 350 residences, 40,900 square feet of commercial space, and 174,400 square feet of community

buildings have been successfully linked to the DHS system created by the municipality of Heerlen. (Michigan Technological University 2013).

The mine water program was developed in two stages. Mine water 1.0 refers to the initial development from 2003 to 2008. It was 48% funded by the European Interreg 3B North West Europe Program. This program is aimed at promoting the economic and environmental future of North West Europe, and the 6th Framework Program project, EC REMINING-lowex (Redevelopment of European Mining Areas into Sustainable Communities by Integrating Supply and Demand Side based on Low Energy Principles) developed by the European Union Commission (Op 't Veld & Demollin-Schneider 2007). A pilot system was developed to investigate the capacity of the geothermal potential and the restrictions of the pre-existing coal mine system.

What makes Heerlen's mine water development significant is that the project is ongoing. Heerlen is currently pursuing mine water 2.0. The second phase of the mine water program is based on the experience gained through the initial pilot projects. The system is currently being upgrading to a full-scale hybrid sustainable energy structure.

Part of the mine water 2.0 program is to establish the mine water corporation. This corporation will coordinate the structures that are connected to the grid, and connect other sustainable energy suppliers to the grid. These other energy suppliers will benefit the energy exchange and reduce the strain on the geothermal resource. In this application, building owners are charged for their connection to the mine water, as well as a user fee based on the amount of water used for geothermal heating and cooling (Op 't Veld & Demollin-Schneider 2007).

The Herleen project also takes advantage of a large scale energy exchange between buildings and geothermal applications. Buildings can be both an energy consumer and an energy supplier. For instance, a building extracting heat from the grid will be supplying cold water to other connected buildings simultaneously. This cold water could be used by other connected buildings. (Op 't Veld & Demollin-Schneider 2007). This demonstrates the potential benefits of economies of scale that can be achieved through large scale geothermal mine water projects, such as the industrial park planned for Springhill.

Furthermore, Herleen is committed to achieving the goals of a sustainable energy plan. This requires a hybrid energy structure based on the combination of mine water and other renewable energy resources (e.g. waste heat/cooling). The energy sources will be connected to the closest cluster through the geothermal mine water infrastructure. The connection of the energy sources is aimed to be done in such a way that the connected buildings form their own self supporting energy exchange cluster. (Op 't Veld & Demollin-Schneider 2007). The wasted energy from one building, is recycled and used productively in adjacent building. This reduces the reliance on the renewable energy sources, and creates greater efficiency per every unit of mine water pumped into the DHS.

There are real limitations in terms of mine water capacity, and flow rates. Specifically, these challenges are: flow rate and storage capacity of the mine water reservoirs; the flow rate of the mine water wells; and flow rate in the mine water infrastructure. In order to mitigate these limitations, the following measures will be taken:

- Well pumps will be replaced by pressure booster systems at the hot and cold production wells in order to increase the flow of the wells;
- A return pipe will no longer be needed and will be used for supply and disposal of additional hot or cold water;
- Booster pumps will be used at cluster grid for enhancing hydraulic capacity (Op 't Veld & Demollin-Schneider 2007).

The Mine water 2.0 system will be fully automatic and demand driven with three levels of control. Each level of control works with an independent process control parameter: Buildings and their Temperature; Energy Clusters and the corresponding flow rates; geothermal wells and the water pressure. The central monitoring system (CMS) will serve as the process control and monitoring platform where the three levels of substations can be visualized monitored, and coordinated (Op 't Veld & Demollin-Schneider 2007).

Moving forward, Heerlen is looking to upgrading its system to an ever higher level—Mine water 3.0. The key components of which will include:

- The addition of heat and cold storage in the buildings and cluster grids;
- A system suitable for demand and supply side management in near future (Op 't Veld & Demollin-Schneider 2007).

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## SZENTES, HUNGARY

Szentes is the third largest town in Csongrád county, located in south-eastern Hungary. Similar to Springhill, Szentes has a high potential for renewable energy. An extensive area of natural heated water is located under the surface of the town. In 1958 the first geothermal water well was drilled for heating the county hospital buildings and the nearby greenhouses. After the oil crisis of the 1970s, people in Szentes have been looking for alternative renewable energy solutions. This resulted in the installation of a direct heating system in 1978 (Szentes Town Council n.d.).

Agriculture and communal heating are two major forms of geothermal usage in Szentes. The energy has been widely used in greenhouses of horticulture, floriculture, vegetable plants, and livestock farms, etc. The direct heating system has been supplying homes and public buildings with the equivalent of 408,150 cubic metres of hot air. The use of geothermal heating in Szentes has reduced the costs of heating the average home by 60% less than the national average (Szentes Town Council n.d.).

One critical factor that largely promotes the economic development in Szentes is the imbedded concept of sustainable energy management and the town's commitment to economic development. The town's investment plan from 2014-2020 recognizes “energy efficiency” and “renewable energy” as critical elements (Szentes Town Council n.d.).

The town's Industrial Park development program highlights “renewable energy zones” as an important development element. This demonstrates the importance of environmental management in congruence with the economic development of Szentes. Szentes has also started the development of solar energy, to diversify the renewable energy sources available in the town. The solar project will be mainly funded by Norway Grants which are intended to help reduce social and economic disparities in Europe. In addition, a biomass power plant is planned, in hopes to turn the harmful waste generated in the region into energy (Szentes Town Council n.d.). The diversification of energy sources in Szentes demonstrates the ability of geothermal technology to be supported by other forms of renewable energy. In order words, it can be part of the larger renewable energy system, and does not require operation in isolation from other renewable energy sources.

To promote and sustain the local economy, the local government surveyed the transaction habits among local businesses and consumers. This indicated consumers' lack of awareness in terms of local products and services. By using incentives, and public relations and marketing strategies, the government effectively strengthens the relationships between local communities and local businesses, which allows more money to stay in the local market (Szentes Town Council n.d.).

Besides economic and environmental sustainable development, the town has also been actively promoting social sustainability and a good quality of life. The local government has been a cooperative partner with the community groups to develop and operate community sites to support sport, cultural, and recreation activities among the local people. And special attention is paid to disadvantaged children to ensure that they have access to cultural, educational and leisure activities (Szentes Town Council n.d.). With such a progressive view of economic and social development, it demonstrates that geothermal energy can underpin this vision and help meaningfully contribute to a progressive social and economic development vision.

## **ECONOMIC FEASIBILITY**

Utilizing geothermal energy as a means of electricity has significant cost considerations. Geothermal requires a sizeable initial capital investment, but can yield significant cost savings over time. The energy source has low annual costs compared to that of traditional systems. Furthermore, the operating and maintenance costs are comparably lower than that of traditional systems.

Anecdotal evidence demonstrates that on average, the per unit cost (cents/kWh) of geothermal is approximately 1.90; less than both diesel and traditional electric heating systems, 1.92 and 1.96,

respectively (Canadian Geothermal Energy Association, 2014). Appendix X compares the total all-in costs of geothermal and traditional heating systems for a 10-year period. The model was created by using the per unit cost provided by the Canadian Geothermal Energy Association. The following additional assumptions were made:

1. Average annual household kWh per year is 11,000
2. Average annual commercial kWh per year is 1.8x that of traditional annual households
3. Annual cost per kWh for geothermal is \$6.00; annual cost per kWh for traditional is an additional \$4.00
4. Annual operations and maintenance per kWh cost for geothermal is \$9.20; annual O&P per kWh cost for traditional is 1.5x geothermal
5. Energy costs grow annual at 2%
6. Initial capital investment for traditional is half that of geothermal; heating and cooling with geothermal is double simple heating with geothermal

Under these assumptions, the model forecasts that annual savings by using geothermal energy average approximately \$3,500 for the simple heating system. The energy cost savings at the end of year 10 result in approximately \$35,000 saved. The true cost savings results from the lower annual costs, and operating and maintenance costs. Annual cost savings accounts for \$80,000; operating and maintenance costs are reduced by \$92,000 annually. The all-in 10-year cost savings are approximately \$1.5 million.

The all-in savings for a heating and cooling system are comparable to the simple heating system. The annual energy cost savings are much lower as the rates are similar for both geothermal and traditional. However, a geothermal energy system has significantly lower annual costs, and O&M costs. The all-in 10-year cost savings are approximately \$2.96 million. The upfront costs are higher, which offsets some of the end savings.

The model further indicates that an initial capital investment of \$500,000 for a simple geothermal heating system can be repaid in savings in 5 years. Furthermore, the payback period on a geothermal heating and cooling system is also approximately 5.3 years.

The economic feasibility is further exemplified through the companies in Springhill that are currently exclusively using geothermal energy. These companies include the local community centre; Surette Batteries; and Ropak Industries. Of the three, Ropak Industries provides greater insight into the economic value of geothermal energy. The company estimates that it saves approximately \$160,000 a year in energy costs. This figure is comparable to the model generated annual total savings of \$176,000 for the geothermal heating system.

In order to stimulate the development of an industrial park that operates using geothermal energy, financial support needs to be provided by all layers of government. Provincial, and federal grants and subsidies would encourage users to adopt the technology, as well as invest in the large upfront capital required. Furthermore, tax credits have the ability to reduce the burden of the initial capital expenditure.

## RECOMMENDATIONS

This section is designed to provide the CEA with some possible alternatives or objectives to work on moving forward, as they plan to continue conceptualizing the development of a geothermal industrial park, and what they can further do to ensure that its development is realized with as little resistance and obstacles as possible. The recommendations that are presented are a product of the previous sections of the report, including the completed environmental analysis and the jurisdictional scan. It also involved incorporating data from previous reports in order to support the following recommendations.

### CONTINUE STUDIES ON EXISTING MINESHAFTS TO DEVELOP A BETTER UNDERSTANDING OF CAPACITY

One of the biggest challenges and determinates for the development of the geothermal industrial park surrounds the capacity of the mineshafts to supply potential businesses. So far there have been many studies completed on the mineshafts, particularly the number 2 mine seam. The first attempt to estimate the volume of mine workings was made by Vaughan Engineering Associates Limited (VEAL) in 1992. Their report findings provided an estimate that the number 2 mine seam could contain approximately 4,350,000 cubic metres of water, while the No.1 Seam could hold 1,058,400 cubic metres of water. Herteis (2006) completed a more detailed assessment of the number 2 seam using GIS models and estimated a total of 5,582,588 cubic metres of water (Michel, 2007). To date, no estimates have been established for other mine workings (seams 3, 4, 6, or 7). Although operational geothermal wells from local businesses are tapping water currently from Seams 6 and 7 (Michel, 2007). Although the use of the number 6 and 7 seams show that there is at least enough warm water to potentially supply businesses. However, without clear empirical data and studies to support these finding it still presents an area of risk and uncertainty to prospective investors. To reduce this uncertainty it is recommended that programs such as the partnership with the Verschuren Centre continue, and continue to conduct studies that develop a better idea of capacity in all mine seams. This capacity can be communicated to businesses that may be interested in investing in the industrial park.

Another issue surrounding capacity is the proportion of the mineshafts that have been studied in detail so far. To date, the majority of operational wells that have been drilled and operationalized by businesses have only harnessed the shallower workings of the mine. To date, there have been no deep-water drills completed to get an idea of the quality of the mine water in the lower depths of the mine. If a geothermal industrial park is to be developed and implemented, and an extensive

expansion of the use of the geothermal water must occur. Therefore it is crucial that the CEA understand the characteristics of the water at deeper depths, such as temperature, water quality, conductivity, pH, and dissolved oxygen. At present, none of these variables are known for certain at the deeper parts of the mine shafts. As a result of this, it is recommended that a study or program be created to look further into the deep water characteristics of the mine seams in order to gather further valuable information that can be used to assist in the development of the geothermal industrial park.

Another potential concern revolves around the structural integrity of the mineshafts and the potential for these open rooms to collapse due to changes in water pressure or volume. The mines operate on a room and pillar design, it is within these rooms that the water is stored. Due to the old age, there can be concerns of structural integrity and the chance that these pillars may collapse during drilling or pumping operations. This is a higher concern at the shallower areas of the mine, as they may not be completely filled with water. Methods such as GIS need to be further utilized in order to accurately locate and predict where many of these room and pillar locations are along the mineshafts in order to cost-effectively implement drilling operations to access the flooded mine workings.

In respect to the development of the industrial park, the main issues are with the incomplete collection of information in all aspects of the mineshafts. There is great uncertainty and risk that companies may feel exist when they are considering investment into the geothermal industrial park. Therefore, further information gathering and growth of knowledge surrounding the deeper workings of the mine will help to reduce the uncertainty that could hinder a company's decision to move their operations to Springhill.

#### EXPLORE THE CREATION OF LONG TERM MONITORING PROGRAMS OF COMPANIES CURRENTLY USING GEOTHERMAL

One of the main incentives for businesses to invest in a new technology, such as geothermal, is to see other examples of successful implementation of that technology. In order to consider the economic impacts to an organization, it is necessary to take all costs into consideration, including capital costs, maintenance, and operating expenses. The capital costs are usually more expensive in a geothermal system, ranging from 20-50% of the total project. However, the operating costs are traditionally much lower, roughly a third of a conventional heating system (Watzlaf and Ackman, 2006). Provided that there are not extensive maintenance costs, this could lead to considerable savings.

Currently in Springhill, most of the users of geothermal energy do not have sufficient details of their geothermal systems, as they have generally had little issues with it. The systems are repaired as required, but these 16 systems perform well and specifics are not required for these operations. Therefore it is recommended that a long term collection program be implemented to collect one to two years of data from current users of geothermal energy. Collecting this data will allow the CEA,

current users, and future users to see trends in the mine water over a time. Some important criteria to consider would be:

- Incoming and outgoing mine water temperatures
- Flow rates
- Well pump and heat pump energy use
- Repairs or system maintenance

This information can be used to estimate energy capture and cost savings for each of these installations. When considered relative to one another, estimates could then be determined for proposed resource installations such as new businesses considering a relocation to the Springhill geothermal industrial park. Once again, this would be a great promotional piece for the CEA to help further the promotion of the green geothermal industrial park as a viable place to do business.

### ENSURE LEGAL REQUIREMENTS ARE IN PLACE PRIOR TO DEVELOPMENT

With the awarding of the special mineral license to Springhill by the province in 2014, it officially gave the town the authority to manage, develop, and promote the geothermal resource in the most efficient way. CEA is committed to using this mine water to create benefits for not only the town and municipality, but for the province as a whole (DNR, 2013). In saying that, it is important to ensure that this mineral lease will not infringe upon any other legislation that the province may have surround energy sources and distribution.

One of the concerns from the literature arose surrounding the establishment of a geothermal utility. For a large scale business park, one of the easiest ways to manage the resource would be to create and operate the geothermal systems in the park as a utility. However, a utility in the province of Nova Scotia would fall under the *Public Utilities Act* and then may be subject to different regulations or restrictions (Michel, 2007). It is recommended that the CEA consult with the provincial government to ensure that the potential creation of a geothermal utility does not infringe upon any existing provincial legislation.

For a business park, such as the one being proposed in Springhill, there are some regulatory ambiguities that need to be addressed before production should proceed. One issue surrounds the provision of geothermal services to multiple users. As has been the practice in the past, the geothermal system has been implemented and controlled by a private user, but opening up the park to multiple users with different capacity needs may result in user conflicts. There needs to be a regulatory system in place to ensure that these issues can be dealt with effectively.

One of the most important aspects for any future development in the proposed geothermal park is to ensure that all users include a two line system in their operations. This is crucial to ensure that water is being reinjected back into the mine shaft upon usage, and not being discarded or pumped outside the system (Michel, 2007). The two line system regulates the volume of water being

removed from the mineshaft and back into it. Any break in the loop would pose a serious threat to the viability of the geothermal operation, and potentially lead to structural issues with the mineshaft. Whether the system will rely on single user wells or a district supply well, this must be decided based on the requirements of the system. As multiple users begin to gain access to the resource, a coordinated well development system needs to be established.

As mentioned earlier, the current geothermal systems in Springhill to date have mostly been minor developments, with single users relying on the resource for their individual businesses. As the geothermal park is developed further and more users begin to access the mine water, the development should be coordinated in order to help resolve conflict issues. Whether the park is developed using continuous single well individual systems, small communal systems, or a large DHS based off of a single well, the coordination, maintenance, and operation of the geothermal resource will need to be regulated and coordinated (Michel, 2007).

## INVESTIGATE FUNDING/INCENTIVE MECHANISMS TO PROMOTE DEVELOPMENT

One of the common themes throughout the jurisdictions scan is that they all attempted to provide some type of funding or incentive to investors to help them adopt geothermal energy. There are various methods such as providing funding for some of the upfront capital costs associated with the initial setup of the geothermal system or creating a payment scheme where payments are reduced for a period of time to avoid intense upfront expenses for the company. In most of the cases examined, the organization trying to develop the geothermal resource usually always had a funding partnership with the local, regional, or federal government. This partnership allowed for funding to be available to help out businesses who were interested in investing in geothermal, but worried about the costs of making the transition. One of the main deterrents for companies that may be looking to invest in geothermal energy is the large upfront capital investment from drilling geothermal wells and excavation to create the well system. However, there are funding mechanisms that can help reduce some of these costs for investors, making the appeal of geothermal energy more enticing (Michigan Technological University, 2013).

The team recommends that the CEA collaborate with the provincial and federal government, and with other associations such as the Canadian Geothermal Energy Association (CanGEA) to look at the potential of creating economic tools to help the CEA provide financial assistance to target industries and companies that might want to invest in geothermal energy. This has already been exhibited locally with the Port Hawkesbury Civic Centre that was opened in 2004. The estimated cost for the centre was estimated at \$17.3 million, of which about \$15.5 million was raised through federal, provincial, and municipal funds and partnerships; as well as community and business-based fundraising (NRCAN, 2009). Any incentives that can be provided to help reduce costs associated with switching to geothermal energy would be a large strength for the CEA, and might help sway businesses who may be on the fence when considering the switch to geothermal energy.

## CONCLUSION

The Springhill Geothermal Industrial Park is a positive initiative for the County of Cumberland, the province of Nova Scotia and all other stakeholders involved. Further understanding into the minewater resource will need to be accomplished to effectively communicate with potential investors.

Large financial risk is required for organizations to invest the initial capital to develop alternative energy. While the payback period has been shown to positively impact the economic feasibility, providing concrete risk prevention and long term regulation strategies will be required to mitigate corporate risk and promote investment.

Geothermal energy is growing in use around the globe, and comparative case studies portray the value to potential investors and developers. Demonstrating the benefits of the Springhill minewater resource over traditional geothermal installations can differentiate the Industrial Park even further from existing installations.

The recommendations previously listed will ensure the development of the Industrial Park is both sustainable and well perceived by potential investors. Investing in further research, laying a foundation for future expansion and regulation, and developing incentives for business are key points which will impact development and expansion.

For more information, please contact the Cumberland Energy Authority at <http://www.cumberlandcounty.ns.ca/cumberland-energy-authority.html>

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## APPENDICES

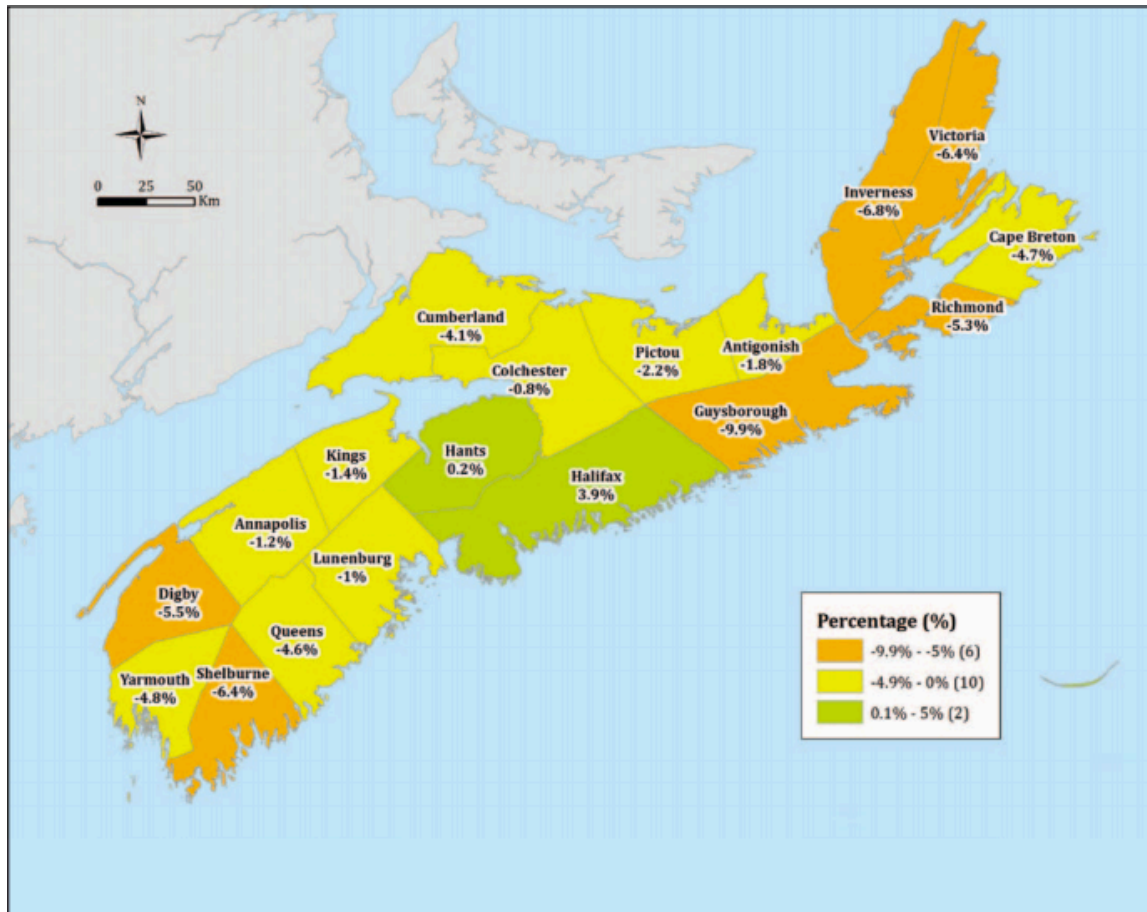
### APPENDIX A: SWOT ANALYSIS

Strengths	Weaknesses	Opportunities	Threats
Several research studies conducted on the resource	Inconsistent data from case studies	Large undeveloped area in Springhill	Feasibility of large scale industrial use of resource from multiple drills
The "Town Loop" water pumping infrastructure exists	Economic feasibility of geothermal infrastructure	Societal trend towards sustainable corporate operations	The dissolution of the township
Development license from the provincial government	Long term viability of using mine water	Political policies to attract business to Nova Scotia	Water quality at lower levels of mine is undetermined
Existing industrial case studies (>10 years usage)	Oxidation of mine water could clog well pumps and heat pumps	Only tapped into the upper depths of the mine reservoirs	Stability at lower level mine
Potentially provide clean and sustainable heating resource		Low cost energy source to replace fossil fuels and others	Proposed neighboring strip mine could theoretically increase oxidation of mine water
Mine water is clean and high quality in relative comparison to other fine water		High volume water usage potential	Population trends show outmigration from the County, this could put a strain on labour capacity.
Location relative to NSCC campuses and education base			

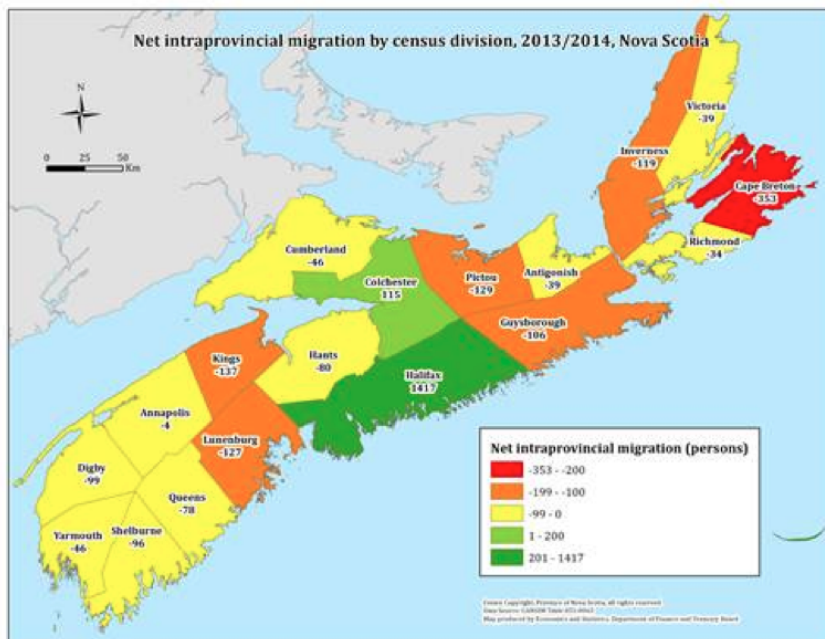
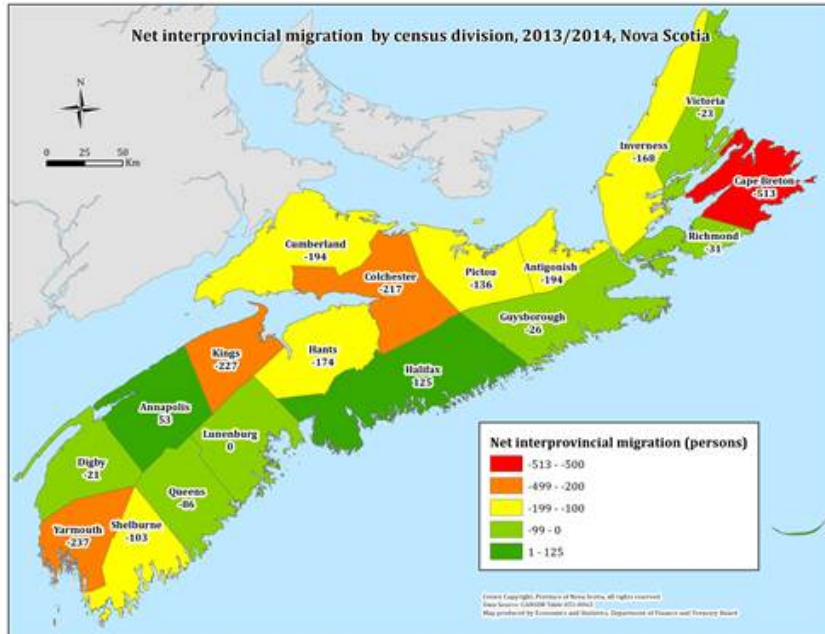
**APPENDIX B: POPULATION CHANGE BY COUNTRY, PROVINCE, TERRITORY (2006-2012).**

Canada	33,476,688	31,612,897	5.9
Ontario	12,851,821	12,160,282	5.7
Quebec	7,903,001	7,546,131	4.7
British Columbia	4,400,057	4,113,487	7
Alberta	3,646,257	3,290,350	10.8
Manitoba	1,208,268	1,148,401	5.2
Saskatchewan	1,033,381	968,157	6.7
Nova Scotia	921,727	913,462	0.9
New Brunswick	751,171	729,997	2.9
Newfoundland & Labrador	514,536	505,469	1.8
Prince Edward Island	140,204	135,851	3.2
Northwest Territories	41,462	41,464	0
Yukon	33,897	30,372	11.6
Nunavut	31,906	29,474	8.3

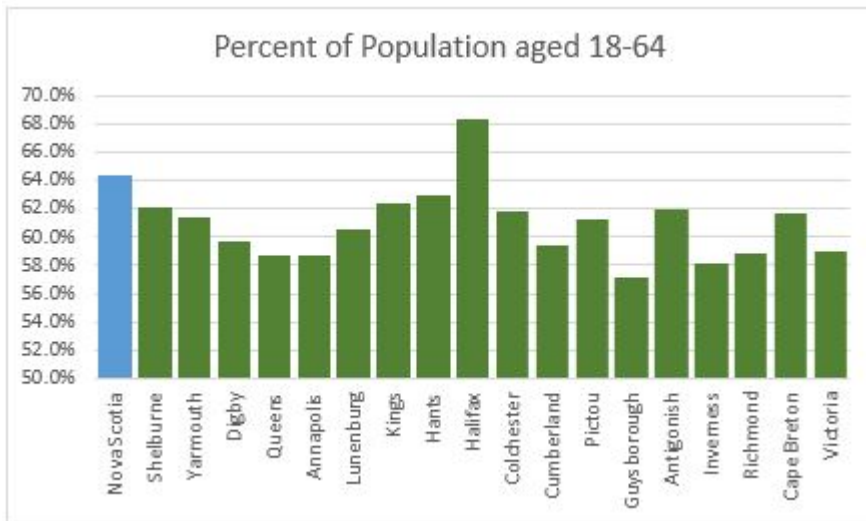
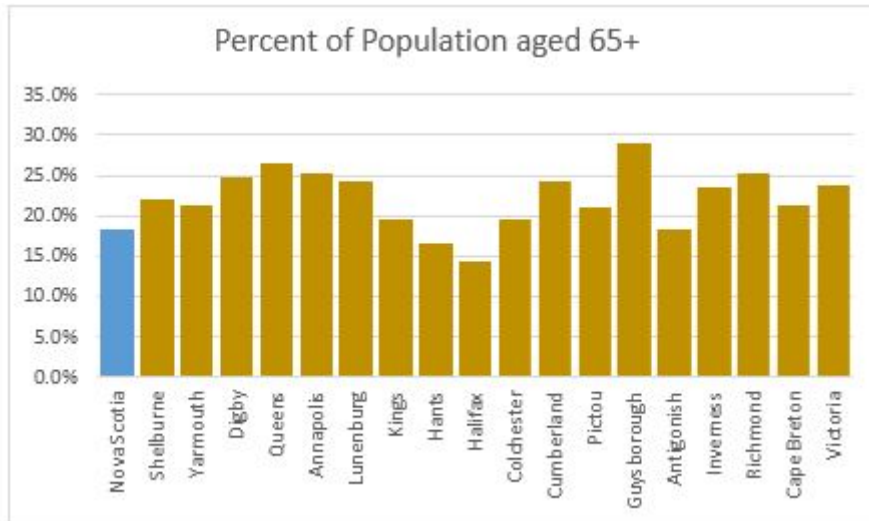
**APPENDIX C: POPULATION CHANGE BY CENSUS DIVISION (ALL AGES), 2010-2014**



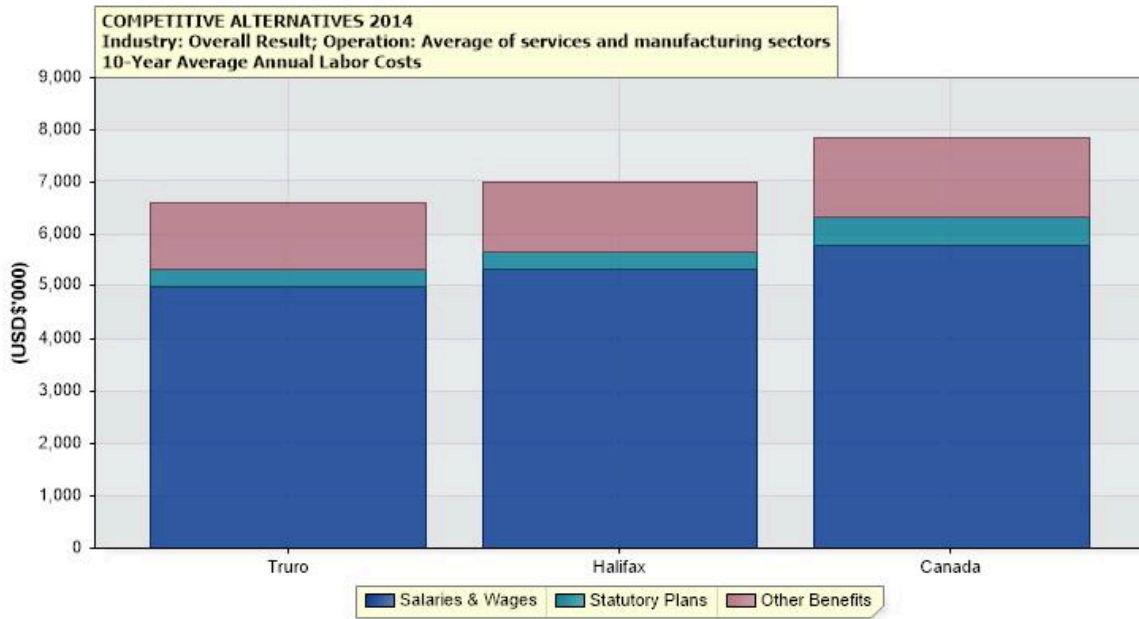
**APPENDIX D: NET INTERPROVINCIAL/INTRAPROVINCIAL MIGRATION BY COUNTY, 2013-2014**



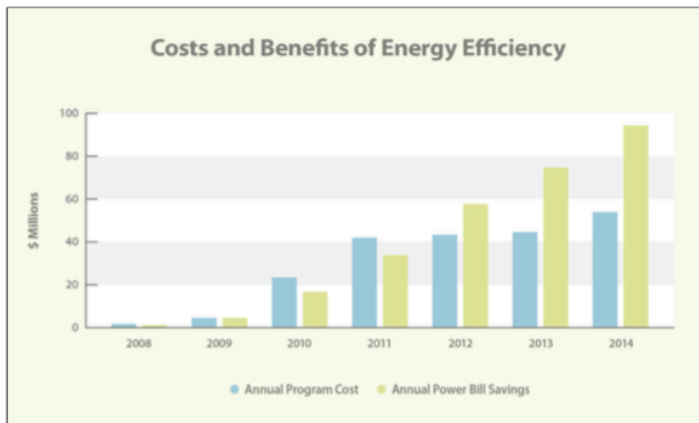
## APPENDIX E: POPULATION DEMOGRAPHICS IN NOVA SCOTIA BY COUNTY



## APPENDIX F: KPMG COMPETITIVE ALTERNATIVES 2014



## APPENDIX G: CASE STUDY EXAMPLES OF ENERGY USAGE



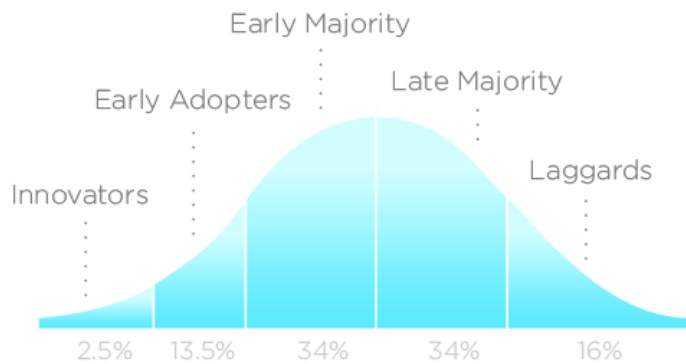
Many businesses insulate walls, conduct home audits, and install heat pumps and other energy efficient technologies. These businesses are based right here in Nova Scotia. In fact, over 60 businesses are focused on efficiency in Nova Scotia, and together they employ over 1100 people full time. The efficiency industry is growing five times faster than the rest of the economy<sup>6</sup>.

(Efficiency NS, 2014)

## APPENDIX H: ECONOMIC FEASIBILITY MODEL

	Geothermal		Traditional	
	Commercial Use	Commercial Use (Heat and cooling)	Commercial Use	Commercial Use (Heat and cooling)
<b>Capital and Annual Costs</b>				
<b>Capital Cost</b>	500,000.00	1,000,000.00	250,000.00	500,000.00
<b>Annual Cost (per kWh)</b>	6.00	6.00	10.00	10.00
<b>Operations and Maintenance</b>	9.20	9.20	13.80	13.80
<b>Energy cost (unit cost cents/kWh)</b>				
<b>Year 1</b>	6.08	2.89	6.24	2.96
<b>Year 2</b>	6.20	2.95	6.36	3.02
<b>Year 3</b>	6.33	3.01	6.49	3.08
<b>Year 4</b>	6.45	3.07	6.62	3.14
<b>Year 5</b>	6.58	3.13	6.75	3.20
<b>Year 6</b>	6.71	3.19	6.89	3.27
<b>Year 7</b>	6.85	3.25	7.03	3.33
<b>Year 8</b>	6.98	3.32	7.17	3.40
<b>Year 9</b>	7.12	3.39	7.31	3.47
<b>Year 10</b>	7.27	3.45	7.46	3.54
<b>All-in 10 year cost</b>	4,875,857.56	7,719,606.77	6,382,651.71	10,678,391.71

## APPENDIX I: INNOVATION ADOPTION LIFECYCLE



**INNOVATION ADOPTION LIFECYCLE**

## APPENDIX J: GEOTHERMAL CAPACITY WORLDWIDE

Categories of direct use worldwide, 1995–2010

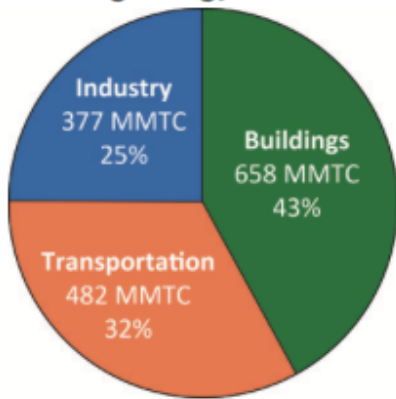
Utilization category	1995	2000	2005	2010
<i>Capacity (megawatt thermal)</i>				
Geothermal heat pumps	1 853	5 275	15 384	33 134
Space heating	2 579	3 263	4 366	5 394
Greenhouse heating	1 085	1 246	1 404	1 544
Aquaculture pond heating	1 097	605	616	653
Agricultural drying	67	74	157	125
Industrial uses	544	474	484	533
Bathing and swimming	1 085	3 957	5 401	6 700
Cooling/snow melting	115	114	371	368
Others	238	137	86	42
<b>Total</b>	<b>8 664</b>	<b>15 145</b>	<b>28 269</b>	<b>48 493</b>

## APPENDIX K: TELUS COMMUNICATIONS GRID MAP



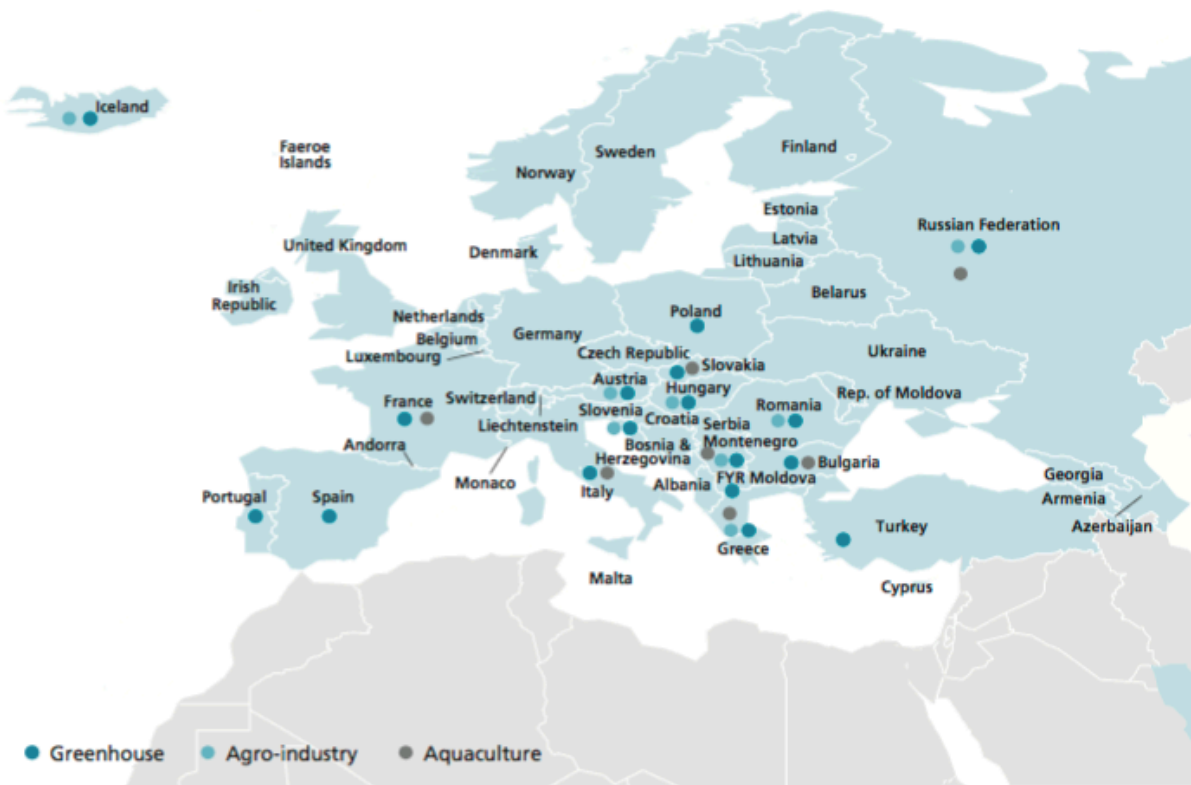
## APPENDIX L: US CARBON EMISSIONS BREAKDOWN

Building energy use emits 43% of total U.S. carbon emission.



## APPENDIX M: EUROPEAN GEOTHERMAL AGRI/AQUACULTURE

### Agricultural and agro-industrial uses of geothermal energy in Europe



Source: P.G. Pálsson, 2013. (Based on UN map No. 4170 Rev. 13, April 2012. Department of Field Support, Cartographic Section).



**VERSCHUREN  
CENTRE**

For Sustainability in Energy  
and the Environment

**REPORT TO  
CUMBERLAND ENERGY AUTHORITY**

## Researching the Geothermal Potential of the Former Springhill Mine

November 2015

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Appendix 2 – Literature Review

Appendix 3 – Geothermal Mine Water Well Database

Appendix 4 - Herteis (2006) - Town of Springhill NS Geothermal Assessment - No. 2 Seam

Appendix 5 – Geothermal Well Monitoring Photograph

## **1 Introduction**

The Cumberland Energy Authority (CEA) entered into a collaborative research program with the Verschuren Centre for Sustainability in Energy and Environment at Cape Breton University (Verschuren Centre) to study the current use of the geothermal resource at the former Springhill Mine and summarize currently available information on the resource. The program was designed to provide a summary report that the CEA can use to move forward other components of the plan to commercialize the geothermal resource associated with the former Springhill Mine.

Exploiting the geothermal potential in the former Springhill Mine is not a new concept. For approximately 30 years, the resource has been studied, explored and used for heating and cooling of businesses in Springhill. While commercial users of the resource have come and gone, some users continue to benefit from using the resource to heat and cool their operations, saving money. How these users make use of the resource, and attempting to quantify the savings to their operations, is a current goal of the CEA and Verschuren Centre research.

## **2 Background**

In many regions of the world, flooded mines are a potentially cost-effective option for heating and cooling using geothermal heat pump systems. There are now many former mining sites across the world that uses geothermal energy to provide heating and cooling for all types of buildings and industries (Watzlaf and Ackman, 2006). Springhill was the original world leader in championing the use of groundwater from flooded coal mine workings for heating and cooling buildings (since 1989), with many other attempts world-wide to follow the lead of Springhill.

Springhill is famed for having some of the deepest coal mines in North America, with depths reaching 1323 m. Coal mining became the primary industry for the town in 1849 and continued until a series of mining disasters forced the closure of the mines in 1958. This was the end of large scale coal mining in Springhill. Over the years, the mine tunnels started to flood with water, providing a valuable resource for the community. Various estimations of the volume of water in the workings have been produced over the years. Vaughan Engineering Associates Limited (1992) estimated that the No. 2 Seam could contain approximately 4,350,000 m<sup>3</sup> of water, while the No. 1 Seam held the potential for 1,058,400 m<sup>3</sup> of water. Brian Herteis (2006) undertook a much more detailed GIS analysis of the No. 2 Seam and estimated a total water storage volume of 5,583,000 m<sup>3</sup>. In general, it can be concluded that the mine workings contain sufficient volume to supply the Town of Springhill.

Interest in the exploitation of this resource and the utilization of geothermal energy has been on-going since 1984 when Ralph Ross first proposed the possible uses of mine warm to help maintain existing industries in Springhill and also attract new industries due to the energy cost savings afforded by geothermal energy systems. The first application of mine water geothermal was made in 1989 at Ropak Can-Am Plastics through a system of heat pumps and wells. The system's first year of operation saved Ropak an estimated \$15,103 on their energy expenses even though the factory was expanded from 35,000 square feet to 117,000 square feet. Today, there are multiple users of geothermal energy in Springhill, with many users satisfied with the benefits of their geothermal systems, which is being used for both heating and cooling purposes.

### **3 Methodology**

This research program was divided into four primary components:

- Review and summary of existing research
- Interviews with current users of the geothermal resource
- Collection of field data
- Mine water quality monitoring

Each of these project components is described in detail in the following four sections.

#### **3.1 Literature Review**

The CEA provided the Verschuren Centre research team with a large number of geothermal related documents dating back to the early 1980s. Our team reviewed the documents in detail and summarized the information that was determined valuable for the CEA moving their goals forward.

The documents included many well drilling reports, information on pumping tests that were conducted after well installations, student studies, consultant reports and provincial agency reports. Many previous reports include general information on geothermal energy or economic development, which is not the primary focus of this report. This report summarizes data specific to the former Springhill Mine that is available in previous studies to make future progress for the CEA as efficient as possible.

In addition to documents and reports available through the CEA, the Verschuren Centre conducted a thorough search of academic publication databases to identify research that focused on, or referenced, the former Springhill Mine. Information from these reports was included in the summary of existing research.

### **3.2 Geothermal User Survey**

The research team approached each of the current mine water geothermal users in Springhill and conducted interviews with company personnel that had some understanding of the geothermal heating and cooling system(s). Interviews were conducted with the following representatives:

- Nova Scotia Community College – Darrin Embree
- Ropak Packaging – Wendell Crowley
- Fitness Centre
- Dr. Carson and Marion Murray Community Centre – Scott Munro
- Surette Battery
- Golden Opportunities Vocational Rehabilitation Centre (GOVRC) – Paul Williams

The information collected during the interviews is summarized in the results section of this report.

### **3.3 Field Data Collection**

The field program was conducted over a period of two months and included two days of onsite data collection. On-site data collection events were conducted on July 15 and September 16, 2015. On-site data collection included a meeting with Brian Herteis, Capital Projects Engineer at Cumberland County, to (i) discuss the previous studies and consultant reports available for this project, (ii) meet with current users of the geothermal resource, (iii) obtain mine water samples, and conduct the following activities:

- Inspection of supply and return wells, both active and inactive
- Measurement of mine water levels
- Installation of temperature and pressure transducers in pumping wells to monitor mine water level and temperature over a two month period
- Inspection of general well integrity.

### **3.4 Mine Water Quality Monitoring**

Mine water quality can have a direct effect on its potential use for geothermal energy. Low quality mine water will be acidic and contain high concentrations of dissolved metals, specifically iron. The acidic nature of the mine water will corrode geothermal infrastructure prematurely. High metals concentrations in mine water can result in precipitation of metals if oxygen is introduced. This precipitation will result in solids forming in the mine water, clogging geothermal infrastructure.

The quality of the mine water currently being pumped and used by active geothermal users was evaluated in several ways. During sample collection from operating systems, field parameters were collected, including the following:

- pH
- Temperature
- Electrical conductivity
- Total dissolved solids
- Dissolved oxygen
- Redox potential

The second step in mine water quality monitoring was the analytical testing of samples for general chemistry and total metals concentrations. In total, six mine water samples were collected from active systems for total metals analysis and two for general chemistry. Locations of these samples include:

- Ropak Packaging
- Town Loop (GOVRC)
- Nova Scotia Community College
- Dr. Carson and Marion Murray Community Centre
- Fitness Centre
- Surette Battery

## 4 Results

### 4.1 Literature Review

Detailed results of the literature review and references are provided in the annotated bibliography provided in **Appendix 2**. A summary of information relevant to this project is provided below.

In 1986, a report was prepared by Booth Engineering Limited. The Springhill Minewater Geothermal Heat Source presented the feasibility and value of using the mine water of the former mine for geothermal applications. It presented the information known at the time on the mine water resource, the technology available to exploit it and the economic benefit to ownership of, and rights to, the resource. The report included mine working plans and descriptions developed by Ross (1981) and proposals by Ross (1984) and Braybrooke (1985).

The first three geothermal wells in Springhill were drilled in 1987 (Jacques Whitford, 1987 and International Groundwater Symposium, 1988). One of the three wells (GTW-3) eventually went into use as the Town Loop supply well. The three wells were advanced into Seam 2 of the former mine with maximum depths of 84 m. One of the three wells did not hit open workings resulting in insufficient yield, and a

second well hit caved workings or the edge of a pillar based on wood in the drill returns. GTW-3 provided sufficient yield for geothermal use and mine water temperatures observed during pump tests following drilling ranged from 9°C to 13°C. The borehole logs for these wells were the earliest record found of geothermal exploration at the former Springhill Mine. Warren (1993) developed temperature logs for these wells.

GTW-4 and GTW-5 were drilled in late 1987 for the Nova Scotia Power facility (Jacques Whitford, 1988), which is now the town Fitness Centre. One well hit pillars in both Seam 1 and Seam 2 so it could not be used as the supply well. GTW-5 was used as the supply well; but during drilling, was reportedly contaminated with inflowing groundwater. Water quality analysis supported this. Both wells were drilled through Seam 1 into Seam 2 with mine water temperatures of 11°C to 14°C. During a seven-day pumping test, a mine water temperature of 13°C was consistent with the groundwater intrusion suspected. Response in water level at other wells was observed during the pumping test. Difficult drilling conditions were recorded in this report due to fracturing and caving zones.

Geothermal wells drilled for ROPAK (GTW-6 and GTW-7) were drilled in 1988 into Seam 2 (GTW-6) and Seam 3 (GTW-7) (Ross, 1988). The supply well GTW-6 was drilled to a total depth of 137.5 m and required replacement in 2000 due to collapsed casing.

Surette Battery had four wells drilled for their geothermal system. In February/March 1989, GTW-8, GTW-9 and GTW-10 were installed in Seams 1, 2 and 3, respectively. GTW-8 was the initial return well but required replacement in 2012. Well depths were 63 m into Seam 1 and 104 m into Seam 2. Water levels have been observed between 8.9 m and 34.6 m below ground with temperatures between 12 °C and 14 °C with over 300 gallons per minute (gpm) production capacity.

GTW-11 and GTW-12 are currently inactive, but were initially drilled for Pizza Delight/JBs Pub (Jessop, 1990). These wells were advanced in Seams 6 and 7, respectively, with total depths of 150 m and 119 m (Seam 6 is deeper than Seam 7). Interestingly, these two wells are only 7 m apart and appear to be the closest supply and return well set observed during this program. This project was considered a success that led to the development of the District Heating Scheme (Town of Springhill, 1990b). Ten sites were identified as potential end users of a geothermal heating loop. GTW-13 and GTW-14 were proposed as part of that program. GTW-13 is a return well for the Town Loop (GTW-3) and was installed into Seam 2 in 1990 (Ross, 1992).

Expansion of the geothermal system in the Industrial Park continued in 1991 with the drilling of GTW-14 and GTW-15 for industrial park use (Ross and Kavanaugh, 1993). Information on these two wells is very limited; however, total depths were 49 m and 68 m, respectively. Similarly, GTW-16 was drilled into Seam 4, but little information is available on this well. GTW-17 and GTW-18 were drilled into Seam 6

for the Parkview Centre offices. GTW-19 was also drilled into Seam 6 with little information available.

In 1992, K. Arkay developed the Geothermal Energy from Abandoned Mines: A Methodology for an Inventory, and Inventory Data for Abandoned Mines in Quebec and Nova Scotia, Geological Survey of Canada Open File 3825, September 2000. He presented and summarized the major point identified in a 1993 report: First Springhill Geothermal Energy Conference, Springhill, Nova Scotia, 28-29 October 1992. Geological Survey of Canada Open File 2773, December 1993.

Brown's Funeral Home once operated on geothermal, with GTW-20 and GTW-21 installed into Seams 6 and 7 in 1994. Also in 1994, a three-month study was conducted with eight users of the geothermal resource to monitor mine water flow, incoming and outgoing temperatures, as well as incoming and outgoing air through the geothermal heat pumps systems (Bagnell, 1994). These resource use parameters have not been sufficiently monitored since that study.

One of the documents provided to the Verschuren Centre by the CEA is a Springhill Geothermal Resource 1994 Report Vol.1 in a white binder. This report provides a very useful summary of the work conducted in 1993 and 1994 to evaluate the geothermal resource at the former Springhill Mine. The Jessop (1993), Ross and Kavanaugh (1993) and Bagnell (1994) reports are included therein, as are DNR maps that were used for resource evaluation.

Jessop, MacDonald and Spence (1995) developed the report: Clean Energy from Abandoned Mines at Springhill, Nova Scotia, and presented at the World Geothermal Congress in Florence, Italy, in 1995. They studied two methods to estimate the volume of the flooded mines, terrestrial heat flow, geothermal gradients and physical processes within the flooded mines. This study reported on the operation of the ROPAK geothermal system between March 1989 and March 1990, including operational costs. This type of data collection is now required in order to quantify the savings being recognized by current users in order to support potential business plans.

The Dr. Caron and Marion Murray Community Centre have a total of six wells associated with its geothermal system. Most were drilled in 2003 (Seams 1 and 2) (Hy-Grade Geoscience, 2004) with a replacement return well (CC-R) drilled into Seam 3 in 2011. Two of the original well drillings were considered unsuccessful due to low yields or observed groundwater intrusion. These wells have since been considered observation wells. The initial return well was decommissioned upon replacement with CC-R.

Supply and return wells at the Nova Scotia Community Centre (NSCC) are installed into Seam 6 and no information could be identified for the inactive supply and return wells at the Fire Department or the Springhill Public Works facility.

Cumberland County Capital Project Engineer, Brian Herteis, generated a very detailed report (Herteis, 2006) for the Town of Springhill prior to joining the Public Works Department. This report includes temperature gradients of eight mine water wells and estimates the mine water capacity of the No.2 Seam based on mining practices in various areas of the mine. The data summarized in this report and the techniques employed should be considered for future research of the resource. Kavanaugh (2006) also developed similar estimates for the No. 6 Seam and No. 7 Seam.

In 2007, the Nova Scotia Department of Energy, Nova Scotia Department of Natural Resources and the Town of Springhill prepared the Evaluation of Geothermal Energy Potential in Springhill, Nova Scotia. This is a very robust report with (i) climate and geology information, (ii) categories of geothermal applications, (iii) a discussion on the importance of understanding subsurface conditions, (iv) references Mr. Ralph Ross as a local resource of geothermal knowledge and experience, (v) mine water temperatures at the Community Centre, (vi) a summary of previous capacity estimates and existing systems, and (vii) calculations of energy potential and critical issues impeding development of the resource.

Recommendations in the report include a GIS study of subsurface mine workings, exploratory drilling of deeper resources, pumping tests to determine interconnectivity, and an evaluation of system requirements to assist system capacity design.

Other documentation that relates to the project, but is essentially a summary or discussion of existing information, is described in **Appendix 2**.

## **4.2 User Interviews**

Six users of the geothermal resource were interviewed as part of the data collection program. In general, the personnel that were interviewed were familiar with the geothermal system(s), but were not able to provide specific details on routine operations. Significant information collected during the interviews is presented in the following subsections.

### **4.2.1 Ropak Packaging**

- Ropak operated in their location since the 1960s, but an expansion in 1989 led to the installation of the geothermal system for both new and existing buildings. Before geothermal, the buildings required approximately 1000 gallons of oil per month for heating purposes.
- Air conditioning is constant through the summers and indoor temperatures are self-regulated at 65°F during the winters. They do not use the geothermal resource for industrial purposes, solely climate control. The only backup system are some baseboard heaters in the front offices.

- They have experienced challenges with infrastructure failures. Their supply well collapsed in 2000 and required a replacement well to be drilled. They have experienced drops in heat pump efficiency due to clogging and ultimately replace these units. They installed five new heat pumps in 2013 and will be ordering another five to replace when the time comes. Approximately every 10 years, the water supply submersible pump requires replacement. This pump is operating at a depth of 240 feet in the well.
- They were not aware of the flow rate or incoming temperature of the mine water.

#### **4.2.2 Nova Scotia Community College**

- The system was installed at the NSCC in 2009/2010 and is a component of the refrigeration program at the school.
- It is used for just a portion of the building, specifically the back laboratories and offices. The remainder of the building uses oil furnaces. The operator believes that the system is sufficient to supply the entire building and some of the required infrastructure is already in place to make that transition.
- Their system includes two closed loop systems for instruction purposes. These systems do not use mine water.
- They have not experienced any significant challenges since the system began operation, with very little maintenance required.
- During the system installation, it was operating at 7-9 gpm. There is currently no measurement of flow, but is assumed to be in the same range. NSCC is considering the installation of monitoring equipment to develop a better understanding of system operation.

#### **4.2.3 Surette Battery**

- The building has been in place since the 1950s and the geothermal wells and system were brought online in 1989.
- They use approximately 80% of their geothermal resource draw for climate control and the remaining 20% for cooling during the manufacturing process.
- The geothermal resource is used for heating and cooling of the production floor and offices year round. They do not require additional sources for heating and cooling with the exception of small heaters in some offices.
- They have experienced some heat pump failures due to the mine water, but it has been seven to eight years since the last replacement. One water supply well (GTW-9) required pump replacement twice in three years, while their second supply well (GTW-10) has not required a pump replacement for more than five years. This suggests different water qualities in the two wells.

- Their system operates at approximately 100 gpm. This was recorded during the replacement of heat pumps or well pumps only, and is not monitored.
- The sample collection point was on the factory floor and part of the industrial cooling component of the system. The sample collected was 17.3 °C suggesting that it was already heated by the climate inside the building or had already been used for industrial cooling.

#### 4.2.4 GOVRC

- This operation began in 1981 and the geothermal system came online around 1993. The current manager has only been in this position for a year, so his knowledge of the system is limited.
- There are three heat pump systems at GOVRC that operate on the Town Loop supply. One heat pump supplies the greenhouse, which requires oil furnace support in winter. A second and third heat pump supply heating and cooling to the main building. An extension for the woodworking operation uses an oil furnace with no source of air conditioning.
- They have experienced issues with system maintenance. As this is a non-profit society, maintenance costs can be an issue. They have experienced pipe leaks due to corrosion and have replaced some metal pipes with plastic.
- They are concerned with high electricity costs for operating the heat pumps; however, electric heat is also used in one building, so a more thorough review of their energy use at GOVRC is warranted.
- The manager had no way of knowing the flow rates that GOVRC was using or the temperature of the incoming mine water.

### 4.3 Field Data Collection

Field inspections of the mine water geothermal wells were conducted on July 15 and September 16, 2015 with the assistance of Brian Herteis. The following points summarize the activities (in addition to interviews and sample collections) undertaken at the well sites during those days, with relevant information provided in other reports sections as warranted. Field measurements are provided in **Table 1** and photographs of the geothermal wells inspected are provided in **Appendix 5**.

- Two inactive geothermal wells were inspected at the former Pizza Delight/JB's Pub. These two wells are located in a residential lot adjacent to the vacant commercial property. Mine water levels were collected (Table 2) and a data-logger was installed in the return well. A submersible pump remains installed in the supply well.
- The Dr. Carson and Marion Murray Community Centre utilizes the geothermal resource for heating and cooling purposes seasonally, making use of the cooling properties to manage heat generated by ice making for the

rink. During the site visit, the flow rate of mine water was recorded from an inline flow meter. Incoming and outgoing mine water temperatures were also available through system monitoring equipment. It was noted that a plate heat exchanger was used as part of the system.

- Golden Opportunities Occupation Rehabilitation Centre (GOVRC) is a government operated work environment for people with learning disabilities. This facility utilizes three geothermal heat pumps for climate control in three main sections of their facility, including a greenhouse. Management are pleased with the operation of the heat pumps, aside of maintenance costs. Due to inadequate plumbing during the first field event, a mine water sample was unavailable. Prior to the second field event, access points were installed for sample collection and monitoring of field parameters. Flow rate was not available. This facility operates on the Town Loop. The Town Loop well was monitored for depth to mine water and a data-logger was installed to monitor changes in water level and temperature. Information was collected from the electrical meter supplying the Town Loop well to estimate costs of operating the Town Loop.
- Two supply wells and one return well were monitored at the Surette Battery facility. Water levels were measured and a data-logger installed in one of the supply wells (GTW-10). It was advised that a water level should not be collected from the return well because it has either sloughed in downhole, or was originally completed within a pillar, reducing its capacity for water discharge and resulting in abnormally high water levels. A sample was collected here during the second field event.
- Fitness Centre – This facility is a residence/small business that has made use of the geothermal resource for over 10 years for heating and cooling. The supply well was measured for water level, a mine water sample was collected for analysis, and field readings were collected.
- NSCC - The NSCC employs a three way geothermal system that includes mine water supply and return wells (in addition to two closed loop systems). Only a portion of the building is heated/cooled using this system. Mine water levels were measured, a mine water sample was collected for analysis, and field parameters were recorded.
- ROPAK Packaging – Both the supply and return wells of the ROPAK geothermal system were monitored for water level. The supply entering the building was sampled and monitored for field parameters.
- Springhill Public Works – This inactive well was monitored for water level only.
- Constituency Office – without prior authorization, our researchers located, but did not monitor this supply well.
- Funeral Home – without prior authorization, our researchers located, but did not monitor these supply and return wells.

- Fire Department – without prior authorization, our researchers located, but did not monitor these supply and return wells.

#### **4.3.1 Mine Water Well Survey**

Verschuren Centre researchers, with the assistance of Brian Herteis, conducted well inspections at as many supply and return wells as possible over the two-day field program. In total, 20 wells were visually inspected; of these, 12 were supply wells and seven were return wells with one well use unknown. Wells were inspected for general integrity, GPS location, mine water level (at locations where permission was obtained), total depth and general information. Of the 21 wells included in the survey, 12 of the wells were in active use and nine wells were inactive. Important information to note about the well systems includes:

- Mine water wells currently in use appear to be regular water well installations. Similarly, the submersible pumps are regular domestic well pumps.
- One active supply well (Community Centre) appears to be slightly damaged in its power supply (broken conduit).
- Several of the mine water wells (both active and inactive) are flush mount wells (flush with ground surface), whereas others have an above-ground section up to 1m above ground surface.

#### **4.3.2 Mine Water Level Monitoring**

Measured depths to mine water range from 1.9m below top of well casing, to 34.6m below top of well casing. The very shallow measurements are attributed to return flow being discharged back into the mine. The deeper measurements are attributed to, at least in part, higher elevations of the well installations (e.g., Ropak and Town Loop).

Water level data collected by the pressure transducers installed in GTW-3 and GTW-10 is presented in **Figure 2 and 3**, respectively. There are data anomalies in both of the figures with spikes in water level that cannot be attributed to rainfall events. These anomalies may be attributed to debris inside the wells that affected the operation of the transducers.

There are two interesting points to observe in the water level trends over this two-month period. Firstly, the water levels decreased over the period from July 15 to September 16. The decrease in water level is not significant (e.g., less than 1 m), but it is likely attributed to a decrease in the infiltration of surface water and shallow groundwater into the mines during low precipitation summer months.

A second interesting note is in the well that was installed at the Surette Battery facility. Upon inspection, it appears that the water level fluctuates on what could be

interpreted as a five-day work week schedule. There appears to be fluctuations in the water level in cycles of five with short stable periods between them. This could appear as mine water level fluctuations during Surette's main production periods, with high demand for heating and/or cooling requirements, followed by "weekend" periods where demand drops off, allowing the mine water level at the supply well to stabilize.

This fluctuation is minor (0.25m) and is not considered a concern. Likewise, the decreasing mine water level over the summer period is not considered to be a concern at this time. But these observations confirm that the water level in the mine(s) fluctuates based both on infiltrating groundwater and surface water, as well as demand and recirculation time.

### **4.3.3 Mine Water Temperature Monitoring**

The transducers that were used to monitoring fluctuations in groundwater level were also used to track changes in the temperature of the mine water over the same period. The transducers were installed within the wellbore of both wells and therefore represent the temperature of the water being extracted by the submersible pump and being used in heat pumps.

As shown in **Figure 4**, the temperatures of the mine water in wells GTW-3 and GTW-10 is very stable in the 12-14 °C range of the period of July 15 to September 16. It is interesting to note that the mine water temperature in both wells increased slightly over the period (somewhere in the range of 0.5 °C). It is possible that a decrease in the infiltration of surface water and shallow groundwater into the mine water during the summer months, may have decreased the cooling effect of this infiltration, thereby increasing the temperature of the mine water being extracted for geothermal use.

## **4.4 Water Quality Monitoring**

### **4.4.1 Field Parameters**

Six mine water samples were collected from active geothermal resource users. In each case, a sample location had to be identified upon the request. In the case of the GOVRC, a sample point had to be installed in the intake system in order to obtain a sample of the mine water.

With the exception of the Fitness Centre, each geothermal system was in full operation at the time of assessment. This means that each system was pumping and operating under normal conditions. In the case of the Fitness Centre, the pump system was activated and allowed to run for 10 minutes before the sample was collected, to ensure a representative mine water sample.

In each case, one sample of the mine water was bottled for water quality analysis, and a second sample was used for the measurement of field parameters. Field parameters measured in the mine water samples presented the following results:

- pH: 6.7 – 7.8
- Electrical Conductivity: 1153 – 5594 uS/cm
- Dissolved Oxygen: 12-70%
- Total Dissolved Solids: 1412 – 4721 ppm
- Redox Potential: -93.6 to 37.7 mV

#### 4.4.2 Water Quality Analysis

During the initial field monitoring event (15 July 2015), two mine water samples were collected (Community Centre and Fitness Centre). These two samples were analyzed for general chemistry and total metals analysis. It should be noted that Maxxam Analytics Inc. of Sydney, Nova Scotia, conducted the general chemistry analysis. Maxxam also provided total metals analysis, which was also conducted by the Verschuren Centre.

It should be noted that Surette Battery uses two supply wells and we were unable to isolate the two wells for water sample collection. It is unclear if the water sample was provided from GTW-9, GTW-10 or a combination of the two.

##### 4.4.2.1 Mine Water Acidity

The majority of acidity in mine water arises from free protons (manifested in low pH) and the mineral acidity arising from dissolved iron, aluminum, and manganese (Watzlaf et al., 2004). The acidity of a mine water sample is calculated from its pH and the sum of the milli-equivalents of the dissolved acidic metals. In many acid mine drainage investigations, the acidity is calculated as follows (Kirby and Cravotta, 2005; Park et al., 2015):

$$Acidity_{calc} = 50 \cdot \left\{ 2 \cdot [Fe] / 56 + 3 \cdot [Al] / 27 + 2 \cdot [Mn] / 55 + 1000 \cdot 10^{(-pH)} \right\} \quad (1)$$

Where: the concentrations of the metals Iron (Fe), Aluminum (Al), and Manganese (Mn) are given in units of mg/L, and 50 is the equivalent weight of CaCO<sub>3</sub>, which converts the acidity in units of meq/L into units of mg/L of CaCO<sub>3</sub> equivalent. A number of studies have demonstrated the acidities estimated using Equation (1) are in good agreement with the measured acidities over a broad range of pH values (e.g., Watzlaf et al., 2004; Kirby and Cravotta, 2005).

Water with pH > 4.5 has acid neutralizing capacity and is said to contain alkalinity. The principal form of alkalinity in mine water is dissolved carbonate, which can exist in bicarbonate and carbonate form. Alkalinity and acidity are not mutually exclusive terms. When water contains both mineral acidity and alkalinity, a

comparison between the two measurements results in a determination as to whether the water is net alkaline (alkalinity > acidity) or net acidic (acidity > alkalinity). Net alkaline water contains enough alkalinity to neutralize the mineral acidity represented by dissolved iron and manganese. Net acidic water means that the mineral acidity plus acidity generated by the oxidation and precipitation of metals exceeds the initial alkalinity. The calculated net acidity is presented as follows (Park et al., 2015):

$$NetAcidity_{calc} = Acidity_{calc} - Alkalinity$$

(2a)

$$NetAcidity_{calc} = 50 \cdot \left\{ 2 \cdot [Fe] / 56 + 3 \cdot [Al] / 27 + 2 \cdot [Mn] / 55 + 1000 \cdot 10^{(-pH)} \right\} - Alkalinity$$

(2b)

Where: alkalinity is measured in mg/L as CaCO<sub>3</sub>.

Geochemical analysis was conducted on the groundwater samples collected from the Community Centre and Fitness Centre on 15<sup>th</sup> July 2015. It is evident from the geochemical properties of the water samples that the acidity in the water is relatively low. For instance, the concentrations of the metals Iron (Fe), Aluminum (Al) and Manganese (Mn) at both locations are low (<5 mg/L), with a corresponding pH of ~7.3. Using Equation 1, this equates to a calculated acidity of 3.98 mg/L for the Community Centre and 9.99 mg/L for the Fitness Centre. Furthermore, it is evident that both groundwater samples contain significant alkalinity (>400 mg/L) that will neutralize the acidity, resulting in net alkaline water.

## 5 Conclusions

The purpose of this study was to collect, review and summarize data that is currently available for the geothermal resource at the former Springhill Mine. The following conclusions can be made:

- The resource is currently being exploited in the shallow sections of the former mine.
- Mine water quality at the current geothermal installations is higher than expected. The water does not present high acidity or metals loadings; mine water factors that can negatively affect geothermal infrastructure.
- Mine water temperatures at the current geothermal installations are normally between 12 and 14 degrees Celsius. It is therefore not the high temperature of the mine water that makes it appealing for geothermal applications; it is the moderate temperature and high capacity.
- With the exception of the Dr. Caron and Marion Murray Community Centre, very little data is being collected from operating geothermal systems. The

NSCC plans to implement a monitoring program to record system data for training purposes.

- Though outside of the scope of work, it was noted that the electrical meter that supplies the town loop recorded 1108 kWh of power used by the Town Loop Submersible pump for a 60-day period. At current rates, this represents a cost of \$166.

## **6 Recommendations**

At this point in the project, the Verschuren Centre research team would like to recommend the following three activities.

### **6.1 Implementation of a data collection program**

Most of the current users of the geothermal resource have little interest in the details of their geothermal systems. The systems are repaired as required, but these systems perform well and specifics are not required for these operations. The research team suggests an ongoing data collection program be implemented to collect one year of data from four-six users of the resource. Data can be collected monthly or quarterly to identify changes and trends in the data. Important information to collect:

- Incoming and outgoing mine water temperatures
- Flow rates
- Well pump and heat pump energy use
- Repairs or system maintenance

This information can be used to estimate energy capture and cost savings for each of these installations. When considered relative to one another, estimates could then be determined for proposed resource installations such as new businesses considering a relation to the Springhill area.

In addition to the collection of data from active geothermal systems, there are several inactive geothermal systems in Springhill that could be assessed for potential use. Well inspections and pumping tests could be conducted on these existing supply/return wells to determine the feasibility of putting them back into use.

### **6.2 GIS mapping of the former Springhill Mine**

Brian Herteis of Cumberland County previously conducted an in-depth study of the former Springhill Mine workings and their locations relative to surface. The importance of this information cannot be overstated. In order to accurately install mine water wells to exploit the geothermal potential of the former mine, precise geographic information must be available prior to the initiation of any drilling

program. Details on the mining method used in different areas of the mine and accurate representation of these areas is required in order to accurately locate a drilling site that will access open and flooded mine workings.

Geographic information systems (GIS) are a powerful tool that has been used to achieve this level of precision on the Sydney Coalfield. Our team recommends that the CEA undertake a GIS survey of the former Springhill Mine, making full use of the experience of Brian Herteis, to develop precise coordinates for future drilling. This exercise will also allow for additional study of the volume of open and flooded mine workings to allow for capacity determinations.

### **6.3 Exploration and Pilot Project**

In order to attract business to the Springhill area, it will not be enough to showcase the current users of the resource. The resource must be explored to fully describe its future potential and secure investment from companies looking to save money on heating and cooling costs.

We propose an exploration program into deeper sections of the mine. This will allow for determination of mine water quality and temperatures at deeper depths, important information that is not currently available with the existing well network. With exploration wells, a pilot project could be implemented. The purpose of the pilot project will be to confirm the potential of the geothermal resource by applying a heating or cooling demand on a pilot system. For example, a greenhouse, temporary or fixed, could be installed for a local grower and make full use of the mine water geothermal energy. This installation would be closely monitored to collect data that supports the savings being recognized using geothermal versus conventional oil or electrical heat. This study would be a selling feature of the resource, demonstrating the economic benefit potential of using this resource efficiently to prospective commercial entities.

### **References (in addition to the annotated bibliography in Appendix 2)**

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# Springhill Business Park

## Microgrid Study

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## EXECUTIVE SUMMARY

This microgrid study was prepared as part of a larger feasibility study to examine the potential to serve the energy needs of a proposed business park from on-site resources. The thermal loads will be met by the geo-exchange district energy system and the remaining loads managed within a microgrid consisting of renewable energy and storage.

A microgrid is a group of interconnected loads and distributed energy sources within a defined boundary and acts like a single controllable system that can be connected to the provincial grid or disconnected to operate in “island mode”. This study includes estimates of building loads, renewable energy generation and storage capacity to determine the feasibility of a microgrid.

By incorporating solar photovoltaics on the building roofs, approximately 80% of the annual energy can be supplied by the building integrated generation. By incorporating ground mounted systems, the microgrid can serve as a distributed energy resource (DER) for the grid.

The wind regime in the Springhill area not sufficient enough to support wind power generation and has been discarded as a potential energy source.

By maximizing the solar power infrastructure and minimizing the building loads, this development has the potential to be a net exporter of energy. To accomplish this, a portion of the open space on each lot must be set aside for ground mounted solar.

The energy storage infrastructure is the key element of resilience for the district. As such, it is recommended to explore in detail, the types of loads to be supported in islanding mode to determine the required storage capacity.

NS Power’s average emissions factor for 2018 was 652.6 g/kWh, the third highest in Canada. The loads introduced by the proposed development under normal circumstances would add GHG emissions to the provincial output. Alternatively, by incorporating renewable energy can present a net positive energy & carbon opportunity with benefits beyond the business park.

The combination of thermal and electrical energy generation coupled with electrical storage is an opportunity to operate as a “net-zero carbon micro-utility”.

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## Introduction

A Microgrid is a group of interconnected loads and distributed energy sources within a defined boundary and acts like a single controllable system that can be connected to the provincial grid or disconnected to operate in island mode. The energy sources commonly associated with microgrids are solar photovoltaic, wind power and electric storage. Periods of generation over-capacity can be absorbed in electrical storage to be dispatched during periods of generation under capacity, or the over-capacity can be exported to the grid.

The end goal is to determine the optimal combination of generation and storage for the specific intention of the micro-grid. The strategies relating to the use of renewable energy and/or storage energy will differ depending on the mix of generation on the grid, greenhouse gas targets and utility transaction structures.

## Microgrid Models

### Grid-Connected

Provincial grid-connected micro-grids are designed to build resiliency in the district served by the microgrid. Interest is growing in California where wildfires have left many communities and urban centres without power during fire prevention outages. In these cases, a great deal of renewable energy and storage is required for islanding.

In some cases, the microgrid is based on a combination of grid power and battery storage. The batteries can be charged during off-peak periods when energy is cheaper and, in the case of Ontario, has lower emissions. The stored energy can be released during an islanded situation, for peak shaving, or dispatched as a generation source by the utility.

### Combined Heat & Power (CHP) Micro-Grid

A gas-powered co-generation system is the source of electric and thermal energy. Typically, a natural gas fired generator with heat recovery from the engine and exhaust is connected to host facilities that have a daily thermal load. Under normal conditions the output of the generator is connected in parallel with the grid, offsetting facility load. During an outage, the generator is controlled for islanding and the interconnection with the grid is opened. Such systems are intended to bring power security.

### Remote Facility or Community

Remote grids have no connection to a provincial grid. In this case the generators on the micro-grid are the only source of energy. These systems are most often powered by wind and solar with diesel generator back-up. Flywheel and battery storage provide the main energy source and micro-grid stability. In these circumstances, renewable energy is the least cost source of energy and zero-emissions. These have recently been installed at mine sites.

### The Microgrids Group at Berkeley Lab

The Microgrids Group at Berkeley Lab studies customer adoption patterns of microgrid technologies as well as microgrid controllers. Their research suggests that there are two key types of microgrids, and two other related types of power systems apply very similar technology. Their definitions are as follows.

1. **Customer microgrids or true microgrids** ( $\mu$ grids) are self-governed, and usually downstream of a single point of common coupling (PCC). Many of the most well-known demonstrations are of this type. They are particularly easy to imagine because they fit neatly into current technology and regulatory structure. Just as a traditional customer has considerable leeway in the operation of the power system on its side of the meter, so the restrictions on the nature of a  $\mu$ grid are relatively loose. For this reason, one would expect much of the early deployment of microgrid technology to be of this type.
2. **Utility or community microgrids** or milligrids (mgrids) involve a segment of the regulated grid. There are also existing well known examples. While technically, they not be different from  $\mu$ grids, they are fundamentally different from a regulatory and business model perspective, primarily because they incorporate traditional utility infrastructure. The corollary of this feature is that utility regulation comes much more significantly into play. In other words, any mgrid must comply with existing utility codes or accommodation must be made in the code.
3. **Virtual microgrids** (vgrids) cover DER at multiple sites but are coordinated such that they can be presented to the grid as a single controlled entity. Very few demonstrations of vgrids exist, but they have been proposed in the literature. To be consistent with this definition, the system must be able to operate as a controlled island or coordinated multiple islands.
4. **Remote power systems** (rgrids) are not able to operate grid-connected, isolated power systems involve similar technology and are closely related. So close that from a research point of view, they are commonly described as microgrids.

## Springhill Industrial Park Microgrid

### Building Loads

The representative building types supplied for this project includes 17 potential businesses including, warehousing, transportation services, greenhouse, food processing, and manufacturing.

<b>Business</b>	<b>Building Use</b>	<b>Lot Size (m<sup>2</sup>)</b>	<b>Building Size (m<sup>2</sup>)</b>
Nova Cold Logistics	Warehouse	20,000	5,720
Stokdijk Greenhouses	Agriculture	70,000	22,285
Kent Distribution Center	Warehouse	140,000	33,625
Loblaws Freezer Building	Warehouse	50,000	13,100
Burnside Lots	Various	12,000	4,920
Atlantic Can (Grow Facility)	Agriculture	20,000	5,070
Wonder	Agriculture	20,000	4,675
LED Roadway	Manufacturing	40,000	5,220
Fed Ex Ground	Transportation Services	22,000	2,850
McKesson Distribution Center	Warehouse	44,000	16,300
Armour Logistics	Transportation Services	62,000	33,620
Maritime Paper	Manufacturing	35,410	16,500
Midland Logistics	Transportation Services	25,090	2,200
Fastfrate Logistics	Transportation Services	63,780	6,250
Ropak Packaging	Manufacturing	33,140	12,800
Surette Battery Company	Manufacturing	62,200	5,582
Maritime Pride Eggs	Agriculture	28,450	3,400
Agropur Cooperative (Farmers Milk)	Agriculture	92,000	11,300
		<b>46,671</b>	<b>11,412</b>

Table 1 - Representative Buildings

With the exception of the transportation services, the loads for these building types are largely “Process” and not influenced by the weather. The process loads for these facilities are unknown and industry data could not be sources to estimate the process loads. To estimate the building loads, an energy model was created for two Archetype buildings that is intended to represent the range of building types. Models were created for a warehouse to represent the warehouse buildings and a medium office to represent the rest of the building types. The load factors in the energy models were based on the 2007 National Energy Code for Buildings (NECB 2017) default values.

The electrical load profile for the building loads vary less than 20% month over month. Furthermore, the profile does not show correlation between load and temperature conditions.

illustrate a fairly consistent demand over the year and are shown in Figures 1 & 2. Both buildings use heat pumps served from the DES to heat and cool.

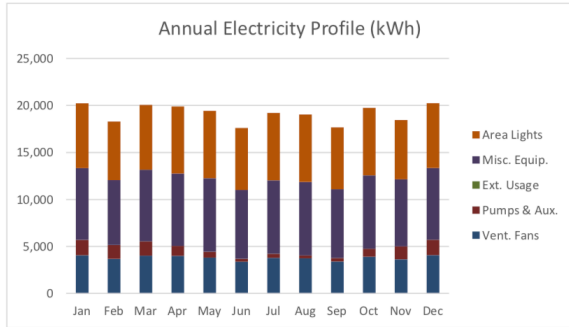


Figure 2 - Medium Office Energy Profile

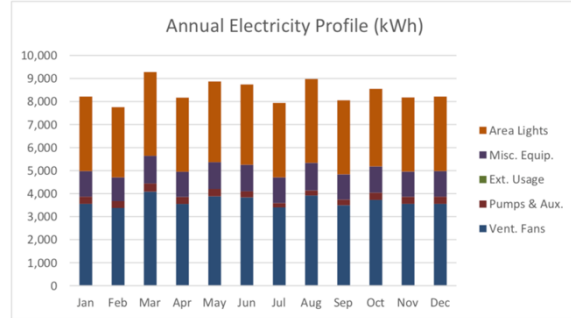


Figure 1 - Warehouse Energy Profile

All results for the DES sizing and electrical storage capacity sizing is based on the summary shown in Table 2.

Business	Buiding Use	Building Size (m <sup>2</sup> )	Energy Intensity (kWh/m <sup>2</sup> )	Annual Energy (MWh)
Nova Cold Logisitcs	Warehouse	5,720	185	1,058
Stokdijk Greenhouses	Agriculture	22,285	323	7,198
Kent Distribution Center	Warehouse	33,625	80.72	2,714
Loblaws Freezer Building	Warehouse	13,100	80.72	1,057
Burnside Lots	Various	4,920	107.03	527
Atlantic Can (Grow Facility)	Agriculture	5,070	323	1,638
Wonder	Agriculture	4,675	107.03	500
LED Roadway	Manufacturing	5,220	107.03	559
Fed Ex Ground	Transportation Services	2,850	80.72	230
McKesson Distribution Center	Warehouse	16,300	80.72	1,316
Armour Logistics	Transportation Services	33,620	80.72	2,714
Maritime Paper	Manufacturing	16,500	107.03	1,766
Midland Logistics	Transportation Services	2,200	80.72	178
Fastrate Logistics	Transportation Services	6,250	80.72	505
Ropak Packaging	Manufacturing	12,800	107.03	1,370
Surrette Battery Company	Manufacturing	5,582	107.03	597
Maritime Pride Eggs	Agriculture	3,400	185	629
Agropur Cooperative (Farmers Milk)	Agriculture	11,300	185	2,091
		<b>11,412</b>		<b>26,646</b>

Table 2 - Building Stock Energy Demand

The results of the energy models

NECB 2017 Baseline Modeled Outputs		
	Office	Warehouse
End Use	kWh	kWh
Space cooling	9,875	0
Space heating	81,656	192,428
Service water heating	34,134	6,685
Ventilation fans	45,406	43,924
Pumps & auxiliary	11,634	3,472
Misc. equipment	90,558	13,483
Area lights	82,304	40,091
Total Energy	355,567	300,083
Archetype area (m <sup>2</sup> )	3,322	3,717
Total EUI (kWh/m <sup>2</sup> )	107.0	80.7

*Table 3 - Building Energy Modeling Results*

Refer to Appendix A for the corresponding modeling reports.

#### Process Loads

Process loads, such as refrigeration are not factored into the building loads. Nor have they been considered in the energy storage or net-energy calculations in this report. If there is a desire to support these loads during grid power outages, it is recommended to incorporate storage in the building's electrical infrastructure.

### Greenhouses

The only data on greenhouse energy use is available from a study prepared by Posterity Group for the IESO in Ontario.

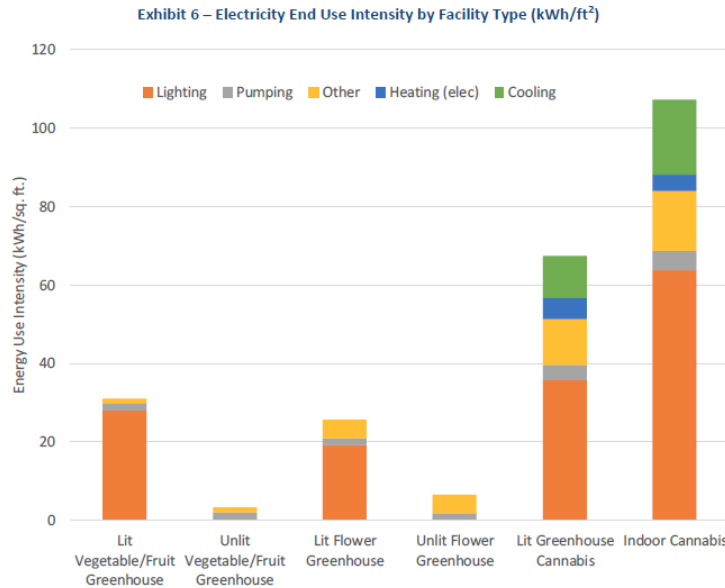


Figure 3 - Ontario Greenhouse Energy Intensities (source: IESO/Posterity Group)

### Summary of Facility Energy Intensities

The following energy intensities will be applied to the microgrid electrical modeling.

Building Type	EUI	Source
Warehouses & Transportation Services	80.7 kWh/m <sup>2</sup>	Energy model
Greenhouses	323 kWh/m <sup>2</sup>	IESO study
Refrigerated Facilities	185 kWh/m <sup>2</sup>	Best guess
All other Buildings	107 kWh/m <sup>2</sup>	Energy model for medium office archetype

Table 4 - Energy Use Intensities

## Solar Photovoltaic Capacity

Two configurations solar arrays have been any assessed for energy production; roof mounted and fixed ground mounted.

### Solar Radiation at Springhill

The solar regime is characterized by the energy production potential of 1245kWh/kW DC PV Capacity. A test case was simulated in PVWatts Calculator from NREL for a 610kW system. Refer to Appendix B for the corresponding report.

The resulting annual energy production is estimated at 726,232kWh. Through iterative runs, it was determined that the optimal angle for year-round production is 40° from the horizontal.

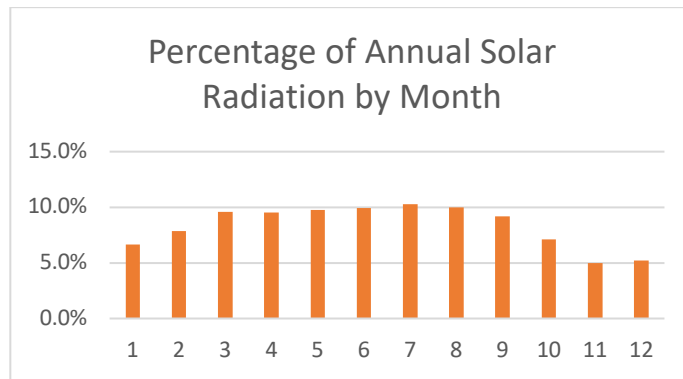


Figure 4 - Monthly Percentage of Annual Solar Production

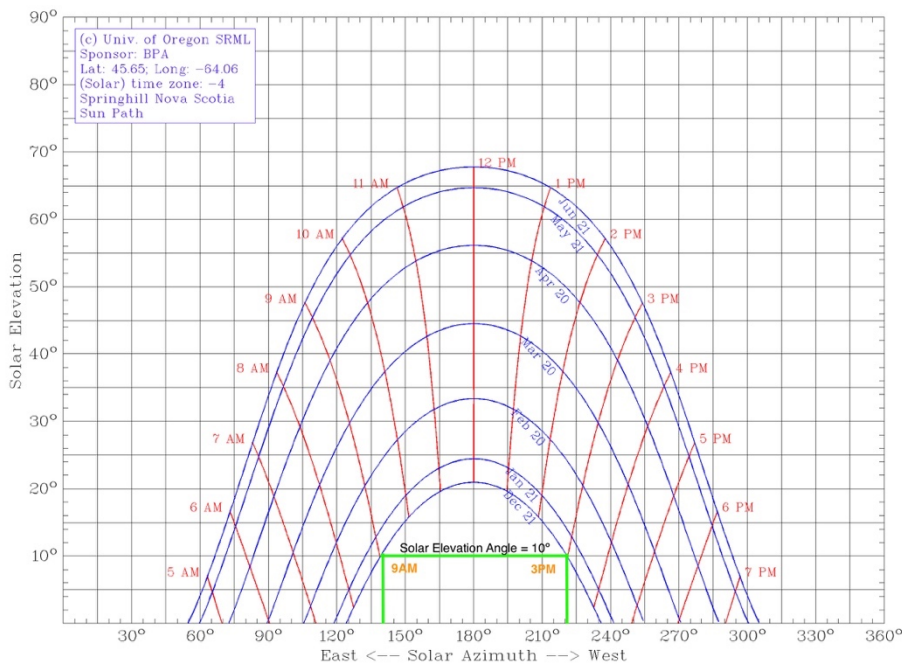


Figure 5 - Sun Path Plots

Panel Spacing and Power Densities

In order to determine the kW potential for roof areas and open space on the properties, the north-south spacing was calculated. The Sun Path in Springhill is shown in Figure 6. Based on this sun angle data, the arrays are designed to have no shadows from the neighboring panels from 9Am to 3PM on December 21<sup>st</sup> (Winter Solstice). The solar panel angle for rooftop applications has been selected as 20° to reduce uplift and dynamic loading. The ground mounted systems are fixed at 40°.

The row spacing is calculated as shown below.

$$\text{Panel Row Spacing} = \frac{\text{SIN (solar panel angle}^\circ \text{) } \times \text{panel width (m)}}{\text{TAN (solar elevation angle}^\circ \text{)}}$$



Figure 8 - Ground Mount System



Figure 7 - Typical Roof Mounted Solar System

Business	Building Use	ROOF MOUNT 20°				GROUND MOUNT 40°				Solar Energy (MWh)									
		Net Roof Area (m <sup>2</sup> )	Solar DC (kW)	Solar AC (kW)	Solar Energy (MWh)	Lot Size (m <sup>2</sup> )	Lot Net Area (m <sup>2</sup> )	Solar DC (kW)	Solar AC (kW)										
Nova Cold Logisitcs	Warehouse	5,115	610	509	726	20,000	7,140	928	774	963									
Stokdijk Greenhouses	Agriculture	21,091	0	0	0	70,000	23,858	3,101	2,585	3,218									
Kent Distribution Center	Warehouse	32,158	3,836	3,197	4,565	140,000	53,188	6,914	5,762	7,174									
Loblaws Freezer Building	Warehouse	12,184	1,454	1,211	1,730	50,000	18,450	2,399	1,999	2,488									
Burnside Lots	Various	4,359	520	433	619	12,000	3,540	460	384	477									
Atlantic Can (Grow Facility)	Agriculture	4,500	537	447	639	20,000	7,465	970	809	1,007									
Wonder	Agriculture	4,128	492	410	586	20,000	7,663	996	830	1,033									
LED Roadway	Manufacturing	4,642	554	461	659	40,000	17,390	2,261	1,884	2,345									
Fed Ex Ground	Transportation Services	2,423	289	241	344	22,000	9,575	1,245	1,037	1,291									
McKesson Distribution Center	Warehouse	15,279	1,823	1,519	2,169	44,000	13,850	1,801	1,500	1,868									
Armour Logistics	Transportation Services	32,153	3,836	3,197	4,565	62,000	14,190	1,845	1,537	1,914									
Maritime Paper	Manufacturing	15,472	1,846	1,538	2,197	35,410	9,455	1,229	1,024	1,275									
Midland Logistics	Transportation Services	1,825	218	181	259	25,090	11,445	1,488	1,240	1,544									
Fastrate Logistics	Transportation Services	5,618	670	558	798	63,780	28,765	3,739	3,116	3,880									
Ropak Packaging	Manufacturing	11,895	1,419	1,183	1,689	33,140	10,170	1,322	1,102	1,372									
Surrette Battery Company	Manufacturing	4,984	595	496	708	62,200	28,309	3,680	3,067	3,818									
Maritime Pride Eggs	Agriculture	2,934	350	292	416	28,450	12,525	1,628	1,357	1,689									
Agropur Cooperative (Farmers Milk)	Agriculture	10,450	1,247	1,039	1,483	92,000	40,350	5,246	4,371	5,442									
						<b>16,913</b>				<b>24,151</b>					<b>34,377</b>				<b>42,799</b>

Table 5 - Solar PV Generation Potential

Business	Building Use	Building Size (m <sup>2</sup> )	Energy Intensity (kWh/m <sup>2</sup> )	Annual Energy (MWh)	Rooftop Solar (MWh)	Net Consumption	Solar Fraction of Total
Nova Cold Logistics	Warehouse	5,720	185	1,058	726	332	69%
Stokdijk Greenhouses	Agriculture	22,285	323	7,198	0	7,198	0%
Kent Distribution Center	Warehouse	33,625	80.72	2,714	4,565	-1,851	168%
Loblaws Freezer Building	Warehouse	13,100	80.72	1,057	1,730	-672	164%
Burnside Lots	Various	4,920	107.03	527	619	-92	118%
Atlantic Can (Grow Facility)	Agriculture	5,070	323	1,638	639	999	39%
Wonder	Agriculture	4,675	107.03	500	586	-86	117%
LED Roadway	Manufacturing	5,220	107.03	559	659	-100	118%
Fed Ex Ground	Transportation	2,850	80.72	230	344	-114	150%
McKesson Distribution Center	Warehouse	16,300	80.72	1,316	2,169	-853	165%
Armour Logistics	Transportation	33,620	80.72	2,714	4,565	-1,851	168%
Maritime Paper	Manufacturing	16,500	107.03	1,766	2,197	-431	124%
Midland Logistics	Transportation	2,200	80.72	178	259	-81	146%
Fastfrate Logistics	Transportation	6,250	80.72	505	798	-293	158%
Ropak Packaging	Manufacturing	12,800	107.03	1,370	1,689	-319	123%
Surrette Battery Company	Manufacturing	5,582	107.03	597	708	-110	118%
Maritime Pride Eggs	Agriculture	3,400	185	629	416	213	66%
Agropur Cooperative (Farmers)	Agriculture	11,300	185	2,091	1,483	607	71%
		<b>11,412</b>		<b>26,646</b>	<b>24,151</b>	<b>2,495</b>	

Table 6 - Rooftop Solar Generation Impact

## Wind Power

The average wind speed in Springhill is less than 15km/h (4.2m/s) as illustrated in Figure 10.

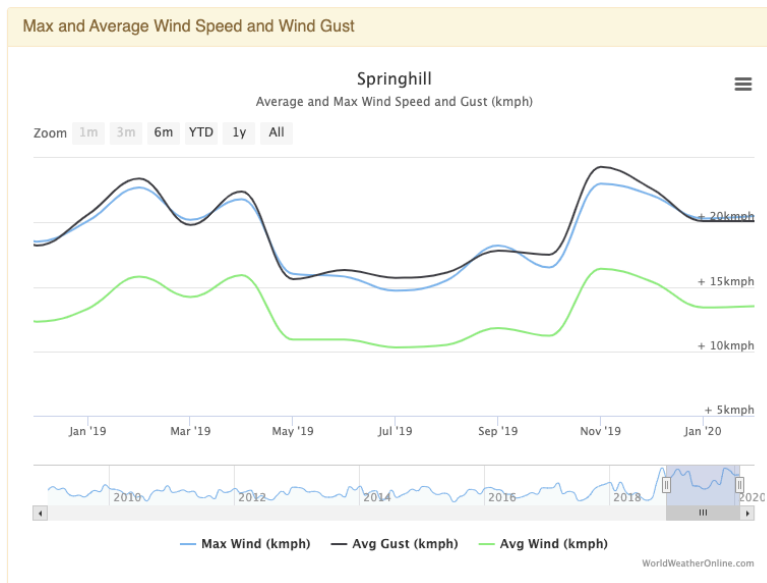


Figure 9 - Wind Speed Profile (source: worldweatheronline.com)

With this average wind, wind-turbines have a capacity factor less than 25% per Figure 11, making wind a poor choice as a feasible energy source.

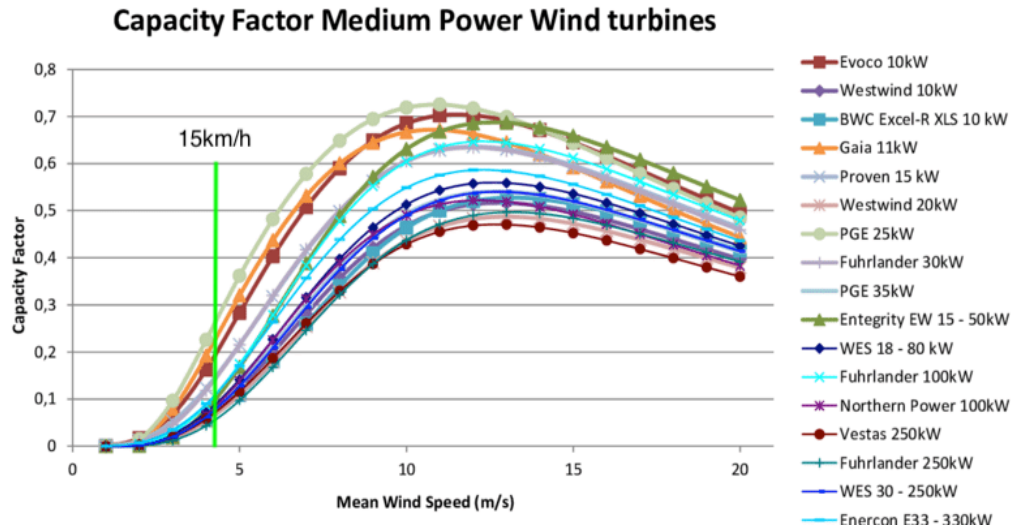


Figure 10 - Capacity Factor and Wind Speeds (source: researchgate.net)

## Electrical Energy Storage

Electrical energy storage for micro-grids include flywheel, lithium battery system and hydrogen loop. Flywheels are useful where wind is the primary generator and the same can be said for the hydrogen loop. All of which store and deliver excess wind power when needed. For systems using solar energy or grid storage, lithium batteries are the choice in the market today.

There are numerous manufacturers and many more are emerging in the market every year. The Tesla Megapack is a suitable option, especially with its, plug & play technology. The 3MWh units have been deployed in multiple gigawatt facilities.



Figure 11 - Tesla Megapack (source: Tesla.com)

Storage in the case of the Springhill development would serve as back-up power to critical systems in the microgrid. Given that the overcapacity in generation can be exported to the grid to offset thermal generation and related GHGs. Battery systems have a 13% round-trip loss in the charging and discharging the batteries. Once the batteries are initially charged by the solar power, exporting to the grid is recommended.

The example below illustrates the amount of storage required to provide back-up to the critical systems. To power the Energy Centre for one day requires four 3MWh battery units (not including energy supply from solar during the 24 hour period).

Energy Centre 24 Hour Supply Storage Scenario		
Energy Centre	0.400	MWh
Hours per day	24	hours
Energy Centre Daily consumption	9.589	MWh
Megapack Battery Storage	3	MWh
# of 3MWh Battery Units	3.2	

Table 7 - Battery Storage Estimate for Energy Centre

A typical essential load model is based on full heating capacity & delivery, and reduced power on the other end uses.

Building Essential Load 24 Hour Supply Storage Scenario		
Essential Loads	1,014	kWh/day/building
# buildings	18	
Total District Loads	18,252	kWh/day
Megapack Battery Storage	3	MWh
# of 3MWh Battery Units	6	

Table 8 - Battery Storage Estimate for Buildings



Figure 12 - Tesla utility Scale Storage (source:pv-magazine.com)

## Nova Scotia Power Grid

The provincial grid is most often the cheapest source electrical energy. This is changing in jurisdictions like Ontario that have a time-of-use rate structure designed to reduce demand during peak periods. Solar PV is cost competitive with the peak utility rates in these cases.

### Grid Emissions Factor

The emerging influential component to energy planning is greenhouse gas emissions. NS Power’s **average emissions factor for 2018 was 652.6 g/kWh**. NS Power is obliged to reduce GHGs along with other sectors of the economy. Therefore, any new development that includes renewable energy is a benefit to the province and planet.

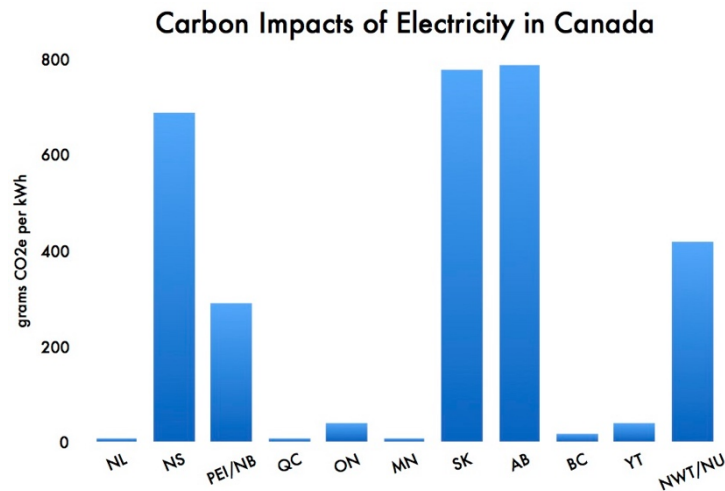


Figure 13 - Provincial Electricity Supply Emissions Factors

NS Power’s emissions are high due to the use of coal combustion. Evidence of the high emissions are illustrated in the emissions factors for the major generators.

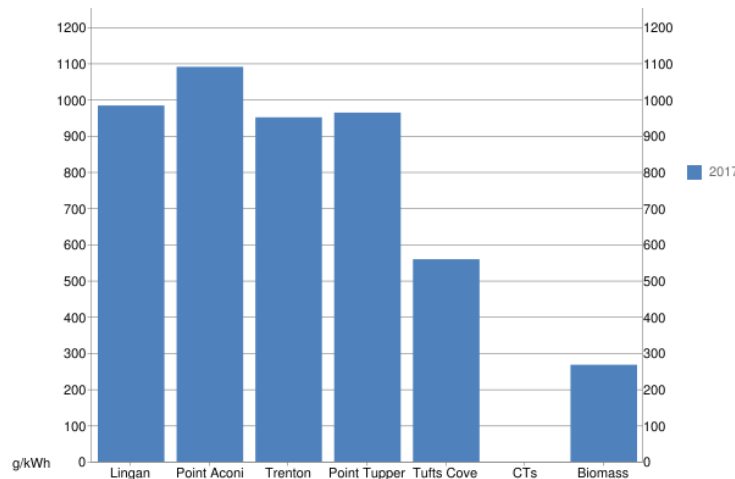


Figure 14 - Nova Scotia Generator Emissions Factors

The loads introduced by the proposed development would add GHG emissions to the provincial output. Alternatively, developments that incorporate renewable energy can present a net positive energy & carbon opportunity.

### Utility Structures

The options at the front end of the process depends on whether the microgrid and thermal district energy system operate as a utility. This option will require legislative support. This project could be the first co-generation local distribution company (LDC).

Nova Scotia Power has a couple of programs for which to sell energy to the utility. Renewable to Retail Market Transition Tariff pays Licensed Retail Suppliers for kW and kWh supplied to the utility. The Generation Replacement and Load Following Tariff is an option where customer has a dispatchable energy source and has generation in excess of their load. The utility has purchase tariffs for this option. Nova Scotia Power's website is an excellent site to research options to engage in energy sales.

## Springhill Business Park Microgrid

The microgrid for the Springhill Industrial Park can operate in a number of modes depending on the dynamic balance between varying loads, varying solar energy generation and the potential dispatching of stored energy by the utility. The district energy system is an all-electric energy supply serving the thermal loads (heating and cooling). The four modes of operation are illustrated below.

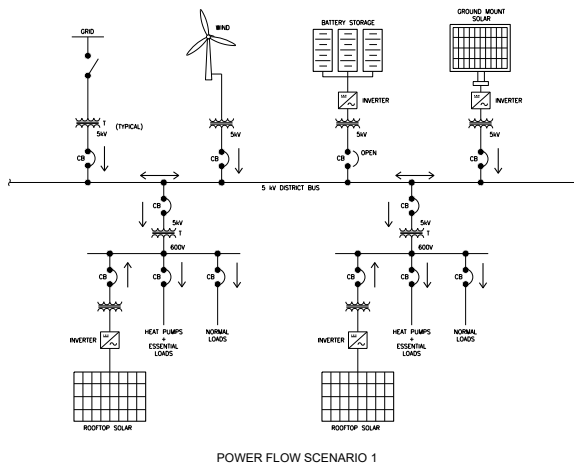


Figure 15 – Net Importing Mode

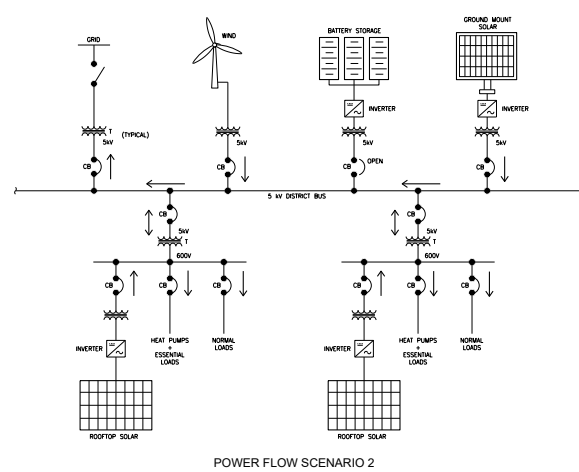


Figure 16 - Exporting Energy Mode

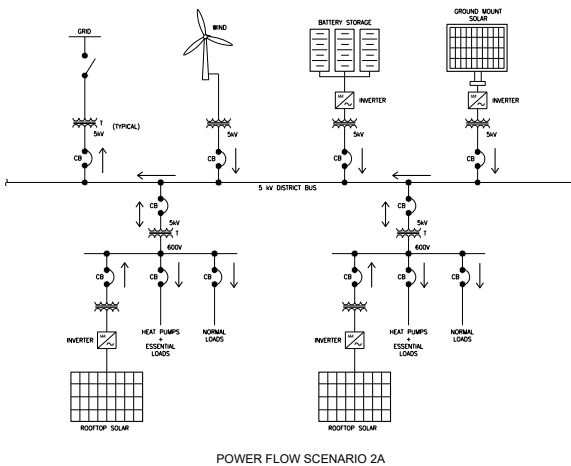


Figure 17 - Exporting with Dispatched Storage Generation

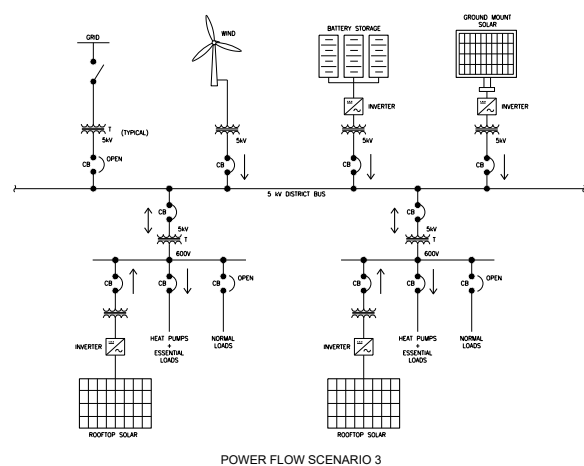


Figure 18 - Islanding Mode

The circuit breakers are controlled by the SCADA system to engage

**Net Importing mode** and **exporting mode** will be automatically alternated with the available solar power. These will likely alternate with the length of the days & nights.

**Exporting with dispatched storage generation mode** provides a means of further monetizing the storage system, rather than keeping it exclusively for islanding. The utility purchases the

clean energy to offset GHGs, for grid stabilization, and load expansion capacity. It's important to note that the round-trip losses from charging and discharging stored energy result in a 13% loss of the available renewable energy.

**Islanding mode** (utility outage) is disconnected from the grid and relies solely on solar generation and battery energy.

<b>Base load of proposed development</b>		
District annual load	30,146	MWh
Greenhouse gases	19,673	tonnes
<b>Potential with rooftop solar</b>		
Base load with rooftop solar	5,995	MWh
Greenhouse gases	3,912	tonnes
Savings	80%	Reduction
<b>Potential with adding ground mounted solar</b>		
Ground mounted solar	42,799	MWh
Base load with rooftop solar	5,995	MWh
Savings	100%	Reduction
Exported energy	36,805	MWh
Additional greenhouse gases avoided	24,019	tonnes

*Table 9 - Renewable Energy & Greenhouse Gas Impacts*

## Discussion

The primary objection in planning microgrids for operation during islanding mode (grid power outage) is to minimize the energy needed by the buildings and systems. This is referred to as “Negawatts”.

By maximizing solar photovoltaics on the building roofs, approximately 80% of the annual energy can be supplied by the building integrated generation. By incorporating ground mounted systems, the microgrid can serve as a distributed energy resource (DER) for the grid.

The most appropriate storage technology is lithium ion batteries. The technology is well commercialized and has demonstrated its reliability in numerous microgrid applications. To determine the amount of storage required, a more detailed study is required to understand which loads can be supported during a grid outage and for how long.

The wind regime in the Springhill area not sufficient enough to support wind power generation and has been discarded as a potential energy source.

Although microgrids have been fully commercialized, they are still a developing concept in Canada. As such, planning requires discussions with the provincial power authority to establish the connection impact of the distributed generation source and the financial transaction structure for exporting energy.

By maximizing the solar power infrastructure and minimizing the building loads, this development has the potential to be a net exporter of energy. The energy storage infrastructure is the key element of resilience for the district. As such, it is recommended to explore in detail, the types of loads to be supported in islanding mode to determine the required storage capacity.

NS Power’s average emissions factor for 2018 was 652.6 g/kWh. The loads introduced by the proposed development under normal circumstances would add GHG emissions to the provincial output. Alternatively, by incorporating renewable energy can present a net positive energy & carbon opportunity with benefits beyond the business park.

The combination of thermal and electrical energy generation coupled with electrical storage is an opportunity to operate as a “net-zero carbon micro-utility”.

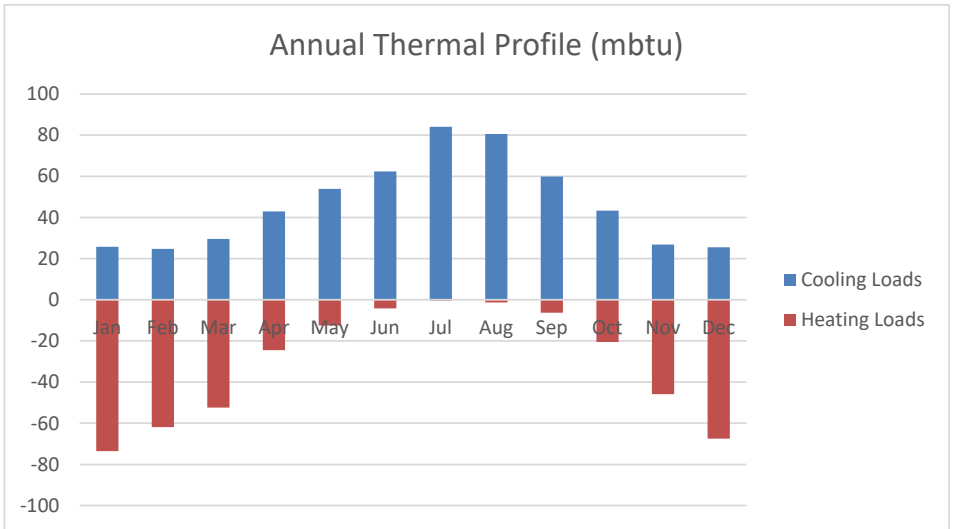
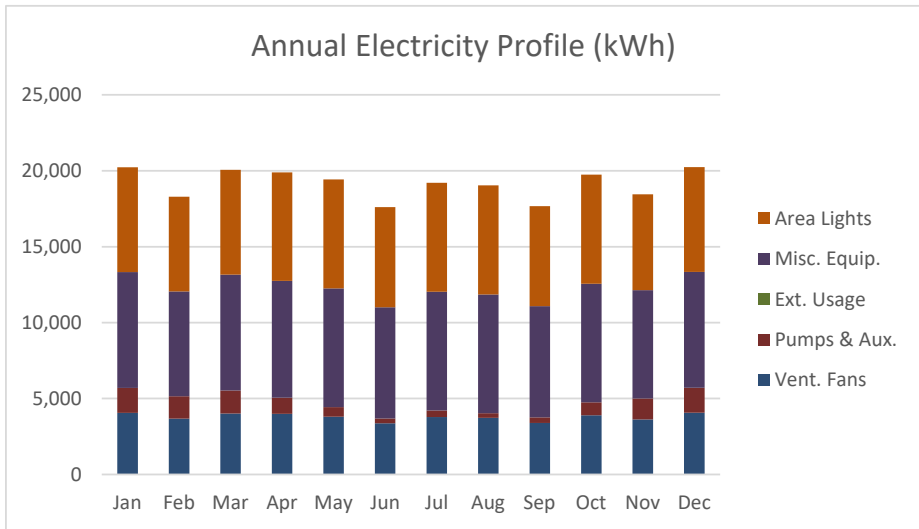
## Appendix A

PB EUI	PB TEDI	GHGI	MFA
ekWh/m <sup>2</sup>	kWh/m <sup>2</sup>	kg/m <sup>2</sup>	m <sup>2</sup>
107.03	20.81	5.35	3,322

**Medium Office Building - NECB 2017 (REV-1)**

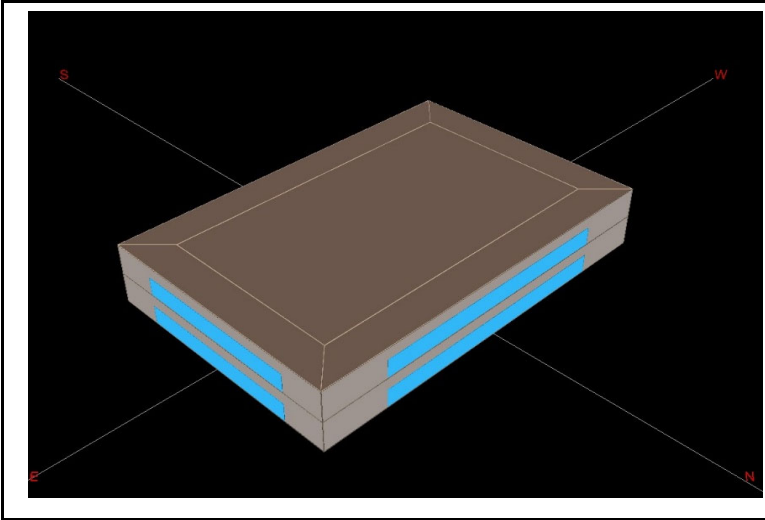
Electricity (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	52	588	1,175	3,718	3,032	1,115	197	0	0	9,875
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	20,479	15,136	11,604	4,882	1,136	139	0	0	290	2,872	8,618	16,500	81,656
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Service Hot Water	3,122	2,917	3,229	3,276	3,091	2,657	2,706	2,596	2,382	2,681	2,530	2,947	34,134
Vent. Fans	4,051	3,673	4,016	3,995	3,800	3,377	3,788	3,726	3,390	3,897	3,629	4,064	45,406
Pumps & Aux.	1,645	1,484	1,515	1,062	633	314	425	314	371	851	1,373	1,646	11,634
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	7,632	6,899	7,632	7,699	7,819	7,325	7,819	7,819	7,325	7,819	7,139	7,632	90,558
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	6,902	6,243	6,902	7,145	7,179	6,590	7,179	7,179	6,590	7,179	6,312	6,902	82,304
<b>Total</b>	<b>43,831</b>	<b>36,352</b>	<b>34,897</b>	<b>28,111</b>	<b>24,246</b>	<b>21,576</b>	<b>25,635</b>	<b>24,667</b>	<b>21,464</b>	<b>25,495</b>	<b>29,601</b>	<b>39,691</b>	<b>355,567</b>

Thermal Loads (mbtu)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Cooling Loads	25.740	24.734	29.568	42.919	53.900	62.405	84.108	80.567	59.895	43.300	26.840	25.479	559.456
Heating Loads	-73.500	-61.899	-52.386	-24.460	-12.520	-4.203	-0.467	-1.294	-6.279	-20.514	-45.880	-67.528	-370.931

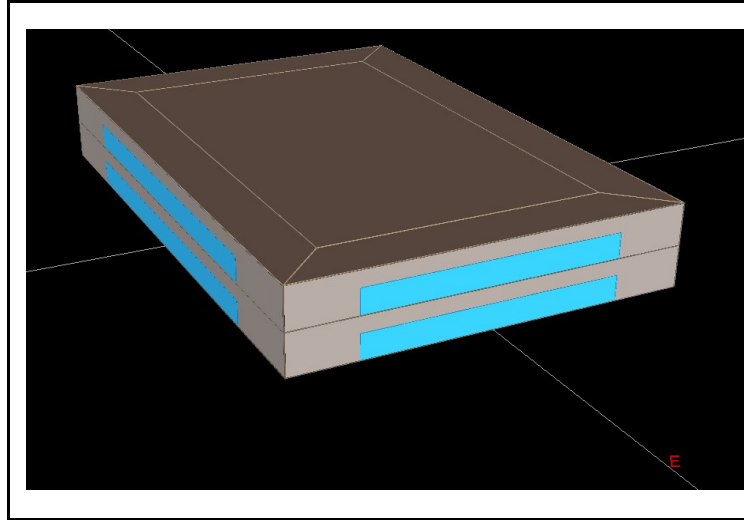


Medium Office Building - NECB 2017 (REV-1)

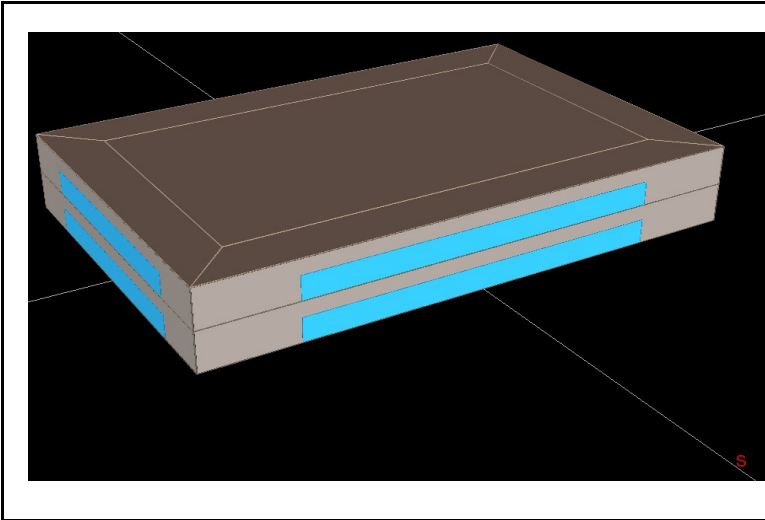
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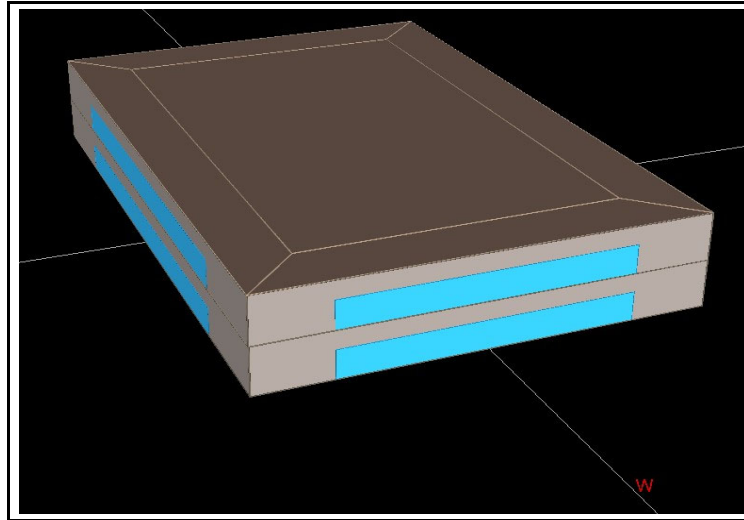
East



South



West



## Medium Office Building - NECB 2017 (REV-1)

### Building Envelope

**Climatic Zone** (NECB 2017 Table C-1): Springhill, Nova Scotia | Degree Days Below 18°C: 4540 HDD18 | Zone 6: 4000°C < HDD18 < 4999°C  
**Exterior Walls** (Zone 6): Assembly USI: 0.247 | Assembly U-Value : 0.043  
**Exterior Roof** (Zone 6): Assembly USI: 0.156 | Assembly U-Value : 0.027  
**Exposed Floors**: not applicable  
**Below Grade Walls** : not applicable  
**Floor/Slab Construction** (Zone 6): Perimeter Assembly USI: 0.250 | Assembly U-Value : 0.044 , Core simulated as adiabatic  
**Window to Wall Ratio**: 40%  
**Infiltration**: 0.025 l/s-m<sup>2</sup> of exterior wall area  
**Fenestration Type** (Zone 6): Assembly USI: 1.9 | Assembly U-Value : 0.335 | SHGC: 0.40

### Electrical Loads

**Appliances & Plug Loads** (NECB 2017 Default Loads): Peak Receptacle Load 7.5 W/m<sup>2</sup> | 0.70 W/ft<sup>2</sup>  
**Interior Lighting** (NECB 2017 Default Loads): Lighting Power Density 8.7 W/m<sup>2</sup> | 0.81 W/ft<sup>2</sup>

### Air-Side HVAC

**System Type**: Package Single Zone - HW Heating Coil & DX Cooling Coil  
**Fan Power**: 2.57 in W.C. | 40% combined efficiency | Total fan power: 12.88 kW  
**Air-side Economizer**: Outdoor Air Control | Dry bulb High Limit 65°F  
**Outdoor Air Rates (ASHRAE 62.1)**: 2.4 L/s-occupant & 0.3 L/s-m<sup>2</sup> | 5 cfm/occupant & 0.06 cfm/ft<sup>2</sup> | Total outdoor air: 3,065 cfm  
**Heat Recovery**: Enthalpy Wheel | Sensible Effectiveness 55% | Latent Effectiveness 55%  
**Cooling**: Supply Temp 55°F | EER 20  
**Heating**: Supply Temp 110°F

### Water-Side HVAC

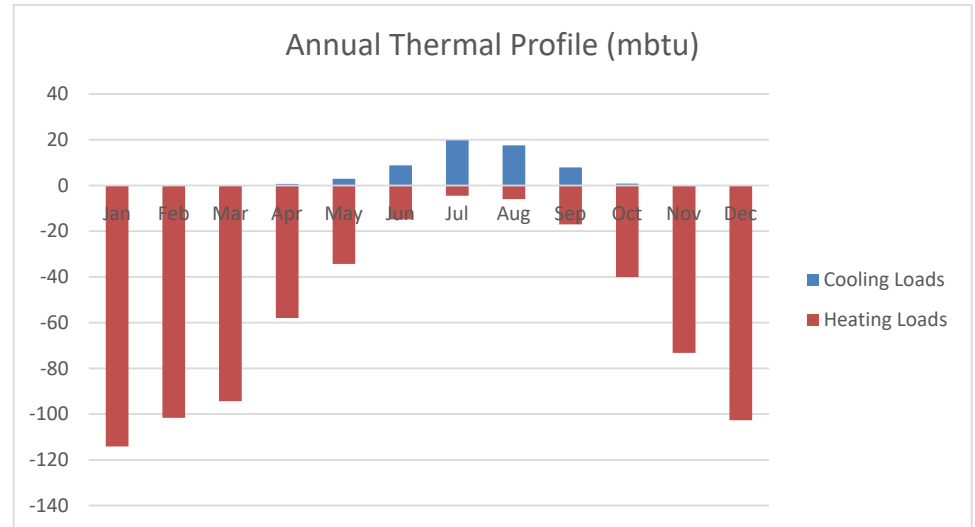
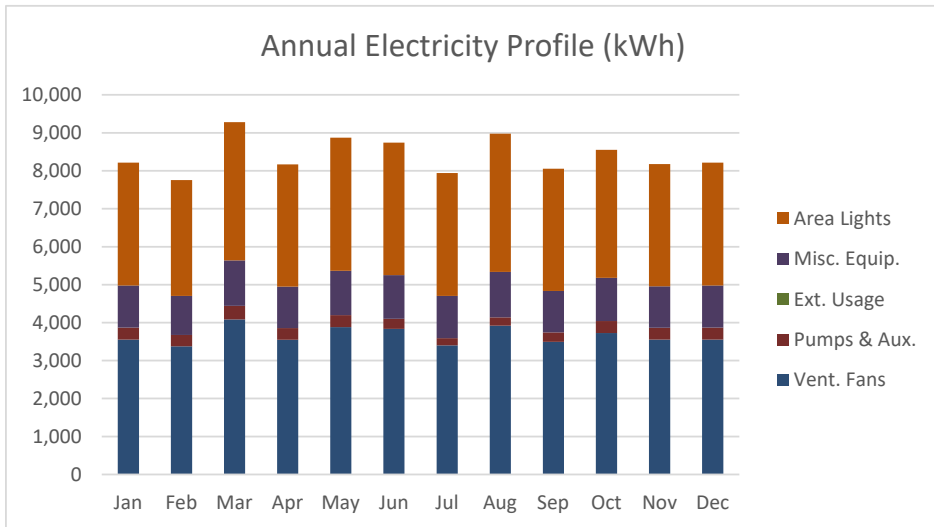
**DHW**: electric hot water heater | efficiency: 100% | service hot water load (90 W/occupant): 1.021 gpm  
**HW Loop**: Served by electric boiler

PB EUI	PB TEDI	GHGI	MFA
ekWh/m <sup>2</sup>	kWh/m <sup>2</sup>	kg/m <sup>2</sup>	m <sup>2</sup>
80.72	46.99	4.04	3,717

**Warehouse Building - NECB 2017 (REV-1)**

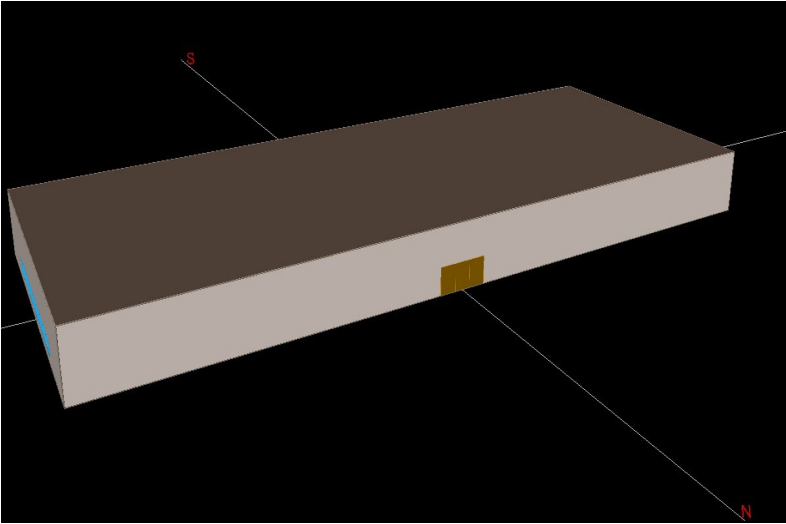
Electricity (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	34,706	29,885	29,029	16,819	10,867	4,106	250	292	3,782	12,016	22,225	28,452	192,428
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Service Hot Water	593	566	666	589	600	559	498	530	479	518	524	563	6,685
Vent. Fans	3,552	3,374	4,085	3,549	3,883	3,835	3,401	3,919	3,495	3,727	3,552	3,552	43,924
Pumps & Aux.	317	300	359	308	317	267	192	221	247	314	313	316	3,472
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	1,111	1,029	1,194	1,093	1,167	1,149	1,111	1,194	1,093	1,139	1,093	1,111	13,483
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	3,238	3,051	3,645	3,221	3,509	3,492	3,238	3,645	3,221	3,373	3,221	3,238	40,091
<b>Total</b>	<b>43,516</b>	<b>38,206</b>	<b>38,978</b>	<b>25,579</b>	<b>20,343</b>	<b>13,408</b>	<b>8,688</b>	<b>9,802</b>	<b>12,317</b>	<b>21,088</b>	<b>30,928</b>	<b>37,231</b>	<b>300,083</b>

Thermal Loads (mbtu)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Cooling Loads	0.000	0.000	0.000	0.650	2.894	8.813	19.721	17.554	7.859	0.822	0.000	0.000	19.721
Heating Loads	-114.145	-101.656	-94.384	-57.999	-34.351	-14.856	-4.530	-6.001	-17.033	-40.027	-73.273	-102.731	-4.530

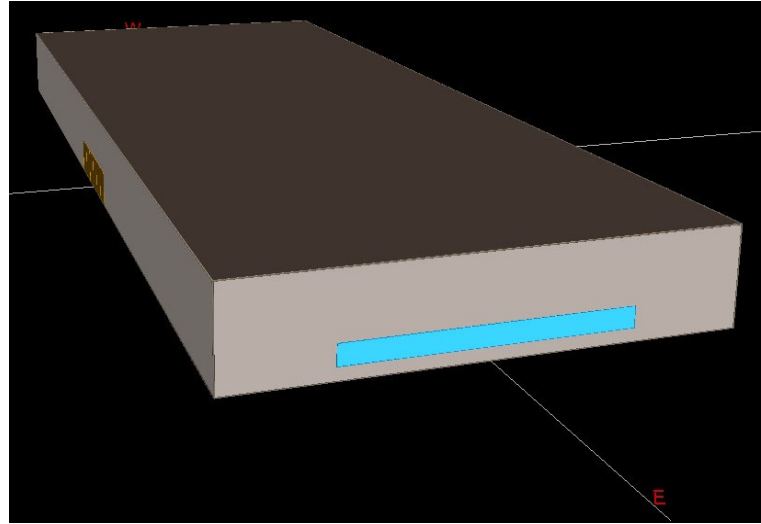


Warehouse Building - NECB 2017 (REV-1)

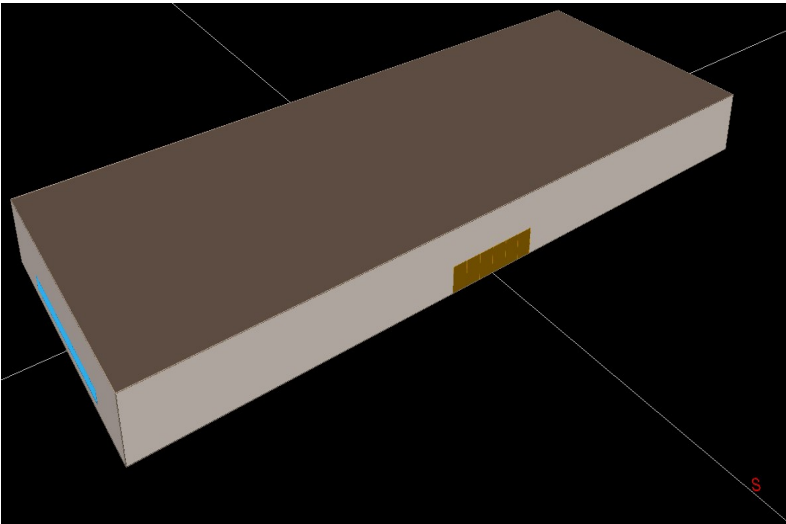
North



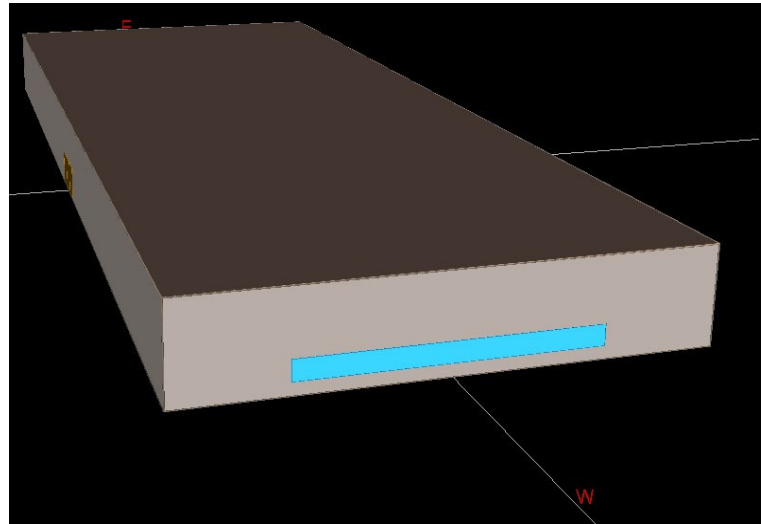
East



South



West



## Warehouse Building - NECB 2017 (REV-1)

### Building Envelope

**Climatic Zone** (NECB 2017 Table C-1): Springhill, Nova Scotia | Degree Days Below 18°C: 4540 HDD18 | Zone 6: 4000°C < HDD18 < 4999°C  
**Exterior Walls** (Zone 6): Assembly USI: 0.247 | Assembly U-Value : 0.043  
**Exterior Roof** (Zone 6): Assembly USI: 0.156 | Assembly U-Value : 0.027  
**Exposed Floors**: not applicable  
**Below Grade Walls** : not applicable  
**Floor/Slab Construction** (Zone 6): Perimeter USI: 0.757 for 1.2m & Core USI: 0.057 | Perimeter U-value: 0.133 for 1.2m & Core U-value: 0.010  
**Opaque Doors** (Zone 6): Assembly USI: 1.9 | Assembly U-Value : 0.335  
**Window to Wall Ratio**: 3.5%  
**Infiltration**: 0.025 l/s-m<sup>2</sup> of exterior wall area  
**Fenestration Type** (Zone 6): Assembly USI: 1.9 | Assembly U-Value : 0.335 | SHGC: 0.40

### Interior Loads & Schedules

**NECB Normalized Schedules**: Warehouse space type = NECB Operating Schedule Group A  
**Occupancy Loads** (NECB 2017 Default Loads): Occupant density 100 m<sup>2</sup>/occupant | 1073 ft<sup>2</sup>/occupant = 37.17 occupants  
**Appliances & Plug Loads** (NECB 2017 Default Loads): Peak Receptacle Load 1 W/m<sup>2</sup> | 0.093 W/ft<sup>2</sup>  
**Interior Lighting** (NECB 2017 Default Loads): Lighting Power Density 3.8 W/m<sup>2</sup> | 0.35 W/ft<sup>2</sup>

### Air-Side HVAC

**System Type**: Package Single Zone - HW heating coil | No cooling  
**Fan Power**: 2.57 in W.C. | 40% combined efficiency | Total fan power: 12.88 kW  
**Air-side Economizer**: Outdoor Air Control | Dry bulb High Limit 65°F  
**Outdoor Air Rates (ASHRAE 62.1)**: 2.4 L/s-occupant & 0.3 L/s-m<sup>2</sup> | 5 cfm/occupant & 0.06 cfm/ft<sup>2</sup> | Total outdoor air: 3,065 cfm  
**Heat Recovery**: Enthalpy Wheel | Sensible Effectiveness 55% | Latent Effectiveness 55%  
**Cooling**: no cooling  
**Heating**: Supply Temp 110°F

### Water-Side HVAC

**DHW**: electric hot water heater (9kW / 15.8L tank) | efficiency: 100% | service hot water load (65 W/occupant): 0.165 gpm  
**HW Loop**: Served by electric boiler

## Appendix B



Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at <https://sam.nrel.gov>) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

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## RESULTS

# 726,233 kWh/Year\*

Month	Solar Radiation ( kWh / m <sup>2</sup> / day )	AC Energy ( kWh )	Value ( \$ )
January	2.55	39,942	N/A
February	3.58	50,294	N/A
March	4.40	67,365	N/A
April	5.02	72,525	N/A
May	5.36	78,660	N/A
June	5.85	81,630	N/A
July	5.85	83,106	N/A
August	5.41	77,416	N/A
September	4.74	65,910	N/A
October	3.20	47,644	N/A
November	2.08	30,983	N/A
December	1.96	30,757	N/A
<b>Annual</b>	<b>4.17</b>	<b>726,232</b>	<b>0</b>

### Location and Station Identification

Requested Location	Springhill Nove Scotia
Weather Data Source	Lat, Lon: 45.65, -64.06 0.6 mi
Latitude	45.65° N
Longitude	64.06° W

### PV System Specifications *(Residential)*

DC System Size	610 kW
Module Type	Premium

OTHER TORTIOUS CLAIM THAT ARISES OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE MODEL.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

## PVWatts Calculator

<b>Array Type</b>	<b>Fixed (open rack)</b>
<b>Array Tilt</b>	<b>20°</b>
<b>Array Azimuth</b>	<b>180°</b>
<b>System Losses</b>	<b>14.08%</b>
<b>Inverter Efficiency</b>	<b>96%</b>
<b>DC to AC Size Ratio</b>	<b>1.2</b>

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**Economics**

<b>Average Retail Electricity Rate</b>	<b>No utility data available</b>
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**Performance Metrics**

<b>Capacity Factor</b>	<b>13.6%</b>
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## Appendix C

## Microgrid Example

Berkley Lab, U.S. Department of Energy ( <https://building-microgrid.lbl.gov/>) have done a great deal of research into the different types of microgrids. The following are from the list of projects with The Microgrids Group at Berkeley Lab.

### Fort Carson

Fort Carson in Colorado Springs is one of several microgrid projects underway on U.S. bases under the SPIDERS (Smart Power Infrastructure Demonstration for Energy Reliability and Security) program. It is a large base with about 14,000 residents, and covering 550 km<sup>2</sup>, with additional firing ranges nearby.

The base as a whole has an ambitious plan to become a net zero facility using huge PV resources, potentially over 100 MW, as well as wind, ground-source heat pumps, biomass, and solar water heating. The microgrid project is intended to keep a group of central base facilities operating without grid power as an island, in the event of grid failure.

The SPIDERS Microgrid is composed of existing assets, a 1 MW PV array and three diesel generators with a total power of 3 MW, and 5 electric vehicles (EVs) with V2G capability. A 3-day operational demonstration took place in October 2013 to assess the robustness of the design. The PV and 4 out of 5 EVs were successfully connected during the field test.

The challenges which were faced during the implementation of the project and the demonstration were solely issues related to system ownership and communication. For instance, a 2 MW array should initially have been integrated to the microgrid. Despite attempts to obtain a site access agreement to the total PV array, it was already too late to include it into the system configuration which might restrain the future use of the microgrid when islanded.

### Mesa Del Sol

The Mesa del Sol mixed commercial-residential development in Albuquerque, New Mexico is the site of a fully functioning microgrid.

The system comprises a 50 kW parking lot canopy solar PV system, and a microgrid enclosure containing an 80 kW fuel cell, a 240 kW natural gas-powered generator, a lead-acid battery bank, hot and cold thermal storage, and an adsorption chiller.

### Huatacondo

The University of Chile has developed Chile's first microgrid project in a remote Andes Mountains community of 150 residents (mostly miners and their families) called Huatacondo. Prior to the microgrid installation, the community had its own electric network (operating independently from the macro-grid) operating 10 hours per day with power provided from a single diesel

generator. The vision of the microgrid was to continue using that diesel generator but supplement it with distributed energy resources, namely solar PV, wind, and a battery system.

The microgrid includes a 150 kW diesel generator, 22 kW tracking solar PV system, a 3 kW wind turbine, a 170 kWh battery, and an energy management system. The energy management system provides online set-points for generation units while minimizing operating costs, taking into account renewable resource forecast, load, solar tracking, and water consumption.

## New York University

New York University (NYU), one of the largest universities in the United States, has produced power on site since the 1960s and installed a large oil-fired cogeneration plant in 1980. At the end of that facility's useful service life, NYU made a transition away from oil-fired technology towards a modern natural-gas fired combined heat and power facility, with eyes towards microgrid capabilities, better reliability, and a better control of their energy expenditures.

The upfront capital cost of the upgrade was significant at \$126 million. However, tax-exempt bonds arranged through the Dormitory Authority of the State of New York and through NYU tuition and fees helped to provide low-cost financing sources.

The CHP system has an output capacity of 13.4 MW (twice as much as the old plant's capacity) and has been fully operational since 2011. It supplies electricity to 22 buildings and heat to 37 buildings across campus. The microgrid consists of two 5.5 MW gas turbines for producing electricity coupled with heat recovery steam generators and a 2.4 MW steam turbine. The NYU microgrid is connected to Con Edison distribution grid and purchases electricity when demand is superior to the on-site generating capacity.

Yet, unlike before, the NYU microgrid is now able to island from the distribution grid. This has been successfully tested during Hurricane Sandy when the NYU microgrid successfully islanded from the local distribution grid and continued to provide reliable power to much of the NYU campus.

## Borrego Springs

San Diego Gas and Electric Company's (SDG&E) utility microgrid in the 2,800 customer residential community of Borrego Springs, California (145 kilometers northeast of San Diego) is an example of an "unbundled utility microgrid", where the distribution assets are owned by the utility, but some or all of the distributed energy resources are owned by customers. The goal of the project is to provide a proof-of-concept test as how information technologies and distributed energy resources (solar PV and batteries primarily) can increase utility asset utilization and reliability.

The project's partners include Lockheed Martin, IBM, Advanced Energy Storage, Horizon Energy, Oracle, Motorola, Pacific Northwest National Laboratories, and University of California San Diego.

The U.S. DOE supported the project with \$7.5 million of federal funding, with additional funding coming from SDG&E (\$4.1 million), CEC (\$2.8 million), and other partners (\$0.8 million).

The community is a somewhat isolated area fed only by a single sub-transmission line. Islanding of the entire substation area is being demonstrated for reliability reasons as well as a potential alternative to building additional transmission capacity. Prior to the microgrid project launch, the community already had many rooftop solar PV systems installed. SDG&E is exploring the possibilities of price driven demand response, via interaction with in-home storage, electric vehicles, and smart appliances using the areas installed smart meters and home area network devices.

The total microgrid installed capacity will be about 4 MW, with the main technologies being two 1.8 MW diesel generators, a large 500 kW/1500 kWh battery at the substation (which will be instrumental in achieving peak load reduction), three smaller 50 kWh batteries, six 4 kW/8 kWh home energy storage units, about 700 kW of rooftop solar PV, and 125 residential home area network systems.

In terms of control systems, the project incorporates supervisory control and data acquisition (SCADA) on all circuit breakers and capacitor banks, Feeder Automation System Technologies (FAST), outage management systems, and price driven load management at the customer level.

## Fort Collins

The Fort Collins Microgrid in Colorado is part of a larger project known as the Fort Collins Zero Energy District (FortZED), where the district plans to create as much thermal and electrical energy locally as it uses.

The main goals are to develop and demonstrate a coordinated and integrated system of mixed distributed resources for the City of Fort Collins, reduce peak loads by 20%-30% on two distribution feeders, increase the penetration of renewables, and deliver improved efficiency and reliability to the grid and resource asset owners.

The microgrid project involves multiple customers including the New Belgium Brewery, InteGrid laboratory, City of Fort Collins facilities, Larimer County facilities, and Colorado State University main campus facilities as well as a variety of distributed energy generation technologies. It has received \$6.3 million in funding from the U.S. Department of Energy and \$4.7 million from the various industry partners, including Eaton, Advanced Energy, and Brendle.

Technologies in the project include solar PV, CHP, microturbines, fuel cells, plug-in hybrid electric vehicles, thermal storage, load shedding, and demand side management. The combined distributed generation and load shedding capabilities is 5 MW spread across five customer locations.

The larger FortZED project represents about 10-15% of Fort Collins Utilities' entire distribution system, with a peak load of 45.6 MW across 7,257 customers. There will be a total of 345 kW of

solar PV, as well as 700 kW of combined heat and power, 60 kW of microturbines, and 5 kW of fuel cells. The brewery in particular can produce over half of the power it consumes, when its own distributed generation facilities (790 kW biogas power, 200 kW solar PV) are running at peak power. Additionally, the various facilities have diesel-based backup generators totaling 2,720 kW in capacity, which are typically used for emergency power.

Demand response will occur through various heating, cooling, and ventilation rescheduling using existing Johnson Controls and Trane building automation systems.

## Isle of Eigg

The 31 square kilometers Isle of Eigg off the stunningly beautiful west coast of Scotland boasts a high renewable content power project. It was completed in 2008 funded partly by the European Regional Development Fund. The Isle of Eigg and its 90 residents were highly dependent on their individual diesel generators to produce their own electricity and a few private mini-hydro systems to individually produce their own electricity.

The microgrid project was highly successful at integrating multiple renewable energy sources into an island-wide community system, and reducing diesel generator use:

- 110 kW of hydro power with one large 100 kW generator and two small generators
- 24 kW from four wind turbines
- 32 kW of PV

The introduction of renewable on-site energy sources was also supported by better load management with energy monitors installed in all properties and droop control of the system based on battery state of charge and frequency.

Since the launch of the full microgrid in 2008, electricity is available 24 hours a day at reduced costs and 95% of it comes from renewable resources.

The project's success is largely due to the involvement of the island's residents, as well as a number of private companies and community organizations.

## Illinois Institute of Technology

There have been a number of drivers for the Illinois Institute of Technology (IIT) to construct the perfect power prototype: the occurrence of at least three power outages per year resulted in a series of teaching and research disruptions with an estimated cost of \$500,000 annually and a growing demand for energy. Infrastructure were needed to accommodate its growth, improve energy efficiency, and reduce consumption.

IIT, in collaboration with the Galvin Electricity Initiative (GEI) and other key partners, is leading an effort to develop and validate innovative smart grid technologies, and demonstrate smart grid applications, community outreach, and renewed policies for better serving the consumers.

This microgrid is sponsored by \$7 million of federal funds (DOE) and \$5 million of industrial funds together for five years. Its main purpose and objectives are to create a self-healing, learning, and self-aware smart grid that identifies and isolates faults, reroutes power to accommodate load changes and generation, and dispatches generation and reduces demand based on price signals, weather forecasts, and grid disruptions.

The IIT prototype will be the first of a kind integrated microgrid system that provides for full islanding of the entire campus load based on PJM/ComEd market signals.

Specific innovative technology applications include: high reliability distribution system, intelligent power system controller, advanced ZigBee wireless technology, advanced distribution recovery systems, buried cable fault detection and mitigation.

The peak load of IIT's campus is around 10 MW. Their on campus DER includes two 4 MW combined cycle gas units and a small wind turbine, with plans to add rooftop PV this summer as well as a 500 kWh battery. Total DER capacity will be close to 9 MW then, so the campus is able to operate as an island most of the time, not importing any power from the grid. Full islanding capability has also been tested.

The campus is located near Comiskey Park where the Chicago White Sox play and IIT is involved in their load reduction program during baseball games for which they receive significant payments. IIT invested \$3 million in smart meters to be able to record how much load is being used in various buildings. Around 20% of IIT's load can be shed with the potential to reduce peak load by up to 50% on demand, and achieve a 3,628,739 kg per year reduction in carbon emissions. IIT has put out a request for proposal for demand response for 25% of the campus's total load.

## UCSD

The UCSD microgrid project supplies electricity, heating, and cooling for 450 hectare campus with a daily population of 45,000.

It consists of two 13.5 MW gas turbines, one 3 MW steam turbine, and a 1.2 MW solar-cell installation that together supply 85% of campus electricity needs, 95% of its heating, and 95% of its cooling.

The turbines produce 75% fewer emissions of criteria pollutants than a conventional gas power plant. For HVAC, it uses a 140,674 kW/hour, 14,385 m<sup>3</sup> capacity thermal energy storage bank, plus three chillers driven by steam turbines and five chillers driven by electricity. A 2.8 MW molten carbonate fuel cell is running on waste methane, which is sponsored by California's self-generation incentive program funds and takes advantage of a 30% federal investment tax credit.

The campus is connected to SDG&E by a single 69 kV substation. IT uses a “straight SCADA system” for the building systems and energy supply to ensure their communication with each other.

UCSD is installing a new, high-end master controller-Paladin, which will control all generation, storage, and loads with hourly computing to optimize operating conditions. It can receive as many as 260,000 data inputs/second. To support Paladin, UCSD will use VPower software to process market-price signals, weather forecasts, and the availability of resources. About 200 power meters on the main lines and at buildings’ main circuit breakers, track use minute-by-minute. The UCSD campus has been installed with power meters throughout the main electrical lines and at the buildings’ main circuit breakers. Lastly, DOE just gave UCSD a grant to model the effects on the local distribution system from the ramping up and down of the solar PV system’s output.

## Hachinohe

The Hachinohe Project in Aomori Prefecture was part of the *Regional Power Grid with Renewable Energy Resource Project* funded by the NEDO. It operated from October 2005 to March 2008. The project was a collaboration between Hachinohe city, Mitsubishi Research Institute, and Mitsubishi Electric.

NEDO’s main goal for this project was to develop an optimum operation and control system, evaluate PQR, cost effectiveness, and GHG emission reductions. Meanwhile, the local governments wanted to construct a new industrial innovation zone centered on environmental and energy technologies.

The central feature of the system is that only renewable energy sources are used to supply electricity and heat. The supply sources include two 50 kW and three 10 kW solar PV systems, small wind turbines, a 100 kW lead-acid battery bank, and three 170 kW gas engines fed by sewage and waste gas by-product. At the sewage plant, a 907 kg/h wood-waste steam boiler was installed to supply heat to protect the bacteria, and exhaust heat from the gas engines was reused in the gas fermentation process.

The TOBU sewage plant treatment system was controlled by an information exchange network. The electricity produced was transmitted to schools, the local city hall, and an office building by a private distribution line 5.4-km, 6 kV feeder, and the whole system connected to grid at a point of common coupling. The energy management system was developed to meet demands for both electricity and heat, while minimizing operation costs and CO<sub>2</sub> emissions.

Islanding operation was performed for one week in 2007, the purpose of which was to evaluate the ability of the system to maintain and control power qualities. The project is no longer in operation due to funding shortage

## Bornholm Island

The island of Bornholm is a Danish island situated just south of Sweden that represents roughly 1% of Denmark's population and electricity load. The OSTKRAFT Company is the utility on the island serving around 28,000 customers. The peak load on Bornholm island is around 63 MW, and annual electricity consumption in 2007 was 262 GWh. Wind power accounted for 30.2% of generation in 2007, which is an above average wind penetration rate in Denmark.

Bornholm island was one of the field test sites for the European Commission's More Microgrids project, due to its ability to go into planned island mode which makes it a good site for demonstration of new technology concepts such as how to incorporate large amounts of wind turbines during islanded operation.

The supply technologies in the Bornholm Island microgrid consists of 14 diesel generators (34 MW), 1 oil-fired steam turbine (25 MW), 1 steam turbine running off a mixture of oil, coal, wood chips (37 MW), 35 wind turbines (29 MW), and 2 biogas turbines (2 MW). The distribution network is split into a 60 kV network and 10 kV network.

OSTKRAFT's main control room for the microgrid incorporates two SCADA systems: ABB Network Manager and Vestas Online. The former system takes measurements as 10 second instantaneous values, 1 minute average values, and 1 hour average values. The latter system is used for 6 controllable wind turbines, and measurements are stored as 10 minute average values.

## Kythnos Island

Kythnos Island is located in the Aegean Sea, close to Athens. The Kythnos Island Project was funded by the European FP 5 Microgrids program, the objective of which was to test centralized and decentralized control strategies for islanding.

It is a small village scale autonomous microgrid, composed of a 3-phase low-voltage network, solar PV generation, battery storage, and a backup generator. The grid is composed of overhead power lines and a communication cable running in parallel to serve monitoring and control requirements.

There are 10 kW of PV at two locations, a nominal 53 kWh battery bank, and a 5 kW diesel genset. A second PV array of about 2 kW connected to an SMA inverter on the roof of the control system buildings provides power for monitoring and communication, backed up by a nearby 32 kWh battery bank.

Three SMA inverters connected in a parallel master-slave configuration supply power to the 12 summer-only residences, whose minimal loads are primarily lighting and water pumping. When more power is demanded by customers than the PV systems can directly provide, one or more of the 3.6 kW battery inverters is activated. The battery inverters can operate in isochronous or

droop mode. Operating in frequency droop mode permits passing of information to switching load controllers, which limit loads if the battery state of charge is low and also constrains the power output of the PV inverters if the battery bank is full.

## Mannheim-Wallstadt

The microgrid project in Mannheim-Wallstadt, Germany, a 1,200 inhabitant ecological estate, has been undertaken and developed by MVV, the state utility company since 2006. It was funded and supported by the “More microgrids project” of the European FP 6 and private investors.

The main goal of this project successfully accomplished was to develop a true microgrid able to swiftly and smoothly switch from grid-connected mode to island mode. The microgrid was also built to let further microgrid operations and innovations be tested and operated in Mannheim-Wallstadt.

The system is addressed to residential and commercial units and loads. The total on-site load varies between 80 kW to 230 kW. The building’s 60 kW ventilation and 48 kW boiler loads are controlled. Several distributed generation technologies are deployed on-site:

- A 4.7 kW fuel cell
- A 3.8 kW solar PV system
- A 1.2 kW flywheel storage unit
- Two CHP units rated at 9 kW and 5.5 kW (electrical)

At present, five PV systems, a total of 30 kW, and 1 CHP system have also been installed by private investors.

MVV tested the ability of the microgrid to switch into islanding mode at Mannheim-Wallstadt Kindergarten. It was a success: the frequency slightly increased by 2 Hz given the cutback of connected loads when the microgrid is islanding. The system returned quickly to its normal frequency as soon as it was reconnected to the main grid.

All of these experiments would never have been possible without the contribution of the Mannheim-Wallstadt community. MVV had them involved in the project by displaying improvements due to the microgrid and regular updates on the microgrid current state. Social acceptance required more investment and energy than expected. It was indispensable to the project’s success and has demonstrated how renewable energy could be adopted by a community and helps improve energy supply.

## Hangzhou Dianzi University

Hangzhou Dianzi University is located in Hangzhou city, at the southern end of the Grand Canal of China which runs to Beijing. The PV microgrid system is a brilliant example of the collaboration between the New Energy and Industrial Technology Development Organization (NEDO) in Japan and the National Development and Reform Commission (NDRC) in China. This field demonstration was built in partnership with the Shimizu Corporation in 2007.

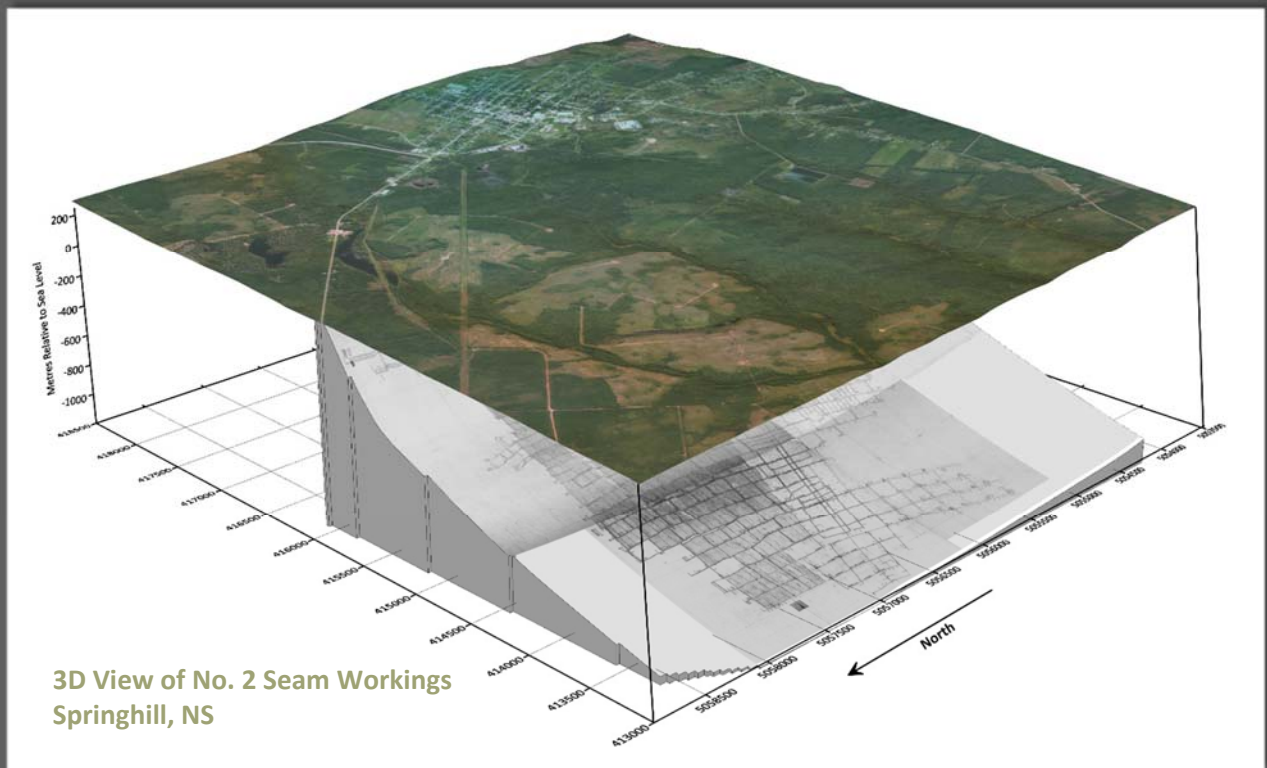
Located on the university campus, the system is powered mainly by PV (120kW) and complemented with a small diesel generator (120kW) and fuel cells. The PV system consists of 728 solar panels, totaling up to an area of 946m<sup>2</sup>. As a result, it is the world's first microgrid to achieve a 50% PV penetration rate.

Coupled with a 100kW capacitor and a 50kW storage battery, the system's goal is to maintain a constant flow of electricity at the coupling point with the grid. The actual fluctuation during the operation was restrained to less than 5kW above or below the targeted power flow. The microgrid is monitored and managed by a power control system, with active power quality control and voltage compensation. When isolated, the system could maintain a constant load, voltage and frequency.

Hangzhou Dianzi University's PV microgrid system proves the concept of a stable microgrid system with high penetration of intermittent power.

# Mine Workings Spatial Analysis Review And Deep Well Test Boreholes

Springhill, NS



172437.00 • Report • March 2017

**ISO 9001**  
Registered Company

Prepared for:  
**Municipality of  
Cumberland**

Prepared by:



**CBCL LIMITED**  
Consulting Engineers



March 28, 2018

Justin Waugh-Cress  
Director, Engineering and Operations  
Municipality of Cumberland  
Cumberland Energy Authority  
Upper Nappan Service Centre  
1395 Blair Lake Road  
Upper Nappan, NS B4H 3Y4

Dear Mr. Waugh-Cress

RE: *Report - Mine Workings Spatial Review and  
Deep Well Test Boreholes – Springhill, Nova Scotia*

CBCL Limited (CBCL) was retained by the Cumberland Energy Authority (CEA) for provision of professional services associated with the Request for Proposal (RFP) RFP-CEA16-01 Mine Water Geothermal Study Mine Workings Spatial Analysis Review and Deep Well Test Boreholes, Springhill Community.

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The purpose of the review was to conduct a spatial analysis review of the abandoned underground coal mine workings at Springhill and provide recommendations and technical assistance for deep well test boreholes. The spatial review involved checking the accuracy of previously geo-referenced mine workings while the borehole component included assisting CEA with locating, drilling, geotechnical logging, and testing boreholes drilled into the mine workings. The project was initiated in May 2017, with drilling taking place in January and February 2018.

All key deliverables were provided previously to CEA on-going through the project. This report summarizes what work was completed and the methods used.

Thank you for the opportunity to work with you on this very interesting project. Please do not hesitate to call if you require clarification of any of the issues discussed.

Yours very truly,

CBCL Limited

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Project No: 172437

**Solving  
today's  
problems  
with  
tomorrow  
in mind**

**ISO 9001**  
Registered Company



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Table 1 List of Digital Imagery

## CHAPTER 1 INTRODUCTION

CBCL Limited (CBCL) was retained by the Cumberland Energy Authority (CEA) for provision of professional services associated with the Request for Proposal (RFP) *RFP-CEA16-01 Mine Water Geothermal Study Mine Workings Spatial Analysis Review and Deep Well Test Boreholes, Springhill Community*.

The purpose of the review was to conduct a spatial analysis review of the abandoned underground coal mine workings at Springhill (Phase 1) and provide recommendations and technical assistance for deep well test boreholes (Phase 2).

The spatial review involved checking the accuracy of previously geo-referenced mine workings while the borehole component included assisting CEA with locating, drilling, geotechnical logging, and testing boreholes drilled into the mine workings. The project was initiated in May 2017, with drilling taking place in January and February 2018.

All key deliverables were provided previously to CEA on-going through the project. This report summarizes what work was completed and the methods used.

## CHAPTER 2 SITE HISTORY

The Springhill coal reserves were originally leased to the General Mining Association (GMA) by the Duke of York in 1825. To facilitate larger commercial development of the reserves, the Springhill Mining Company was formed in 1870, and with the expansion of the railway in 1884, the Cumberland Railway and Coal Company was formed from various independent operators. From that time, large scale coal mining continued uninterrupted by them and their successors until October 1958.

The Springhill coal resource consisted of seven (7) coal seams that maintain a constant thickness of between 1.4 and 3 m. The seams outcrop at surface, and typically dip at 30 degrees near surface to 11 degrees at depth. Over the life of the operations, underground mining extended a distance of over 4,400 m to the west and reached a vertical depth of 1,320 m (No. 2 Seam). Mining methods progressed from Room and Pillar to Room and Pillar Extraction to Long Wall Advance to Long Wall Retreat. Continuous large scale production continued until a major rock burst closed the No. 2 Mine in 1958 (Springhill Mine Disaster).

Since their abandonment in 1958, the workings flooded. In the late 1980s and early 1990s, their value as a geothermal energy source was realized and a number of boreholes were drilled to tap the energy source. Some of the original wells, and a number of new wells, are still being utilized as a mine water geothermal energy source. All the geothermal wells have been drilled in the upper portions of the mine workings.

## CHAPTER 3 SCOPE OF WORK AND APPROACH

The following sections list the tasks associated with project, the methodology and approach for the review and how key deliverables were produced.

### 3.1 Phase 1 - Geo-Reference Mines Plans, Site Plans and Aerial Photographs

CEA identified that geo-reference work was required for mine plans for workings on seams No's. 1, 2, 3, 4, 6 and 7 in the Springhill Coalfield. The following sections list the tasks associated with project, the methodology and approach for the review and how key deliverables were produced.

CBCL first reviewed the CEA supplied documents and mine plans to see what data was available and also what information gaps existed. Table 1 lists the digital imagery provided and summarizes what georeferencing was completed. CBCL used Golden Software mapping products <http://www.goldensoftware.com/> for the georeferencing conversion and mapping. All images were referenced to NAD83 CSRS UTM Zone 20 (UTM).

#### Base Mapping

The first step that CBCL undertook in the geo-reference mapping process was to obtain mapping of the coalfield geology and associated mining. This information is provided on NSDNR map "Map 95-1 Geology Map of the Springhill Coalfield, Cumberland County, Nova Scotia, J.H. Calder" and comes already georeferenced to UTM, NAD83 zone 20. This map would serve as a reference base when assembling the more detailed larger scale mine plans. In addition, a request was made to Nova Scotia Department of Natural Resources (NSDNR) to see if they had any new information that might aid mine plan geo-referencing; from that request, they provided CBCL their most current Abandoned Mine Openings database. The database provides NSDNR's current interpretation of former mine opening positions, including those in Springhill.

In addition, to aid with georeferencing, provincial topographic mapping (1:10,000 scale) was obtained from GeoNova. This provided the position of road, streets, highways, railway lines, water bodies, topography and infrastructure.

## **Aerial Photographs**

Historic aerial photographs from 1939, 1951, 1954, 1964 and 2014 were next added to the mapping layers. Years 1939, 1954 and 1964 were purchased for this project. The 1939, 1951, 1954, and 1964 photos were georeferenced-based on features common on the 2014 photo (which was already georeferenced) and provincial geographic details shown on 1:10,000 scale mapping. Historic aerial photos are important georeference sources as they show features that often are included on mine plans such as bankheads, hoists, buildings, railway lines and streets. All georeferenced aerial photographs were submitted previously to CEA.

## **Surface Plans**

Several surface plans that show mining features were also provided to CBCL by CEA. Three (3) that were considered important to the project were:

1. Subsidence Post Plan
2. General Layout (No. 2 Mine Site and surrounding area)
3. Surface Plan of No 6 Mine

Georeferencing for these plans was completed using modern sub-metre surveys (by CEA) of remnant surface features that are shown on the plans and also through features that are common on the historic aerial photos. All georeferenced surface plans were submitted previously to CEA.

## **Mine Plans**

CEA provided CBCL twenty-six (26) mine plan sheets in digital form. The initial review showed that two (2) separate local survey grids were in use during the mining period covered by the plans. The older (1920s) grid was in use for mining operations at No. 6 and No. 7 Mines. The grid origin appears to be the portal for the Cumberland Railway & Coal Company Ltd. (CR&CCL) No.6 Hoisting Slope and the "0" north line runs through the centerline of the slope; which places the 1920 grid north approximately 14<sup>0</sup> west of the UTM grid. The grid drawn on the original plans has a 1000-foot spacing.

### Georeferencing for No. 6 and No. 7 Mines:

1. The No. 6 Mine plan image was first georeferenced to the original 1920s grid. This was necessary so as to make the plan symmetrical to the local grid. This process removes any spatial errors induced by previous blue printing, photo copying, scanning or sheet stitching.
2. The plan image was then digitally stretched to scale so that ground distances on the image equate to distances within the UTM system.
3. The mine plan was then rotated and moved into position such that two (2) features shown on the plan match the same two (2) points for which UTM grid coordinates have been established; those points being the No. 6 Hoist structure, which was positioned during georeferencing of the Surface Plan of No. 6 and the CR&CCL No. 2 Main Slope, which was positioned using several sources that includes surveys of nearby structures, aerial photographs and the Surface Plan.
4. With the plan in its correct position, UTM grid coordinates could then be calculated for the local 1920 grid intersections. Using these points the image was then georeferenced to UTM.

5. Because No. 7 Mine shares the same local grid with No. 6, georeferencing was completed directly using the UTM positions established for the local 1920 grid.

The geo-referencing accuracy of the No. 6 and 7 plans is estimated to be about three (3) metres.

#### Georeferencing for No. 2 Mine Plan and other plans using the same 1950's grid.

CEA provided CBCL the No. 2 Mine plan georeferenced to UTM in digital form. Georeferencing was conducted by an NSDNR cartographer an unknown number of years ago (personal communication with NSDNR). CBCL's initial review noted that the plan appeared to be approximately in the correct position but the local grid was not symmetrical. Measurements between plan grid lines were off in some places ten (10) metres or more. Therefore, it was decided to make the plan symmetrical with the local grid and then establish UTM coordinates for the local 1950s grid using the same procedure as described above for No. 6 Mine.

For the No. 2 Plan, the two (2) anchor points with known UTM coordinates used to position the plan were the CR&CCL No. 2 Main Slope, described above, and the CR&CCL Aberdeen Slopes. Coordinates for the Aberdeen Slopes were collected recently by NSDNR when the slopes were uncovered during the excavation of a coal bulk sample. With the plan in its correct position, UTM grid coordinates were then calculated for the local 1950s grid intersections. Using these points the image was then georeferenced to UTM. This method of georeferencing provides a plan that is very accurate spatially with the best accuracy close to and in between the two (2) anchor points (accuracy estimate is 2 to 3 metres). In this case, the anchor points are approximately 2 km apart which provides a reasonable plan rotation angle, however even a very small change in rotation can impact plan accuracy away from the anchor points and therefore the western, northern and southern extents of the mine plan, which are up to 3.6 km from the anchor points, may only have a georeferenced accuracy of 10 to 15 metres.

All other mine plans with the 1950s grid were subsequently georeferenced using the UTM coordinates established for the 1950s grid.

#### Comments on the 1950's Local Grid Origin.

The No. 2 Mine plan georeferencing placed the 1950's grid origin within 2 to 3 metres of a survey point identified as "corner" on the Subsidence Post plan (E 416997.4, N 5055500.9). The point is shown on several plans and on some plans, lines extending from the point are referred to as "COAL AREA LINE". CEA personnel examined the area in the field and found a bent over, flattened metal pipe buried under approximately 0.30 metres of coal mine waste rock at E 416995.2, N 5055502.7. This evidence suggests that the "corner" survey point may be the grid origin. The pipe may have once marked the "corner" survey point; however its exact original position is not known as it had been disturbed. All georeferenced mine plans were submitted previously to CEA.

#### **Geo-reference Comparison**

As part of the georeferencing procedure, CBCL was asked to provide a series of Northing's and Easting's of mine plan locations that can be compared to the same points on the Municipality of

Cumberland geo-referenced plans. The locations were tabulated so that a measured relative difference could be calculated by CEA.

CBCL created comparisons plans on each of the five (5) major seams and one (1) for the Subsidence Post Plan. Four (4) representative locations within the plans were chosen. To aid in locating each point, CBCL created a key image of the overall mine plan, and close ups images of each point. This information was submitted previously to CEA.

### **Recommendations**

To improve the accuracy of the georeferencing procedure, CBCL recommends searching for documents that describe the derivation of the local grids used at Springhill during mining. From that a direct transformation from local grids to UTM could be produced. The plans could then georeferenced to the accuracy provided by the original surveying and drafting.

## **3.2 Phase 2 –Drilling**

### **Drilling Contractor Tender**

CBCL assisted the CEA in the selection of a drilling contractor by reviewing and commenting on the drilling contractor tender document. In addition, CBCL reviewed all tender submissions and provided recommendations regarding selection of the drilling contractor; final contractor selection was completed by CEA.

### **Identify Potential Borehole Locations**

Using the new geo-referenced mine plans, CBCL was asked to identify several potential borehole locations within the mine workings that would assist in the assessment of the geothermal resource at deeper elevations (200 to 300 metres below ground surface). As part of this task, CBCL first constructed structure contours (seam elevation relative to sea level) for each seam. When planning drilling programs, accurate seam structure is necessary for determining borehole depths.

Normally the best elevation data are the spot elevations posted on the originally mine plans. In this case, elevations were sparse and often not available in the earlier mined shallower areas. Lack of mine plan elevation data required obtaining the information from other sources such as: Recent well drilling logs, historic borehole logs, NSDNR mapping, seam grade information, coal seam outcrop positions, mine plan geometry and exploration reports. The compiled information was reviewed and new digital structure contours were developed. CBCL has previously provided CEA with CBCL's interpretation of the seam structure contours for No 1, 2 and 3 Seams in both feet and metres in SHP file format.

Working with CEA staff, CBCL recommended several new well locations. Targets were chosen that would be approximately 250-metres deep and that would have the best probability of encountering mine water while avoiding potential trouble areas. After several iterations, it was mutually decided that two (2) potential drill targets would be as follows:

**Hole 1** would be drilled at UTM coordinate E 461,233 N 5,055,256, with the intention of intersecting Seam No. 3 workings at approximately 250 metres depth.

**Hole 2** would be drilled at UTM coordinate E 416,522 N 5,055,372256, with the intention of intersecting Seam No. 1 or No. 2 Seam workings at approximately 220 and 265 metres depth respectively.

### **Borehole Logging and Assessment**

The initial schedule had drilling commencing in the fall of 2017; however, drilling contractor availability pushed the start of drilling to the end of January 2018. CBCL was asked to have a geologist present during drilling, to provide geologic assessments, and to collect rock chip samples to determine rock type, occurrence of fracture zones and staining which may indicate the presence of mine water in the strata. CBCL was on-site to monitor drilling at Hole 1 for drilling depths between 18 and 174 metres. The hole was stopped short of the target depth due to excessive groundwater inflow estimated at approximately 1.5 m<sup>3</sup>/minute (400 gal/min). Water producing aquifers were encountered at depths 40, 55, 82, 90 and 110 metres below ground surface.

An attempt was made to start the second hole however surface ground conditions (freeze / thaw) prohibited the drill from being able to set up a stable base so CEA decided that drilling would be postponed until ground conditions improved.

## CHAPTER 4 CONCLUSION

Thank you for the opportunity to work with you on this very interesting project. Please do not hesitate to call if you require additional information or clarification of any of the issues discussed.

**Table 1 List of Digital Imagery**  
**Mine Workings Spatial Review and Deep Well Test Boreholes – Springhill NS**

Image Category	Plan Title	Seam	Original Scale	Date	Comment	Original file name	GR File Name	Number of images in mosaic	Number of GR images
Aerial Photograph	1939 Aerial Photograph	NA	NA	26/06/1939	GR using locations common to 2014 airphoto and mine plan surface features	A-6612-85.tif	A6612_085v2.jpg	1	1
	1951 Aerial Photograph	NA	NA	1951	GR mosaic of two photos using locations common to 2014 airphoto and mine plan surface features	Springhill_1951_18.tif Springhill_1951_19.tif Springhill_1951_20.tif	1951_18-20v2.jpg	2	2
	1964 Aerial Photograph	NA	NA	1954	GR mosaic of two photos using locations common to 2014 airphoto and roads and street from provincial mapping	A14010_012.tif A14289_132.tif	1954 mosaic.jpg	2	3
	1964 Aerial Photograph	NA	NA	1964	GR mosaic of two photos using locations common to 2014 airphoto and roads and street from provincial mapping	18577_025_048.tif 18577_140_047.tif	1964 A18577_025-140.jpg	2	4
Surface Plan	Subsidence Post Plan	NA	1" = 100'	Post September 1952	Surface plan that has several field surveyed features that enabled the plan to be accurately GR. It includes the "Corner" survey marker which has been identified as the 0,0 point for the 1950s local grid.	HPSC0227.tif	SubsidencePosts_1-100.tif	1	5
	General Layout	NA	1" = 50'	Unknown	GR using several survey surface features and historic aerial photos. General Surface Layout of No. 2 Bankhead area	Mine_Site_Surface_Plan.tif	SurfacePlanNo2_1-50.tif	1	6
	Surface Plan of No 6 Mine	NA	1" = 50'	Unknown	GR using best fit and survey of features thought to be No. 6 hoist and bankhead	HPSC0232.tif	SurfacePlanNo6Mine_1-50.tif	1	7
Mine Workings Plans	Workings in Top Coal No. 1 Seam	No. 1	1" = 200'	1950s	GR using 1950 grid. One sheet. Best for detail in deeper area. Missing shallow area	HPSC0230.tif	No1_Top_1-200.tif	1	8
	Plan of Workings in No. 1 Seam	No. 1	1" = 400'	1950s	GR using 1950 grid. One sheet. Shows outline of shallow area	HPSC0225.tif	No1_Top_1-400.tif	1	9
	Plan of No. 1 WKGS	No. 1	1" = 2 chn	1924	GR using No. 2 bankhead and deeper connections with No. 2, Aberdeen Slope, NSDNR No. 1 slope position and NSDNR shaft to the south. Shows near surface workings.	No_1_Seam_Workings.tif	No1_1-2chn.tif	1	10
	No. 1 Seam Showing Workings in Bottom Coal	No. 1 Bottom	1" = 200'	1954	GR using 1950 grid. Small detail area. Near No. 2 Main slope. Has 1950s grid	HPSC0237.tif	No1_Bot_1-200.tif	1	11
	Plan of No. 2 Mine	No. 2	1" = 200'	Appears to be final plan. Date on longwall is Nov 1958	1. Plan was initially GR and scaled to local grid but was missing near surface grid lines. Stretched to scale and rotated so as to position No. 2 slopes and Aberdeen Slopes. 2. Plan was then GR to UTM grid based on step 1. 3. Grid lines for the near surface area was provided. The 1950s grid was established using the new information and converted to UTM; the plan was GR again to this grid.	No_2_Mine_Plan.tif	No2_1-200.tif	1	12
	Geological Projection of the No. 3 Top Seam in No. 3 Colliery	No. 3	Not Shown 1" = 400'?	Unknown	GR using 1950 grid. One sheet	No_3_Top_Seam_Workings.tif	No3_Top_1-400.tif	1	13
	Plan of No. 6 Mine	No. 6	1" = 100'	1930?	GR to old grid and stretched to scale. Made Negative of blue print. Positioned plan based on No. 2 bankhead and surveyed No. 6 hoist structure and slope structure.	No_6_Mine_Workings.tif	No6_1-100.tif	1	14
	Plan of No. 6 Seam	No. 6	1" = 200'	1950s	GR using 1950 grid. Stitched two sheets. Shows both early shallow workings and deeper workings from No. 4 mine.	HPSC0235.tif HPSC0236.tif	No6_1-200.tif	2	15
	Plan of No. 7 Mine	No. 7	1" = 100'	1933	GR to old grid established for No. 6 Mine. Made Negative of blue print and stitched 3 images together to make mosaic.	No_7_Mine_Workings.tif No_7_Mine_Workings_1.tif No_7_Mine_Workings_3.tif	No7_1-100.tif	3	16
	Plan of Workings in No. 7 Seam No. 4 Mine	No. 7	1" = 200'	1950s	GR using 1950 grid. Shows both shallow southerly workings and deeper workings from No. 4. Does not show shallow early No. 7 workings to the north.	HPSC0239.tif	No7_1-200.tif	1	17
No name	No. 7	1" = 200'	1950s	GR using 1950 grid. Shows deep No. 7 Seam workings not shown on other plans.	HPSC0240.tif	No7_1-200_deep.tif	1	18	
Reviewed but not Georeferenced	Plan of Workings in Top Coal No. 1 Seam	No. 1	1" = 2 chn	Unknown	Not GR. Small detail area. Near Aberdeen slopes.	HPSC0231.tif			
	Plan of No. 1 WKGS	No. 1	1" = 200'	1924	Not GR. Only northern part. Similar to No_1_Seam_Workings.tif	No_1_Seam_Workings_4.tif			
	Workings in Top Coal No. 1 Seam	No. 1	1" = 200'	Unknown	Not GR. Very similar to HPSC0230.tif	No_1_Seam_Workings_1.tif			
	Plan of No. 3 Slope Workings	No. 3	1" = 2 chn	Unknown	Not GR. Maybe better detail surface than plan "Geological Projection of the No. 3 Top Seam in No. 3 Colliery" but plan is partial.	No_3_Slope_Workings.tif			

## DESIGN BRIEF

March 16, 2020

# Water, Wastewater, and Stormwater Springhill Business Park, Springhill, Nova Scotia



SUBMITTED BY:

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SUBMITTED TO:


**Cumberland Energy Authority**

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Springhill Business Park – Springhill, Nova Scotia



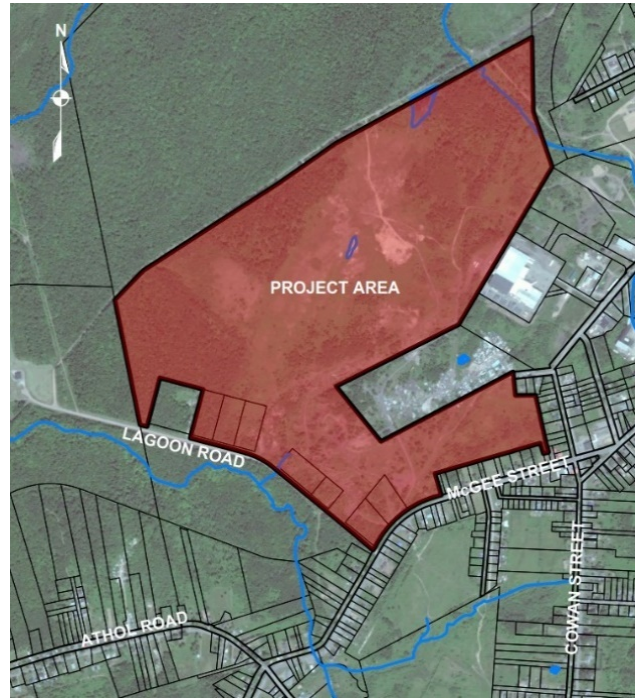
Issued For	By	Date
Draft Report	N. Fougere	March 16, 2020
Final Report		
Project Manager 	Review Engineer	
<hr/> Neil Fougere, P. Eng.	<hr/>	

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# 1.0 INTRODUCTION

The Cumberland Energy Authority (CEA) is preparing the conceptual design of a green business park in Springhill, Nova Scotia that harnesses the geothermal potential of Springhill’s abandoned mine network. The current concept plan includes 31 building lots ranging in size from 2.2 to 22.5 acres. The plan, which includes the PIDs listed in Table 1, is located on the West side of the Town of Springhill and is 222.6 acres in total. The site can be serviced from McGee Street, Herett Road, and Miners Memorial Drive where there is an existing 350 mm, 200 mm, and 350 mm water main respectively. An existing 900 mm concrete trunk sewer is located on the northwest boundary of the site; running east to west.



An important initial step in a project like of this nature is to understand off site infrastructure capacities and if any upgrades are required. The following sections summarize the reviews completed for the wastewater, stormwater, and water systems.

Table 1: Property Owners

PID	Current or Former Owners
25374349	Municipality of Cumberland County
25374356	Municipality of Cumberland County
25384199	Municipality of Cumberland County
25231341	CEA
25238171	Fundy Industries Ltd.
25223836	Fundy Industries Ltd.

## 2.0 CONCEPT PLAN

The existing site is part of the former Springhill Mine and is located to the west of the Town of Springhill, Nova Scotia. The site is approximately 86 Ha in size and is currently undeveloped and is currently zoned urban industrial. The applicable zoning requirements were used to develop a concept plan for the site, as well as lot sizing information which was gathered by a review of existing business parks with similar types of uses as those planned for this project. Other considerations while developing the conceptual site plan included site access, active transportation, and allowances for green infrastructure, for example vegetated ditches to improve water quality. Several options were prepared for consideration by the CEA. The preferred option was Option 2A, a copy of this plan is included in Appendix A. In addition to the concept plan a cross section of the proposed travelled way was also developed for the project, a copy of this cross section is also included in Appendix A.

## 3.0 WASTEWATER SERVICING

The site is anticipated to drain by gravity towards the existing trunk sewer on the northwest boundary and eastern boundary of the site; which ultimately discharges to the treatment plant nearby. The existing trunk sewer along the boundary consists of 900 mm diameter concrete pipes which eventually joins with another 450 mm diameter concrete sewer running along the treatment plant access road before discharging to the existing treatment plant.

Design requirements indicate that the existing system capacity shall be reviewed such that the proposed development does not have a negative impact on the existing system. The wastewater servicing schematic, which shows the proposed infrastructure layout is included in Appendix B. Based on this layout we have three connection points to the existing sewer; two connections are proposed to the existing 900 mm diameter trunk sewer and one connection to the existing 450 mm diameter sewer.

The following criteria was used to evaluate the projected sewage flows from the proposed development:

- Sewage generation based on an equivalent population of 85 persons/ha (based on the Atlantic Canada Wastewater Guidelines Manual);
- Sewer Shed Areas for each lot (a summary of the lot areas is included in Appendix C)
- Infiltration and inflow allowance of 24 m<sup>3</sup>/day/ha (0.28 L/s/ha) (based on the Atlantic Canada Wastewater Guidelines Manual);
- Total area for sewage calculation of 77.3 ha (191 acres); and
- Peaking based on Harmon Peaking Factor.

Based on the calculations completed for this development using densities consistent with current zoning, we have determined the peak flows for each connection point. The flow to the 900 mm diameter sewer is estimated to be 146.7 L/s and the flow to the 450 mm diameter connection is 26.87 L/s. These flows would require 11.4% of the capacity of the 900 mm diameter trunk sewer and 13.3% of the capacity of the existing 450 mm diameter sewer.

The wastewater calculations are included in Appendix C.

## 4.0 WATER SERVICING

The site will be serviced from the water main along McGee Street (Route 2), an existing 350 mm water main that supplies water to the area with a hydraulic grade line of 692.3 ft (211 m). The proposed development has areas that are well above the maximum serviceable pressure limit. As a result, pressure release valves (PRVs) would be required at three locations in the system or individual PRVs would be required for each individual development site.

### 4.1.1 Model Schematic

The hydraulic water model was developed using Haestad Methods' WaterCad in accordance with Municipality of Cumberland County requirements and was prepared based on existing record information provided by Municipality of Cumberland County as well as the proposed extension to the system. The model was constructed by placing junctions at key locations throughout the study area (i.e. intersections) complete with elevations. The junctions were connected with pipes and each pipe was assigned a diameter, length, and roughness coefficient. A schematic of the model is shown in Appendix D.

### 4.1.2 Domestic Analysis

Domestic demands were added to each junction based on the anticipated demands as per the following requirements from Atlantic Canada Wastewater Guidelines Manual are listed in Table 2 below:

Table 2: Water Requirements

Criteria	Flow per Person/Dwelling	Flow
Average Day Demand	24.31 L/min/ha	2190 L/min
	35.01 m <sup>3</sup> /day/ha	3154 m <sup>3</sup> /day
Maximum Daily Demand	26.74 L/min/ha	2409 L/min
	38.51 m <sup>3</sup> /day/ha	3469 m <sup>3</sup> /day
Peak Hour Demand	29.17 L/min/ha	2628 L/min
	42.00 m <sup>3</sup> /day/ha	3785 m <sup>3</sup> /day
Based on 77.3 ha and 85 persons/ha.		
Minimum Allowable Pressure = 175 kPa (40 psi), Maximum Allowable Pressure = 620 kPa (90 psi)		

Junction elevations and demands as well as pipe information are included in the schematic in Appendix E.

The model was run using maximum daily demands and the peak hour demands. The results of the analysis, including the junction input data, are shown in Appendix E. The maximum pressure at the junctions listed in the appendix are above maximum pressure of 90 psi.

### 4.1.3 Fire Flow Analysis

In addition to the domestic demand analysis, a fire flow analysis was completed to confirm the capacity of the proposed system to understand any impacts from the development. The fire flow analysis applies the fire demand to a junction, checks all the remaining junctions for residual pressure, and then repeats this process for each junction of interest until all the junctions have been analyzed.

Typically, design fire flows are based on municipal specifications or the Fire Underwriters Survey Water Supply for Fire Protection which details calculation methods for fire flow requirements of structures.

Detailed fire flow requirements for many of the larger industrial, commercial, institutional (ICI) facilities requires detailed knowledge of the construction and fire protection systems within each structure. Therefore, a general fire flow requirement currently used by Halifax Water has been assumed for ICI facilities is shown below in Table 3.

Table 3: Fire Flow Requirements

Land Use	Minimum Fire Flow Available	Minimum Residual Pressure in System	Maximum Pipe Velocity in System
ICI	13,620 L/min (3,000 IGPM)	150 kPa (22 psi)	3.0 m/s (9.8 ft/s)

A scenario was developed with these demands and the model was run. The results are shown in Appendix E.

#### 4.1.4 System Testing

A fire flow test was conducted along McGee Street to confirm the existing system capacity on October 18, 2017 by municipal staff. The test was measured at a hydrant on McGee Street near Athol Road. The fire flow test results are summarized in the table below. The test was used as the source in the hydraulic model.

Before moving further along with detailed design a more comprehensive fire flow test should be conducted to get a better understanding of the existing system.

Table 4 - Fire Flow Test

Static Pressure, psi	89
Flow, L/s	3785
Flow Hydrant Pressure, psi	42
Residual Hydrant, psi	85

## 5.0 STORMWATER

The intent for this project is to achieve a balance of the pre-development vs post-development stormwater flows. The site is anticipated to have an increase in stormwater generation since the existing site has a greater ability to absorb rainfall as it is currently undeveloped. The stormwater will be collected from the lots and roads via roadside ditches and culverts, water will be conveyed to one of three separate detention ponds; these ponds will gradually release the water into nearby waterways.

The stormwater servicing schematic is included in Appendix F.

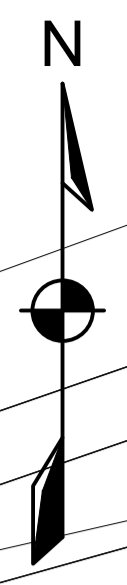
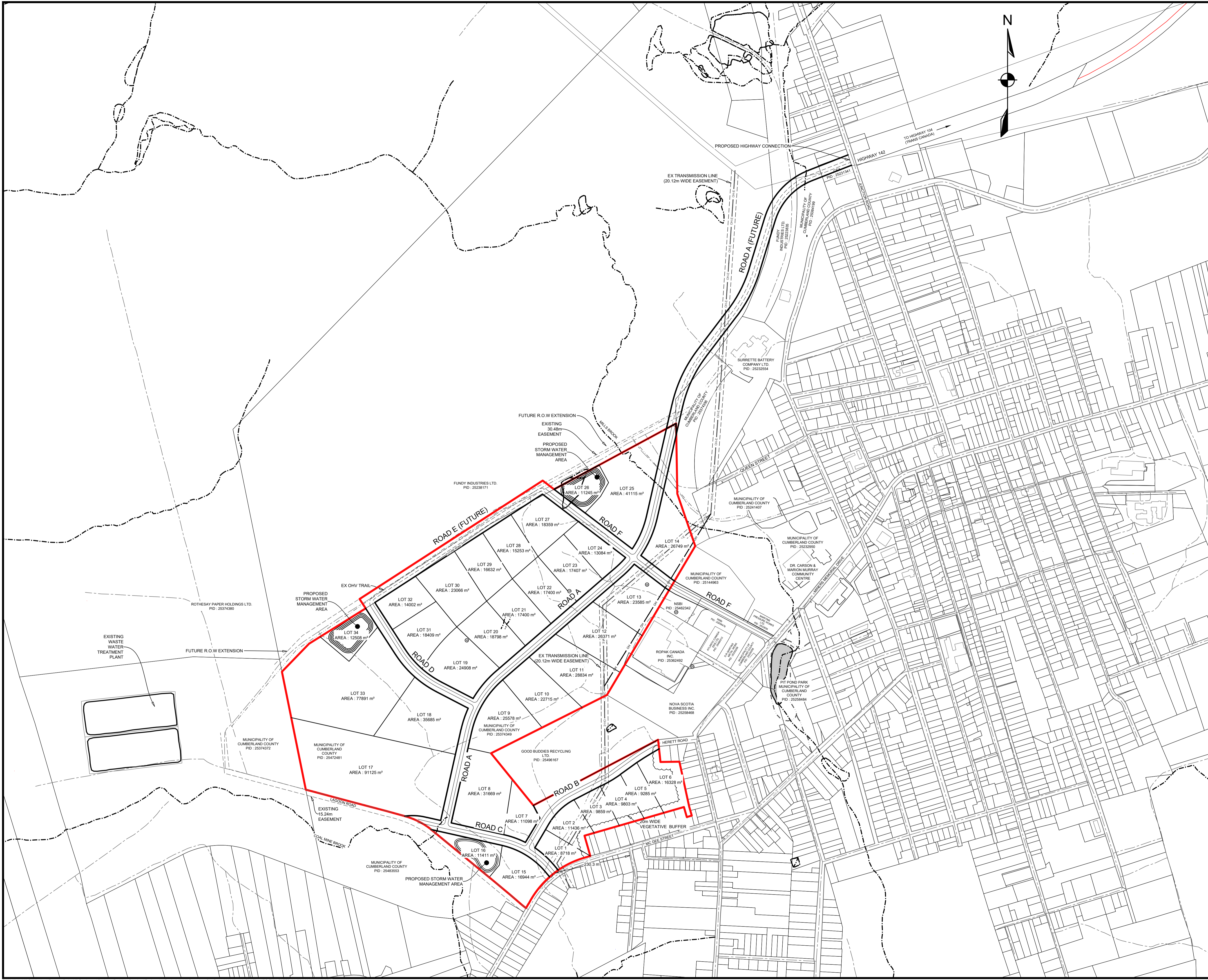
## 6.0 COST ESTIMATE

Using the concept plan and the servicing schematic for the water, wastewater, and stormwater systems a Class 'D' estimate of probable cost was generated for the construction of the Springhill Geothermal Business Park. As part of the estimate a 25% contingency was included along with a 7.5% engineering cost. The total cost for the construction on the roads, water system, wastewater system, and stormwater system is approximately \$8,600,000, this cost does not include any lot development. A detailed cost summary is included in Appendix G.

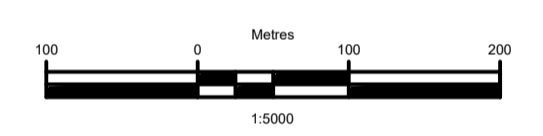
## 7.0 SUMMARY

Based on the model prepared for the wastewater and water systems for this proposed development as summarized above, the proposed and existing wastewater and water systems reviewed as part of this study can adequately service the proposed development.

# APPENDIX A – APPROVED CONCEPT PLAN AND ROAD CROSS SECTION



**NOTES:**  
 PROPERTY LINES BASED ON PROVINCIAL MAPPING INFORMATION AND ARE SUBJECT TO SURVEY.  
 CONTOURS BASED ON 1:10000 TOPOGRAPHIC DATA FROM GEONOVA.  
 SITE LAYOUT IS PRELIMINARY AND SUBJECT TO DETAILED DESIGN AND LAND SURVEY.  
 WATERCOURSE / WETLANDS BASED ON PROVINCIAL MAPPING DATA.  
 PROPOSED ROADS THAT CONNECT TO EXISTING ROADS ARE SUBJECT TO CHANGE BASED ON A SIGHT LINE ANALYSIS.



ISSUE	DATE	DESCRIPTION
1	Sep 30, 2019	ISSUED FOR REVIEW

CONSULTANT

DESIGN POINT  
ENGINEERING & SURVEYING

PHONE: 902.832.5597      www.designpoint.ca

CLIENT

cumberland  
ENERGY AUTHORITY

PROJECT DESCRIPTION

**SPRINGHILL BUSINESS PARK**

SPRINGHILL, NOVA SCOTIA

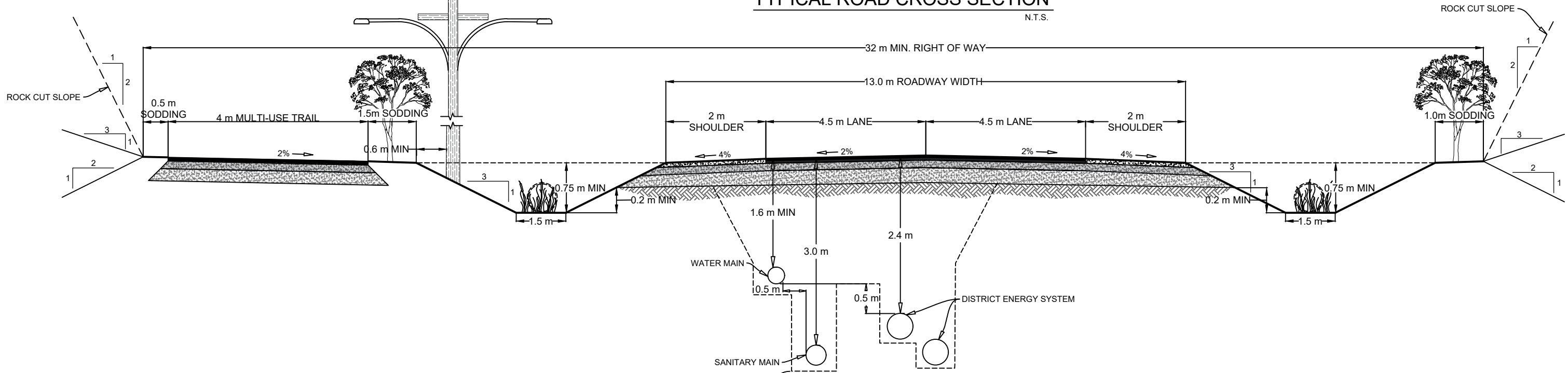
SHEET DESCRIPTION

**PRELIMINARY CONCEPT PLAN**

Drawn J.KEEPING	Engineer N.FOUGERE	Project No. 19-148	Drawing No. CP-1
Date of 1st Issue Sep 30, 2019	Scale 1:5000	Filename 19-148 Base.dwg	2 of 14

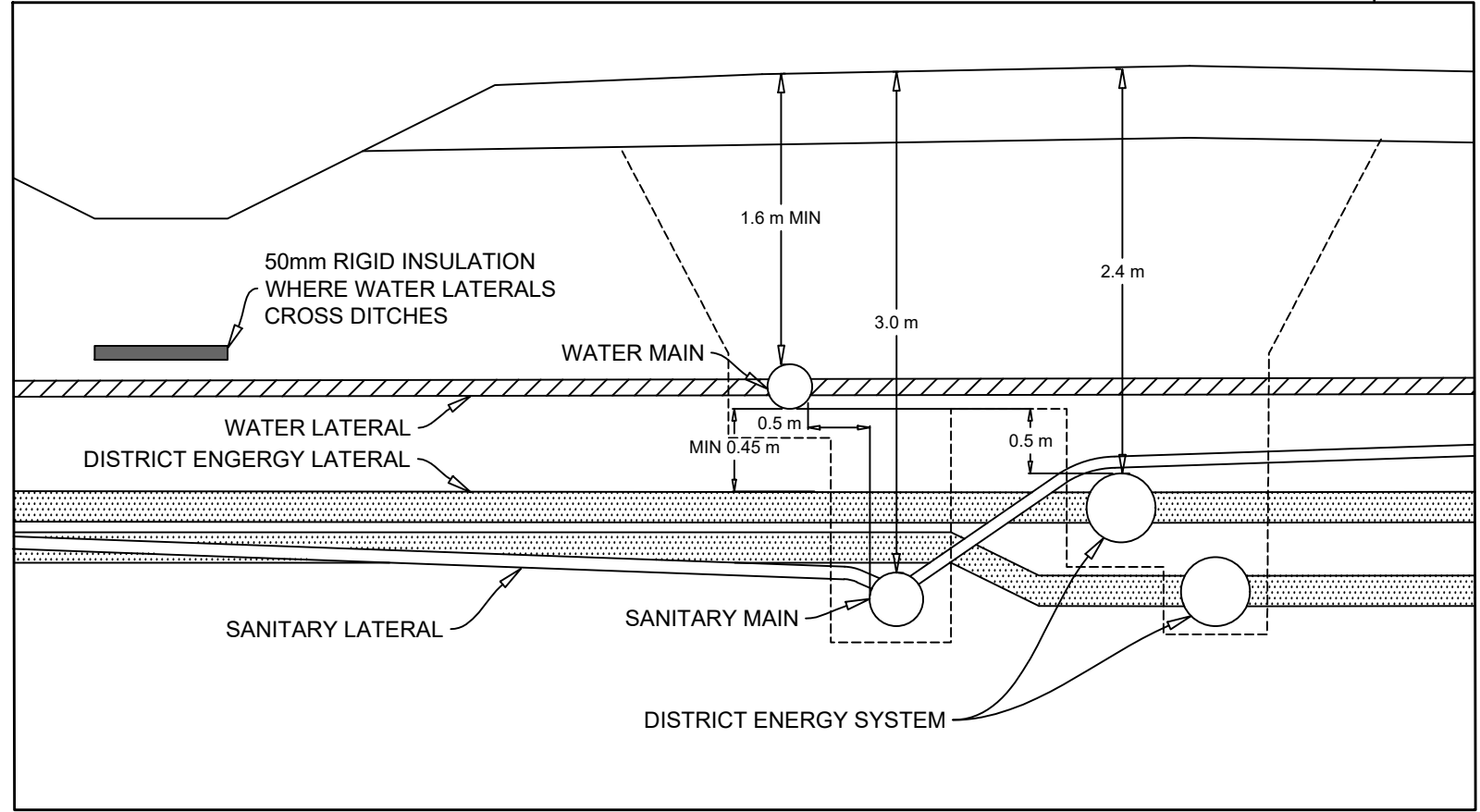
# TYPICAL ROAD CROSS SECTION

N.T.S.



# SERVICE LATERAL DETAIL

N.T.S.



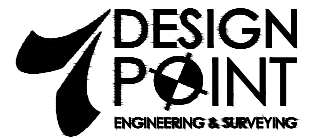
NOTES

**PRELIMINARY**

CLIENT



CONSULTANT

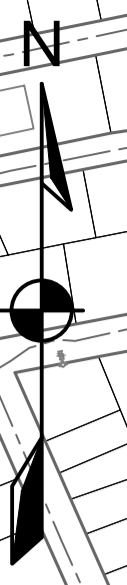
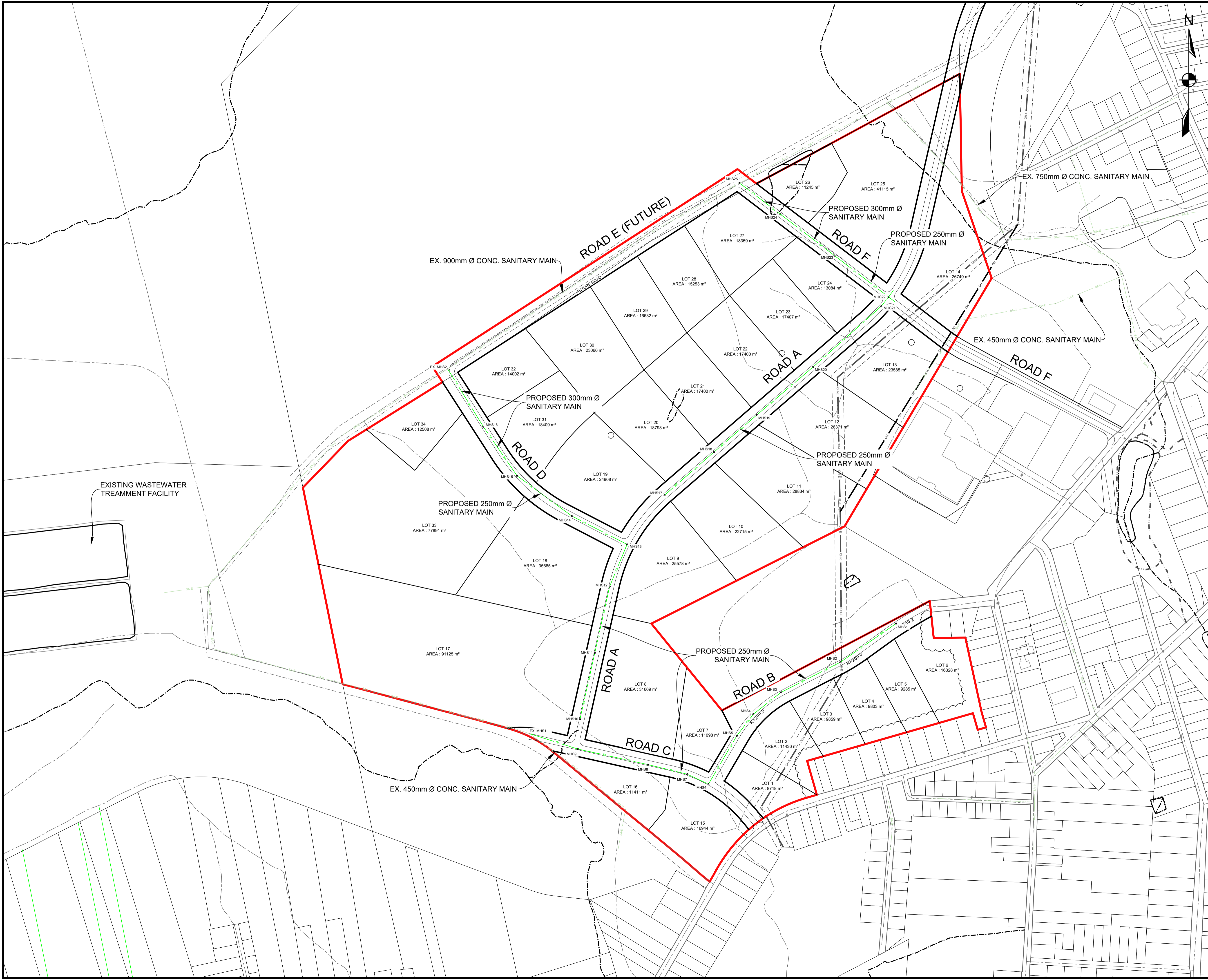


PROJECT DESCRIPTION

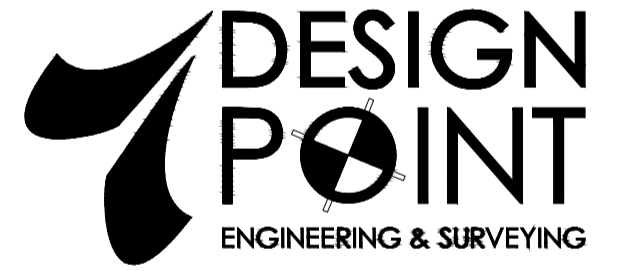
SPRINGHILL BUSINESS PARK  
SPRINGHILL, NOVA SCOTIA

PROJECT NO. 19-148	DATE 17-DEC-2019	DRAWING SCALE NTS
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## APPENDIX B – WASTEWATER SERVICING SCHEMATIC



ISSUE	DATE	DESCRIPTION
1	MAR. 16, 2020	ISSUED FOR REVIEW



PHONE: 902.832.5597 www.designpoint.ca



**SPRINGHILL GEOTHERMAL BUSINESS PARK**  
 SPRINGHILL, NOVA SCOTIA

**WASTEWATER SCHEMATIC**

Drawn A.LEAHY	Engineer N.FOUGERE	Project No. 19-148	Drawing No. SCH-02
Scale 1:3000	Filename 19-148_SCH.dwg		2 of 14

## APPENDIX C – SEWER AREA TABLE AND WASTEWATER SERVICING CALCULATIONS

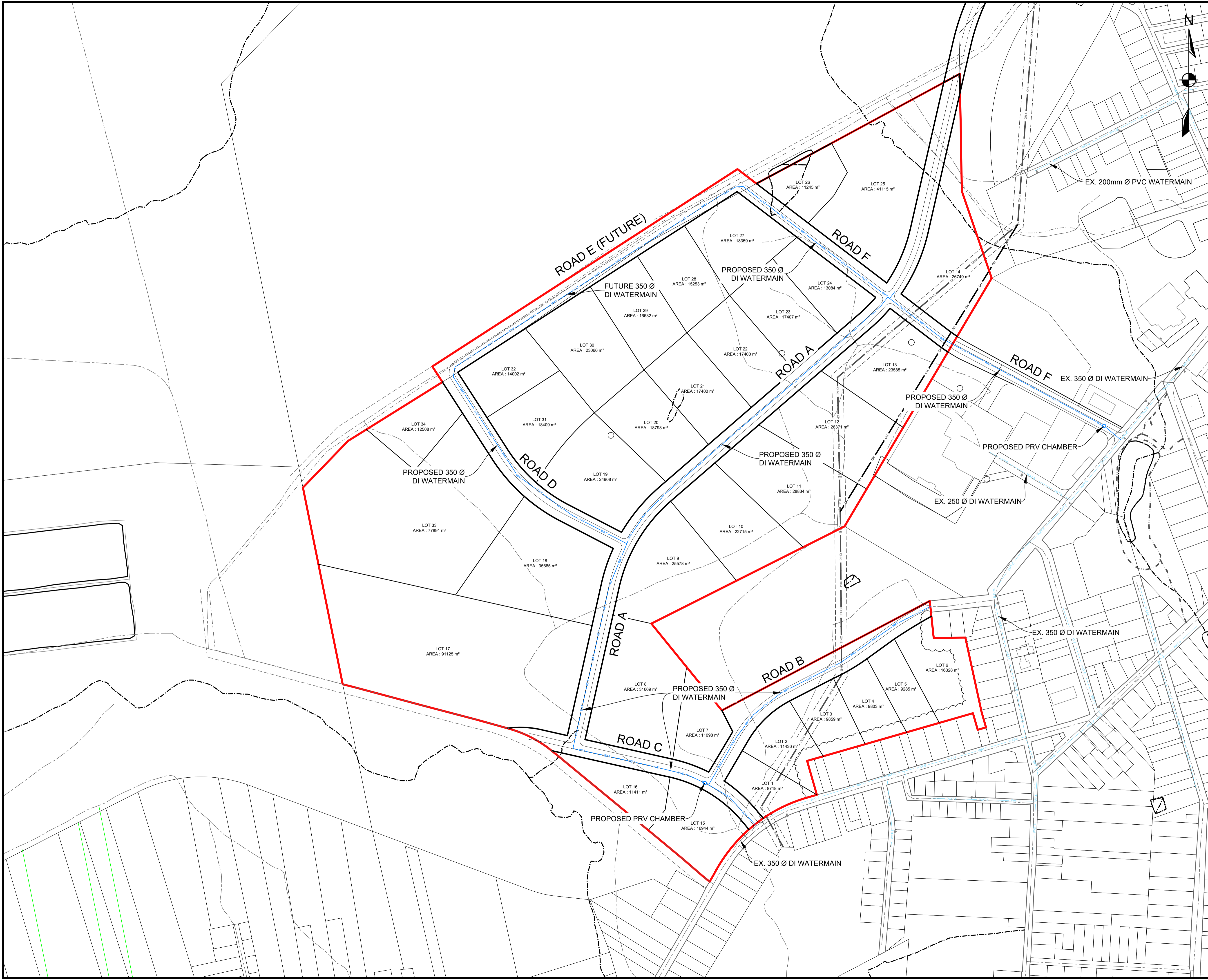
<b>Sewershed Areas</b>			
Area	Area ID	Total Area (m <sup>2</sup> )	Total Area (ha)
Lot 1	1	8,718	0.9
Lot 2	2	11,436	1.1
Lot 3	3	9,859	1.0
Lot 4	4	9,803	1.0
Lot 5	5	9,285	0.9
Lot 6	6	16,328	1.6
Lot 7	7	11,098	1.1
Lot 8	8	31,669	3.2
Lot 9	9	25,578	2.6
Lot 10	10	22,715	2.3
Lot 11	11	28,834	2.9
Lot 12	12	26,371	2.6
Lot 13	13	23,585	2.4
Lot 14	14	26,749	2.7
Lot 15	15	16,944	1.7
Lot 16	16	11,411	1.1
Lot 17	17	91,125	9.1
Lot 18	18	33,685	3.4
Lot 19	19	24,908	2.5
Lot 20	20	18,798	1.9
Lot 21	21	17,400	1.7
Lot 22	22	17,400	1.7
Lot 23	23	17,407	1.7
Lot 24	24	13,084	1.3
Lot 25	25	41,115	4.1
Lot 26	26	11,245	1.1
Lot 27	27	18,359	1.8
Lot 28	28	15,253	1.5
Lot 29	29	16,632	1.7
Lot 30	30	23,066	2.3
Lot 31	31	18,409	1.8
Lot 32	32	14,002	1.4
Lot 33	33	77,891	7.8
Lot 34	34	12,508	1.3
<b>Total</b>		<b>772,670</b>	<b>77</b>



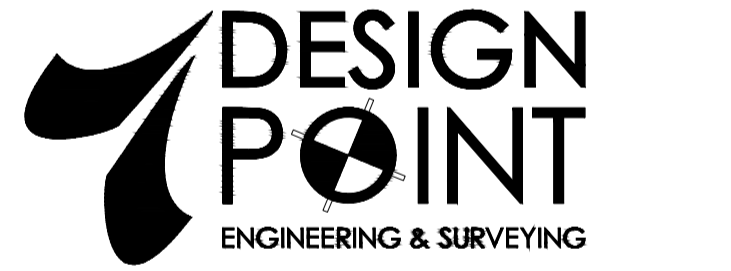
U/S MH	D/S MH	TRIBUTARY AREAS	Total Area (Ha)	Equivalent Population (People/Ha)	Tot. Pop. "P"	Domestic Load (L/day)	Average Dry Weather (L/day)	Average Dry Weather (L/s)	Harmon Peaking Factor	Peak Commercial Load (L/day)	Peak Commercial Load (L/s)	Peak Dry Weather (L/day)	Peak Dry Weather (L/s)	Safety Factor	Peak Dry Weather incl SF (L/s)	I/I Allowance (L/s/Ha)	I/I Loading (L/s)	Peak Wet Weather (L/s)	Pipe Size (mm)	Pipe Slope (%)	Pipe Manning's "n"	Pipe Capacity (L/s)	Percent Full (%)	NOTES
1	2	4,5,6	3.5	85.0	301	340	102352	1.18	4.08	417374	4.83	834749	9.7	1	9.7	0.28	1.0	10.7	250	1.00%	0.011	70.4	15	
2	3	3,4,5,6	4.5	85.0	385	340	130845	1.51	4.03	527314	6.10	1054627	12.2	1	12.2	0.28	1.3	13.5	250	1.00%	0.011	70.4	19	
3	4	3,4,5,6	4.5	85.0	385	340	130845	1.51	4.03	527314	6.10	1054627	12.2	1	12.2	0.28	1.3	13.5	250	1.00%	0.011	70.4	19	
4	5	2,3,4,5,6	5.7	85.0	482	340	163895	1.90	3.98	652685	7.55	1305371	15.1	1	15.1	0.28	1.6	16.7	250	1.00%	0.011	70.4	24	
5	6	1,2,3,4,5,6	6.5	85.0	556	340	189090	2.19	3.95	746906	8.64	1493812	17.3	1	17.3	0.28	1.8	19.1	250	1.00%	0.011	70.4	27	
6	7	1,2,3,4,5,6,15	8.2	85.0	700	340	238058	2.76	3.89	927116	10.73	1854233	21.5	1	21.5	0.28	2.3	23.8	250	1.00%	0.011	70.4	34	
7	8	1,2,3,4,5,6,7,15	9.3	85.0	795	340	270131	3.13	3.86	1043300	12.08	2086599	24.2	1	24.2	0.28	2.6	26.8	250	1.00%	0.011	70.4	38	
8	9	1,2,3,4,5,6,7,15	9.3	85.0	795	340	270131	3.13	3.86	1043300	12.08	2086599	24.2	1	24.2	0.28	2.6	26.8	250	1.00%	0.011	70.4	38	
9	EX. 1	1,2,3,4,5,6,7,15	9.3	85.0	795	340	270131	3.13	3.86	1043300	12.08	2086599	24.2	1	24.2	0.28	2.6	26.8	250	1.00%	0.011	70.4	38	
10	11	8,17	12.3	85.0	1044	340	354875	4.11	3.79	1344242	15.56	2688483	31.1	1	31.1	0.28	3.4	34.6	250	1.00%	0.011	70.4	49	
11	12	8,17	12.3	85.0	1044	340	354875	4.11	3.79	1344242	15.56	2688483	31.1	1	31.1	0.28	3.4	34.6	250	1.00%	0.011	70.4	49	
13	14	8,9,17	14.8	85.0	1261	340	428795	4.96	3.73	1600592	18.53	3201183	37.1	1	37.1	0.28	4.2	41.2	250	1.00%	0.011	70.4	59	
14	15	8,9,17,19	17.3	85.0	1473	340	500779	5.80	3.69	1845508	21.36	3691016	42.7	1	42.7	0.28	4.9	47.6	250	1.00%	0.011	70.4	68	
15	16	8,9,17,19,31,33	27.0	85.0	2291	340	779086	9.02	3.54	2757270	31.91	5514541	63.8	1	63.8	0.28	7.5	71.4	300	1.00%	0.011	114.4	62	
16	EX. 2	8,9,17,19,31,32,33	28.4	85.0	2410	340	819552	9.49	3.52	2885937	33.40	5771873	66.8	1	66.8	0.28	7.9	74.7	300	1.00%	0.011	114.4	65	
17	18	10,20	4.2	85.0	353	340	119973	1.39	4.05	485582	5.62	971163	11.2	1	11.2	0.28	1.2	12.4	250	1.00%	0.011	70.4	18	
18	19	10,11,20,21	8.8	85.0	746	340	253589	2.94	3.88	983547	11.38	1967094	22.8	1	22.8	0.28	2.5	25.2	250	1.00%	0.011	70.4	36	
19	20	10,11,12,20,21,22	13.2	85.0	1118	340	380087	4.40	3.77	1432271	16.58	2864541	33.2	1	33.2	0.28	3.7	36.8	250	1.00%	0.011	70.4	52	
20	21	10,11,12,13,20,21,22,23	17.3	85.0	1466	340	498554	5.77	3.69	1838001	21.27	3676001	42.5	1	42.5	0.28	4.8	47.4	250	1.00%	0.011	70.4	67	
21	22	10,11,12,13,20,21,22,23	17.3	85.0	1466	340	498554	5.77	3.69	1838001	21.27	3676001	42.5	1	42.5	0.28	4.8	47.4	250	1.00%	0.011	70.4	67	
22	23	10,11,12,13,14,20,21,22,23	19.9	85.0	1694	340	575859	6.67	3.64	2096586	24.27	4193172	48.5	1	48.5	0.28	5.6	54.1	250	1.00%	0.011	70.4	77	
23	24	10,11,12,13,14,20,21,22,23,24,25	25.3	85.0	2154	340	732494	8.48	3.56	2608008	30.19	5216016	60.4	1	60.4	0.28	7.1	67.5	300	1.00%	0.011	114.4	59	
24	25	10,11,12,13,14,20,21,22,23,24,25,27	27.2	85.0	2310	340	785551	9.09	3.54	2777886	32.15	5555771	64.3	1	64.3	0.28	7.6	71.9	300	1.00%	0.011	114.4	63	

Flow to 900mm 146.7  
 Flow to 450mm 26.8  
**Total Flow 173.4**

## APPENDIX D – WATER SYSTEM SCHEMATIC



ISSUE	DATE	DESCRIPTION	CONSULTANT
1	MAR. 16, 2020	ISSUED FOR REVIEW	



CLIENT



PROJECT DESCRIPTION

**SPRINGHILL GEOTHERMAL BUSINESS PARK**

SPRINGHILL, NOVA SCOTIA

SHEET DESCRIPTION

Drawn A.LEAHY	Engineer N.FOUGERE	Project No. 19-148	Drawing No. SCH-03
Scale 1:3000	Filename 19-148_SCH.dwg		3 of 14

## APPENDIX E – WATER MODEL SCHEMATIC AND RESULTS

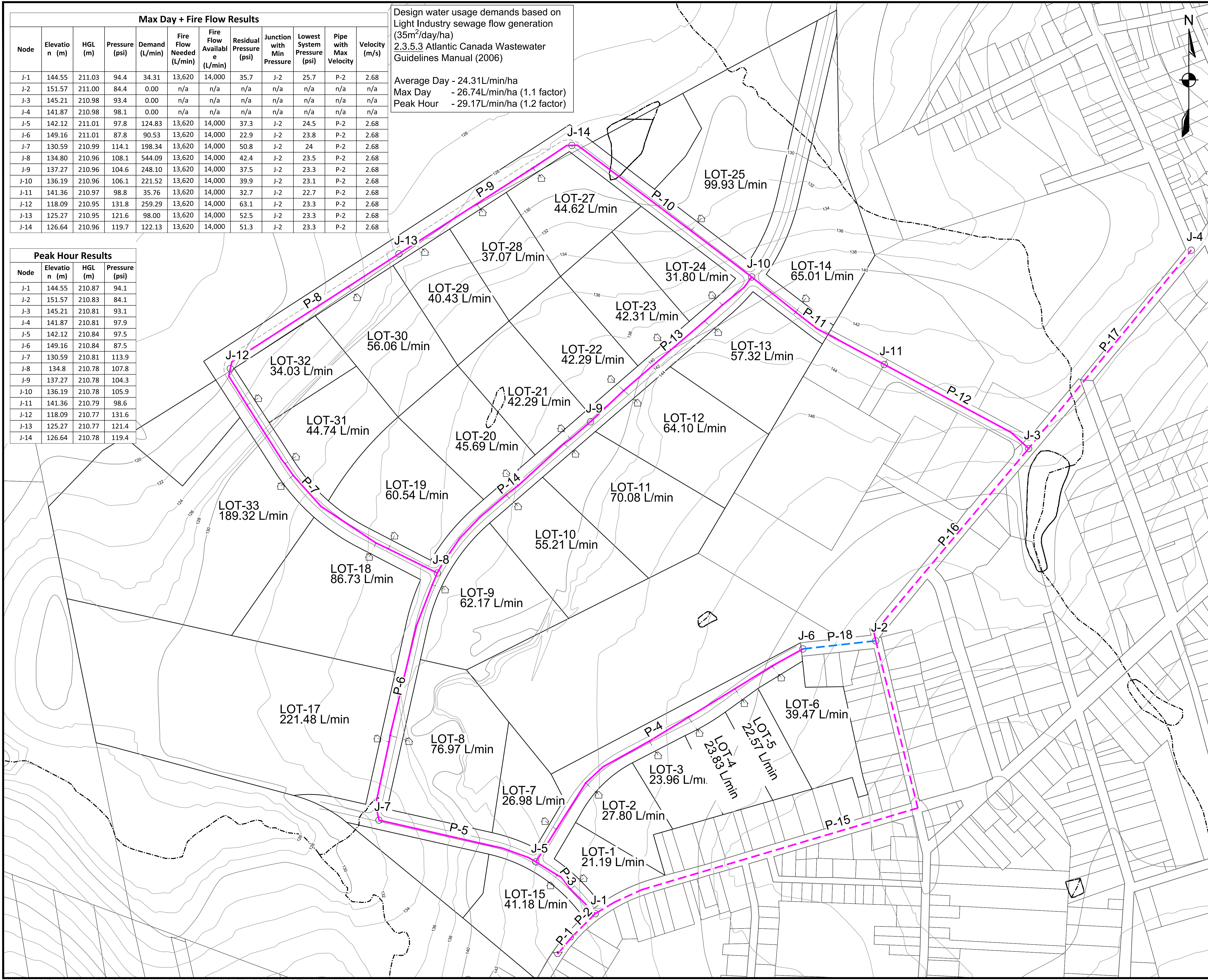
**Max Day + Fire Flow Results**

Node	Elevation (m)	HGL (m)	Pressure (psi)	Demand (L/min)	Fire Flow Needed (L/min)	Fire Flow Available (L/min)	Residual Pressure (psi)	Junction with Min Pressure	Lowest System Pressure (psi)	Pipe with Max Velocity	Velocity (m/s)
J-1	144.55	211.03	94.4	34.31	13,620	14,000	35.7	J-2	25.7	P-2	2.68
J-2	151.57	211.00	84.4	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a
J-3	145.21	210.98	93.4	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a
J-4	141.87	210.98	98.1	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a
J-5	142.12	211.01	97.8	124.83	13,620	14,000	37.3	J-2	24.5	P-2	2.68
J-6	149.16	211.01	87.8	90.53	13,620	14,000	22.9	J-2	23.8	P-2	2.68
J-7	130.59	210.99	114.1	198.34	13,620	14,000	50.8	J-2	24	P-2	2.68
J-8	134.80	210.96	108.1	544.09	13,620	14,000	42.4	J-2	23.5	P-2	2.68
J-9	137.27	210.96	104.6	248.10	13,620	14,000	37.5	J-2	23.3	P-2	2.68
J-10	136.19	210.96	106.1	221.52	13,620	14,000	39.9	J-2	23.1	P-2	2.68
J-11	141.36	210.97	98.8	35.76	13,620	14,000	32.7	J-2	22.7	P-2	2.68
J-12	118.09	210.95	131.8	259.29	13,620	14,000	63.1	J-2	23.3	P-2	2.68
J-13	125.27	210.95	121.6	98.00	13,620	14,000	52.5	J-2	23.3	P-2	2.68
J-14	126.64	210.96	119.7	122.13	13,620	14,000	51.3	J-2	23.3	P-2	2.68

Design water usage demands based on Light Industry sewage flow generation (35m<sup>2</sup>/day/ha)  
 2.3.5.3 Atlantic Canada Wastewater Guidelines Manual (2006)  
 Average Day - 24.31L/min/ha  
 Max Day - 26.74L/min/ha (1.1 factor)  
 Peak Hour - 29.17L/min/ha (1.2 factor)

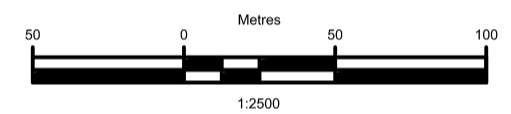
**Peak Hour Results**

Node	Elevation (m)	HGL (m)	Pressure (psi)
J-1	144.55	210.87	94.1
J-2	151.57	210.83	84.1
J-3	145.21	210.81	93.1
J-4	141.87	210.81	97.9
J-5	142.12	210.84	97.5
J-6	149.16	210.84	87.5
J-7	130.59	210.81	113.9
J-8	134.8	210.78	107.8
J-9	137.27	210.78	104.3
J-10	136.19	210.78	105.9
J-11	141.36	210.79	98.6
J-12	118.09	210.77	131.6
J-13	125.27	210.77	121.4
J-14	126.64	210.78	119.4

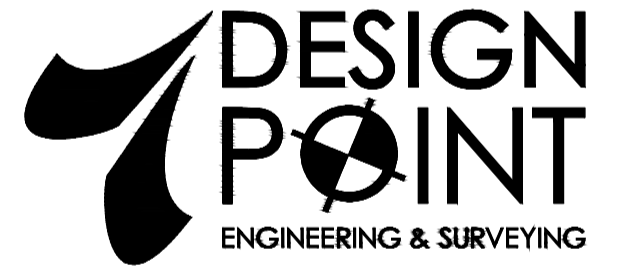


**LEGEND**

EX. CONTOUR (MAJOR)	---
EX. CONTOUR (MINOR)	---
LOT LINE	---
RIGHT OF WAY	---
EASEMENT	---
NEW 100 mm PIPE	---
NEW 150 mm PIPE	---
NEW 200 mm PIPE	---
NEW 250 mm PIPE	---
NEW 300 mm PIPE	---
NEW 350 mm PIPE	---
NEW 400 mm PIPE	---
NEW 450 mm PIPE	---
EX. 100 mm PIPE	---
EX. 150 mm PIPE	---
EX. 200 mm PIPE	---
EX. 250 mm PIPE	---
EX. 300 mm PIPE	---
EX. 350 mm PIPE	---
EX. 400 mm PIPE	---
EX. 450 mm PIPE	---
WATERCOURSE	---
NEW SERVICE LATERAL	---



1	DRAFT	DRAFT
ISSUE	DATE	DESCRIPTION
CONSULTANT		



PHONE: 902.832.5597 www.designpoint.ca

CLIENT

PROJECT DESCRIPTION

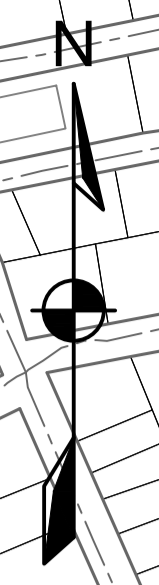
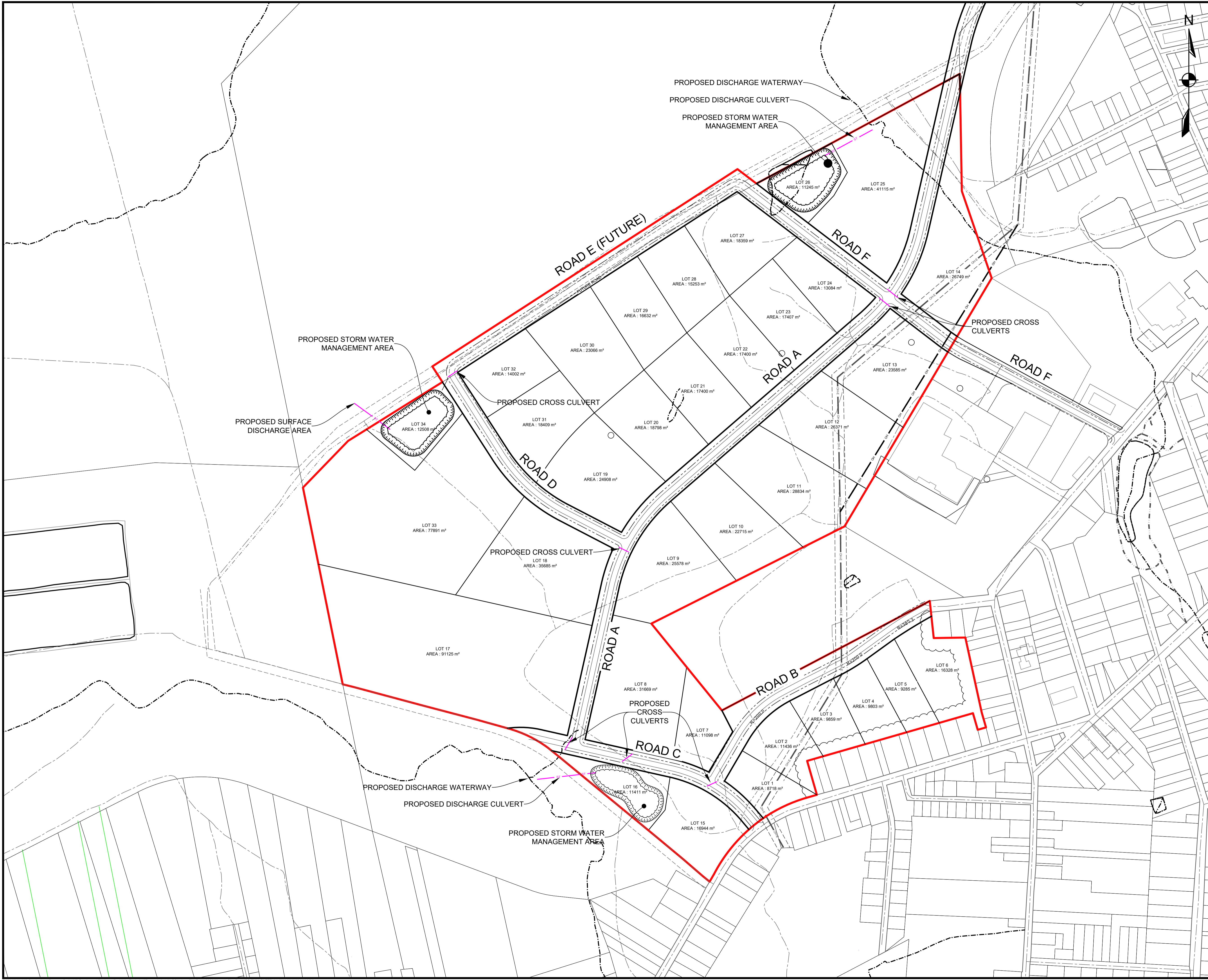
**SPRINGHILL GEOTHERMAL BUSINESS PARK**

SPRINGHILL, NOVA SCOTIA

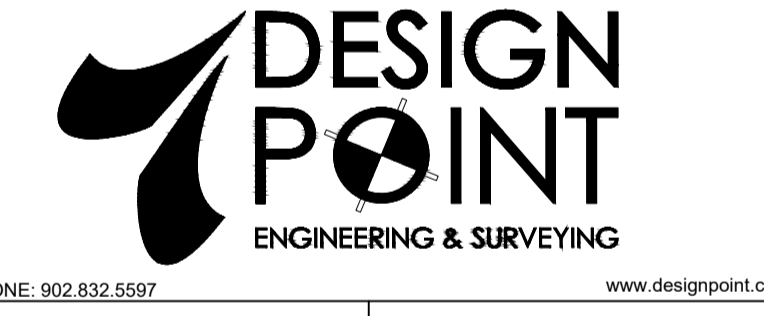
**WATER SYSTEM SCHEMATIC**

Drawn A.LEAHY	Engineer N.FOUGERE	Project No. 19-148	Drawing No. SCH-01
Scale #####	Filename 19-148_WAT-SCH.dwg	1 of 14	

## APPENDIX F – STORMWATER SYSTEM SCHEMATIC



ISSUE	DATE	DESCRIPTION	CONSULTANT
1	MAR. 16, 2020	ISSUED FOR REVIEW	



**PRELIMINARY**




**SPRINGHILL GEOTHERMAL BUSINESS PARK**  
SPRINGHILL, NOVA SCOTIA

STORMWATER SYSTEM SCHEMATIC

Drawn A.LEAHY	Engineer N.FOUGERE	Project No. 19-148	Drawing No. SCH-04
Scale 1:3000	Filename 19-148_SCH.dwg	4 of 14	

## APPENDIX G – COST ESTIMATE

ESTIMATE OF PROBABLE COST					
Springhill Geothermal Business Park					
					
Project Number: 19-148					
Date: March 16, 2020					
Drawings: Concept Plan 2A Date September 19 2019					
<small>Note: This estimate of probable cost is prepared for Halifax Regional Municipality inspection fee calculation purposes only. The estimate is based on unit rates obtained from previous tenders of similar work and represents a budget only. The actual construction cost will be subject to various factors that are not known at the time of estimate preparation, including market conditions, industry workload, and changes to the design through the approval process. The actual cost cannot be known until the project is tendered and a contract is awarded. This estimate should be used with caution if using for business budgeting purposes.</small>					
No.	Unit Description	Unit	Quantity	Unit Rate	Estimated Cost
1.00	<b>Earthworks</b>				
1.01	Clearing	Ha	13	\$ 5,000.00	\$ 65,000.00
1.02	Grubbing	Ha	13	\$ 25,000.00	\$ 325,000.00
1.03	Mass Excavation - Common	m <sup>3</sup>	20000	\$ 10.00	\$ 200,000.00
1.04	Mass Excavation - Rock	m <sup>3</sup>	3000	\$ 20.00	\$ 60,000.00
1.05	Environmental Measures	l.s.	1	\$ 25,000.00	\$ 25,000.00
	Subtotal				\$ 675,000.00
2.00	<b>Water System</b>				
2.01	350mm DI CL52	m	2650	\$ 375.00	\$ 993,750.00
2.02	350mm Gate Valve	each	15	\$ 2,750.00	\$ 41,250.00
2.03	Hydrant	each	30	\$ 3,400.00	\$ 102,000.00
2.04	PRV Chamber	each	2	\$ 250,000.00	\$ 500,000.00
2.05	Connection to Existing	each	3	\$ 5,000.00	\$ 15,000.00
	Subtotal				\$ 1,652,000.00
3.00	<b>Sanitary System</b>				
3.01	250mm PVC DR35	m	2000	\$ 220.00	\$ 440,000.00
3.02	300mm PVC DR35	m	440	\$ 250.00	\$ 110,000.00
3.03	1050mm Precast Manhole	each	24	\$ 3,000.00	\$ 72,000.00
3.04	1200mm Precast Manhole	each	1	\$ 4,000.00	\$ 4,000.00
3.05	Connection to Existing	each	3	\$ 3,000.00	\$ 9,000.00
	Subtotal				\$ 635,000.00
4.00	<b>Storm System</b>				
4.01	450mm PVC DR35	m		\$ 180.00	\$ -
4.02	525mm CSA A257.2	m	50	\$ 200.00	\$ 10,000.00
4.03	600mm CSA A257.2	m	100	\$ 250.00	\$ 25,000.00
4.04	750mm CSA A257.2	m	25	\$ 300.00	\$ 7,500.00
4.05	2100mm CSA A257.2	m	25	\$ 1,250.00	\$ 31,250.00
4.06	Precast Headwall with Grate (450-750)	each	20	\$ 2,500.00	\$ 50,000.00
4.07	Cast in Place Headwall with Grate (1050-2100)	each	2	\$ 9,000.00	\$ 18,000.00
4.08	Drainage Ditch	m	50	\$ 100.00	\$ 5,000.00
4.09	Stormwater Management Pond	each	3	\$ 150,000.00	\$ 450,000.00
4.10	Rocklining (100mm-200mm)	m <sup>2</sup>	50	\$ 7.00	\$ 350.00
4.11	Connection to Existing	each	3	\$ 5,000.00	\$ 15,000.00
	Subtotal				\$ 612,100.00
5.00	<b>Street System</b>				
5.01	Type 1 Gravel (150mm Thick)	m <sup>3</sup>	5050	\$ 45.00	\$ 227,250.00
5.02	Type 2 Gravel (450mm Thick)	m <sup>3</sup>	17000	\$ 45.00	\$ 765,000.00
5.03	Asphalt Concrete Type C-HF	m <sup>3</sup>	1944	\$ 450.00	\$ 874,800.00
5.04	Asphalt Concrete Type B-HF	m <sup>3</sup>	1300	\$ 450.00	\$ 585,000.00
5.05	3.0m Wide AT Trail	m	2650	\$ 100.00	\$ 265,000.00
5.06	Street Trees	each	100	\$ 600.00	\$ 60,000.00
5.07	Street Signs incl. bases	each	10	\$ 500.00	\$ 5,000.00
	Subtotal				\$ 2,782,050.00
6.00	<b>Electrical/Communication</b>				
6.01	Poles	each	70	\$ 1,500.00	\$ 105,000.00
	Subtotal				\$ 105,000.00
				Sub Total	\$ 6,461,150.00
				Contingency (25%)	\$ 1,615,287.50
				Engineering (7.5%)	\$ 484,586.25
				Total	\$ 8,561,023.75



**DRAFT**  
**Springhill Geothermal  
Business Park -  
District Energy System  
Design Brief**  
Cumberland, NS

Prepared for:

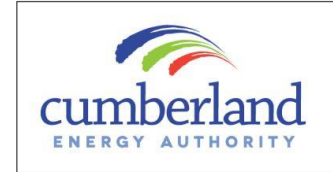
**Cumberland Energy Authority**  
1395 Blair Lake Rd  
Upper Nappan, NS, B4H 3Y4

March 20, 2020

Pinchin File: 0243394.000



**Issued to:** Cumberland Energy Authority  
**Contact:** Justin Waugh-Cress  
Manager, Energy & Wastewater  
**Issued on:** March 20, 2020  
**Pinchin File:** 0243394.000  
**Issuing Office:** Victoria, BC  
**Primary Pinchin**  
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## EXECUTIVE SUMMARY

The Cumberland Energy Authority (CEA) is in the process of planning a new geothermal business park in Springhill, NS. The proposed 100-acre business park sits atop the former Springhill coal mines. The remaining workings, which cover an area of 16 km<sup>2</sup> and extend to a depth of 1,300m, have since flooded with water and present a unique opportunity for geothermal heat recovery. The CEA is proposing that the new geothermal business park include a district energy system (DES) based on mine water heat recovery. Several existing facilities in Springhill are currently using mine water heat exchange to meet their space and process heating and cooling needs. These existing businesses have demonstrated the technical viability of mine water heat recovery in Springhill.

This design brief provides an overview of the types of district energy system that could be considered for the business park. Both hot water district heating systems and ambient temperature district energy systems were considered in context of the expected park customer loads and relative system efficiencies, capital costs, and operation and maintenance requirements.

An ambient temperature DES approach was recommended for the business park. An ambient temperature DES delivers energy as ambient temperature water to all customers. Heat pumps are installed in each customer building to provide heating and/or cooling for space, domestic hot water, or process loads. This approach to district energy design—locating the heat pumps at the customer buildings—improves system efficiency by allowing each heat pump to operate at the best efficiency point based on its own specific load. This approach also greatly simplifies the energy centre design and reduces its capital cost and O&M requirements. An ambient approach enables the use of lower-cost high density polyethylene (HDPE) distribution piping and reduces the capital cost of public infrastructure.

A district energy concept design has been prepared for the proposed ambient temperature DES. The concept design consists of the following major components:

- Mine Water Tie-In which includes three wells for extraction of mine water from the No. 2 seam haulage slope tunnel and three wells for injection of mine water back into the No. 3 seam workings.
- Energy Centre which includes double wall titanium heat exchangers for transferring energy between the mine water and the DES, pumps for circulating DES water to customers, backup generator, and controls.
- Distribution Piping System consisting of uninsulated, HDPE supply and return mains extending from the energy center to each customer lot underneath the roadways.



- Service connections to each customer lot to be installed in the future by hot-tap as the lots are subdivided and customer buildings are built.
- Energy Transfer Stations in each customer building which meter and transfer energy between the DES loop and the customer heating and cooling systems.

A main driver for the development of the geothermal business park DES is the significant energy cost and greenhouse gas (GHG) emissions savings that can be achieved by using heat pumps and mine water heat recovery. The following table provides a comparison of the total business park customer buildings heating fuel cost and GHG emissions under the proposed DES concept compared with the same energy being delivered via “business-as-usual” fuels.

*Table i: Full Site Annual Heating Fuel Cost and GHG Emissions Comparison*

	<b>Electric Resistance Heat</b>	<b>Propane Heat</b>	<b>Ambient DES HP Heat</b>
<b>Annual Heating Requirement</b>	10,000 MWh		
<b>Primary Fuel Source</b>	Electricity	Propane	DES / Electricity
<b>Fuel Use</b>	10,000 MWh Electricity	12,500 MWh Propane	2640 MWh Electricity 6860 MWh DES 625 MWh Propane*
<b>Annual Fuel Cost</b>	\$1,300,000	\$1,325,000	<b>\$409,500 + DES charges</b>

Notes: \*Ambient DES scenario for the full site assumes 10% of annual heating requirement is delivered by backup or “peaking” energy sources including electric resistance heat and propane boilers.  
Electricity based on blended general service rate of \$130.00 /MWh.  
Propane based on \$0.75 /L.  
DES utility charges for heating energy are not included.

As illustrated in the tables above, the DES presents a good opportunity to deliver heating energy at significantly lower annual cost than ‘business-as-usual’ fuel sources. The proposed DES could provide \$900,000 per year in heating energy cost savings for the fully constructed business park.

A capital cost estimate for the design and construction of the DES has been prepared. Capital cost estimates are provided to a Class D level of accuracy (-20% to +30%). A Class D estimate is appropriate at this conceptual design stage and can be refined as the project progresses to detailed design stage. Capital costs reflect equipment sizing which is based on the estimated energy loads from the expected future park customers.



Capital cost estimates include indirect costs for engineering consulting services and owner's overhead. Contingency is not included. A recommended contingency is included in the capital cost estimate breakdowns included in Appendix 5.

The DES cost estimate for utility-provided infrastructure is \$7.37 million. This includes the mine water tie-in, energy center, and distribution piping system. Customer-provided infrastructure includes the energy transfer stations and service connections for each lot which is estimated at \$3.4 million for the full site (34 lots). Combined, the total cost for the ambient DES is estimated at \$10.77 million.



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APPENDIX V	Capital Cost Estimate



## **LIST OF ACRONYMS**

ATDES	Ambient Temperature District Energy System
CEA	Cumberland Energy Authority
COP	Coefficient of Performance
DES	District Energy System
DHS	District Heating System
DHW	Domestic Hot Water
DPS	Distribution Piping System
DTS	District Heating System
ETS	Energy Transfer Station
EUI	Energy Use Intensity
HDPE	High Density Polyethylene
HVAC	Heating, Ventilation, Air Conditioning
kW	Kilowatt
kWh	Kilowatt-hour
NECB	National Energy Code for Buildings
O&M	Operations and Maintenance

## **TERMS AND LIMITATIONS**

Specific limitations related to the legal and financial and limitations to the scope of the current work are outlined in our proposal and the Authorization to Proceed, Limitation of Liability and Terms of Engagement contract form which accompanied the proposal.

Information provided by Pinchin is intended for Cumberland Energy Authority use only. Pinchin will not provide results or information to any party unless disclosure by Pinchin is required by law. Any use by a third party of reports or documents authored by Pinchin or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Pinchin accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted. No other warranties are implied or expressed.



## **1.0 BACKGROUND**

The Cumberland Energy Authority (CEA) is in the process of planning a new geothermal business park in Springhill, NS. The proposed 100-acre business park sits atop the former Springhill coal mines. The coal mines were active from the early 1800's to 1958 when a rock burst closed the No. 2 mine and ended large scale mining operations in Springhill. The remaining workings, which cover an area of 16 km<sup>2</sup> and extend to a depth of 1,300m, have since flooded with water and present a unique opportunity for geothermal heat recovery.

The CEA is proposing that the new geothermal business park include a district energy system (DES) based on mine water heat recovery. The DES will be designed to extract and distribute thermal energy from the mine water to the future businesses that will occupy the park. Several existing facilities in Springhill are currently using mine water heat exchange to meet their space and process heating and cooling needs. These existing businesses have demonstrated the technical viability of mine water heat recovery in Springhill.

## **2.0 WHY DISTRICT ENERGY?**

### **2.1 Benefits of District Energy in Springhill**

District energy is being investigated for the proposed geothermal business park to deliver affordable, low-carbon thermal energy to customers in the park. District energy is a good way of making sources of renewable energy—in this case mine water geothermal energy—easily accessible to a wide range of customers. Benefits of geothermal-based district energy for the proposed business park include:

- An electrically driven heat pump, using mine water geothermal energy, can provide heating at substantially lower fuel input cost and with fewer greenhouse gas emissions than other common energy sources.
- A district energy system allows many customers to connect to the geothermal energy source through a single set of wells. Significantly fewer wells are needed to service the same number of buildings on a district energy system compared to numerous standalone systems. Well locations for district energy can be designed around the mine workings better than smaller standalone systems.
- A district energy system provides hydraulic separation of the mine water from the water that circulates to customer equipment. This helps reduce maintenance issues associated with direct use of mine water in customer equipment.



- Some district energy system types can provide cooling which enables heat recovery and energy sharing between buildings in the geothermal business park.
- A district energy system is commonly setup as a utility which reduces a customer's upfront cost of accessing the mine water. The utility takes on the initial investment and risk associated with drilling wells into the mine workings. The utility recoups its costs over a number of years (often 30 years or more) by charging customers for service.
- Utility involvement brings qualified personnel for operation and maintenance of the system which improves reliability and performance.

### **3.0 TYPES OF DISTRICT ENERGY**

#### **3.1 District Heating and District Cooling**

A district heating system (DHS) is the most common type of district energy deployed in North America. District heating systems consist of one or more energy centres that produce heating energy in the form of steam or hot water. Heat is distributed throughout the district by a distribution piping system (DPS) most commonly constructed of supply and return pairs of insulated steel pipe. Customer buildings each receive heat at an energy transfer station (ETS) that normally includes a heat exchanger (to provide hydraulic separation between the building system and the DHS) and a control valve (to regulate the transfer of energy through the ETS). The ETS replaces the boiler plant in the connected buildings and is therefore designed to provide 100% of the space and domestic hot water heating load.

Operating temperatures for district heating systems vary, but generally are at least high enough to heat domestic hot water to 60°C. Steam systems operating at over 100°C were common in the early to mid-1900's. Many steam systems have been converted to hot water systems (95°C+). Newer district heating systems are often designed as low-temperature hot water (65 – 95°C) which enables higher central plant efficiency through condensing boilers and the ability to incorporate heat pump based renewable energy sources.

Similar to a district heating system, a district cooling system generates chilled water (5° - 10°C) at a central plant. Chilled water is distributed to ETSs in connected buildings through a network of insulated steel or polyethylene pipes. The chilled water ETS replaces the chiller plant that would otherwise be required in each building.

#### **3.2 Ambient Temperature District Energy**

An ambient temperature district energy system (ATDES) operates by distributing energy in the form of low 'ambient' temperature water (10 – 25°C). One or more energy centres—often based on renewable energy



sources—distribute ambient temperature water to customer buildings through a distribution piping system. Customer buildings receive heat at an ETS consisting of heat exchangers and/or heat pumps. Customer buildings require one or more heat pumps to upgrade thermal energy for space, process, or domestic hot water heating.

One advantage of an ambient temperature system is that it also provides cooling from the same infrastructure. For most buildings, the same heat pumps used to provide heating in the winter can be reversed to provide cooling in the summer. In some cases, buildings may be able to make direct use of the ambient temperature water for certain industrial cooling loads such as process equipment cooling, or heat rejection from refrigeration systems for ice arenas and cold storage warehouses. In cooling mode, excess heat is returned to the DPS and flows back to the energy centre.

At times of the year when some customers are in 'heating mode' and some are in 'cooling mode', an ambient temperature system enables recovery and reuse of energy. The low-grade heat rejected from buildings in cooling mode is returned to the energy centre and then distributed back into the supply network to be used by buildings that need heat. This principle is referred to as energy sharing and can contribute greatly to reducing a community's net annual energy consumption.

The energy centre operates to maintain the system supply temperature within a certain ideal range for the customer heat pumps by adding or removing heat, as required. Renewable energy sources such as geexchange, wastewater heat recovery, and air source heat pumps are well-suited for ambient temperature systems as they can provide both heating and cooling capacity.

Waste heat from refrigeration plants, industrial process loads, or data centres can also be recovered and shared through an ambient temperature system. Connecting to these types of year-round waste heat sources increases the available supply of renewable energy and can reduce the size and cost of the geexchange or other renewable energy source.

Some ambient temperature systems include boilers to provide supplemental heat for back up and peaking—to be used at times when customer loads may exceed the available renewable energy capacity. Backup sources may be located at the energy centre, customer building, or both.

Because of the low operating temperatures, the distribution piping system for an ambient temperature system normally consists of supply and return pairs of uninsulated high-density polyethylene (HDPE) piping. These pipes are directly buried and offer a lower installed cost and longer life than similarly sized steel piping options.



## 4.0 DISTRICT ENERGY FOR SPRINGHILL GEOTHERMAL BUSINESS PARK

### 4.1 DES Planning Approach

Selecting an appropriate type of district energy system requires an understanding of the thermal energy loads and thermal energy sources available at the project site. Sites with high heating loads, minimal cooling loads, and easily available sources of high-grade heat (such as biomass, industrial waste heat, or fossil fuel boilers) would be well suited for a district heating system. Sites with predominantly cooling loads, especially those located in warmer climates and with low heating loads, are well suited for a district cooling system. A site with a mixture of heating and cooling loads (especially if concurrent heating and cooling is prevalent) and with available low-temperature energy sources (such as geexchange, or wastewater heat recovery) are well suited to an ambient temperature district energy or district energy sharing system.

Once the site loads and sources are understood, the most appropriate type of district energy system can be chosen to service the expected customer buildings.

### 4.2 Expected Park Customer Energy Use Intensities

Because the Springhill Geothermal Business Park does not yet exist, assumptions must be made about the customers that will eventually populate the business park. The types, sizes, and energy loads of the future businesses must be estimated.

The Cumberland Energy Authority has provided guidance around the types of business that may eventually populate the park (as described in the EfficiencyOne study dated July 31, 2017). Potential park businesses may include:

- Food and beverage companies
- Rubber and plastics manufacturers
- Greenhouses
- Dairies
- Sugar processing
- Warehousing and logistics<sup>1</sup>
- Cold storage<sup>1</sup>
- Poultry and egg farming<sup>1</sup>

---

<sup>1</sup> Industries not mentioned in the prior study but identified by the CEA for consideration.



These potential businesses have been categorized into four 'archetype' customers, each with an expected thermal energy load profile:

- Highly heating dominated: facilities with high year-round space or hot water heating loads primarily due to process load requirements. Examples include greenhouses or poultry farms which need to maintain high indoor space temperatures, or food production facilities which have high domestic hot water loads.
- Moderately heating dominated: facilities with moderate, heating-dominated load profiles. Examples include warehouses, light industrial, or other buildings that predominantly need space heating and have little space cooling requirement. Cooling is assumed to be limited to front offices consisting of 10% of the building's floor area.
- Moderately cooling dominated: facilities that have above-average internal heat gains from light process equipment, lighting, computers, printers, etc., and therefore require space cooling (air conditioning) throughout most of the spring, summer, and fall. Examples include offices, technology companies, and light manufacturing facilities which have some heat generating equipment on the production floor.
- Highly cooling dominated: facilities that have high year-round process cooling loads and/or internal heat gains. Examples of cooling-intensive process loads include plastics manufacturing, refrigerated warehouses, and data centres.

Energy use intensity (EUI) assumptions for each archetype have been created from energy modelling and a review of available process load data. An energy model was completed for an example 3,700 m<sup>2</sup> warehouse and a 3,200 m<sup>2</sup> office building. Both buildings are assumed to be constructed to the minimum standards of the National Energy Code for Buildings (2017)<sup>2</sup>. Buildings were simulated using typical weather data for Springhill, NS. From the simulation load profiles, peak (W/m<sup>2</sup>) and annual (kWh/m<sup>2</sup>) heating and cooling energy use intensities were developed. The simulated warehouse and office models form the basis of the EUI assumptions for 'moderately heating dominate' and 'moderate cooling dominate' archetypes, respectively.

Estimates for process load heating and cooling energy use intensity have been made. The process heating and cooling loads have been added to the warehouse energy modelling simulation to form the basis of the 'highly heating dominated' and 'highly cooling dominated' archetypes, respectively.

Energy use intensity estimates are subject to significant variability depending on the types, sizes, and operation of the businesses that will occupy the park. Process load estimates are based on a review of

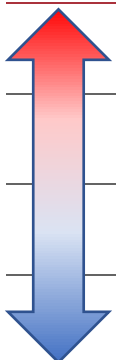
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<sup>2</sup> NECB 2017 is the energy efficiency standard for new buildings constructed in Nova Scotia effective January 1, 2020.

available energy use data from the EfficiencyOne study, discussions with operators at Ropak Packaging in Springhill, and energy analysis of the types of process loads expected.

The number and size of businesses that will occupy the park is unknown and so assumptions have also been made about the percentage of the future customers (by % of gross floor area) that is expected to fall under each energy use archetype. Based on initial discussions with the CEA, it is expected that the proposed business park will be most appealing to warehousing and logistics operations due to the convenient geographic location of Springhill. As such, warehouses—falling under the ‘moderate heating dominate’ archetype—are assumed to be most common energy archetype in the park.

*Table 1: Assumed Energy Use Intensities and Percentage of Gross Floor Area by Building Archetype*

	<b>Archetype</b>	<b>Peak Heating (W/m<sup>2</sup>)</b>	<b>Peak Cooling (W/m<sup>2</sup>)</b>	<b>Annual Heating (kWh/m<sup>2</sup>)</b>	<b>Annual Cooling (kWh/m<sup>2</sup>)</b>	<b>Expected % of Park Buildings</b>
	<b>High Heating Dominant</b>	100	6	150	5	20%
	<b>Moderate Heating Dominate</b>	50	6	50	5	45%
	<b>Moderate Cooling Dominate</b>	40	55	30	45	20%
	<b>High Cooling Dominate</b>	50	110	20	370 <sup>3</sup>	15%

Note that in Table 1 above ‘heating’ includes space and domestic hot water heating as well as any process heating loads that can be serviced by a district energy system. Some process heating loads (i.e. for pasteurization or sanitization) may require high temperature water (70°C+) or steam. These high temperature loads are not easily serviced by heat-pump based district energy systems. Heating energy for other process loads such as kilns, cooking, plastic injection molding, etc. could not be serviced by a district energy system and are not included.

In Table 1 above, ‘cooling’ includes space cooling as well as any process cooling loads that could be serviced by a district energy system. Most process cooling loads that could be serviced by an on-site

<sup>3</sup> Process cooling annual load assumption is based on available data from Ropak Packaging and discussions with their facility manager. Annual process cooling load can vary significantly and could be as high as 600 kWh/m<sup>2</sup> for cold storage facilities.



chiller and cooling tower system, could be designed to be serviced by an ambient temperature district energy system or district cooling system.

### 4.3 Expected Park Customer Building Area

Design Point, with input from the project team, has prepared a concept plan for the proposed Geothermal Business Park. The proposed park includes an expected 74 hectares of developable land. The park is divided initially into 34 parcels of with an average size of 22,000 m<sup>2</sup>. Final subdivision may change the number and sizes of lots to accommodate the requirements of the businesses that will occupy the park.

Based on a review of the land and building sizes of 17 similar business in the region around Springhill, an average lot coverage ratio of 20% is forecasted for the park<sup>4</sup>. Assuming 10% of building area is two-storey, the resulting expected gross floor area of all buildings built in the business park is 167,000 m<sup>2</sup>. A summary of the 17 comparable businesses referenced for developing lot coverage assumptions is provided in [Appendix 1](#).

### 4.4 Expected Park Customer District Energy Loads

Combining the assumed energy use intensities for various customer archetypes, assumed percent of park buildings of each energy archetype, and total expected floor area for the park, the projected energy loads for the Geothermal Business Park district energy system customers can be estimated. The estimated customer heating and cooling loads that could be serviced by a DES are summarized in the following table.

*Table 2: Geothermal Business Park Estimated Customer Heating & Cooling Loads*

	<b>Floor Area (m<sup>2</sup>)</b>	<b>Peak Heating (kW)</b>	<b>Peak Cooling (kW)</b>	<b>Annual Heating (MWh)</b>	<b>Annual Cooling (MWh)</b>
<b>Site Loads</b>	167,000	9,100	5,200	10,000	11,000

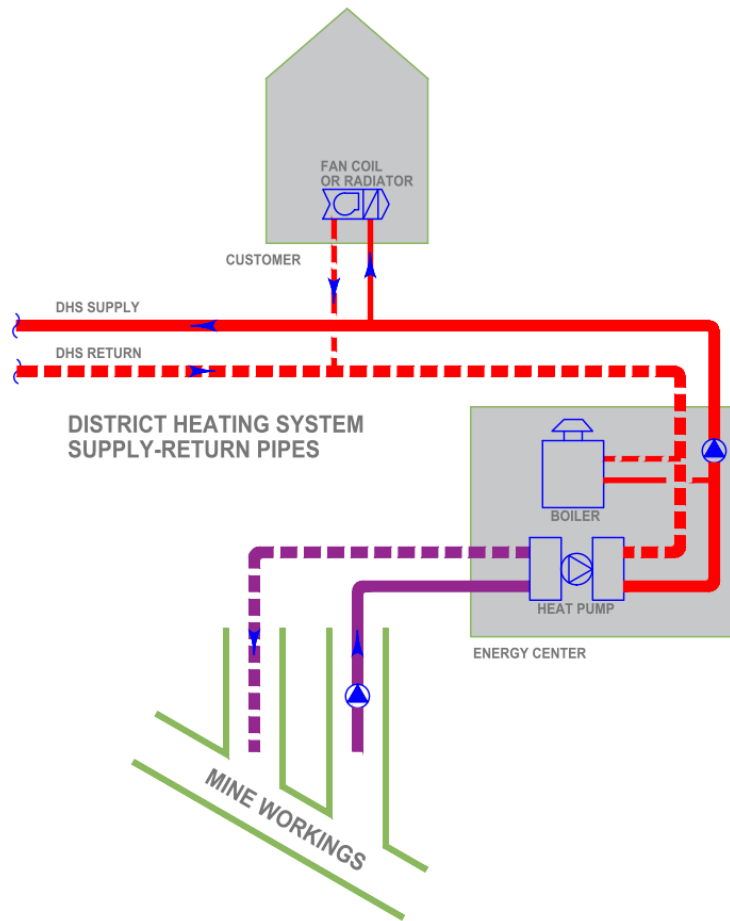
### 4.5 Comparison of District Energy System Options for Springhill Geothermal Business Park

The energy source for the DES is intended to be mine-water drawn from the flooded mine workings beneath the business park at an estimated temperature ranging from 12-17°C.

<sup>4</sup> Calculated lot coverages for similar businesses were determined from aerial imagery and ranged from 9% to 54%.

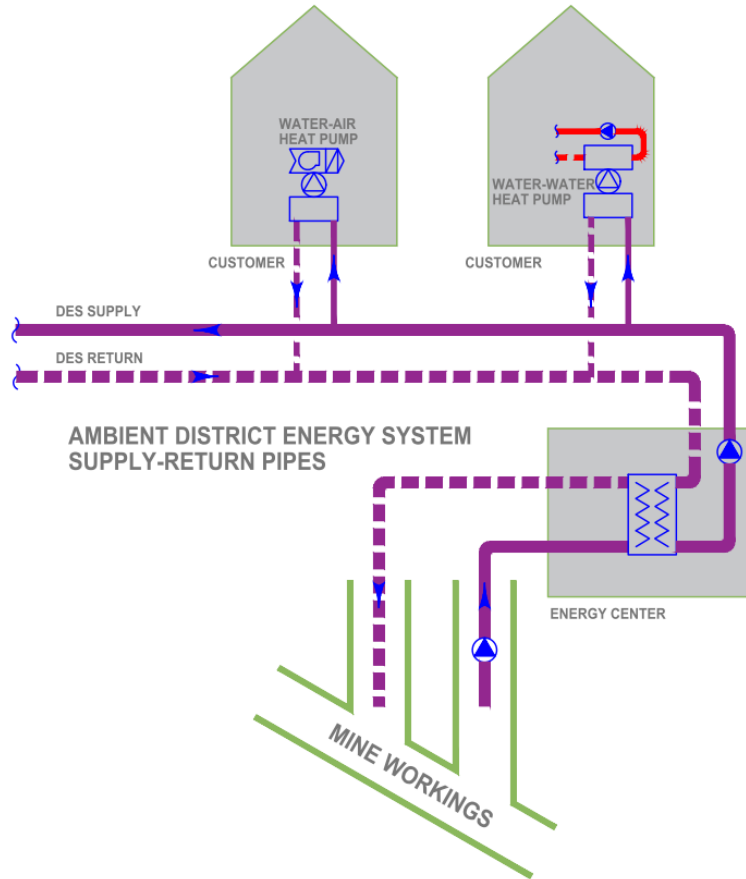
Using this mine water as an energy source, the DES to service the expected park loads could be constructed as a hot water district heating system (with or without district cooling) or an ambient temperature district energy system.

Figure 1: District Heating System Example



As a hot water district heating system, the low-grade heat in the mine water would have to be upgraded by using one or more large heat pump(s) in the energy centre. These heat pumps would produce hot water at 50° to 65°C that would be distributed around the site in the DPS. Each customer building would have a heat exchanger ETS to transfer thermal energy from the DPS to the building heating system. Cooling loads would have to be met either by a second network of pipes distributing chilled water (which would be generated by the energy centre heat pump) or by individual cooling systems at each customer building.

Figure 2: Ambient Temperature District Energy System Example



As an ambient temperature DES, the mine water would be used for direct heat exchange with the ambient temperature water in the DPS loop. The energy centre would include heat exchangers (for transferring energy while maintaining hydraulic separation between the mine water and the DPS loop) and pumps for circulating the DPS loop water. Pumps for the mine water would be located in the tie-in well(s). Ambient temperature water would be distributed to customers where it could be used for heating (with a heat pump) or cooling (either with a heat pump or by direct heat transfer to process equipment).

A comparison of the pros and cons of hot water and ambient temperature district energy options, in respect to the proposed business park, is provided in Table 3. Items identified as advantages are shown in green, and items identified as drawbacks are shown in red.

Table 3: Comparison of Hot Water vs Ambient Temperature Systems

Evaluation Criteria	Hot Water District Heating	Ambient Temperature District Energy
<b>Suitability for Expected Customer Loads</b>	<p>Good at meeting the expected customer heating loads.</p> <p>Not suitable for meeting high-temperature hot water (90°C+) or steam heating loads (as may be required at a brewery or dairy processing plant).</p> <p>Not suitable for meeting customer cooling loads without a 2<sup>nd</sup> distribution network for chilled water.</p> <p>A chilled water district cooling system is an inefficient way to meet many process cooling loads (such as refrigerated warehouses).</p>	<p>Provides both heating and cooling.</p> <p>Heat pumps and energy transfer station are designed specifically to meet the load requirements of each customer which increases efficiency.</p> <p>Not suitable for meeting high-temperature hot water (90°C+) or steam heating loads (as may be required at a brewery or dairy processing plant).</p>
<b>Suitability for Mine Water Heat Recovery</b>	<p>Good. Requires one or more large heat pumps in the energy centre to produce hot water (and potentially chilled water) from the mine water.</p> <p>Relatively warm mine water contributes to increased heat pump efficiency.</p>	<p>Very good. Requires small heat pumps in every customer building to produce heating or cooling energy for the load.</p> <p>Relatively warm mine water contributes to increased heat pump efficiency.</p>
<b>DES Capital Cost (public infrastructure)</b>	<p>Higher due to the high upfront cost of installing the central heat pump and the higher cost of the insulated steel DPS.</p>	<p>Lower due to the lower cost of the heat exchanger-based energy centre and the lower cost of using uninsulated HDPE pipes for the DPS.</p>
<b>DES Capital Cost (in-buildings equipment)</b>	<p>For heating-only spaces, the in-building equipment costs are lower than ambient temp option due to lower cost of heat exchanger-based ETS and ability to supply hot water to customer HVAC systems.</p> <p>For spaces requiring heating and cooling, costs are the same or higher than an Ambient Temperature District Energy System (ATDES) option because cooling systems must be provided by the customer for additional cost.</p>	<p>Cost impact on customer buildings depends on what type of HVAC system the customer originally intended to use.</p> <p>For spaces intended as heating-only, cost is usually higher because heat pumps are needed to upgrade ambient-temp energy for space heating. However, the same heat pumps can be run in reverse to provide cooling for no additional cost.</p> <p>For spaces intended to be heated and cooled, they can often be designed to use ambient district energy to provide heating and cooling for comparable or lower cost.</p>



<p><b>System Efficiency</b></p>	<p>Fair. A central heat pump coefficient of performance (COP) of 3.0 could be expected producing hot water (60°C) at the energy centre.</p> <p>The central HP must generate hot water for all customers at a temperature high enough to meet the highest temperature requirement of any single customer. Therefore all customer loads are met with the same, lower COP.</p>	<p>Great. Distributed heat pumps COP of 4.5 could be expected using DES water at 12°C.</p> <p>Each HP can be operated at the lowest output temperature necessary to meet its own specific load—increasing its COP.</p>
<p><b>Electricity Consumption</b></p>	<p>Higher due to the lower COP of the central heat pump.</p>	<p>30-40% lower than a central heat pump due to the higher average COP of the distributed heat pumps.</p>
<p><b>Fossil Fuel Consumption</b></p>	<p>Energy centre would generally include significant boiler capacity to provide backup and peaking energy for the heat pump(s).</p> <p>Generally, 25%-50% of annual heating energy would be from fossil fuel sources.</p>	<p>Lower fossil fuel consumption. Many customer heat pumps may be sized for 100% of the space heating load and therefore would not require any peaking energy use.</p> <p>Backup boilers or electric heaters in customer building may be necessary but would be run infrequently and would be expected to account for 0%-30% of annual heating.</p>
<p><b>Operations &amp; Maintenance (Utility Perspective)</b></p>	<p>The utility operator would be responsible for operation and maintenance of a large, custom-made heat pump package and large boilers at the energy centre.</p> <p>Would require specialized operator expertise (power engineer and refrigeration mechanics) on staff or on contract.</p> <p>Utility would need to ensure very high reliability of service as there are no backup systems at customer buildings.</p> <p>Utility has very little maintenance responsibility for equipment in customer buildings.</p>	<p>The utility operator would be responsible for operation of only the mine water wells and pumping in the energy centre.</p> <p>Central heat exchangers require little maintenance.</p> <p>More resiliency. Backup heat sources at customer buildings would engage in the event of brief DES service interruptions.</p> <p>Customer heat pumps would mostly be smaller packaged 'off the shelf' units.</p> <p>Heat pumps and backup systems at each customer building ETS could be owned and maintained by either the customer or the utility.</p> <p>If customer equipment is maintained by the utility: there would be equipment to maintain in the many ETSs (one at each customer building), but the utility can engage experienced maintenance staff</p>



		<p>and engineering oversight which helps reduce issues and improve performance.</p> <p>If customer equipment is maintained by the customer: there is very little equipment for the utility to maintain in customer buildings, but lack of qualified O&amp;M on the customer's part could lead to service issues and complaints.</p>
<p><b>Operations &amp; Maintenance (Customer Perspective)</b></p>	<p>Reduced heating system O&amp;M requirements for customers because traditional boilers have been replaced by the heat exchanger ETS. Heat exchanger is not complicated and requires little or no maintenance.</p> <p>Customer must still maintain their own cooling system (if they have one).</p>	<p>In-buildings equipment would be similar to the types of boilers and geothermal heat pumps often found in buildings in the region.</p> <p>Heat pumps add O&amp;M responsibilities that customers may not be used to.</p> <p>Can be complicated for non-sophisticated customers to operate the heat pumps and boilers to make efficient use of the ambient temperature DES.</p> <p>The utility could choose to provide O&amp;M services for the customer ETS heat pumps which reduces responsibilities and provides peace of mind for the customers.</p>

#### 4.6 Recommended Approach for Springhill District Energy

Two approaches for district energy for the Geothermal Business park have been considered: district heating and ambient temperature district energy.

In summary, a district heating approach centralizes the heat pumps at an energy centre and delivers hot water to each customer. This reduces the costs and logistical challenges that comes with operating and maintaining many smaller, distributed heat pumps in each customer building. However, a centralized approach comes with its own challenges including the high upfront capital cost for the system, lower overall efficiency, and difficulty delivering cooling. Under a DHS approach, either a separate district cooling system must be provided (for substantial extra cost), or any customer who requires cooling must provide their own cooling systems (with the associated capital cost and maintenance requirements). A district heating approach would not facilitate the use of mine water for free cooling by customers. A district heating system operates at lower overall efficiency because the central HP must generate hot water for all customers at a temperature high enough to meet the highest temperature requirement of any single customer. Therefore all customer loads are met with the same, lower COP. The operator of a DHS bears



greater responsibility and liability for operation and maintenance of the system since customers would not usually have their own backup heating systems.

An ambient temperature DES approach delivers ambient temperature water to all customers and the heat pumps are installed in each customer building. This approach greatly simplifies the energy centre design and reduces its capital cost and O&M requirements. An ambient approach enables the use of lower-cost HDPE distribution piping and reduces the capital cost of public infrastructure. However, a distributed approach means that every customer must design and install heat pumps to make use of the ambient temperature energy. This can be seen as an extra cost burden by some customers because heat pumps (and the associated hydronic systems) are fairly expensive to install compared to certain other low-efficiency heating systems (such as electric resistance baseboards, high temperature oil boilers, or propane unit heaters). Customers who were planning to provide space cooling systems in their buildings anyways (in particular labs, offices, and air-conditioned warehouses) may not see this as any extra burden at all. The ambient temperature DES approach shifts O&M responsibilities for the heat pumps onto the customers (unless the utility opts to provide O&M services for heat pumps in customer buildings).

Considering these factors, as well as the expected importance of cooling to some of the customers expected to occupy the park, and the overall lower cost to develop an ambient temperature system, it is recommended that the project move forward with developing a concept design for an ambient-temperature district energy system for the geothermal business park.



## 5.0 DISTRICT ENERGY CONCEPT DESIGN

### 5.1 Overview

A concept design for the Springhill Geothermal Business Park District Energy System has been created based on an ambient temperature style of system.

Mine water would be withdrawn from the workings by submersible pumps in three extraction wells. Mine water is carried to the energy centre through dedicated HDPE mine water pipes. At the energy centre, the mine water is passed through double wall heat exchangers to transfer thermal energy to or from the district energy water. After heat exchange, the mine water would be returned to the mine workings via three injection wells at various locations around the site.

The energy centre includes pumps and heat exchangers for the DES. The DES pumps circulate clean water through the distribution piping system to each customer building. The heat exchangers allow heat transfer between the mine water and the DES water while maintaining hydraulic isolation.

The distribution piping system (DPS) carries district energy water around the site under the roadways. As lots are subdivided, sold, and built, a service connection will be sized and installed for each lot by hot tapping into the existing mains.

Each customer building will require an energy transfer station (ETS) to transfer energy between the DPS and the customer HVAC and process mechanical systems. An ETS provides an important, clear point of delivery of energy to the customer. The ETS typically includes an energy meter, control valve and heat exchanger.

### 5.2 Mine Water Tie-In

A concept design for three pairs of mine water extraction and injection wells has been developed by geothermal subject matter experts at Falcon Engineering. A technical memorandum describing the geothermal mine water harness evaluation and concept design completed by Falcon is included in [Appendix 2](#).

In summary, the proposed mine water tie-in concept includes a cluster of three 250mm (10-inch) diameter extraction wells to be located near the proposed energy center and drilled into the No. 2 workings haulage slope tunnel. The slope tunnel is expected to be relatively large diameter and capable of supporting the substantial flows required by the three extraction wells. Further, the No. 2 workings were the deepest workings in Springhill and withdrawing mine water from the haulage slope tunnel therefore provides access to the water temperatures available from the deepest workings. Each extraction well would be provided with a submersible well pump with variable speed control capable designed to provide up to 63 L/s (1000 GPM) of mine water flow.



Three injection wells for return of mine water to the workings are proposed to be drilled into the shallower No. 3 mine workings. Approximate locations for the proposed wells have been identified around the site as shown in Figure E of [Appendix 2](#). Vertical separation of extraction and injection wells between the No. 2 and No. 3 seams promotes thermal stability of the geexchange system by providing a longer and more tortuous pathway between injection and supply wells. As noted by Falcon in their report, some anecdotal evidence suggests there is hydraulic connection between the two seams, however this must be confirmed through testing to ensure there is not unstable dewatering of the No. 2 seam. Risk mitigation measures for a dewatering scenario are proposed by Falcon in their memo.

### 5.3 Energy Centre

The concept design includes one energy centre, centrally located, to service the heating and cooling loads of the geothermal business park. A concept schematic and floor plan of the proposed Energy Centre are included in [Appendix 3](#).

The energy centre will house key equipment including heat exchangers and DES pumps. Heat exchangers will be double wall, vented, titanium plate frame type due to the mine water. In addition, the energy centre will include:

- Controls systems for the DES equipment and mine water pumps.
- Water treatment systems to maintain water quality in the DES.
- Mine water gas and debris control systems to filter debris and control the potential releases of dissolved gases that may be present in the mine water. Dissolved gasses can come out of solution as the mine water is raised from a high-pressure environment deep below ground to a low-pressure condition at the ground surface.
- Electrical power systems for the energy centre and mine water pumps including a backup generator.
- HVAC systems for the energy centre.

The energy centre is expected to be a single storey, slab-on-grade building of typical construction. The building is expected to be designed primarily as a functional utility building to house the DES equipment.

The energy centre concept includes DES pumps which operate to provide flow through the DPS and maintain a minimum supply-return pressure differential to all customer ETSs. The energy centre control system operates the mine water pumps on variable speed control to circulate mine water through the heat exchangers as needed to maintain the DES supply temperature within an acceptable range.



### 5.3.1 DES Operating Temperatures

The expected, relatively warm geothermal mine water allows the system to be designed to operate at temperatures above freezing therefor not requiring antifreeze. Based on the analysis of mine water temperatures available at the proposed extraction wells completed by Falcon, mine water is forecasted to be at least 12°C.

Falcon notes that previous work by others indicates mine water temperatures exceeding 15°C may be available. Warmer mine water temperatures would allow warmer DES supply water temperature and improve system efficiency. If mine water temperatures in excess of 15°C were consistently available, it may reduce the number of mine water extraction/injection well pairs required from three to two—saving substantial capital cost.

With assumed 12°C mine water for heating mode (winter) design condition, a minimum DES supply temperature of 10°C can be expected. This design temperature accounts for a 2°C approach across the energy centre heat exchangers. Customer ETSs should be designed to operate with a 5°C delta-T resulting in design, heating mode return temperatures of 5°C.

For cooling mode (summer) design conditions, a relatively warm mine water temperature of 17°C has been assumed. This corresponds to a maximum summer design DES supply temperature of 19°C accounting for a 2°C approach across the heat exchangers.

With mine water between 12-17°C, design DES supply and return temperatures for winter (heating) and summer (cooling) operation are summarized in Table 4.

*Table 4: Expected DES Operating Temperatures*

Season	Mine Water Temperature	DES Supply	DES Return
Winter	12-17°C	10°C	5°C
Summer		19°C	24°C

### 5.3.2 Energy Centre Phased Buildout

The energy centre concept includes multiple, parallel equipment to allow for N+1 redundancy and a phased buildout of equipment. An N+1 redundancy level allows the energy centre to maintain the design service level ('N') with one piece of equipment (i.e. pump, or strainer) down for maintenance or repair.

Using multiple, smaller pieces of equipment allows a phased buildout of the energy centre. This reduces upfront capital cost by delaying some equipment purchases until the loads appear. For the initial



construction it would be recommended to include two heat exchangers, two DES pumps, two mine water extraction wells, and one mine water injection well. In the future, as system load increases, two more DES pumps, one more heat exchanger, one more mine water extraction well, and two more mine water injection wells can be added.

#### **5.4 Distribution Piping System**

The proposed DES is expected to operate at a minimum temperature of 10°C supply (5°C return) in the winter and a maximum temperature of 19°C supply (24°C return) in the summer. System operating temperatures are driven by the available mine water temperature. Because the temperature of the water in the DES is close to ground temperature, there is very little heat loss to the ground. The distribution system piping can therefore be constructed of uninsulated high-density polyethylene (HDPE) pipe. HDPE acts as a partial insulator due to the high wall thickness and the low conductivity of the material.

HDPE piping is relatively easy and low-cost to install. All HDPE pipe joints are thermally welded or flanged to ensure a reliable, watertight system. Pipes are warranted for a 50-year life but, when properly installed, can be expected to last much longer. Because of the low operating temperature and the material properties of HDPE, no expansion loops are required which simplifies system layout and reduces cost compared to steel distribution piping systems.

The DPS pipe will be installed below the frost depth—at similar elevation to water mains. Because the DPS contains no antifreeze, it is important that the pipes remain protected from freezing. Water is a preferred transport medium over an antifreeze solution because of improved thermal transfer properties, lower viscosity, lower upfront and ongoing costs, and lower environmental impact from leaks and spills.

Distribution piping system routing has been coordinated with proposed storm, sanitary, and water main locations to take advantage of efficiencies of using a common trench for some or all utilities. A common trench can reduce installation costs associated with excavation and backfill. While sharing a common trench, minimum Nova Scotia Environment separations must be maintained. The district energy system contains non-potable water and is generally considered to be a pressure-rated wastewater pipe when evaluating clearance requirements to potable water piping. A utility corridor cross section showing the DES and other utilities is included as part of Design Point's concept design package for the business park.

Because of the flexible subdivision plan and uncertain loads at each future lot, a flexible approach to servicing is proposed for the DES. Under this flexible approach, each DES service connection is to be sized and installed in the future at the time of construction of the customer's building. Customers will be required to excavate into the road right-of-way to install their services by hot-tapping into the existing DPS mains. The service connection sizing should be completed based on the customer's load requirement and



the available capacity of the DPS mains. The design of these service connections can be done by the DES Utility operator, based on loads provided by the customer; or done by the customer's engineering team, based on standard details provided by the Utility and subject to review by the Utility's engineer. Care must be taken by the Utility to ensure that hot tapping does not negatively impact the operation of the DES.

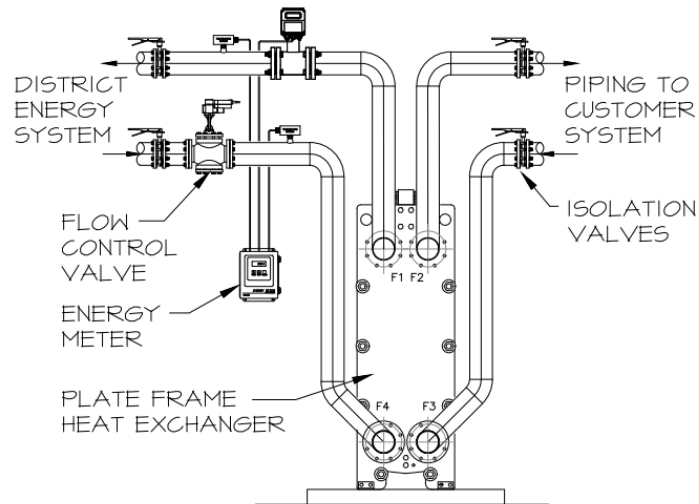
## **5.5 Energy Transfer Stations**

An energy transfer station at each customer site serves as the point at which energy is transferred from the DES to the customer systems. The DES service connection enters the customer building at the ETS. ETSs are generally owned and maintained by the DES utility and form part of the district energy system. An ETS generally includes the following equipment:

- A heat exchanger which allows energy transfer between the DES water and the fluid in the customer's system.
- An energy meter which enables the utility to track energy consumption by the customer for billing and monitoring purposes.
- Control valve(s) to regulate the flow of DES water through the heat exchanger to meet the varying load demands by the customer.
- Related controls and mechanical assemblies.

In some cases, an ETS may not include a heat exchanger, instead allowing direct use of DES water in parts of the customer's system. An example of this may include a central refrigeration plant where the DES water is restricted to a small amount of customer-owned piping and equipment. Eliminating the ETS heat exchanger increases customer system efficiency and saves ETS capital cost, but at the risk of potential contamination of the DES by the customer-owned equipment, and additional piping leakage risk. A risk-benefit analysis should be considered by the utility as part of the detailed ETS design for each customer.

Figure 3: Typical Energy Transfer Station



The ETS equipment is generally located in a room (approximately 10 m<sup>2</sup> in size) provided by the customer within their building. Access to the ETS room is restricted to utility personnel only. A legal mechanism such as an easement, right of way, or bylaw grants the utility operator access across the private land to the ETS room for the purpose of inspecting and maintaining the ETS.

The ETS design is usually completed by the DES utility operator based on loads provided by the customer. Close coordination with the customer's engineering team is necessary to ensure the ETS is correctly designed for the customer's needs.

The capital cost of the ETS can be either paid by the utility or paid by the customer. If the utility pays the upfront cost of the ETS, it must recoup that investment by charging higher rates. If the customer pays the ETS cost, the utility can charge lower rates. A utility financial analysis and preliminary rate design should be completed to compare these options. Proper rate design is imperative to ensure competitive cost of energy, positive business case for both the utility and customer, and equitable sharing of costs across varying customer types. In either case, the utility normally operates and maintains the ETS once constructed.

## 5.6 Customer Building Systems

Every customer building must be designed with heat pumps to provide heating and/or cooling from the DES. Although heat pump-based heating systems often have a higher capital cost than some common, heating-only systems like propane or electric resistance heaters, the fuel cost of an electrically driven heat pump is lower than propane, oil, or electric resistance heat (see Table 5 for a comparison of heating



energy sources). Also, the same heat pump may be operated for cooling in the summer providing added benefit.

Customer buildings should be designed with 'traditional' backup heat sources such as propane boilers or electric resistance heaters to provide supplemental heating on the coldest days of the year as well as backup heat in the event that the DES is offline. These backup systems can be included for relatively low additional cost.

Backup systems can also be designed and operated to provide supplemental peaking energy on the coldest days of the year. This can provide significant reductions in the size and cost of the renewable energy source, DPS, ETS, and customer heat pump system(s). For example, a heat pump sized for only 50% of a building's peak heating load can be expected to deliver 85% or more of the annual heating energy. This common design approach shortens the payback for geothermal energy systems as the capital cost is significantly reduced while still delivering most of the annual energy savings.

Backup systems could be included in the ETS design and owned and operated by the utility or included in the customer building mechanical design and owned and operated by the customer. Many businesses in the park may feel that installing and owning their own backup system is a prudent risk-mitigation strategy.

A selection of possible HVAC systems for the geothermal business park customer types include:

#### *5.6.1 Distributed Heat Pumps*

Water-to-air heat pumps in each space provide heating and cooling by exchanging heat with a piping loop throughout the building. Customer HVAC system includes pumps which circulate fluid between the heat pumps and the ETS. The ETS heat exchanger transfers energy between the DES and the building heat pump loop.

#### *5.6.2 Hot and Chilled Water*

Heating (and/or cooling) is provided for the building from centralized water-to-water heat pumps through a four-pipe heating and cooling hydronic system. Heat pumps are located primarily in a central mechanical room and generate hot (and/or chilled) water for the building HVAC system. The ETS heat exchanger would transfer energy between the DES and the heat pumps in the central mechanical room.

#### *5.6.3 Variable Refrigerant Flow*

A variable refrigerant flow (VRF) system could be installed to provide heating and cooling throughout the building. Condenser units of the VRF system would be water-sourced type and located in a central location near the ETS room. The condenser units would transfer energy with the DES through the ETS.



#### 5.6.4 Process Heating or Cooling Loads

Process loads may include heat pumps or chillers used to produce hot or chilled water for manufacturing, production, cooling, or other process requirements. Data centres or refrigerated warehouses may also fall under this category. Process loads are varied but must be designed to use DES water at 10°C to 19°C as a source of energy to meet their heating or cooling requirements.

## 6.0 ECONOMIC AND ENVIRONMENTAL PERFORMANCE

### 6.1 Energy Sources Comparison

A main driver for the development of the geothermal business park DES is the significant energy cost and greenhouse gas (GHG) emissions savings that can be achieved by using heat pumps and mine water heat recovery. The following table provides a comparison of the energy cost and GHG emissions to deliver a single unit of space heating energy (1 MWh) from the proposed DES and several commonly found heating system types.

Table 5: Nova Scotia Heating Systems Energy and GHG Comparison

	<b>Electric Resistance Heat</b>	<b>Air Source Heat Pump</b>	<b>Propane Unit Heaters</b>	<b>Oil Boiler Heating</b>	<b>Ambient DES HP Heating</b>
<b>Space Heating</b>	1 MWh				
<b>Fuel Source</b>	Electricity	Electricity	Propane Gas	Heating Oil	Electricity/DES
<b>Efficiency</b>	100%	240%	80%	80%	420%
<b>Fuel Use</b>	1.00 MWh Electricity	0.42 MWh Electricity	1.25 MWh Propane	1.25 MWh Fuel Oil	0.24 MWh Electricity 0.76 MWh DES
<b>Fuel Rate (\$/MWh)</b>	\$130	\$130	\$106	\$98	\$130 Electricity
<b>Fuel Cost (\$/MWh delivered heat)</b>	\$130.00	\$54.60	\$132.39	\$121.98	<b>\$31.20</b>
<b>Fuel GHG Intensity (tCO<sub>2</sub>e/MWh)</b>	0.652	0.652	0.215	0.250	0.652 Electricity 0.013 DES
<b>GHG Emissions (tCO<sub>2</sub>e/MWh delivered)</b>	0.652	0.274	0.269	0.312	<b>0.166</b>



The heating option with the lowest fuel input cost and GHG emissions per MWh of space heating delivery is the ambient DES Heat Pump option.

Table 6 provides a comparison of the energy costs and GHG emissions to deliver a single unit of space cooling energy (1 MWh) from a variety of possible cooling system types.

Table 6: Nova Scotia Cooling Systems Energy and GHG Comparison

	<b>Air-Source Heat Pump or A/C</b>	<b>Chiller and Cooling Tower</b>	<b>Ambient DES HP Cooling</b>
<b>Space Cooling</b>	1 MWh		
<b>Fuel Source</b>	Electricity	Electricity	Electricity/DES
<b>Efficiency (EER)</b>	12.5	17	20
<b>Fuel Use</b>	0.27 MWh electricity	0.20 MWh electricity	0.17 MWh Electricity
			1.17 MWh DES
<b>Fuel Rate (\$/MWh)</b>	\$130.00	\$130.00	\$130 Electricity
<b>Fuel Cost (\$/MWh delivered cooling)</b>	\$35.10	\$26.00	<b>\$22.10</b>
<b>Fuel GHG Intensity (tCO<sub>2e</sub>/MWh)</b>	0.652	0.652	0.652 Electricity
			0.013 DES
<b>Total GHG Emissions (tCO<sub>2e</sub>)</b>	0.176	0.130	<b>0.126</b>

Notes: Electricity based on blended general service rate of \$130.00 /MWh  
 DES utility charges for heating energy are not included.  
 Additional savings over a cooling tower system would be available from reduced water usage and chemical treatment costs.

The cooling system option with the lowest fuel input cost and GHG emission per MWh of space cooling delivery is the ambient DES heat pump option, however, this offers only a slight energy cost and emissions savings over a chiller and cooling tower option.

One key advantage of the ambient DES option for cooling is the capital and maintenance cost savings of not having to provide and maintain a cooling tower as part of the customer HVAC system. Potable make up water and chemical treatment costs are eliminated. Customers connected to the DES can use the DES water for heat rejection.



## 6.2 Economic Performance

A 'typical' 5,000 m<sup>2</sup> warehouse has been used to illustrate the potential fuel cost savings of DES versus other common fuel sources. According to Natural Resources Canada 2016 data, the predominant space heating energy sources for warehouses in Atlantic Canada are electricity (40%), natural gas (30%), and light fuel (20%). Given that natural gas is not available in Springhill, electricity and propane have been selected for comparison to DES. Table 7 presents a comparison of fuel use and energy cost for space heating a 'typical' 5,000m<sup>2</sup> warehouse.

Table 7: Example 5,000m<sup>2</sup> Warehouse Annual Heating Fuel Cost Comparison

	<b>Electric Resistance Heat</b>	<b>Propane Heat</b>	<b>Ambient DES HP Heat</b>
<b>Annual Heating Requirement</b>	250 MWh		
<b>Fuel Source</b>	Electricity	Natural Gas	Electricity/DES
<b>Fuel Use</b>	250 MWh Electricity	313 MWh Propane	60 MWh Electricity
			190 MWh DES
<b>Annual Fuel Cost</b>	\$32,500	\$33,178	<b>\$7,800 + DES Charges</b>

Notes: Electricity based on blended general service rate of \$130.00 /MWh  
 Propane based on \$0.75 /L  
 DES utility charges for heating energy are not included.

Using the estimated, combined annual heating load for all customers at full buildout of the business park (from Table 2), a comparison of full business park customer fuel costs with DES versus propane and electricity is provided in Table 8. This full site analysis accounts for the expectation that 10% of the annual heating load would be provided by electric or propane peaking boilers.



Table 8: Full Site Annual Heating Fuel Cost and GHG Emissions Comparison

	<b>Electric Resistance Heat</b>	<b>Propane Heat</b>	<b>Ambient DES HP Heat</b>
<b>Annual Heating Requirement</b>	10,000 MWh		
<b>Primary Fuel Source</b>	Electricity	Propane	DES / Electricity
<b>Fuel Use</b>	10,000 MWh Electricity	12,500 MWh Propane	2640 MWh Electricity 6860 MWh DES 625 MWh Propane*
<b>Annual Fuel Cost</b>	\$1,300,000	\$1,325,000	<b>\$409,500 + DES charges</b>
<b>Premium Over DES</b>	+\$890,500	+\$915,500	--
<b>Annual GHG Emissions (tCO<sub>2</sub>e)</b>	6520	2691	<b>1945</b>

Notes: \*Ambient DES scenario for the full site assumes 10% of annual heating requirement is delivered by backup or “peaking” energy sources including electric resistance heat and propane boilers.  
 Electricity based on blended general service rate of \$130.00 /MWh.  
 Propane based on \$0.75 /L.  
 DES utility charges for heating energy are not included.

As illustrated in the tables above, the DES presents a good opportunity to deliver heating energy at significantly lower annual cost than ‘business-as-usual’ fuel sources. The proposed DES could provide \$900,000 per year in heating energy cost savings for the fully constructed business park.

The above tables do not include the charges levied on customers by the district energy utility operator to provide the DES service. DES rates must be determined as part of a financial analysis for the utility that is considerate of, and balances, the net present value of the DES for both the customer and the Utility. DES rates can vary depending on several factors including:

- Who pays for ETS infrastructure (the utility or the customer)?
- Is the energy rate based on a variable, fixed, or hybrid rate structure?
- What is the desired rate of return for the utility?
- What operation, maintenance, and replacement responsibilities will the utility provide?
- And what financial metrics will govern the utility operation?



These questions should be answered in conjunction with preparation of a business case and revenue forecast for the utility that will own and operate the DES.

### **6.3 Environmental Performance**

Mine water heat recovery is a carbon-neutral energy source. It requires only a small amount of pumping electricity to access and provide a large quantity of ambient temperature energy to customers. The DES energy therefore has a very low carbon intensity per MWh of delivered 'ambient' heat. Most of the carbon emissions associated with ambient temperature DES are generated by the consumption of electricity at the customer-level to operate the heat pump systems. Because a heat pump using mine water operates with a COP of 4.2 or higher, it uses less than one quarter of the electricity of a comparably sized electric resistance heater. As presented in Table 8 above, the DES option can provide GHG emissions savings of 30% to 70% compared to 'business-as-usual' heating system options.

### **7.0 CAPITAL COST**

A capital cost estimate for the design and construction of the DES has been prepared and is provided in Table 9 below. The DES cost estimate includes direct costs for construction of the mine water tie-in wells with well pumps; the energy centre building with DES equipment; and the distribution piping system under the roads. The cost estimate includes all initial and future installed energy centre equipment and mine water tie-in wells needed for the estimated full site loads. The utility may choose to delay the installation of some energy centre equipment and mine-water tie-in wells to reduce upfront capital costs and allow future flexibility in the design.

Indirect costs for engineering consulting services and owner's overhead and project management are included.

Capital cost estimates are provided to a Class D level of accuracy (-20% to +30%). A Class D estimate is appropriate at this conceptual design stage and can be refined as the project progresses to detailed design stage. Capital costs reflect equipment sizing which is based on the estimated energy loads from the expected future park customers.

Contingency is not included in the capital cost estimates presented below. Recommended contingency is provided for each system in the detailed capital cost breakdowns in the appendix. Mine water tie-in wells cost includes an allowance (contingency) for the likely need to drill additional mine water tie-in wells due to an anticipated 1 in 3 failure rate of drilling non-productive wells.

A detailed breakdown of capital cost estimates is provided in [Appendix 5](#).



Table 9: DES Capital Cost Estimate

<b>Systems / Components</b>	<b>(\$'000)</b>
1. MINE WATER TIE-IN WELLS & PUMPS	\$2,490
2. ENERGY CENTRE	\$2,180
3. DISTRIBUTION PIPING SYSTEM	\$2,700
<b>TOTAL</b>	<b>\$ 7,370</b>

Service connections and energy transfer stations are expected to be constructed in the future as the customer buildings are built. As such, ETS costs are presented separately from the costs for other utility infrastructure. A capital cost estimate for a 'typical' ETS and service connection for a 'typical' 5,000 m<sup>2</sup> warehouse has been prepared. The ETS cost includes the ETS heat exchanger, energy meter, piping and controls. The service connection includes trenched HDPE service pipes, curb stop isolation valves, excavation into the road, hot tapping into the existing mains, and surface restoration. Costs for this 'typical' ETS were scaled across the full site floor area to develop ETS cost estimates for the full site. Full site ETS and service connection costs are presented in Table 10.

Table 10: ETS and Service Connection Capital Cost Estimates (Full Site)

<b>Systems / Components</b>	<b>(\$'000)</b>
4. ETSs (FOR 34 LOTS)	\$ 1,620
5. SERVICE CONNECTIONs (FOR 34 LOTS)	\$ 1,780
<b>TOTAL</b>	<b>\$ 3,400</b>

Combined, the total installed cost of the DES including utility infrastructure and customer service connections and energy transfer stations is estimated at **\$10.77 million**.



## 8.0 RECOMMENDATIONS AND NEXT STEPS

This design brief has been prepared to document the recommended design strategy and provide a capital cost estimate for the proposed Geothermal Business Park District Energy System. As next steps, we recommend Cumberland Energy Authority to undertake the following:

- Prepare a business case analysis for the proposed district energy system for the Geothermal Business Park. A well-designed business case will consider all the revenue and expenses of the DES utility operator over a 25 year timeframe. Factors to be considered in the business case analysis should include:
  - Year by year revenue from energy sales as the business park grows
  - Utility operating and maintenance costs, including overhead
  - Utility energy purchases
  - Schedule of capital expenditures by year including capital replacements
  - Depreciation and debt servicing expense
  - Expected return on investment
- As part of a business case analysis, develop a rate structure that meets the revenue requirements of the utility. Utility rates should be compared with business-as-usual energy rates to determine the annual energy savings that could be expected by customers.
- Decide whether the utility will pay for, install, own, and/or operate the customer energy transfer stations and service connections. Various combinations are possible with advantages and disadvantages of each. The decision often depends on the availability of capital financing, system operator experience and resources, project objectives, and customer needs. Whichever ETS ownership path is chosen, an equitable method for ETS capital cost recovery should be accounted for in the rate design.
- To further improve the business case for the DES, consider opportunities to connect the DES to service nearby existing buildings such as Ropak Packaging or the Dr Carson and Marion Murray Community Centre. These sites with existing mine water systems may benefit from increased access to mine water energy and improved water quality available through the DES.
- The planned future Main Street DES Feasibility Study should consider interconnection with the Geothermal Business Park DES.
- It was noted that the wastewater treatment lagoon is in the vicinity of the proposed business park. Ambient temperature DES is well suited to wastewater heat recovery. The opportunity to



supplement mine water heat recovery with wastewater heat recovery should be screened for integration into the DES design.

- As recommended by Falcon in their memo, consider conducting pumping tests on the two deep wells (constructed in 2018) while monitoring the response in the other deep well and surrounding shallow wells. Pumping tests would provide valuable data on mine water temperatures and hydraulic connectivity between the No. 2 and No. 3 seams.

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Template: Master Report Template, HO, March 15, 2019

**APPENDIX I**

**Lot Sizes Comparison Table**

Client  
Project #  
Project Name  
Sheet Description

Cumberland Energy Authority  
0243394.000  
Springhill Geothermal Business Park DES  
Lot Sizes Comparison

Author AB / NF  
Revision 1  
Update Date 16-Dec-19



Business	Building Use	Location	Lot Size (m <sup>2</sup> )	Lot Size (acres)	Building Size (m <sup>2</sup> )	Building Size (ft <sup>2</sup> )	Lot Coverage (%)	Heating/Cooling Requirements	Process Energy Use	Lot Depth (m)
Nova Cold Logisitcs	Warehouse	Burnside NS	20,000	4.9	5,720	61,570	28.6%	High Cooling	Low	180
Stokdijk Greenhouses	Agriculture	Truro NS	70,000	17.3	22,285	239,874	31.8%	High Heating	Low	240
Kent Distribution Center	Warehouse	Moncton NB	140,000	34.6	33,625	361,936	24.0%	Moderate Heating	Low	270
Loblaws Freezer Building	Warehouse	Moncton NB	50,000	12.4	13,100	141,007	26.2%	High Cooling	Low	220
Burnside Lots	Various	Burnside NS	12,000	3.0	4,920	52,958	41.0%	Moderate Cooling	Low	135
Atlantic Can (Grow Facility)	Agriculture	Bedford, NS	20,000	4.9	5,070	54,573	25.4%	High Heating	High	100
Wonder	Agriculture	Amherst, NS	20,000	4.9	4,675	50,321	23.4%	Moderate Heating/Cooling	High	100
LED Roadway	Manufacturing	Amherst, NS	40,000	9.9	5,220	56,188	13.1%	Moderate Heating	Low	150
Fed Ex Ground	Transportation Services	Moncton NB	22,000	5.4	2,850	30,677	13.0%	Moderate Heating/Cooling	Low	170
McKesson Distribution Center	Warehouse	Moncton NB	44,000	10.9	16,300	175,452	37.0%	Moderate Heating	Low	230
Armour Logistics	Transportation Services	Moncton NB	62,000	15.3	33,620	361,883	54.2%	Moderate Heating	Low	200
Maritime Paper	Manufacturing	Burnside NS	35,410	8.7	16,500	177,605	46.6%	Moderate Heating	High	150
Midland Logistics	Transportation Services	Burnside NS	25,090	6.2	2,200	23,681	8.8%	Moderate Heating	Low	150
Fastfrate Logistics	Transportation Services	Burnside NS	63,780	15.8	6,250	67,274	9.8%	Moderate Heating	Low	300
Ropak Packaging	Manufacturing	Springhill NS	33,140	8.2	12,800	137,778	38.6%	High Cooling	High	165
Surette Battery Company	Manufacturing	Springhill NS	62,200	15.4	5,582	60,084	9.0%	Moderate Heating	High	160
Maritime Pride Eggs	Agriculture	Amherst, NS	28,450	7.0	3,400	36,597	12.0%	High Heating	High	170
Agropur Cooperative (Farmers Milk)	Agriculture	Bedford, NS	92,000	22.7	11,300	121,632	12.3%	Moderate Heating	High	300
<b>Average Size</b>			<b>46,671</b>	<b>11.5</b>	<b>11,412</b>	<b>122,838</b>	<b>25%</b>			<b>188</b>

**Business Park Building Size Estimates**

Developable Land Area	76.1 Ha	From Concept Design
Expected Lot Coverage	20%	Midpoint of DesignPoint's analysis
Expected Floor Area Ratio	0.22	Accounting for 10% of buildings area being two-storey
<b>Total Park Buildings Floor Area</b>	<b>167,420 m<sup>2</sup></b>	

**APPENDIX II**

**Minewater Evaluation Tech Memo – Falcon Engineering**

## TECHNICAL MEMORANDUM

**TO:** Neil Fougere, P.Eng.; DesignPoint Engineering & Surveying Ltd.  
Andrew Byrnes, P.Eng.; Pinchin Ltd.

**FROM:** Jeff Quibell, P.Eng. Falcon Engineering Ltd.

**DATE:** 18 March 2020

**SUBJECT:** **GEOTHERMAL MINEWATER HARNESS EVALUATION  
SPRINGHILL BUSINESS PARK  
SPRINGHILL, NOVA SCOTIA**

**PROJECT No.:** 19148.001

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### 1.0 INTRODUCTION

Large-scale mining in the Springhill Collieries began in the 1870s and extracted millions of tonnes of coal until 1958 when mining operations abruptly ceased following an enormous and deadly rock burst in the lower depths of the No. 2 mine on October 23, 1958.

With mining ceased, dewatering of the mineworkings was stopped and the workings filled with water. The water residing in the mineworkings (referred henceforth as *minewater*) can be harnessed for geothermal heat and cooling), and indeed small commercial-scale application of minewater geothermal was developed in the late 1980s in Springhill.

The mineworkings are extensive. Several different seams were worked through the mining era. The No. 2 Seam was the most extensively mined with the workings extending downslope over 4,000 m along the dip angle of the coal-bearing strata, with the deepest of the outer workings at approximately 1,200 m below the ground surface. These workings are unique in that they are some of the deepest coal workings in all of North America and among the deepest in the world at the time.

The condition of the workings is largely unknown. Over time, the underground workings inevitably collapse leading to the loss of some void openings and also leading to loss of connectivity of void openings.

### 2.0 OBJECTIVES

Objectives of the analysis:

- Review information relating to minewater temperature
- Consider amount of minewater extraction flow required to serve prescribed heating/cooling loads

- Identify suitable minewater extraction and injection well locations
- Consider needs for lateral and/or vertical separation of points of extraction and injection
- Consider construction configuration of extraction and injection wells
- Consider cost of minewater harness system

### **3.0 FUNDAMENTALS**

There are a variety of different types of geothermal heat exchange systems. The most suitable type for minewater heat harnessing is the open-loop type well system.

#### **3.1 Open-Loop Type Well Systems**

Open-loop well systems adapted to a minewater application extract minewater from the subsurface workings by way of extraction wells, then pass the water through a heat exchanger at the surface (in the Energy Centre Building in this case) for transferring heat from the minewater in heating mode (or to the minewater in cooling mode) and then the minewater is returned back to the subsurface workings by way of injection wells.

In this manner the water is circulated through the system. If the volume of the water circulated in the system is very large and the mass of the host rock that the water is in encapsulated within is very large, then the heat exchange can be sustained on an ongoing basis.

#### **3.2 Springhill Setting**

Despite there being an enormous amount of water present in the Springhill mineworkings, only a very small fraction of the water is realistically available for reliable and cost-effective circulation through a geothermal heat exchange system.

If the mineworkings were flat-lying and present at a shallow depth throughout, then the minewater extraction could occur with wells placed at one end of the workings and the injection could occur at the other end of the mineworkings. In this manner, most, if not all, of the overall minewater volume and the entirety of the mass of the host rock that encapsulates the minewater would be available to exchange heat with the geothermal system and hence the system capacity would be enormous.

However, the Springhill mines are not flat-lying with most of the body of the mineworkings lying at considerable depth below the ground surface. The mineworkings dip to the northwest at dip angles varying from about 30 degrees in the upper 100 to 200 m and dipping more gently at a dip angle of less than 15 degrees at deeper depths. Thus, the depth to the workings becomes quite deep with outward lateral northwest distance (up to 1.2 km below ground surface at outer extent of the workings).

While wells could be drilled to the outer extent of the mine, several factors combine to discourage the need for positioning wells at the outer extent:

- Costs mount and risks increase to drill to depths greater than 500 m and certainly over 1,000 m (particularly since there is no certainty that a well drilled at any given location will encounter open and well-connected voids within the workings).

- The outermost extent of the mine exists well beyond the perimeter of the business park footprint. Thus, access arrangements, easements, and additional pipeline construction would be required to establish and serve such wells.
- The business park heating/cooling loads are expected to be satisfactorily served by harnessing minewater from a much smaller fraction of the available mineworkings. The enormous full extent of the mineworkings are not required for serving the scale of anticipated business park heating and cooling loads.

#### **4.0 PERFORMANCE SUSTAINABILITY**

Performance sustainability is considered in terms of *thermal stability* (the ability to operate within an acceptable envelope of source supply/return temperatures) and *hydraulic stability* (the ability to sustainably manage water production and water levels at extraction and injection wells).

##### **4.1 Thermal Stability**

The ability of the system to sustainably serve the heating and cooling demands placed upon it is a function of:

- The heating and cooling load profile placed upon the system:
  - The relative balance of heat removed from the mineworkings in winter heating relative to the amount of heat rejected to the mineworkings in summer cooling promotes better sustainability because the heat withdrawn in winter is replenished in summer.
- The volume of minewater in hydraulic circulation between the extraction and injection wells:
  - More volume provides greater thermal mass of minewater and greater thermal stability buffer.
- Tortuosity of the subsurface flow pathways through the mineworkings from injection wells back to the extraction wells:
  - The more tortuous the path, the longer the flow distance and the more mass of host rock that the circulating minewater is in thermal connection with.
  - The more tortuous the path, the more likely that water has opportunity for multiple different flowpaths on journey from injection wells back to extraction wells, leading again to more mass of host rock that the circulating minewater is in thermal connection with.

##### **4.2 Hydraulic Stability**

The ability of the system to maintain adequate water availability at extraction wells, while avoiding troublesome mounding of rejected water at the injection points. For most open-loop systems this usually requires that extraction wells are in direct hydraulic connection with the injections wells.

It is worthy of note that conditions that favour more certain hydraulic stability (such as close spacing between extraction wells and injection wells in the same saturated water zone) act to reduce the thermal stability. Open-loop design configurations typically aim to balance enough thermal sustainability without compromising hydraulic sustainability.

## 5.0 INFORMATION AVAILABLE FOR REVIEW

The following relevant information was provided by the project steering committee for review:

- **Report – Mine Workings Spatial Review and Deep Well Test Boreholes – Springhill, Nova Scotia**, CBCL Consulting Engineers, March, 2018; (CBCL, 2018)
- **Springhill Geothermal Energy Use Study**, Efficiency One Services, July 2017; (Efficiency, 2017)
- **Researching the Geothermal Potential of the Former Springhill Mine**, Post Doctoral Fellow Geophysical Mapping; Verschuren Centre for Sustainability in Energy and the Environment; (provided without appendices - request for appendices unmet); (Verschuren, 2015)
- **Springhill Geothermal Project – Preliminary Report**, Hy-Grade Geoscience, January 2004; (Hy-Grade, 2004)
- **Springhill Mine Water Geothermal**, Presentation Prepared by Brian Herteis for Presentation at CEA Symposium, undated file
- Geographic referenced information, including mine layouts of No. 2 and No. 3 mines superimposed on base-mapping, and structure contours of No. 2 and No. 3 seams; provided by DesignPoint Engineering and Surveying Ltd.
- Unbound charts showing water temperatures and water levels in various wells with descriptive contextual information or interpretation discussion.
- Unbound informal information regarding two deep wells installed in 2018, without lithology logs or well completion logs.
- General information about past and current plans for business park development.

In addition to this information, Falcon Engineering sought additional formal information, to provide additional contextual information regarding the mineworking setting and potential geothermal harnessing attributes:

- **Clean Energy from Abandoned Mines at Springhill, Nova Scotia**, ALAN M. JESSOP, JACK K. MACDONALD & HOWARD SPENCE (1995) Energy Sources, 17:1, 93-106, DOI: 10.1080/00908319508946072; (Jessop, 1995)
- **Rock Mechanics Analysis of Springhill Mine Disaster (October 23, 1958)**; K.R. Notley, Queen's University Mining Engineering Dept., Kingston, Ontario, July 1983 (Notley, 1983)
- **Geothermal Energy from Abandoned Mines: A Methodology for an Inventory, and Inventory Data for Abandoned Mines in Quebec and Nova Scotia**; Geological Survey of Canada; Open File 3825; K. Arkay, 2000 (Arkay, 2000)

Two reports were provided late in the information review process following request by Falcon for information relating to any prior pumping tests performed:

- **Town of Springhill Geothermal Demonstration Project; Report on Test Drilling and Pumping Test Results**; Project No. 4215; Jacques Whitford and Associates Ltd., Sept, 1987 (Jacques, 1987)

- **Town of Springhill Geothermal Demonstration Project (Phase 2); Report on Production Wells 8, 9, 10; Surrrette Battery Co. Ltd., Springhill, Nova Scotia;** Ralph Ross, Project Site Coordinator, Town of Springhill Geothermal Committee, March, 1989 (Town of Springhill, 1989)

## 6.0 ANALYSIS

### 6.1 Loads

Heating/cooling loads referenced as Energy Centre plant loads (heat exchanged from or to the minewater) was provided by Pinchin and is included below:

- **Heating (transferred from minewater)**
  - Peak Heating: 4638 kW
  - Annual Heating: 5759 MWh
- **Cooling (transferred to minewater)**
  - Peak Cooling: 3589 kW
  - Annual Cooling: 6655 MWh

### 6.2 Minewater Source Temperatures

The amount of minewater flow required to deliver prescribed heat at the Energy Centre is directly related to the temperature of the minewater. Previous work conducted by others (Jacques, 1987), (Town of Springhill, 1989), and (Jessop, 1995) suggest minewater at temperatures exceeding 14 to 15°C is expected to be available.

A minewater temperature plot was provided to us for reference review (however, without interpretive discussion). It is included here as Figure A. The plot shows that two deep wells apparently constructed in 2018 appear to exhibit unusually cool temperatures (between 8 and 9°C in both of the wells at a depth of 200 m. In discussion with Brian Herteis (representative of Cumberland Energy Authority), we understand there is a belief that the unusually cool minewater temperatures measured in these wells may be due to mixing with upper cooler groundwater that may be migrating down the well bore (pers. Comm Brian Herteis, August 14, 2019). We understand the upper, cased interval of the well was not securely sealed with an annular grout to prevent migration of the cooler groundwater on the outside of the casing.

From the balance of information available for review we infer that the minewater temperatures measured in the two new deep wells are perhaps not reflective of the temperature available with a more methodical well construction with adequately sealed casing to prevent mixing with the upper cooler water.

For purposes of this analysis we infer source minewater temperature of 12°C is available.

### 6.3 Minewater Flow Demand

Calculations are based on the following parameters:

- Incoming minewater source temperature: 12°C
- Minimum leaving temperature: 5°C  
(allowing minimum temperature on load side of heat

- exchanger to maintain 4°C to avoid antifreeze)
- Peak heating load: 4638 kW

At these parameters, a minewater flow of 159 L/sec (2513 USgpm) is required.

If it is assumed that 10-inch diameter extraction wells are to be installed and each of the wells intersects open well void with ample available water, then the diameter constraint of the submersible well pump will limit the available pumping capacity from each well to approximately 63 L/sec (1000 USgpm). Therefore, to produce 159 L/sec, at least 3 extraction wells are expected.

## 6.4 Minewater Harness Configurations

### 6.4.1 Extraction Wells

The dipping coal strata favoured the development of main “slope tunnel” access into the each of the mine seams as shown on the structure contour figures for the No. 2 Seam Mine in Figure B and the No. 3 Seam Mine in Figure C. These main slope tunnels likely accommodated twin mine haulage railway line access for transporting coal from the depths of the mine. These haulage slope tunnels are considered the most favourable location to extract minewater. Since the No. 2 mine was the deepest and most extensive of the mines, the No. 2 haulage slope tunnel is targeted for minewater extraction.

Since the tunnel is expected to be relatively large diameter (sufficient to accommodate a double tracked narrow gauge railway), and expected to be able to support significant flow relative to the capture flow of an intersecting well, the extraction wells are expected to be suitable for clustering in close proximity as shown in Figure D.

### 6.4.2 Injection Wells

The location of the injection wells is shown in Figure E and shown to penetrate into the shallower No. 3 mineworkings.

The rationale for penetrating the No. 3 workings for the injection wells is described in the context of *Performance Sustainability* as introduced in Section 4.0:

- *Thermal Stability* is more likely to be served by the separating the extraction from No.2 Seam and the injection to the No. 3 seam, because the vertical separation in addition to the lateral separation of the extraction and injection points will promote a longer and more tortuous pathway between injection and extraction positions.
- *Hydraulic Stability* is more likely to be compromised by injecting to a different seam than the extraction occurs. While there is some anecdotal suggestion of hydraulic connection between the No. 2 and No.3 seams, it does not seem assured. It is therefore possible that injection to the No. 3 zone could result in hydraulic separation which could cause unsustainable dewatering of the No. 2 Seam extraction wells to occur and/or could lead to unsustainable rise in water levels in the No. 3 Seam injection wells (leading to possibility of undesired performance or flooding concerns).

### 6.4.3 Thermal Stability Calculations

Calculations were carried out to determine the subsurface pathway distance required to support adequate minewater heat exchange to support the prescribed loads. A cylindrical source mathematical heat exchange model was developed as described in Attachment 2. For model simplification purposes, it is based on stated conservative assumptions. With these assumptions, if the heat exchange were to occur in a linear direct-path single channel (such as the main haulage slope tunnel, a subsurface separation pathway distance of over 11,000 m would be required between injection and extraction wells to maintain thermal stability. This calculated result leads initially to favour constructing the injection wells to penetrate into the No. 3 Seam.

However, if the path is sufficiently tortuous, or if the water has opportunity to travel by multiple separate pathways (in and around room and pillar arrangements, for example), then the effective pathway distance is much greater than the linear separation distance between injection and extraction wells. Considering that the calculations are based on conservative assumptions and recognizing that the effective pathway distance is likely many times greater than the linear separation distance, injection well penetration to the No. 2 Seam should not be discounted.

### 6.4.4 Option to Extend Injection Wells

The injection wells can be constructed so that they can be deepened if necessary at a future date. In this manner they can be constructed to penetrate only into the shallower No. 3 Seam initially. Then, if hydraulic stability concerns occur after testing, or in the future during use, the wells could be subsequently deepened to penetrate into the lower No. 2 Seam.

### 6.4.5 Staging Considerations

The buildout of the business park will likely occur over time and it is unlikely that the full minewater exchange capacity will be required immediately at system development. Accordingly, it is prudent to build out the system one pair at a time, with a single extraction/injection well pair at the first stage and then building out the remaining pairs as necessary with the design and configuration of the wells informed by the actual performance of the initial well pair.

## 7.0 WELL CONSTRUCTION CONSIDERATIONS

We currently interpret that future wells need to be constructed more carefully than the 2018 deep wells, with adequately sealed casing in critical zones to avoid mixing of cooler water into the well bores. Factors that warrant consideration:

- Casing and grouting:
  - The upper overburden zones (above the bedrock) and fractured zones or coal seams that occur in the upper bedrock zone require adequately sealed surface casing to preserve the grade of the geothermal resource.
  - Careful and methodical installation of the casing and grout sealing of the casing can add considerable cost.
  - Grout seals using bentonite or cementitious grout (neat cement) may be required to adequately seal the casing.
  - The grout seal may require installation by the “Halibuton displacement method” for adequate seal.

- Diameter:
  - Extraction and injection wells should be at least 10-inch service diameter or greater. The cost for each increment of diameter from 8 to 10 inch, and from 10 to 12 inch is significant but the larger diameter wells are more versatile for larger pumps and serviceability.
- Dry-hole gamble:
  - The reviewed reports including (Jacques, 1987) and (Town of Springhill, 1989) indicate that there is no certainty that a drilled well will encounter open void of the mineworkings. The room and pillar mining method inherently implies that some of the coal was left behind to act as “pillars” to keep the mineworks from collapsing. It is likely prudent to count on 1 in 3 drilled wells not encountering open mine void and to be unusable.

## **8.0 WELL INSTALLATION COST**

The appropriate design for deep wells has not yet been proven. The needs for casing and seal installation and the dry-hole ratio will directly affect construction cost. Cost will vary by 20 to 50% or more based on what proves to be necessary for adequate construction.

For wells up to 800 feet deep we have provided guidance to Pinchin which is reflected in cost tables presented in the main body of their report. Following is a summary of information provided:

- Each 10-inch diameter well is expected to cost approximately \$100,000 per well to depths up to 244 m (800 feet):
  - Cost will be largely determined based on length of casing required and the measures required to seal the annulus on the outside of the casing
  - Properly installed and sealed casing will be crucial to avoid mixing of shallow cool groundwater with warmer minewater
  - Pressure grouting the annular seal with cementitious grout will likely be required – no evidence this was done on any previous wells
  - Properly installed and sealed casing can be expensive and needs to adapt to conditions actually encountered
  - Thermal mixing due to poor casing seals is a documented problem that has occurred on previous wells
  - 2 out of 3 wells may be useful (i.e., 1 out of 3 may encounter pillars or collapsed workings that may impair their usefulness)
  - There is documented information indicating previous wells have encountered conditions that have rendered them unusable
- Surface completions for each well: \$35,000 per well including spooled pitless adaptor, and tubing and connection to pipeline
- Submersible Well Pump: \$80,000 per pumping well
- VFD and power filter: \$30,000 per pumping well

## **9.0 WELL TESTING**

There is no information to suggest that the two deep wells installed in 2018 have been subjected to pumping tests. Pumping of both wells should be carried out separately at the maximum sustainable

rate that can be pumped from each well, while monitoring the response in the other deep well and the other shallower surrounding wells. Among the objectives, the pumping tests might indicate that the cool water column in these wells under static conditions might be overcome during dynamic pumping where new water is lifted into the well bore from depth.

Cost for this type of pumping test typically varies upward from \$20,000 depending on the specific prescribed scope.

## **10.0 LIMITATIONS OF THE ANALYSIS**

This analysis is limited in the refinement of its findings for three reasons:

- While there is a lot of relevant information and data available, much of it has not been digested nor integrated and interwoven with other information in a formal manner. Project outcomes would be well served with the preparation of a formal compendium of relevant information. We continued to discover critical information of various sorts through the execution period of this scope. There's likely additional information that would be beneficial for incorporation into this analysis that we've not identified.
- Carefully detailed documentation of the 2018 deep well construction, including detailed foot-by-foot lithologic log and detailed well completion logs showing precise well construction configuration, materials used, and quantities used in addition to any unusual observations or troublesome encounters was not available for review. This is critically important information that would have provided benefit to the outcome this analysis.
- The information about the mines and the related infrastructure that Mr. Brian Herteis obviously possesses is tremendously valuable. More of the information that he possesses should be formally recorded and integrated into a compendium of relevant information. Unfortunately, our request to travel to Springhill and spend two full days with Mr. Herteis including walking the sites, reviewing mine archives, and reviewing documents together was ungranted. While we appreciate the input we received from Mr. Herteis by telephone, the analysis and findings presented in this report would certainly have benefited from a closer and more direct association with Mr. Herteis.

## **ATTACHMENTS:**

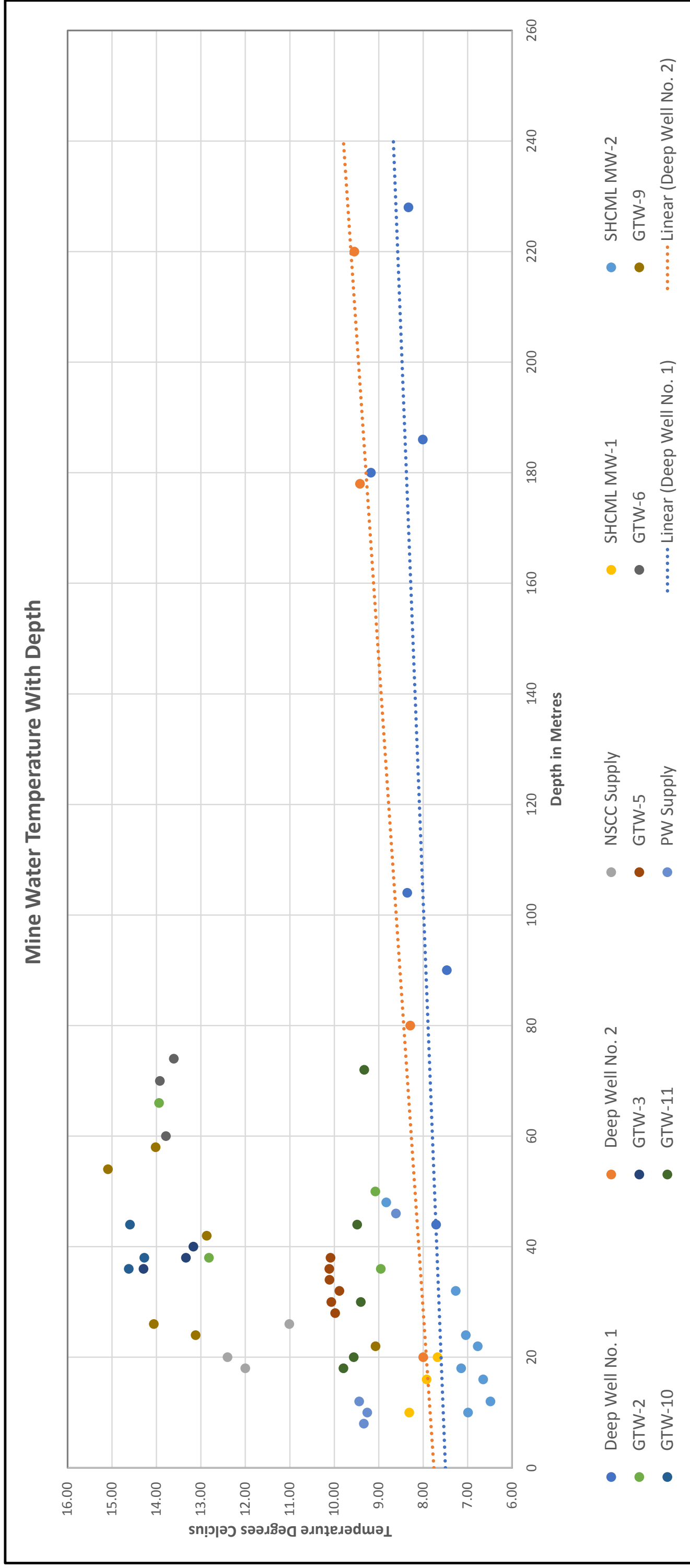
Attachment 1: Figures

Attachment 2: Cylindrical Source Heat Transfer Mathematical Model

# Attachment 1

## Figures

# Figure A



**No. 2 Seam Structure Contours**  
Contours denote elevations relative to mean sea level  
(Information provided and not independently verified)

**Figure B**



### No. 3 Seam Structure Contours

Contours denote elevations relative to mean sea level  
(Information provided and not independently verified)

## Figure C

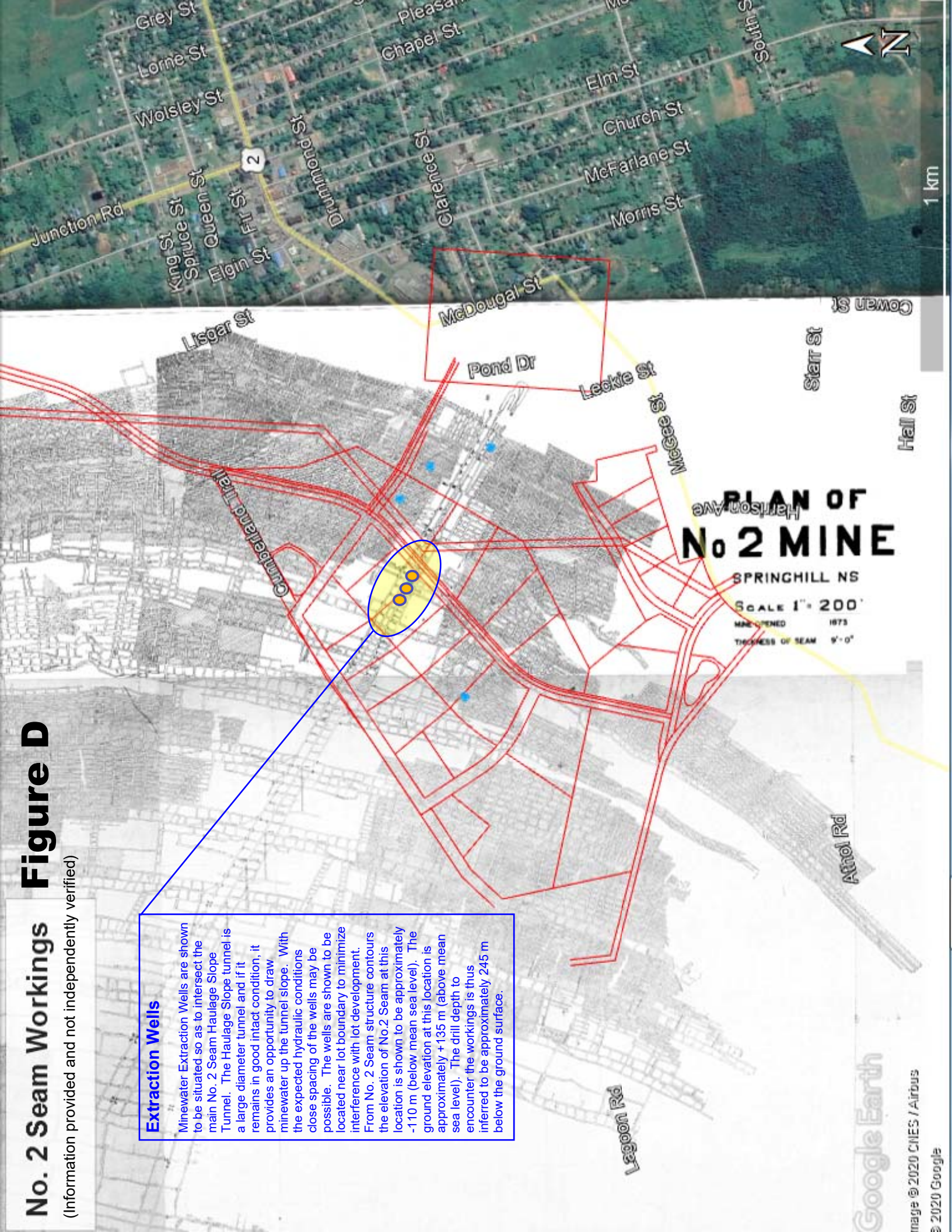


# No. 2 Seam Workings

(Information provided and not independently verified)

## Extraction Wells

Minewater Extraction Wells are shown to be situated so as to intersect the main No. 2 Seam Haulage Slope Tunnel. The Haulage Slope tunnel is a large diameter tunnel and if it remains in good intact condition, it provides an opportunity to draw minewater up the tunnel slope. With the expected hydraulic conditions the close spacing of the wells may be possible. The wells are shown to be located near lot boundary to minimize interference with lot development. From No. 2 Seam structure contours the elevation of No.2 Seam at this location is shown to be approximately -110 m (below mean sea level). The ground elevation at this location is approximately +135 m (above mean sea level). The drill depth to encounter the workings is thus inferred to be approximately 245 m below the ground surface.



# No. 3 Seam Workings

# Figure E

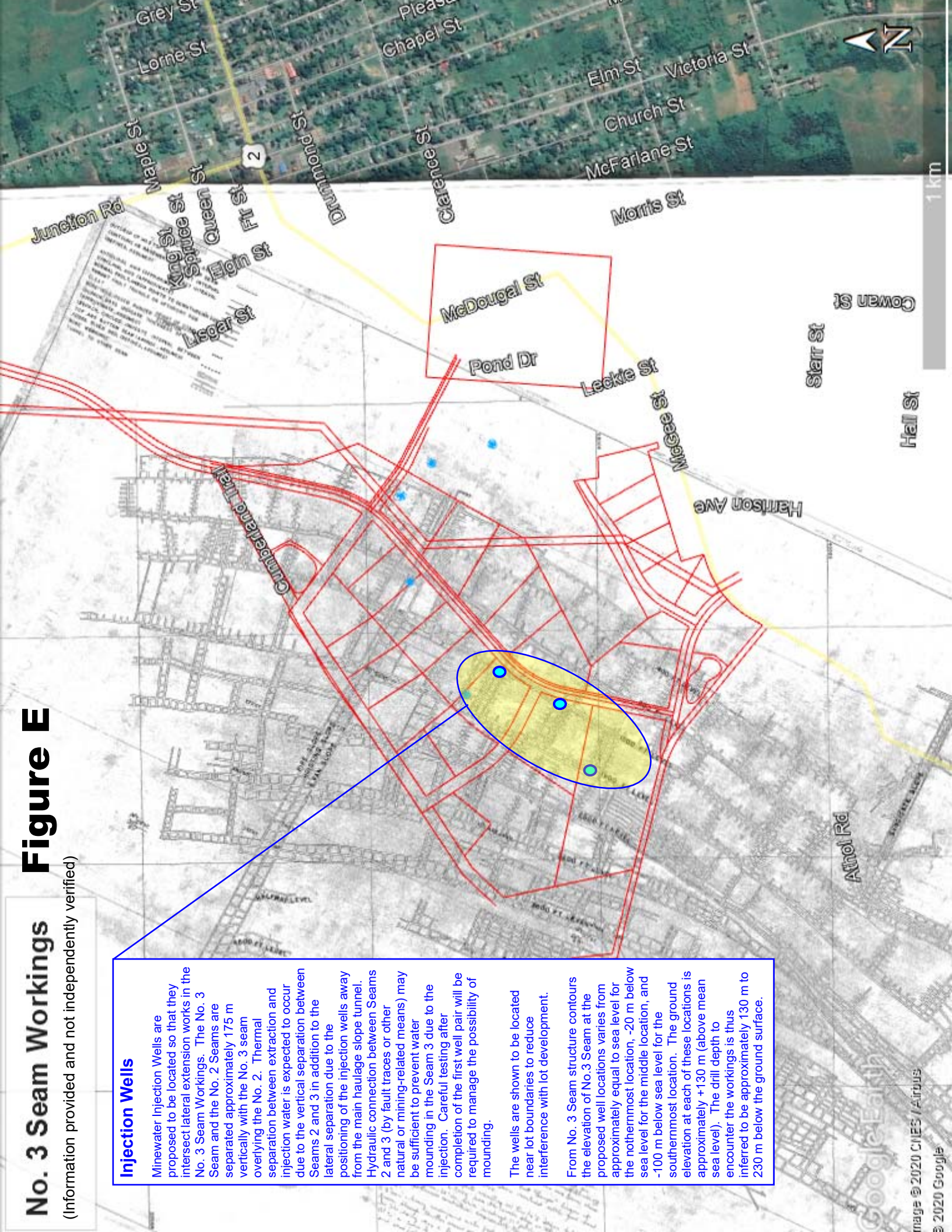
(Information provided and not independently verified)

## Injection Wells

Minewater Injection Wells are proposed to be located so that they intersect lateral extension works in the No. 3 Seam Workings. The No. 3 Seam and the No. 2 Seams are separated approximately 175 m vertically with the No. 3 seam overlying the No. 2. Thermal separation between extraction and injection water is expected to occur due to the vertical separation between Seams 2 and 3 in addition to the lateral separation due to the positioning of the injection wells away from the main haulage slope tunnel. Hydraulic connection between Seams 2 and 3 (by fault traces or other natural or mining-related means) may be sufficient to prevent water mounding in the Seam 3 due to the injection. Careful testing after completion of the first well pair will be required to manage the possibility of mounding.

The wells are shown to be located near lot boundaries to reduce interference with lot development.

From No. 3 Seam structure contours the elevation of No. 3 Seam at the proposed well locations varies from approximately equal to sea level for the northernmost location, -20 m below sea level for the middle location, and -100 m below sea level for the southernmost location. The ground elevation at each of these locations is approximately +130 m (above mean sea level). The drill depth to encounter the workings is thus inferred to be approximately 130 m to 230 m below the ground surface.



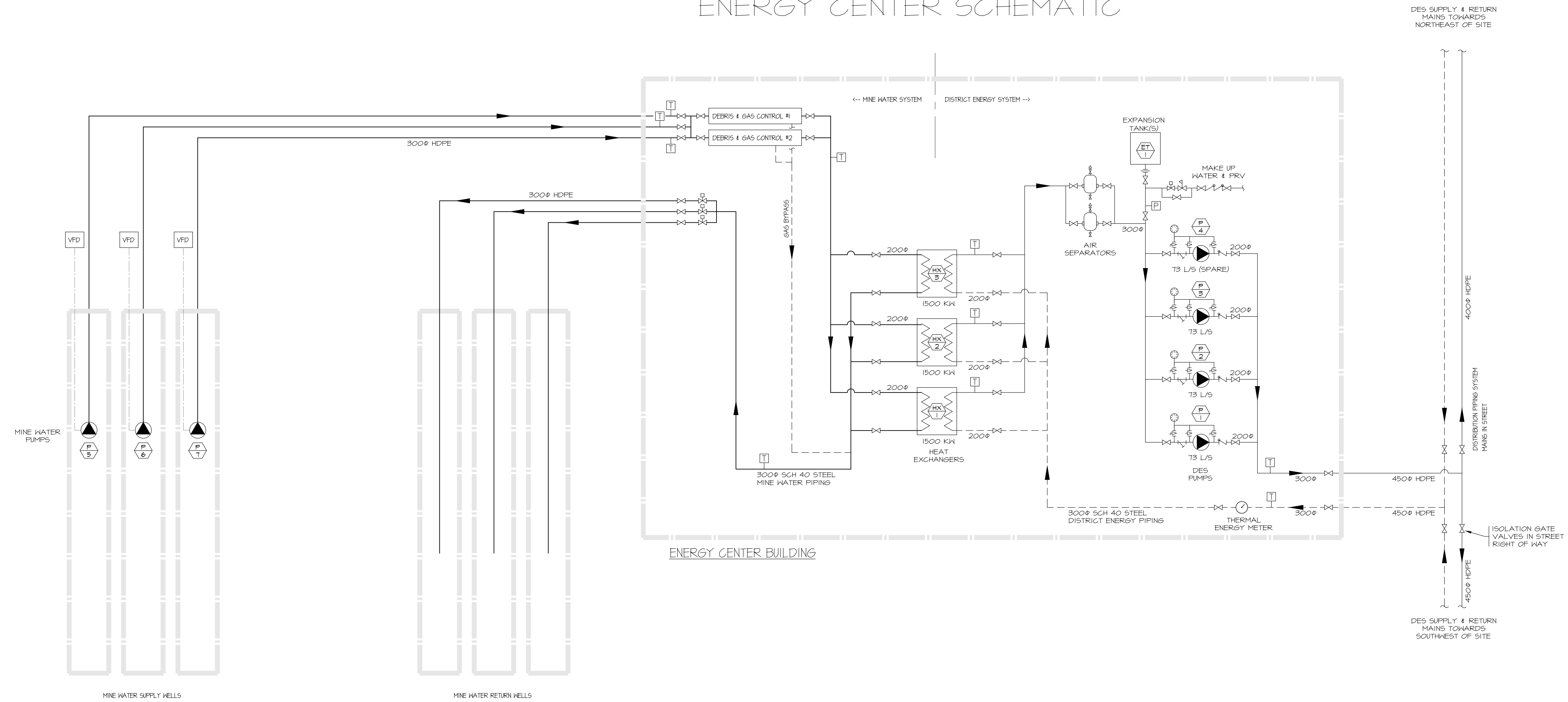
## **Attachment 2**

# **Cylindrical Source Heat Transfer Model**

**APPENDIX III**

**DES Energy Centre Concept Schematic and Floor Plan**

# ENERGY CENTER SCHEMATIC



## GENERAL NOTES

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No.	1	CONCEPT DESIGN	MAR 13, 2020
		REVISION/ ISSUE	DATE

CONSULTANT NAME AND ADDRESS:

**PINCHIN**

PINCHIN LTD  
MECHANICAL ENGINEERING DIVISION  
1375 COMMERCE PARKWAY, SUITE 200  
RICHMOND, BC V6V 2V4  
604.244.8101 | WWW.PINCHIN.COM

CLIENT:

**CUMBERLAND ENERGY AUTHORITY**

SHEET NAME AND DISCIPLINE:

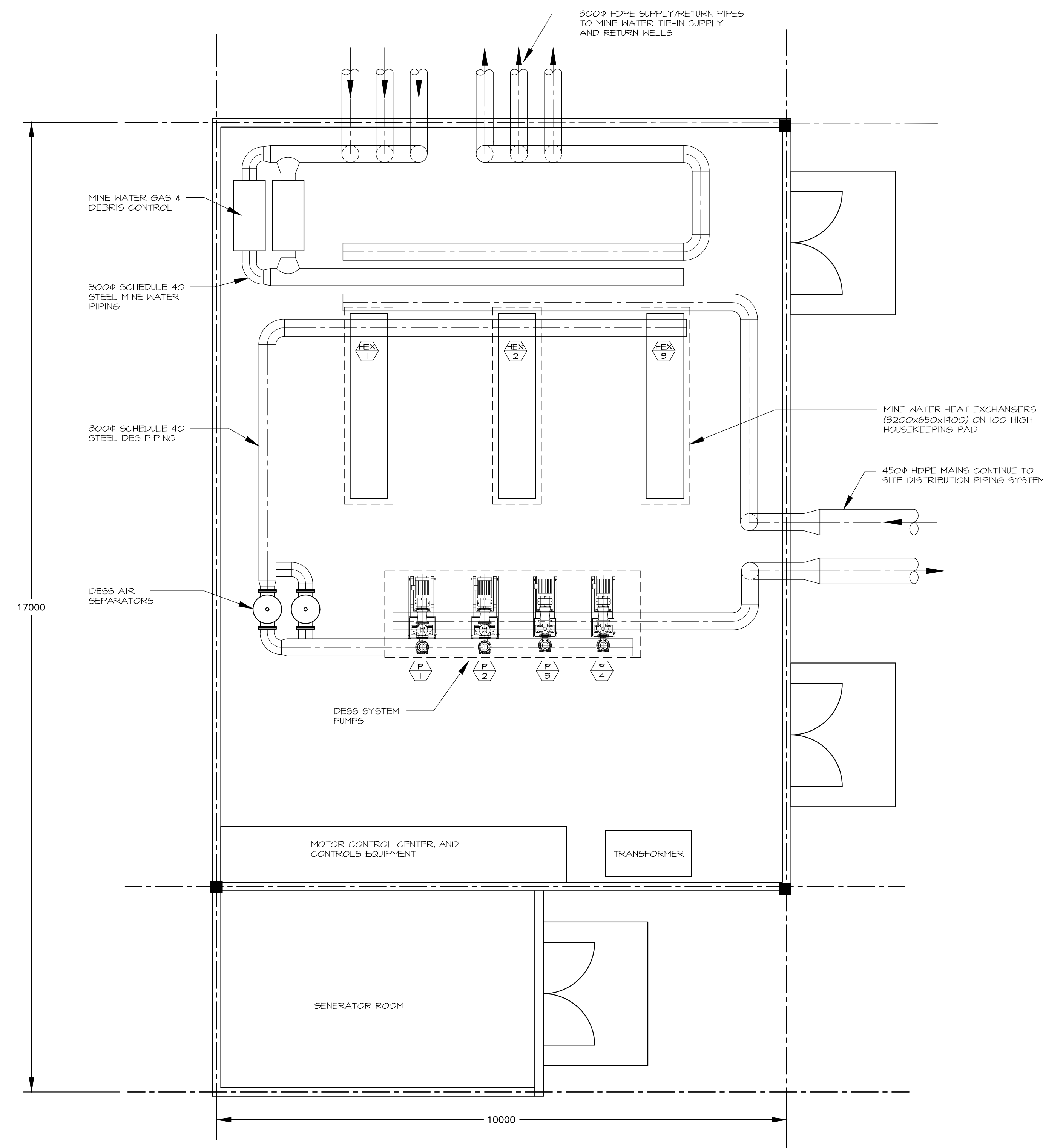
**ENERGY CENTER-  
CONCEPT SCHEMATIC**

PROJECT NAME AND ADDRESS:

**GEOHERMAL BUSINESS PARK DISTRICT ENERGY SYSTEM  
SPRINGHILL, NS**

PROJECT NO.	0243394		
DRAWN	AB	CHECKED	RM
DATE	FEB 19, 2020	SHEET NO.	M-1
SCALE	N.T.S.		

PLOT DATE: Mar 13, 2020 - 8:54pm CAD FILE: \\FSRMD\ubb\2433000s\0243394\000\_CEA\_Springhill\GeothermalBusinessPark\MEC\DES\Drawings\Energy\_Center\_Concept\_Pin.dwg



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No.	CONCEPT DESIGN	MAR 13, 2020
	REVISION/ ISSUE	DATE

CONSULTANT NAME AND ADDRESS:

  
**PINCHIN LTD**  
 MECHANICAL ENGINEERING DIVISION  
 13775 COMMERCE PARKWAY, SUITE 200  
 SPRINGHILL, TN 37174  
 604.244.8101 | WWW.PINCHIN.COM

CLIENT:

**CUMBERLAND ENERGY AUTHORITY**

SHEET NAME AND DISCIPLINE:

**ENERGY CENTER-  
CONCEPT LAYOUT**

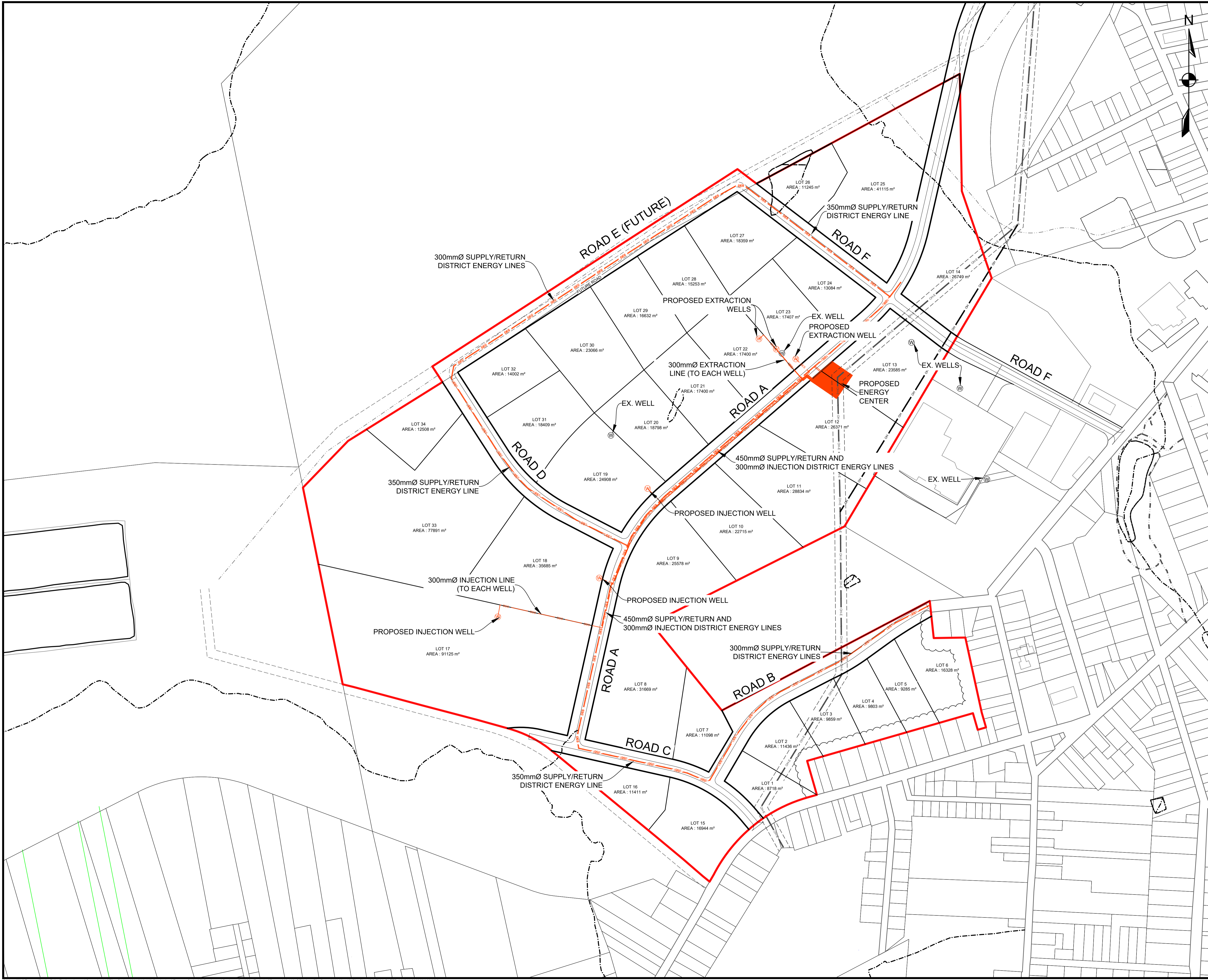
PROJECT NAME AND ADDRESS:

**GEOTHERMAL BUSINESS PARK DISTRICT ENERGY SYSTEM  
SPRINGHILL, NS**

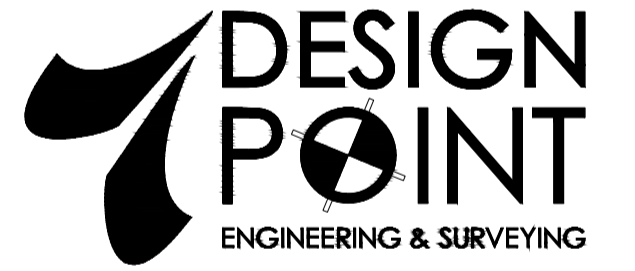
PROJECT NO.	0243394	
DRAWN	AB	CHECKED RM
DATE	FEB 19, 2020	SHEET NO.
SCALE	1:50	<b>M-2</b>

**APPENDIX IV**

**District Energy Site Plan – March 19, 2020**



ISSUE	DATE	DESCRIPTION	CONSULTANT
1	MAR. 19, 2020	ISSUED FOR REVIEW	



PHONE: 902.832.5597 www.designpoint.ca



PROJECT DESCRIPTION  
**SPRINGHILL GEOTHERMAL BUSINESS PARK**  
SPRINGHILL, NOVA SCOTIA  
SHEET DESCRIPTION

DISTRICT ENERGY SCHEMATIC

Drawn A.LEAHY	Engineer N.FOUGERE	Project No. 19-148	Drawing No. SCH-01
Scale 1:3000	Filename 19-148_SCH.dwg		1 of 14

**APPENDIX V**  
**Capital Cost Estimate**

Client Cumberland Energy Authority  
 Project # 0243394.000  
 Project Name Springhill Geothermal Business Park DES  
 Sheet Description Capital Cost Estimate

Author AB  
 Revision 1  
 Update Date 20-Mar-20

### Ambient District Energy System Cost Estimate

#### System Capacity

System Cooling Capacity	3,600 kW
System Heating Capacity	4,600 kW

### 1. Mine Water Tie-In

#### Mine Water Wells

3 Well Pairs	Drilling		\$	600,000
	Allowance for re-drilling non-productive wells		\$	300,000
3 Well Pairs	Surface Completions		\$	210,000
3 @ 1000gpm	Submersible Well Pumps w/ VFDs		\$	240,000
			\$	<b>1,350,000</b>

#### Mine Water Distribution Piping to Energy Center

1900 m	Distribution Piping, HDPE, 300mm		\$	<b>660,000</b>
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#### Warranty, Bonding and Insurance

Warranty	0.40%	\$	8,040
Performance Bond	0.43%	\$	8,643
Labour and Material Bond	0.43%	\$	8,643
Insurance	1.50%	\$	30,150

#### General Contractor Overhead and Profit

OH&P	10%	\$	201,000
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#### Subtotal Direct Costs

		\$	<b>2,266,476</b>
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Engineering	10%	\$	226,648
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#### Subtotal Direct and Indirect Costs

		\$	<b>2,493,124</b>
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Contingency	20%	\$	498,625
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### 2. Energy Center

#### Energy Center - Building and Site Grading

	Site Prep & Mobilization		\$	50,000
	Building Cost	175 m2	\$	350,000
			\$	<b>400,000</b>

#### Energy Center - DES Mechanical

3500 gpm	DES Piping and Pumps		\$	270,000
	Geothermal Water Piping		\$	135,000
4500 kW	Heat Exchangers		\$	580,000
	Instrumentation & Controls		\$	90,000
			\$	<b>1,075,000</b>

#### Energy Center - Electrical

	Backup Generator, 125kW		\$	80,000
	Electrical		\$	110,000
			\$	<b>190,000</b>

#### Warranty, Bonding and Insurance

Warranty	0.40%	\$	6,660
Performance Bond	0.43%	\$	7,160
Labour and Material Bond	0.43%	\$	7,160
Insurance	1.50%	\$	24,975

#### General Contractor Overhead and Profit

OH&P	10%	\$	166,500
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#### Subtotal Direct Costs

		\$	<b>1,877,454</b>
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Engineering	16%	\$	300,393
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#### Total Direct and Indirect Costs

		\$	<b>2,177,847</b>
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Contingency	30%	\$	653,354
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### 3. Distribution Piping System

#### Distribution Piping System

HDPE Mains in Trench	6300 m	\$	2,400,000
Isolation Valves	22 ea	\$	104,000
Bypass & Air Vent Manholes	2 ea	\$	20,000
		\$	<b>2,524,000</b>

#### Warranty, Bonding and Insurance

Warranty	0.40%	\$	10,096
Performance Bond	0.43%	\$	10,853
Labour and Material Bond	0.43%	\$	10,853
Insurance	1.50%	\$	37,860

#### General Contractor Overhead and Profit

OH&P	10%	\$	252,400
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#### Subtotal Direct Costs

Engineering	7%	\$	176,680
-------------	----	----	---------

#### Total Direct and Indirect Costs

Contingency	20%	\$	540,136
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### 4. Customer Energy Transfer Station Cost Estimate

			(Full Site Cost)	(Single 5,000m <sup>2</sup> Warehouse)
<b>Customer Energy Transfer Station</b>				
200 kW	Energy Transfer Station	\$	1,236,000	\$ 37,000
<b>General Contractor Overhead and Profit</b>				
	OH&P	12%	\$ 148,320	\$ 4,440
<b>Subtotal Direct Costs</b>			<b>\$ 1,384,320</b>	<b>\$ 41,440</b>
	Owners Overhead	1%	\$ 13,843	\$ 414
	Engineering	16%	\$ 221,491	\$ 6,630
<b>Total Direct and Indirect Costs</b>			<b>\$ 1,619,654</b>	<b>\$ 48,485</b>
	Contingency	40%	\$ 647,862	\$ 19,394

### 5. Customer Service Connection Cost Estimate

			(Full Site Cost)	(Single 5,000m <sup>2</sup> Warehouse)
<b>Customer Service Connection and Hot Tap</b>				
	HDPE Service Connection & Hot Tap into Mains	\$	1,369,000	\$ 41,000
<b>General Contractor Overhead and Profit</b>				
	OH&P	12%	\$ 164,280	\$ 4,920
<b>Subtotal Direct Costs</b>			<b>\$ 1,533,280</b>	<b>\$ 45,920</b>
	Engineering	16%	\$ 245,325	\$ 7,347
<b>Total Direct and Indirect Costs</b>			<b>\$ 1,778,605</b>	<b>\$ 53,267</b>
	Contingency	40%	\$ 711,442	\$ 21,307

#### Total Direct and Indirect Costs

		\$	<b>10,769,909</b>
--	--	----	-------------------

Total Contingency		\$	<b>3,051,418</b>
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# Springhill Geothermal Energy Use Study

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Prepared for Cumberland Energy Authority  
(CEA)

Date: July 31, 2017

230 Brownlow Avenue, Suite 300 | Dartmouth, Nova Scotia, Canada | B3B 0G5

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Golden Opportunities Vocational Rehabilitation Centre	
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BWAY Packaging	
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## List of Abbreviations & Acronyms

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CAD	Canadian Dollar
CEA	Cumberland Energy Authority
Community Centre	Dr. Carson and Marion Murray Community Centre
EMO	Energy Management Opportunity
GHG	Green House Gas
GOVRC	Golden Opportunities Vocational Rehabilitation Centre
HVAC	Heating, Ventilation and Air Conditioning
IPMVP	International Performance Measurement and Verification Protocol
KPI	Key Performance Indicator
kWh	Kilowatt Hour
LED	Light Emitting Diode
NSP	Nova Scotia Power
US gpm	United States Gallons per Minute

## Acknowledgments

EfficiencyOne Services would like to thank those businesses that contributed to this study by sharing site information and access. This includes: BWAY Packaging Corporation, Public Works, Dr. Marion and Murray Community Centre, and Golden Opportunities Vocational Rehabilitation Centre.

Thanks to Brian Herteis, Capital Projects Engineer at the Municipality of Cumberland, for supporting the team during the review of the coal mine layout, and during the measurement planning phase.

Thanks to Scott Munroe, Manager of Facilities & Parks at the Municipality of Cumberland, for access to the Community Centre, and supplying building automation system trends.

Thanks to Wendell Crowley, Shift Supervisor at BWAY Packaging, for access to the facility, coordination of the heat pump power measurement and providing us with system layouts.

Thanks to Ralph Ross for his continued support through the measurement phase of the project, and for reviewing system layouts and developing specific recommendations.

Special thanks to Peter Scott of Enermagic for his technical support and consultation on the BWAY Packaging geothermal system.

## Overview

### Abstract

The town of Springhill in Cumberland County is home to the now-defunct coal mines that have served the area's industry as a valuable geothermal resource. EfficiencyOne Services is providing this report at the request of the Cumberland Energy Authority (CEA), who sought technical assistance to analyze the energy and cost savings realized from the use of this geothermal energy resource. This report also explores the energy efficiency opportunities available to participating facilities in the Springhill Industrial Park, which are summarized in Table 1 below.

**Table 1: Summary of Energy Management Opportunities**

Facility	Proposed EMO	Installed Cost (CAD \$)	Energy Reduction (kWh/year)	Cost Savings (CAD \$/year)	Payback <sup>1</sup> (years)
Community Centre	Lighting Retrofit	\$2,033	5,535	\$773	2.1
	Low Emissivity Ceiling	\$35,000	40,000	\$4,746	6.5
GOVRC	Lighting Retrofit	\$7,270	11,976	\$2,151	2.3
Public Works	Lighting Retrofit	\$14,253	20,640	\$3,239	3.1
BWAY Packaging	Lighting Retrofit	\$141,696	263,856	\$38,336	3.0
	Free-Cooling for Production	\$120,000	1,300,000	\$132,000	0.9
	Power Factor Correction	\$51,300	0	\$27,500	1.9
<b>Total</b>		<b>\$371,552</b>	<b>1,646,007</b>	<b>\$208,745</b>	<b>1.6</b>

<sup>1</sup> This includes estimated incentives from Efficiency Nova Scotia

An energy use study of the current geothermal users in the area required EfficiencyOne Services to measure power consumption of participating facilities' heating and cooling systems over a period greater than six months. EfficiencyOne Services chose the measurement period

length to accurately capture energy and power trends of heating and cooling systems that indirectly utilize the geothermal resource. The results will help develop an understanding of the geothermal energy being captured by the current geothermal users; furthermore, EfficiencyOne Services compared these results to other heating and cooling systems to present the benefits of the geothermal resource to industry in Springhill. EfficiencyOne Services also conducted research into the industries that would gain the greatest benefit from the geothermal resource in an effort to guide future marketing for CEA.

### Study Objectives

The purpose of this study was to deliver on the following primary objectives:

- Facility energy benchmarking
- Facility energy audits
- Energy performance comparative analysis

This study involved the participation of businesses in the town of Springhill with access to the Springhill mine geothermal resource. EfficiencyOne Services completed each of the above objectives for those businesses that volunteered access to facilities, production and utility data. The results are detailed in the following sections.

### Facility Energy Audits

#### Summary & Methodology

Between December 2016 and June 2017, EfficiencyOne Services carried out a number of energy audits for participating facilities in Springhill with the objective of identifying energy management opportunities and their quantitative impact to the businesses' utility costs. The ASHRAE Procedures for Commercial Building Energy Audits was used to guide the energy audit scope and on-site activities. EfficiencyOne Services modeled the electrical consumption of the existing and proposed lighting systems, adjusting the model to reflect the interactive effects on the buildings' HVAC systems. The following section details the findings and results of each site's energy modeling.

Supporting information can be found in Appendix A: Facility Energy Audit Supporting Documents.

#### Energy Audit Findings: Dr. Carson & Marion Murray Community Centre

The Dr. Carson & Marion Murray Community Centre is a multipurpose centre that accommodates sporting, recreational, cultural, tourism and business activities. The facility features an arena with an NHL-sized ice surface and a seating capacity of 800. In addition,

there are five dressing rooms, a room for officials, lobby and storage facilities, a walking track, canteen and kitchen, coatroom, meeting/boardroom, a 3,100 square foot common room and a teen centre. Administrative offices for the Town's Park and Recreation Department are also located in the Community Centre.

There is a single geothermal supply well with primary pump and single return well that supplies three separate distribution loops:

- 1) An Ice Kube geothermal heat pump system, consisting of eight units, that is used to create and maintain the rink's ice surface and to supply heat to the in-floor distribution system throughout the rink seating.
- 2) A separate Ice Kube geothermal heat pump used to pre-heat domestic hot water. Primary heating is performed by two electric resistance hot water tanks that supply the entire facility.
- 3) A space heating/cooling loop that conditions various zones throughout the facility except the rink. This loop also services two dehumidification units located inside the rink.

The following table summarizes the energy management opportunities identified at the Community Centre. Measure details are included in the following sections.

**Table 2: Community Centre Energy Management Opportunities**

Facility	Proposed EMO	Installed Cost (CAD \$)	Energy Reduction (kWh/year)	Cost Savings (CAD \$/year)	Payback <sup>1</sup> (years)
Community Centre	Lighting Retrofit	\$2,033	5,535	\$773	2.1
	Low Emissivity Ceiling	\$35,000	40,000	\$4,746	6.5
<b>Total</b>		<b>\$37,033</b>	<b>45,535</b>	<b>\$5,519</b>	<b>5.9</b>

<sup>1</sup> This includes estimated incentives from Efficiency Nova Scotia

## Lighting

EfficiencyOne Services estimates that an LED conversion of remaining fixtures at the Community Centre will cost approximately \$2,033 and be eligible for incentives of \$416 through Efficiency Nova Scotia's Business Energy Rebates program. An LED conversion of remaining fixtures would result in electrical energy and peak monthly demand savings of approximately 5,535 kWh and 2 kW respectively, corresponding to an annual reduction in utility and maintenance costs of approximately \$773, and a simple payback of 2.1 years.

The detailed lighting survey can be found in Appendix A: Facility Energy Audit Supporting Documents.

**Table 3: Facility Lighting Upgrade**

<b>Estimated Annual Savings (kWh/year)</b>	<b>5,535</b>
<b>Estimated Annual Cost Savings (CAD \$/year)</b>	<b>\$773</b>
<b>Estimated Measure Cost (CAD \$)</b>	<b>\$2,033</b>
<b>Simple Payback With Incentives (years)</b>	<b>2.1</b>

### Low Emissivity Ceiling

Low emissivity ceilings are commonly installed in rinks primarily to reduce the amount of heat radiated to the ice surface, thereby reducing the cost to run the ice rink chilling plant. These systems provide additional benefits by reducing condensation problems and improving the ice conditions. Emissivity describes the ability of a given material to radiate heat rather than absorb it. In an ice rink a low emissivity material above the rink will radiate less heat from the building envelope to the ice surface.

EfficiencyOne Services’ engineers estimate that a low emissivity ceiling at the community centre would cost approximately \$35,000 and be eligible for incentives of \$4,000 through Efficiency Nova Scotia’s Custom program. This upgrade would result in annual electrical energy savings of approximately 40,000 kWh/year. This corresponds to an annual utility cost reduction of approximately \$4,746, and a simple payback of 6.5 years.

**Table 4: Low Emissivity Ceiling for Ice Rink**

<b>Estimated Annual Savings (kWh/year)</b>	<b>40,000</b>
<b>Estimated Annual Cost Savings (CAD \$/year)</b>	<b>\$4,746</b>
<b>Estimated Measure Cost (CAD \$)</b>	<b>\$35,000</b>
<b>Simple Payback With Incentives (years)</b>	<b>6.5</b>

### Energy Audit Findings: Golden Opportunities Vocational Rehabilitation Centre

Golden Opportunities Vocational Rehabilitation Centre (GOVRC) is a small workshop facility operated by a non-profit society. They produce low-cost wood products (primarily pallets), small

crafts, and seedlings, and also conduct auctions of donated items. The main building contains a cafeteria with a small kitchen, a classroom, locker room, washrooms, three offices, and two woodworking shops.

GOVRC is heated primarily by two ducted geothermal heat pumps sharing a supply and return well; there are also several backup heating systems. The water level in the wells, until recently, was below the suction level of the pump so the system had not been in use until this past season. An oil-fired boiler heats half of the building through an in-floor distribution system, and the other half is heated with electric baseboards. There are electric resistance fan units in the woodworking shops. An adjacent greenhouse is heated primarily with a single geothermal heat pump sharing the same well as the other, and backed up by an oil-fired furnace.

The following table summarizes the energy management opportunities identified at GOVRC. Measure details are outlined in the following sections.

**Table 5: GOVRC Energy Management Opportunities**

Facility	Proposed EMO	Installed Cost (CAD \$)	Energy Reduction (kWh/year)	Cost Savings (CAD \$/year)	Payback <sup>1</sup> (years)
GOVRC	Lighting Retrofit	\$7,270	11,976	\$2,151	2.3
<b>Total</b>		<b>\$7,270</b>	<b>11,976</b>	<b>\$2,151</b>	<b>2.3</b>

<sup>1</sup> This includes estimated incentives from Efficiency Nova Scotia

## Lighting

EfficiencyOne Services estimates that an LED conversion at GOVRC will cost approximately \$7,270 and be eligible for incentives of \$2,395 through Efficiency Nova Scotia’s Small Business Energy Solutions program. An LED conversion would result in electrical energy and peak monthly demand savings of approximately 11,976 kWh and 4 kW respectively. This corresponds to an annual reduction in utility costs of approximately \$2,151 and a simple payback of 2.3 years.

The detailed lighting survey can be found in Appendix A: Facility Energy Audit Supporting Documents.

## Energy Audit Findings: Public Works

The Public Works building is located on the edge of the town, and administrative offices and a vehicle bay for assorted utility vehicles. It was originally built as a recycling facility with an in-floor geothermal heating system; however, the installation was not successful due to issues with the concrete, so two oil-fired furnaces were installed to heat the vehicle bay. The primary heat

source of the office areas is electric resistance baseboard units. As a result of the original geothermal specification, supply and return wells have been drilled nearby. It would be possible to install a new in-floor distribution system and pour new concrete over the existing floor, and replace the oil-fired furnaces with geothermal heat pumps. This would result in estimated heating cost savings of 60%.

The following table summarizes the energy management opportunities identified at Public Works. Measure details are outlined in the following sections.

**Table 6: Public Works Energy Management Opportunities**

Facility	Proposed EMO	Installed Cost (CAD \$)	Energy Reduction (kWh/year)	Cost Savings (CAD \$/year)	Payback <sup>1</sup> (years)
Public Works	Lighting Retrofit	\$14,253	20,640	\$3,239	3.1
<b>Total</b>		<b>\$14,253</b>	<b>20,640</b>	<b>\$3,239</b>	<b>3.1</b>

<sup>1</sup> This includes estimated incentives from Efficiency Nova Scotia

## Lighting

We estimates that an LED conversion at the Public Works Building will cost approximately \$14,253 and be eligible for incentives of \$4,086 through Efficiency Nova Scotia’s Small Business Energy Solutions program. An LED conversion would result in electrical energy and demand savings of approximately 20,640 kWh and 7 kW respectively. This corresponds to an annual reduction in utility costs of approximately \$3,239 and a simple payback of 3.1 years.

The detailed lighting survey can be found in Appendix A: Facility Energy Audit Supporting Documents.

## BWAY Packaging Energy Audit Findings

Formerly known as Ropak Manufacturing, BWAY Packaging primarily makes plastic containers, and occupies several large warehouse structures in the Springhill industrial park.

A single supply well and a single return well feed all geothermal uses within the building. The primary loop runs through the main warehouse facility to water source heat pumps located on the production floor; these are primarily used for space heating and cooling. A 2008 energy audit contained numerous recommendations around improving the energy efficiency of industrial processes; EfficiencyOne Services consulted this report and included the measures we deemed feasible.

The following table summarizes the energy management opportunities identified at BWAY Packaging. Details for each measure are outlined in the following sections.

**Table 7: BWAY Packaging Energy Management Opportunities**

Facility	Proposed EMO	Installed Cost (CAD \$)	Energy Reduction (kWh/year)	Cost Savings (CAD \$/year)	Payback <sup>1</sup> (years)
BWAY Packaging	Lighting Retrofit	\$141,696	263,856	\$38,336	3.0
	Free-Cooling for Production	\$120,000	1,300,000	\$132,000	0.9
	Power Factor Correction	\$51,300	0	\$27,500 <sup>2</sup>	1.9
<b>Total</b>		<b>\$312,996</b>	<b>1,563,856</b>	<b>\$197,836</b>	<b>1.5</b>

<sup>1</sup>Includes estimated incentives from Efficiency Nova Scotia

<sup>2</sup>This measure results in negligible energy savings but has a direct impact on billable demand

## Lighting

We estimate that an LED conversion at BWAY Packaging will cost approximately \$141,696 and be eligible for incentives of \$27,058 through Efficiency Nova Scotia’s Business Energy Rebates program. An LED conversion would result in electrical energy and peak monthly demand savings of approximately 263,856 kWh and 75 kW per month respectively. This corresponds to an annual reduction in utility and maintenance costs of approximately \$38,336 and a simple payback of 3.0 years.

The detailed lighting survey can be found in Appendix A: Facility Energy Audit Supporting Documents.

**Table 8: Plant LED Lighting Upgrade**

Estimated Annual Savings (kWh/year)	263,856
Estimated Annual Cost Savings (CAD \$/year)	\$38,336
Estimated Measure Cost (CAD \$)	\$141,696
<b>Simple Payback With Incentives (years)</b>	<b>3.0</b>

## Production Free Cooling Opportunities

One of the main purposes of this study is to quantify BWAY Packaging’s energy savings from the geothermal system as compared to a standard HVAC system. Though these energy savings are significant, the engineering team found that that there is still significant opportunity for

BWAY Packaging to reduce its current energy costs by taking further advantage of the geothermal resource. Using the mine water for free process cooling could result in an additional savings of over 1,000,000 kWh/year.

BWAY Packaging's geothermal heat pump system has been operating since 1989 when 11 water-to-air heat pumps were installed to provide space heating and cooling to the factory. The heat pumps recovered energy from the nearby abandoned flooded mines. Two wells were drilled into the mines, one to a depth of 140 metres from which water was extracted at a year-round temperature of 18°C, and a second shallower well into which water was returned at 13°C (with heat pumps operating in heating mode) or 23°C (when operating in cooling mode). The system has been expanded to a current total of 17 water-to-air heat pumps but these appear to be unable to meet current peak heating demand.

A local contractor reported a significant reduction in the mine source temperature, down from the previous year-round temperature of 18°C to a current 10°C. The change apparently resulted from open cast mining which compromised parts of the underground workings, allowing colder surface water to enter and mix with the warmer underground water. There is reportedly little doubt of this being the cause of the lower source temperature which in turn is affecting heat pump performance. A reduction in average temperature from 15.5°C to 7.5°C is significant and could reduce heat pump heating capacity by up to 30%.

It may be possible to attempt restitution of the damage to underground mines but these efforts would be difficult and expensive with a low chance of success.

The reduction in mine water temperature presents an opportunity for BWAY Packaging to meet all or part of the process cooling load using the 10°C source water. Three chillers currently provide approximately 290 tons of cooling capacity; however, the cooler source water could instead provide direct cooling to the injection moulding machines. EfficiencyOne Services built a model in RETScreen to determine potential savings and found that switching to this free cooling has the potential to save 1,300,000 kWh/year of electrical energy. This corresponds to a utility savings of approximately \$132,000 per year, and would be eligible for an Efficiency Nova Scotia rebate to cover the cost of an investment grade feasibility study. The installation of heat exchangers may be needed to isolate mine water from the final cooling circuit to prevent fouling, but this would be easily achievable. Our model showed that a second (independent) geothermal circuit would also be required, providing an average cooling temperature of 12.8°C from a 10°C supply and 15.6°C return temperature. A supply flow rate of 300 US gpm would deliver an estimated 455 kW of cooling capacity at an average cooling temperature of 12.8°C to meet some of the facilities' cooling requirements.

If BWAY Packaging deems the free cooling option feasible, the potential energy savings would be substantial; however, if the cooling temperature is prohibitive, BWAY Packaging may also consider using a combination of free cooling and chiller. Adding the existing 140T chiller to the proposed circuit could reduce the supply temperature to 4.8°C which, with a return temperature of 15.6°C, would produce an average cooling temperature of 10.2°C and increase the cooling capacity to an estimated 858 kW.

EfficiencyOne Services recommends conducting a trial on a single injection molding machine to determine the potential for the use of free cooling.

Return flow rates and temperatures for both above options (free cooling alone or in combination with a chiller) remain the same at 300 US gpm and 15.6°C. During the heating season, this return flow can be diverted to the heat pump circuit, increasing the average temperature from the current 7.5°C to 13.3°C, offsetting much of the damage caused to the existing mine-based geothermal system.

During the cooling season, BWAY Packaging may consider using the 10°C mine water as a source for free space cooling and dehumidification for the entire building.

Conceptual system layouts and seasonal operational of the proposed production cooling system are provided in Appendix A: Facility Energy Audit Supporting Documents.

**Table 9: Space and Production Cooling Free-Cooling Opportunities**

<b>Estimated Annual Savings (kWh/year)</b>	<b>1,300,000</b>
<b>Estimated Annual Cost Savings (CAD \$/year)</b>	\$132,000
<b>Estimated Measure Cost (CAD \$)</b>	\$120,000
<b>Simple Payback With Incentives (years)</b>	<b>0.9</b>

### Power Factor Correction

Power factor is the ratio of true power (Watts) to apparent power (Volt-amperes, or VA). Inductive electrical loads (e.g. devices with magnetic components, such as electric motors, fluorescent lamp ballast units, and transformers, etc.) have lower power factors than pure resistive loads such as incandescent light bulbs. BWAY Packaging’s electricity tariff compensates for this anomaly with a maximum demand charge based on the kVA of the maximum demand occurring in a billing cycle.

The effect of maximum demand charge can be reduced by installing power factor correction capacitors to reduce the kVA loading, as illustrated in the vector diagram in Appendix A. Power factor correction capacitors are normally described by their kilovolt-ampere reactive capacity (KVAR), and we have provided sizing, estimated installation costs and savings for BWAY metered supply in Table 10: Power Factor Correction, assuming a current power factor of 0.9 will be increased to 0.975.

BWAY Packaging’s power factor should be confirmed before proceeding with this type of upgrade. We assumed the current power factor of 0.9 because the facility was on an interruptible rate class until 2015 and a minimum power factor of 0.9 would have been a

prerequisite for eligibility to this rate class. Nova Scotia Power should be consulted to provide clarity on the potential rate class impacts of this upgrade.

Additional details on this measure can be found in Appendix A: Facility Energy Audit Supporting Documents.

**Table 10: Power Factor Correction**

<b>Estimated Annual Savings (kWh/year)</b>	<b>Insignificant</b>
<b>Estimated Demand Reduction (kVA)</b>	192
<b>Estimated Annual Cost Savings (CAD \$/year)</b>	\$27,500
<b>Estimated Measure Cost (CAD \$)</b>	\$51,300
<b>Simple Payback With Incentives (years)</b>	<b>1.9</b>

## Other Considerations

### Compressed Air Leaks

BWAY Packaging is currently participating in an Efficiency Nova Scotia compressed air pilot program aiming to reduce the load on the air compressor by reducing leakage from the compressed air system. This follows an upgrade where multiple old compressors were replaced with a single 125-horsepower variable speed drive compressor.

This pilot identified annual energy savings of approximately 305,000 kWh and annual cost savings of approximately \$27,276.

### Space Free Heating Upgrade

If BWAY Packaging opts not to pursue the upgrade described above which involves replacing the chillers with free cooling from the mine water, there is still an opportunity to address the heating issues in the building. In this scenario the chillers would remain in operation and free heat could be removed using fan coil units with the production waste heat that would otherwise be rejected through the cooling towers. This would not result in energy savings since the heat pumps currently do not meet the space heating requirements during the winter, but it would increase occupant comfort.

## Energy Benchmarking

### Summary & Methodology

A preliminary analysis of a building's energy consumption helps to establish an energy baseline from which to evaluate building energy performance. One common effective method is Energy Use Intensity (EUI). EUI is expressed in equivalent kilowatt hours per square foot (ekWh/ft<sup>2</sup>) and is calculated by summing all energy types for the building and dividing by the building's conditioned floor area. For industrial facilities, the benchmark is expressed in equivalent kilowatt hours per ton of production, as units of production have a stronger relationship to overall energy usage.

EfficiencyOne Services conducted an energy benchmarking analysis for three of the buildings using Natural Resources Canada's (NRCan) ENERGY STAR® Portfolio Manager and RetSCREEN Expert software and the associated databases of commercial and industrial buildings throughout the world. This software allows energy usage to be tracked and compared to facilities of similar size, usage type, climate zone, and production. The following section summarizes the results of the analysis for three of the facilities: BWAY Packaging, the Community Centre, and GOVRC. Supporting information can be found in Appendix B: Energy Benchmarking Supporting Documents.

### Results

#### Dr. Carson & Marion Murray Community Centre

The total conditioned floor area of the community centre is approximately 75,000 ft<sup>2</sup>. This building is classified as a multi-use facility and is comprised of an ice rink (55%), multi-purpose area/conference (40%), and offices (5%). Electricity is the only energy source currently used at the community center. Consumption over baseline period (July 2016 - June 2017) is 1,145,880 kWh.

The community centre's current EUI is approximately 15.3 ekWh/ft<sup>2</sup>. The median EUI for buildings with similar end use as the community centre is 27.1 ekWh/ft<sup>2</sup>. The community centre is 43.6% better than the median.



**Table 11: Community Centre Energy Benchmarking Metrics**

<b>Building Usage Type</b>	55% Arena, 40% Convention Centre, 5% Office
<b>Energy Consumption (2016/2017) (ekWh)</b>	1,145,000
<b>Total Conditioned Floor Area (sq. ft.)</b>	75,000
<b>GHG Emissions (tons of CO<sub>2</sub>)</b>	1,036
<b>KPI (kwh/sq. ft.)</b>	15.3
<b>Reference KPI (kWh/sq. ft.)</b>	27.1
<b>Variance from Reference Building</b>	<b>-43.6%</b>

### Golden Opportunities Vocational Rehabilitation Centre (GOVRC)

The total conditioned floor area of GOVRC is approximately 7,401ft<sup>2</sup>. This building is a vocational rehabilitation school. The facility utilizes both oil and electricity. Energy consumption over the 2015 baseline period is 141,407 ekWh.

The current EUI of GOVRC is approximately 19.1 ekWh/ft<sup>2</sup>. The median EUI for buildings with similar end use as GOVRC is 21.7 ekWh/ft<sup>2</sup>. GOVRC is 11.9% better than the median.



**Table 12: GOVRC Energy Benchmarking Metrics**

<b>Building Usage Type</b>	Vocational Rehabilitation School
<b>Energy Consumption 2015 (ekWh)</b>	141,407
<b>Total Conditioned Floor Area (sq. ft.)</b>	7,401
<b>GHG Emissions (tons of CO<sub>2</sub>)</b>	84
<b>KPI (kwh/sq. ft.)</b>	19.1

Reference KPI (kwh/sq. ft.)	21.7
Variance from Reference Building	-11.9%

## BWAY Packaging

BWAY Packaging is an industrial facility that manufactures plastic packaging. The total annual production of BWAY Packaging is approximately 6,266 tons. Electricity is the facility’s primary energy source. Electricity consumption over the 2016 baseline period is 10,755,744 kWh.

BWAY Packaging’s current energy intensity is approximately 1,806 ekWh/ton. The median energy intensity for facilities with similar end use as BWAY Packaging is approximately 2,500 ekWh/ton. BWAY Packaging is approximately 27.7% better than the median.



**Table 13: BWAY Packaging Energy Benchmarking Metrics**

Building Usage Type	Plastic Packaging Factory
Energy Consumption 2016 (ekWh)	10,755,744
Production (tons)	6,266
GHG Emissions (tons of CO <sub>2</sub> )	9,402
KPI (kwh/ton)	1,806
Reference KPI (kwh/ton)	2,500
Variance from Reference Facility	-27.7%

## Energy Performance Comparative Analysis

### Summary & Methodology

A primary objective of this study was to compare the energy performance of facilities using the geothermal resource in the Springhill Industrial Park to alternative heating and/or cooling

options. EfficiencyOne Services's comparative analysis included three phases: 1) System Measurement, 2) Analytics and 3) Alternative Heating/Cooling System Modeling.

The measurement phase took place between December 2016 and June 2017 in which EfficiencyOne Services logged power data for facilities' heating and cooling system(s) along with all measurable parameters that could influence power and energy consumption.

EfficiencyOne Services reviewed power and energy trends and compared them to several variables including but not limited to weather, production and operational schedules. The aforementioned comparison allowed EfficiencyOne Services to develop models that could predict annualized energy consumption for the existing building systems. These energy models would be the basis for comparison to alternative heating and cooling systems and would thus provide a better understanding of the benefits of the Springhill geothermal resource.

EfficiencyOne Services approach to the measurement and analytics was based on the International Performance Measurement and Verification Protocol (IPMVP). The IPMVP is an internationally recognized protocol for measurement of water and energy efficiency savings. Part of the IPMVP provides the best practice approach to sorting energy consumption data and normalizing energy consumption data for the purposes of comparison. EfficiencyOne Services normalized energy consumption data during the measurement period to ensure that weather, production, operational schedule etc. were adjusted to match a set of normal conditions. Once energy consumption data from the measurement period was adjusted to normal conditions, a prediction of the building systems annual energy consumption could be made. It was on the basis of annual energy consumption that the existing facility systems and alternative systems were compared.

Through consultation with the town engineer and businesses in the industrial park we were able to find two businesses willing to participate in this part of study. The following section summarizes the results of this energy performance comparative analysis for the Community Centre and BWAY Packaging facility heating and cooling systems.

### Results

#### Dr. Carson & Marion Murray Community Centre

The measurement and analysis of the energy consumption for the geothermal system at the Community Centre showed promising results. EfficiencyOne Services compared the existing community centre Ice Kube geothermal system to two commonly used ice rink chilling systems. EfficiencyOne Services found that the existing system was far more efficient than those of the modeled alternative systems. This can be attributed to the consistent water supply temperatures from the mines which results in the heat pump systems having higher cooling capacity and superior seasonal efficiencies.

Option B of the IPMVP was used to develop an energy model for the existing system. The existing Ice Kube system services the heating and cooling needs for the facility including: cooling for the ice rink, domestic hot water pre-heat and conditioning for parts of the facility.

Power trends were consistent with consultations on the facility operation. Daily peaks could be seen as the ice surface was flooded and domestic hot water peak loads during periods of high activity in the facility.

### System 1 – Theoretical Alternative System

EfficiencyOne Services developed a model for an alternative system which utilized ammonia (R717) based ice rink chilling for servicing the ice rink and an oil fired water heater for domestic hot water service. EfficiencyOne Services found that the existing Ice Kube system uses 49% less energy than System 1 to provide the same service. The annualized cost comparison result was the approximately the same. The results of the comparison are summarized in the following table.

### System 2 – Theoretical Alternative System

EfficiencyOne Services developed a model for an alternative system which utilized a Chlorodifluoromethane (R22) based ice rink chilling system for servicing the ice rink and an oil fired water heater for domestic hot water service. EfficiencyOne Services found that the existing Ice Kube system uses 56% less energy than System 2 to provide the same service. The annualized cost comparison result was the approximately the same. The results of the comparison are summarized in the following table.

**Table 14: Energy and Cost Comparison to Existing Geothermal System**

<b>Energy Consumption Comparison:</b> Existing Heating/Cooling System vs. System 1	-49%
<b>Utility Cost Comparison:</b> Existing Heating/Cooling System vs. System 1	-48%
<b>Energy Consumption Comparison:</b> Existing Heating/Cooling System vs. System 2	-56%
<b>Utility Cost Comparison:</b> Existing Heating/Cooling System vs. System 2	-55%

### BWAY Packaging

EfficiencyOne Services compared the existing BWAY Packaging water-to-air heat pumps to two systems commonly utilized for space heating and cooling. EfficiencyOne Services found that the existing system was far more efficient than the modelled systems. This result is in agreement with our literature review of system efficiencies. BWAY Packaging’s access to cool ground water at a consistent temperature results in higher performance of the existing water-sourced systems than equivalent air-sourced units. The heat pump’s capacity and performance is influenced by the temperature of the source medium. Air-sourced heat pumps are efficient systems but their performance is reduced as outside air temperature drops. With this understanding it is easily

understood how the consistent mine water temperatures can benefit a heat pump’s operation and available capacity.

EfficiencyOne Services wants to emphasize that, though BWAY Packaging has benefited from access to the mine water geothermal resource, there is far more potential to use this resource. Details on energy management opportunities and associated savings are detailed in the above section BWAY Packaging Energy Audit Findings.

Option B of the IPMVP was used to develop an energy model for the existing system. The existing water-sourced heat pumps provide heating or cooling for the production floor space. The conditions on the production floor change considerably over the year. Heat rejected from production equipment to the space results in a need for space cooling by the heat pumps. The heat pumps are switched to heating mode in the winter.

### System 1 – Theoretical Alternative System

EfficiencyOne Services developed a model for a comparison system which utilized air-sourced heat pumps for space cooling and a propane fired system for space heating. EfficiencyOne Services found that the existing water-sourced heat pumps use 63% less energy than System 1 to provide the same service; this is equivalent to a 78% utility cost reduction. The results of the comparison are summarized in the following table.

### System 2 – Theoretical Alternative System

EfficiencyOne Services developed a model for a comparison system which utilized air-sourced heat pumps for space cooling and an oil fired system for space heating. EfficiencyOne Services found that the existing water-sourced heat pumps use 75% less energy than System 2 to provide the same service. The annualized cost comparison result was approximately the same. The results of the comparison are summarized in the following table. The results of the comparison are summarized in the following table.

**Table 15: Energy and Cost Comparison to Existing Geothermal System**

<b>Energy Consumption Comparison:</b> Existing Heating/Cooling System vs. System 1	-63%
<b>Utility Cost Comparison:</b> Existing Heating/Cooling System vs. System 1	-78%
<b>Energy Consumption Comparison:</b> Existing Heating/Cooling System vs. System 2	-75%
<b>Utility Cost Comparison:</b> Existing Heating/Cooling System vs. System 2	-76%

## Other Considerations

Facilities' heating, air-conditioning and refrigeration needs are costly to meet. Energy prices will continue to increase and fuel costs will continue to be volatile which makes this efficient resource a compelling option for potential industry and commercial operations.

The Springhill Industrial Park geothermal resource is an attractive option for future development. The mine water temperature makes it possible for free cooling opportunities and provides an efficient temperature source for heating and cooling systems. Technologies such as heat pumps greatly benefit from consistent temperatures for improved seasonal performance, along with increased heating and cooling capacities. A disadvantage for some industry is that heat pump technologies can only provide low grade heat. It should be noted that CO<sub>2</sub> refrigerant heat pumps are making this technology viable for meeting high temperature process loads. A review of industry that use a significant amount of heat below 100°C range reveals an efficiency opportunity businesses to utilize heat pumps in conjunction with the mine water resource. Also facilities which have simultaneous heating and cooling loads can readily utilize heat recovery systems in combination with the ground sourced heat pumps to improve the overall heating/cooling plant efficiency. EfficiencyOne Services believes that the following industries, for aforementioned reasons, would be able to maximize the potential of the geothermal resource: food, beverage, dairy, rubber product, plastic product, greenhouses and sugar processing facilities. These industries have as high as 25% of their heating needs between 0°C and 100°C according to the Eco-Efficiency and Industrial Process Department at the EDF Research & Development group.

Targeted marketing with proper engineering consultation can be used to attract and assess the value of potential future facilities in the Springhill Industrial Park.

## Recommendations and Next Steps

Springhill's coal mining history has left a legacy of flooded coal mines that offer an abundant source of clean, inexpensive energy. The former town has been a leader in geothermal energy development in Canada dating back 30 years when the Ropak packaging facility opened for business with a state of the art geothermal HVAC system. Several factors including an increase in energy costs, advances in heat pump technology to enable provision of high temperature process heating, a focus on greenhouse gas reduction at every level of government, and the availability of various sources of infrastructure funding make it an excellent time to market the industrial park as an attractive location for specific energy-intensive industries.

This report has demonstrated the savings existing facilities in Springhill have achieved by utilizing the geothermal resource; however, the audit team concluded that more can be done to maximize these benefits. In particular, BWAY Packaging can utilize the mine water as a source of free cooling and significantly reduce the load on its three chillers. There is also further capacity to use the existing district mine water loop.

The audit team recommends producing marketing material to communicate the value of the geothermal resource and the availability of industrial park real estate. Furthermore, the team recommends developing a targeted campaign to attract specific industries that can maximize the benefit from the park's geothermal resource. Advances in heat pump technology have opened up new applications for geothermal energy, including in process heating/cooling by producing more extreme water temperatures. Examples of businesses well suited to take advantage of the geothermal include: food and beverage companies, rubber and plastics manufacturers, greenhouses, dairies, sugar industry etc.

The Cumberland Energy Authority should consider applying to several sources for funding to develop this resource. The Green Municipal Fund, administered by the Federation of Canadian Municipalities, offers funding for energy projects, including energy efficiency, renewable energy and district energy. This includes grants and low-cost financing for plans, studies and capital projects. Efficiency Nova Scotia provides funding to new and existing facilities for energy feasibility studies, energy modeling and energy efficiency upgrades. The Province's cap and trade program that is set to begin in 2018 may open opportunities for the sale of carbon offsets to carbon market participants. Finally, CEA may consider working with a partner to develop and market this resource if the municipality lacks the needed resources.



## Springhill Geothermal Energy Use Study

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### Appendix A: Facility Energy Audit Supporting Documents

The following information summarizes the energy audit findings at participating facilities in the Springhill Industrial park.



## Springhill Geothermal Energy Use Study

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Summary All Participating Facilities

### **Lighting Upgrades**

Year:	2017
Customer:	Cumberland Energy Authority
Project:	Springhill Energy Study

**Project Summary**

Site Information	Rate Information	Electrical Rates		Retrofit Savings									Project Costs						Simple Payback (Years)	Efficiency Nova Scotia				Revised Simple Payback with ENS Rebates	Net Present Value (NPV)
		Demand Cost (\$/kW/m)	Energy Cost (\$/kWh)	Monthly Demand Savings (kW/mth)	Retrofit Energy Savings (kWh/year)	Months of use	Total Electrical Savings (\$/year)	HST Reduction Balance	Maintenance Savings (\$/year)	Heating Penalty (GJ)	Heating Penalty (\$/year)	Total Annual Savings	Engineering	Material	Installation	Other	Contingency & Allowance (15%)	Tax (15%)		Total Project Cost	Estimated ENS Rebates	OEM Recovery %	OEM Recovery Fee		
<b>BWAY</b>	23M - Large Industrial	##### #	0.078	75	263,856	12	\$31,409	\$4,711	\$2,756	-36	-\$540	\$33,625	\$103,630	\$19,584	\$0	\$0	\$18,482	\$141,696	3.7	\$27,058	0%	\$0	\$27,058	3.0	
<b>GOVRC</b>	10M - Small General	-	0.151	4	11,976	12	\$1,804	\$271	\$81	0	-\$6	\$1,880	\$4,500	\$1,822	\$0	\$0	\$948	\$7,270	3.4	\$2,395	0%	\$0	\$2,395	2.3	
<b>COMMUNITY CENTRE</b>	11M - General	##### #	0.085	2	5,535	12	\$669	\$100	\$15	-1	-\$11	\$673	\$1,560	\$208	\$0	\$0	\$265	\$2,033	2.6	\$416	0%	\$0	\$416	2.1	
<b>PUBLIC WORKS</b>	11M - General	##### #	0.085	7	20,640	12	\$2,641	\$396	\$242	-3	-\$41	\$2,843	\$10,280	\$2,114	\$0	\$0	\$1,859	\$14,253	4.4	\$4,086	0%	\$0	\$4,086	3.1	
<b>Totals</b>				<b>88</b>	<b>302,007</b>		<b>\$36,523</b>	<b>\$5,479</b>	<b>\$3,095</b>	<b>-40</b>	<b>-\$598</b>	<b>\$39,020</b>	<b>\$0</b>	<b>\$119,970</b>	<b>\$23,728</b>	<b>\$0</b>	<b>\$0</b>	<b>\$21,555</b>	<b>\$165,253</b>	<b>4.2</b>	<b>\$33,955</b>	<b>\$0</b>	<b>\$33,955</b>	<b>3.4</b>	



## Springhill Geothermal Energy Use Study

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Community Centre

**Lighting Upgrades**

Year:	2017
Customer:	Cumberland Energy Authority
Project:	Springhill Energy Study
Location:	COMMUNITY CENTRE

Site Information				Existing Fixtures									New Fixtures									Load Reduction		Estimated Costs						ENS Rebates		Heating Penalty		Cooling Bonus		NET Electrical Savings		Existing Fixtures		New Fixtures		Total										
Interior / Exterior	Area / Room / Zone	Primary Heat Source	Heating System Efficiency	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wks/year)	Schedule (hr/year)	kWh/year	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wks/year)	Schedule (hr/year)	kWh/year	Connected Load (kW)	kWh/year	Material Costs per Fixture	Labor Costs per Fixture	Other costs per Fixture	Total Costs per Fixture	Fixture Sub-total Cost	Contingency & Allowance (15%)	Tax (15%)	Total Cost	ENS Rebates per fixture	Total ENS Rebates	¢	Heating Cost (\$)	kW	kWh/year	kW	kWh/year	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Maintenance Savings (\$/year)
Interior	Various Locations	Heat Pump	400%	Linear T8 Fluorescent	104	34	20,000			100%	4	72	52	3,744	13,239	Linear LED Tubes	104	20	25,000			100%	2	72	52	3,754	7,809	1	5,430	\$15	\$2	\$17	\$1,768	\$0	\$265	\$2,033	\$4	\$416	-1	-11	0.1	105	1.6	5,535	5.341880342	\$4	\$78	6.7	\$4	\$62	\$15	
					<b>4</b>									<b>13,239</b>		<b>2</b>											<b>7,809</b>	<b>1</b>	<b>5,430</b>	<b>\$1,768</b>	<b>\$0</b>	<b>\$265</b>	<b>\$2,033</b>	<b>\$416</b>	<b>-1</b>	<b>-11</b>	<b>0.1</b>	<b>105</b>	<b>1.6</b>	<b>5,535</b>							<b>\$15</b>					

**Assumptions:**

Air Conditioning COP	3.1
Building Voltage	
GJ Prices (Base Charge + Gas Cost) - DND	\$15.10



## Springhill Geothermal Energy Use Study

Golden Opportunities Vocational Rehabilitation Centre

### **Lighting Upgrades**

Year:	2017
Customer:	Cumberland Energy Authority
Project:	Springhill Energy Study
Location:	GOVRC

Site Information				Existing Fixtures								New Fixtures								Load Reduction		Estimated Costs						ENS Rebates		Heating Penalty		Cooling Bonus		Net Electrical Savings		Existing Fixtures			New Fixtures			Total										
Interior / Exterior	Area / Room / Zone	Primary Heat Source	Heating System Efficiency	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wk/day)	Schedule (hr/year)	kWh/year	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wk/day)	Schedule (hr/year)	kWh/year	Connected Load (kW)	kWh/year	Material Costs per Fixture	Labor Costs per Fixture	Other costs per Fixture	Total Costs per fixture	Fixture Sub-total Cost	Contingency & Allowance (15%)	Tax (15%)	Total Cost	ENS Rebates per fixture	Total ENS Rebates	GJ	Heating Cost (\$)	kWh	kWh/year	kWh	kWh/year	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Maintenance Savings (\$/year)
Interior	Various	Oil FA	80%	4 Lamp 4' T12	1	160	20,000			100%	0	60	52	3,120	499	4 Lamp LED	1	80	25,000			100%	0	60	52	3,129	250	0	249	\$100	\$60	\$160	\$160	\$24	\$184	\$51	0	-1	0.0	5	0.1	254	6.41025641	\$60	\$9	8.0	\$60	\$8	\$2			
Interior	Various	Oil FA	80%	2 Lamp 8' T12	10	160	20,000			100%	2	60	52	3,120	4,992	4 Lamp LED	10	80	25,000			100%	1	60	52	3,129	2,503	1	2,489	\$100	\$60	\$160	\$1,600	\$240	\$1,840	\$507	0	-5	0.1	48	0.9	2,537	6.41025641	\$60	\$94	8.0	\$60	\$75	\$19			
Interior	Various	Oil FA	80%	2 Lamp T12	32	80	20,000			100%	3	60	52	3,120	7,987	2 Lamp LED	32	40	25,000			100%	1	60	52	3,129	4,005	1	3,983	\$60	\$30	\$90	\$2,880	\$432	\$3,312	\$812	0	0	0.1	77	1.4	4,060	6.41025641	\$30	\$150	8.0	\$30	\$120	\$30			
Interior	Various	Oil FA	80%	Linear T8	96	32	20,000			100%	3	60	52	3,120	9,585	Linear LED	96	20	25,000			100%	2	60	52	3,129	6,007	1	3,578	\$15	\$2	\$17	\$1,632	\$245	\$1,877	\$729	0	0	0.1	69	1.2	3,647	6.41025641	\$10	\$150	8.0	\$10	\$120	\$30			
Interior	Various	Oil FA	80%	Incandescent	5	100	20,000			100%	1	60	52	3,120	1,560	LED Lamp	5	7	50,000			100%	0	60	52	3,129	109	0	1,451	\$8	\$2	\$10	\$50	\$8	\$58	\$296	0	0	0.0	28	0.5	1,479	6.41025641	\$4	\$3	16.0	\$4	\$1	\$2			
					<b>8</b>									<b>24,623</b>		<b>4</b>											<b>12,874</b>	<b>4</b>	<b>11,749</b>			<b>\$6,322</b>	<b>\$0</b>	<b>\$948</b>	<b>\$7,270</b>	<b>\$2,395</b>	<b>0</b>	<b>-6</b>	<b>0.3</b>	<b>227</b>	<b>4.1</b>	<b>11,976</b>						<b>\$81</b>				

**Assumptions:**

Air Conditioning COP	3.1
Building Voltage	
GJ Prices (Base Charge + Gas Cost) - DND	\$15.10



## Springhill Geothermal Energy Use Study

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Public Works

**Lighting Upgrades**

Year:	2017
Customer:	Cumberland Energy Authority
Project:	Springhill Energy Study
Location:	PUBLIC WORKS

Site Information				Existing Fixtures										New Fixtures										Load Reduction		Estimated Costs							ENS Rebates		Heating Penalty		Cooling Bonus		Net Electrical Savings		Existing Fixtures			New Fixtures			Total					
Interior / Exterior	Area / Room / Zone	Primary Heat Source	Heating System Efficiency	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wk/year)	Schedule (hr/year)	Wht/year	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wk/year)	Schedule (hr/year)	Wht/year	Connected Load (kW)	Wht/year	Material Costs per Fixture	Labor Costs per Fixture	Other costs per Fixture	Total Costs per Fixture	Fixture Sub-total Cost	Contingency & Allowance (15%)	Tax (1.9%)	Total Cost	ENS Rebates per Fixture	Total ENS Rebates	GJ	Heating Cost (\$)	KW	Wht/year	KW	Wht/year	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Maintenance Savings (\$/year)
Interior	Various	Oil Forced Air	80%	400 W Metal Halide	19	458	20,000			100%	9	60	52	3,120	27,150	LED	19	150	100,000			100%	3	60	52	3,129	8,916	6	18,234	\$500	\$100	\$600	\$11,400		\$1,710	\$13,110	\$195	\$3,705	-3	-38	0.5	352	6.3	18,586	6.41025641	\$100	\$296	32.0	\$100	\$59	\$237	
Interior	Various	Oil Forced Air	80%	T8 Linear Fluorescent	32	34	20,000			100%	1	60	52	3,120	3,395	Linear LED	32	20	25,000			100%	1	60	52	3,129	2,002	0	1,392	\$15	\$2	\$17	\$544		\$82	\$626	\$8	\$256	0	-3	0.0	27	0.5	1,419	6.41025641	\$4	\$20	8.0	\$4	\$16	\$4	
Interior	Various	Oil Forced Air	80%	2 Lamp T12 Linear Fluorescent	5	80	20,000			100%	0	60	52	3,120	1,248	2 Lamp LED	5	40	25,000			100%	0	60	52	3,129	626	0	622	\$60	\$30	\$90	\$450		\$68	\$518	\$25	\$125	0	0	0.0	12	0.2	634	6.41025641	\$8	\$6	8.0	\$8	\$5	\$1	
					<b>10</b>									<b>31,793</b>		<b>4</b>											<b>11,544</b>	<b>7</b>	<b>20,248</b>				<b>\$12,394</b>	<b>\$0</b>	<b>\$1,859</b>	<b>\$14,253</b>	<b>\$4,086</b>	<b>-3</b>	<b>-41</b>	<b>0.5</b>	<b>391</b>	<b>7.0</b>	<b>20,640</b>						<b>\$242</b>			

**Assumptions:**

Air Conditioning COP	3.1
Building Voltage	
GJ Prices (Base Charge + Gas Cost) - DND	\$15.10

Voltage



## Springhill Geothermal Energy Use Study

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BWAY Packaging

**Lighting Upgrades**

Year:	2017
Customer:	Cumberland Energy Authority
Project:	Springhill Energy Study
Location:	BWAY

Site Information				Existing Fixtures								New Fixtures								Load Reduction		Estimated Costs						ENS Rebates		Heating Penalty		Cooling Bonus		Net Electrical Savings		Existing Fixtures			New Fixtures			Total										
Interior / Exterior	Area / Room / Zone	Primary Heat Source	Heating System Efficiency	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wks/year)	Schedule (hr/year)	kWh/year	Type	Fixture Quantity	Watts per Fixture	Lamp Life (hours)	Foot Candles	Control Method	Dimming Factor	Connected Load (kW)	Schedule (hr/week)	Schedule (wks/year)	Schedule (hr/year)	kWh/year	Connected Load (kW)	kWh/year	Material Costs per Fixture	Labor Costs per Fixture	Other costs per Fixture	Total Costs per fixture	Fixture Sub-total Cost	Contingency & Allowance (15%)	Tax (15%)	Total Cost	ENS Rebates per fixture	Total ENS Rebates	GJ	Heating Cost (\$)	kWh	kWh/year	kWh	kWh/year	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Relamp Frequency (years)	Relamp Cost (\$/fixture, incl. labour and materials)	Total Annual Maintenance Cost	Maintenance Savings (\$/year)
Interior	Manufacturing Area	Heat Pump	400%	HB Metal Halide	173	458	25,000			100%	79	72	52	3,744	296,652	HB LEDs	173	150	100,000			100%	26	72	52	3,754	97,424	53	199,228	\$500	\$100	\$600	\$103,800	\$0	\$15,570	\$119,370	\$130	\$22,490	-28	-416	4.4	3,851	57.7	203,080	6.677350427	\$150	\$3,886	26.6	\$200	\$1,299	\$2,587	
Interior	Manufacturing Area	Heat Pump	400%	T8 Linear Fluorescent	1142	34	20,000			100%	39	72	52	3,744	145,372	Linear LED	1142	20	25,000			100%	23	72	52	3,754	85,748	16	59,624	\$15	\$2	\$17	\$19,414	\$0	\$2,912	\$22,326	\$4	\$4,568	-8	-124	1.3	1,153	17.3	60,777	5.341880342	\$4	\$855	6.7	\$4	\$686	\$169	
					<b>118</b>									<b>442,024</b>		<b>49</b>											<b>183,172</b>	<b>69</b>	<b>258,853</b>				<b>\$123,214</b>	<b>\$0</b>	<b>\$18,482</b>	<b>\$141,696</b>	<b>\$27,058</b>	<b>-36</b>	<b>-540</b>	<b>5.7</b>	<b>5,004</b>	<b>75.0</b>	<b>263,856</b>						<b>\$2,756</b>			

**Assumptions:**

Air Conditioning COP	3.1
Building Voltage	
GJ Prices (Base Charge + Gas Cost) - DND	\$15.10

## BWAY Packaging

### **Free cooling for Production**

We conducted the analysis using a RETScreen model that was developed based on information from site and consultations. What follows is a third-party (Enermagic) energy model and conceptual layout under winter/summer operation.

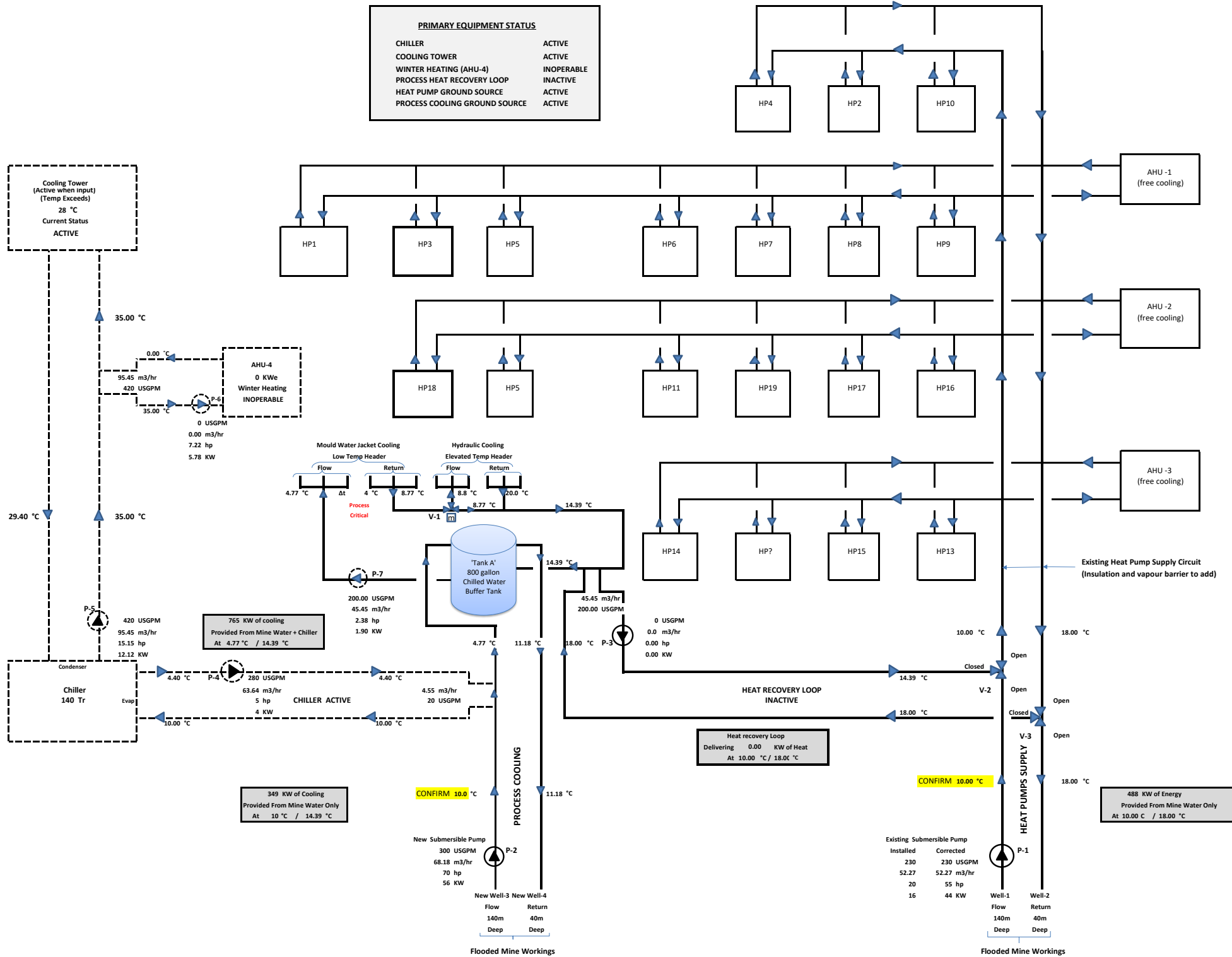


### **Free cooling for Production: Enemagic Model Summer Operation with Chiller**

Enemagic conceptual layout under summer operation with the 140T existing chiller included

**BWAY PACKING CANADA**  
**Springhill Plant**  
**Proposed Modifications to**  
**Geo Thermal HVAC & Chilled Water Services**

**SUMMER OPERATION**



PRIMARY EQUIPMENT STATUS		
CHILLER		ACTIVE
COOLING TOWER		ACTIVE
WINTER HEATING (AHU-4)		INOPERABLE
PROCESS HEAT RECOVERY LOOP		INACTIVE
HEAT PUMP GROUND SOURCE		ACTIVE
PROCESS COOLING GROUND SOURCE		ACTIVE

PUMP SCHEDULE		Max Pumping Rate	Set Pumping Rate	Head	Power
Reference	Purpose	USGPM	M <sup>3</sup> /Hr	Metre	Feet
P-1	Heat Pump Ground Source	230	52.27	200	656
P-2	Process Cooling Ground Source	300	68.18	200	656
P-3	Heat Recovery Loop	180	40.91	20	66
P-4	Chiller Evap Output	280	63.64	15	49
P-5	Chiller Cond Output	420	95.45	15	100
P-6	AHU-4 Winter Heat (Chiller source)	400	90.91	15	49
Check P-7	Mould WJ Cooling	200	45.45	10	33
Check P-8	Hydraulic Cooling	100	22.73	10	33

SUNDRY DEVICES		Purpose	% Flo to Load
V-1	3 port mixing valve	Temp control Hydraulic cooling	50%
V-2	3 port mixing valve	Heat Pump Cct energy source	Auto
V-3	3 port mixing valve	Heat Pump Cct energy source	Auto

CHILLER SCHEDULE		Capacity	Condenser	Evaporator
Reference	Tons r	KWe	Flow Rate	Flow Rate
C-1	70 Tr	246 KW	210 gpm 47.73 m <sup>3</sup> /hr	140 gpm 31.82 m <sup>3</sup> /hr
C-2	80 Tr	281 KW	240 gpm 54.55 m <sup>3</sup> /hr	160 gpm 36.36 m <sup>3</sup> /hr
C-3	140 Tr	492 KW	420 gpm 95.45 m <sup>3</sup> /hr	280 gpm 63.64 m <sup>3</sup> /hr

HEAT PUMP SCHEDULE		Heat Output	COP	Power Cons
Reference	BTU <sup>3</sup>	KW		KW
HP1	60	17.58426	5	5
HP2	70	20.51497	5.9	5.9
HP3	60	17.58426	5	5
HP4	70	20.51497	5.9	5.9
HP5	60	17.58426	5	5
HP6	60	17.58426	5	5
HP7	70	20.51497	5.9	5.9
HP8	70	20.51497	5.9	5.9
HP9	60	17.58426	5	5
HP10	70	20.51497	5.9	5.9
HP11	90	26.3764	7.5	7.5
HP12	90	26.3764	7.5	7.5
HP13	90	26.3764	7.5	7.5
HP14	90	26.3764	7.5	7.5
HP15	90	26.3764	7.5	7.5
HP16	60	17.58426	5	5
HP17	AC only			
HP18	AC only			
HP19	70	20.51497	5.9	5.9
HP20	Fresh Air			
<b>Total Heat Output</b>		<b>1230 BTU</b>		
<b>Total Heat Output</b>		<b>360.4774 KWe</b>		
<b>Total Power Consumption</b>		<b>103 KW</b>		

Existing Submersible Pump		Well-1	Well-2
Installed	Corrected	Flow	Return
230	230 USGPM	140m	40m
52.27	52.27 m <sup>3</sup> /hr	Deep	Deep
20	55 hp		
16	44 KW		

New Submersible Pump		New Well-3	New Well-4
Installed	Corrected	Flow	Return
300 USGPM	300 USGPM	140m	40m
68.18 m <sup>3</sup> /hr	68.18 m <sup>3</sup> /hr	Deep	Deep
70 hp	70 hp		
56 KW	56 KW		

765 KW of cooling  
 Provided From Mine Water + Chiller  
 At 4.77 °C / 14.39 °C

349 KW of Cooling  
 Provided From Mine Water Only  
 At 10 °C / 14.39 °C

Heat recovery Loop  
 Delivering 0.00 KW of Heat  
 At 10.00 °C / 18.00 °C

488 KW of Energy  
 Provided From Mine Water Only  
 At 10.00 °C / 18.00 °C

**BWAY PACKING CANADA  
SUMMARY**

ITEM	Energy Consumption	Energy Production	Energy Savings	System COP
Original Geo Thermal System (HP Supply)		488 KWe	444 KWe	11.09
P-1 Submersible Pump	44.00 KW			
Existing Water to Air Heat Pumps		360 KWe	257 KWe	3.5
HP compressors and Fans	102.99 KW			
New Geo Thermal System (Process Cooling)		349 KWe	293 KWe	6.23
P-2 Submersible Pump	56.00 KW			
Process Heat Recovery Loop		0 KWe	0 KWe	0.00
P-3 Circulating Pump	0.00 KW			
Winter Space Heating		0 KWe	0 KWe	0.00
P-6 Supply pump to AHU-4	5.78 KW			
* Cooling Tower Load Reduction	0.00 KW			0.00
** Process Chiller - 1    70 Tr		)		
Process Chiller - 2    80 Tr		) Yet to complete to address implications of deleted chillers and towers?		
Process Chiller - 3    140 Tr		)		
<b>SUMMARY</b>	<b>Consumption 208.77 KW</b>	<b>Production 1197 KWe</b>	<b>Saving 994 KWe</b>	<b>C.O.P 5.74</b>

Note: Assumes all water to air heat pumps are operational in same mode (i.e. either heating or cooling) which may not be the case. Adjustment may be necessary to address thi

**Notes**

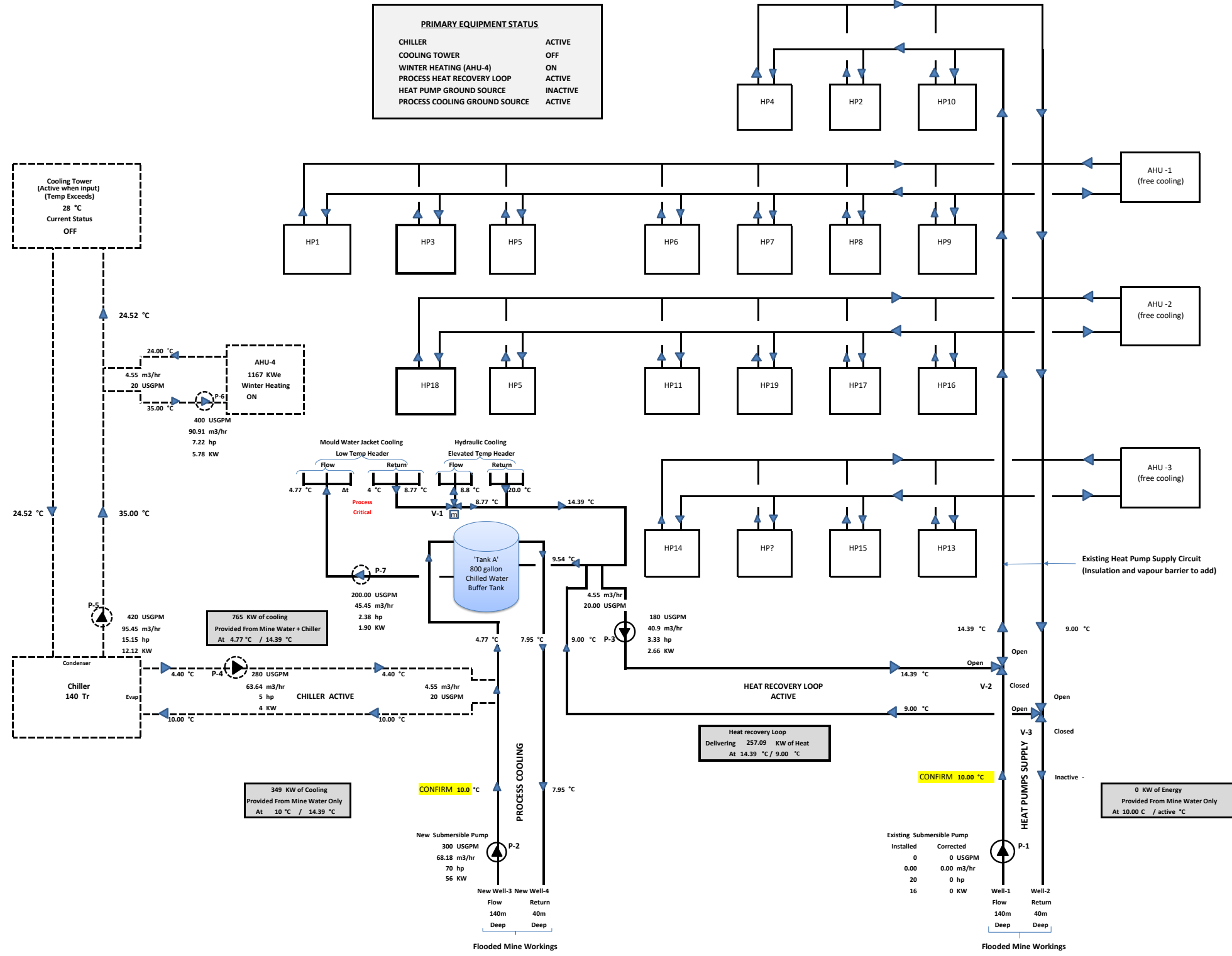
- \* If cooling by ground source only can be achieved the following can be ignored. Tower saving winter only unless cooling load can be met by ground source. Power, water and chemical consumption to establish to quantify savings.
- \*\* If the ground source is able to meet the process cooling load year round at temperatures acceptable by the process requirements the chillers and their associated cooling towers could be omitted. This would however cancel 1167KW of winter space heating proposed to be recovered from the chiller condenser discharge. Offset would be applicable.

These figures represent instantaneous peak values at the stated temperatures and flow rates. Adjustments have yet to be established and applied for load and diversity factors along with operational hours of the various systems. When done, this will facilitate the production of reasonable indications of likely energy savings that could be achieved in use and along with budget capital and operational costs, the

**Free cooling for Production: Enermagic Model Winter Operation with Chiller**

Enermagic conceptual layout under winter operation with the 140T existing chiller included

WINTER OPERATION



**PUMP SCHEDULE**

Reference	Purpose	Max Pumping Rate		Set Pumping Rate		Head	Power		
		USGPM	M <sup>3</sup> /hr	USGPM	M <sup>3</sup> /hr		Metre	Feet	HP
P-1	Process Cooling Ground Source	230	52.27	0	0.00	200	656	55.00	44.00
P-2	Heat Pump Ground Source	300	68.18	300	68.18	200	656	70.00	56.00
P-3	Heat Recovery Loop	180	40.91	180	40.91	20	66	4.29	3.43
P-4	Chiller Evap Output	280	63.64	280	63.64	15	49	5.00	4.00
P-5	Chiller Cond Output	420	95.45	420	95.45	15	100	15.15	12.12
P-6	AHU-4 Winter Heat (Chiller source)	400	90.91	400	90.91	15	49	7.22	5.78
Check	P-7 Mould WJ Cooling	200	45.45	200	45.45	10	33	2.38	1.90
Check	P-8 Hydraulic Cooling	100	22.73	100	22.73	10	33	3.33	2.66

**SUNDRY DEVICES**

Reference	Description	Purpose	% Flo to Load
V-1	3 port mixing valve	Temp control Hydraulic cooling	50%
V-2	3 port mixing valve	Heat Pump Cct energy source	Auto
V-3	3 port mixing valve	Heat Pump Cct energy source	Auto

**CHILLER SCHEDULE**

Reference	Capacity	3 Flow Rate	Condenser T in	T out	2 Flow Rate	Evaporator T in	T out			
C-1	70 Tr	246 KW	210 gpm	47.73 m <sup>3</sup> /hr	29.4 °C	35 °C	140 gpm	31.82 m <sup>3</sup> /hr	10 °C	### °C
C-2	80 Tr	281 KW	240 gpm	54.55 m <sup>3</sup> /hr	29.4 °C	35 °C	160 gpm	36.36 m <sup>3</sup> /hr	10 °C	### °C
C-3	140 Tr	492 KW	420 gpm	95.45 m <sup>3</sup> /hr	29.4 °C	35 °C	280 gpm	63.64 m <sup>3</sup> /hr	10 °C	### °C

**HEAT PUMP SCHEDULE**

Reference	Heat Output	0.000293 COP	3.5 Power Cons
HP1	60	17.58426	5
HP2	70	20.51497	5.9
HP3	60	17.58426	5
HP4	70	20.51497	5.9
HP5	60	17.58426	5
HP6	60	17.58426	5
HP7	70	20.51497	5.9
HP8	70	20.51497	5.9
HP9	60	17.58426	5
HP10	70	20.51497	5.9
HP11	90	26.3764	7.5
HP12	90	26.3764	7.5
HP13	90	26.3764	7.5
HP14	90	26.3764	7.5
HP15	90	26.3764	7.5
HP16	60	17.58426	5
HP17	AC only		
HP18	AC only		
HP19	70	20.51497	5.9
HP20	Fresh Air		

**Total Heat Output 1230 BTU**  
**Total Heat Output 360.4774 KWe**  
**Total Power Consumption 103 KW**

**BWAY PACKING CANADA  
SUMMARY**

ITEM	Energy Consumption	Energy Production	Energy Savings	System COP
Original Geo Thermal System (HP Supply)		0 KWe	0 KWe	0.00
P-1 Submersible Pump	0.00 KW			
Existing Water to Air Heat Pumps		360 KWe	257 KWe	3.5
HP compressors and Fans	102.99 KW			
New Geo Thermal System (Process Cooling)		349 KWe	293 KWe	6.23
P-2 Submersible Pump	56.00 KW			
Process Heat Recovery Loop		257 KWe	254 KWe	96.51
P-3 Circulating Pump	2.66 KW			
Winter Space Heating		1167 KWe	1161 KWe	201.99
P-6 Supply pump to AHU-4	5.78 KW			
* Cooling Tower Load Reduction	0.00 KW			0.00
** Process Chiller - 1    70 Tr		)		
Process Chiller - 2    80 Tr		) Yet to complete to address implications of deleted chillers and towers?		
Process Chiller - 3    140 Tr		)		
<b>SUMMARY</b>	<b>Consumption 167.43 KW</b>	<b>Production 2133 KWe</b>	<b>Saving 1966 KWe</b>	<b>C.O.P 12.74</b>

Note: Assumes all water to air heat pumps are operational in same mode (i.e. either heating or cooling) which may not be the case. Adjustment may be necessary to address thi

- Notes
- \* If cooling by ground source only can be achieved the following can be ignored. Tower saving winter only unless cooling load can be met by ground source. Power, water and chemical consumption to establish to quantify savings.
  - \*\* If the ground source is able to meet the process cooling load year round at temperatures acceptable by the process requirements the chillers and their associated cooling towers could be omitted. This would however cancel 1167KW of winter space heating proposed to be recovered from the chiller condenser discharge. Offset would be applicable.

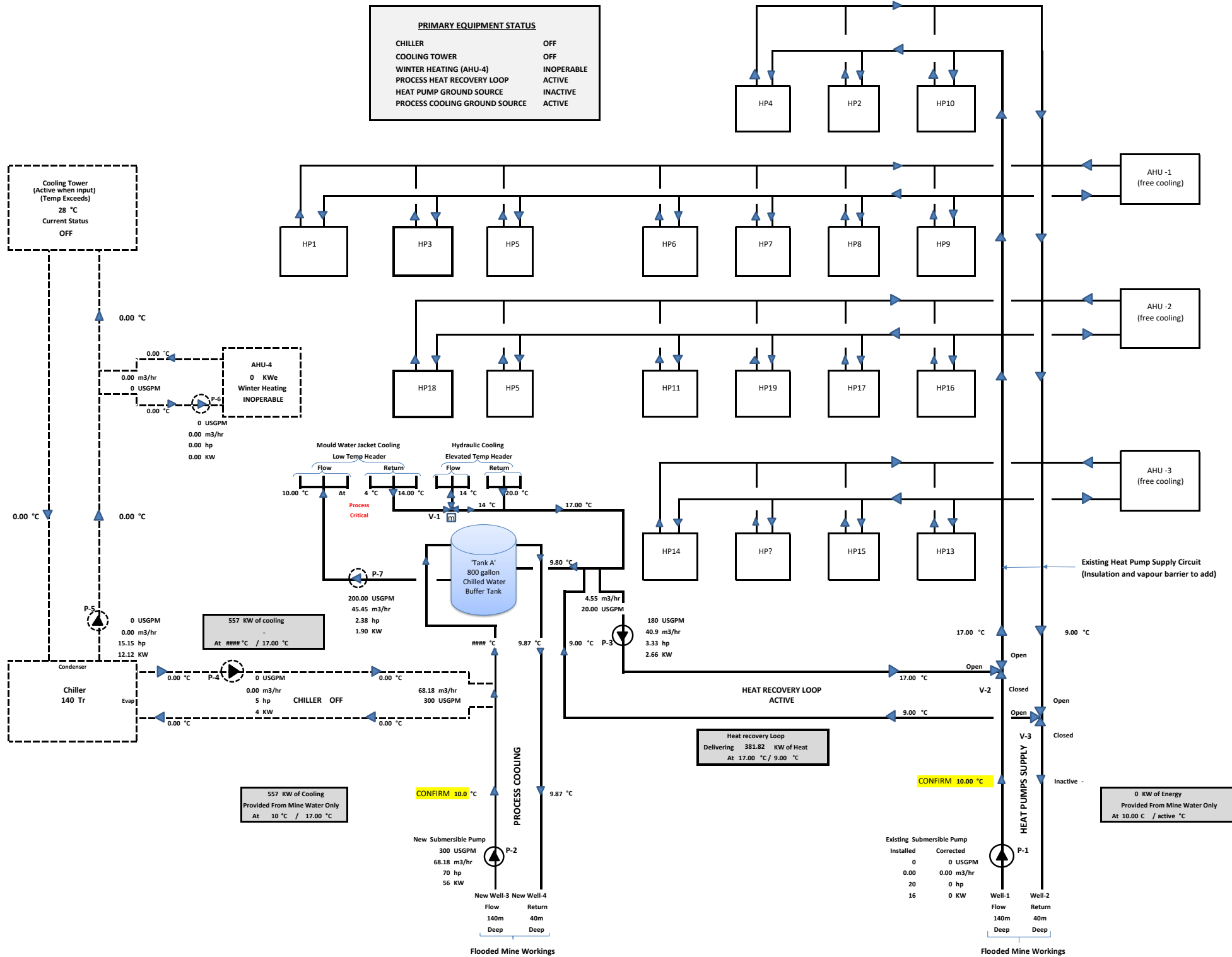
These figures represent instantaneous peak values at the stated temperatures and flow rates. Adjustments have yet to be established and applied for load and diversity factors along with operational hours of the various systems. When done, this will facilitate the production of reasonable indications of likely energy savings that could be achieved in use and along with budget capital and operational costs, the

### **Free cooling for Production: Enermagic Model Winter Operation without Chiller**

Enermagic conceptual layout under winter operation without mechanical cooling

**BWAY PACKING CANADA**  
**Springhill Plant**  
**Proposed Modifications to**  
**Geo Thermal HVAC & Chilled Water Services**

**WINTER OPERATION**



PRIMARY EQUIPMENT STATUS	
CHILLER	OFF
COOLING TOWER	OFF
WINTER HEATING (AHU-4)	INOPERABLE
PROCESS HEAT RECOVERY LOOP	ACTIVE
HEAT PUMP GROUND SOURCE	INACTIVE
PROCESS COOLING GROUND SOURCE	ACTIVE

PUMP SCHEDULE		Max Pumping Rate		Set Pumping Rate		Head		Power	
Reference	Purpose	USGPM	M <sup>3</sup> /Hr	USGPM	M <sup>3</sup> /Hr	Metre	Feet	HP	KW
P-1	Process Cooling Ground Source	230	52.27	0	0.00	200	656	55.00	44.00
P-2	Heat Pump Ground Source	300	68.18	300	68.18	200	656	70.00	56.00
P-3	Heat Recovery Loop	180	40.91	180	40.91	20	66	4.29	3.43
P-4	Chiller Evap Output	280	63.64	0	0.00	15	49	5.00	4.00
P-5	Chiller Cond Output	420	95.45	0	0.00	15	100	15.15	12.12
P-6	AHU-4 Winter Heat (Chiller source)	400	90.91	0	0.00	15	49	7.22	5.78
Check	P-7 Mould WJ Cooling	200	45.45	200	45.45	10	33	2.38	1.90
Check	P-8 Hydraulic Cooling	100	22.73	100	22.73	10	33	3.33	2.66

SUNDRY DEVICES		Purpose		% Flo to Load
Reference	Description			
V-1	3 port mixing valve	Temp control Hydraulic cooling		50%
V-2	3 port mixing valve	Heat Pump Cct energy source		Auto
V-3	3 port mixing valve	Heat Pump Cct energy source		Auto

CHILLER SCHEDULE		Condenser		Evaporator					
Reference	Capacity	Flow Rate	T in	T out	Flow Rate	T in	T out		
C-1	70 Tr	210 gpm	47.73 m <sup>3</sup> /hr	29.4 °C	35 °C	140 gpm	31.82 m <sup>3</sup> /hr	10 °C	### °C
C-2	80 Tr	240 gpm	54.55 m <sup>3</sup> /hr	29.4 °C	35 °C	160 gpm	36.36 m <sup>3</sup> /hr	10 °C	### °C
C-3	140 Tr	420 gpm	95.45 m <sup>3</sup> /hr	29.4 °C	35 °C	280 gpm	63.64 m <sup>3</sup> /hr	10 °C	### °C

HEAT PUMP SCHEDULE		Heat Output	COP	Power Cons
Reference		BTU <sup>3</sup> KW	3.5	KW
HP1	60	17.58426		5
HP2	70	20.51497		5.9
HP3	60	17.58426		5
HP4	70	20.51497		5.9
HP5	60	17.58426		5
HP6	60	17.58426		5
HP7	70	20.51497		5.9
HP8	70	20.51497		5.9
HP9	60	17.58426		5
HP10	70	20.51497		5.9
HP11	90	26.3764		7.5
HP12	90	26.3764		7.5
HP13	90	26.3764		7.5
HP14	90	26.3764		7.5
HP15	90	26.3764		7.5
HP16	60	17.58426		5
HP17	AC only			
HP18	AC only			
HP19	70	20.51497		5.9
HP20	Fresh Air			
<b>Total Heat Output</b>		<b>1230 BTU</b>		
<b>Total Heat Output</b>		<b>360.4774 KWe</b>		
<b>Total Power Consumption</b>		<b>103 KW</b>		

**BWAY PACKING CANADA  
SUMMARY**

ITEM	Energy Consumption	Energy Production	Energy Savings	System COP
Original Geo Thermal System (HP Supply)		0 KWe	0 KWe	0.00
P-1 Submersible Pump	0.00 KW			
Existing Water to Air Heat Pumps		360 KWe	257 KWe	3.5
HP compressors and Fans	102.99 KW			
New Geo Thermal System (Process Cooling)		557 KWe	501 KWe	9.94
P-2 Submersible Pump	56.00 KW			
Process Heat Recovery Loop		382 KWe	379 KWe	143.33
P-3 Circulating Pump	2.66 KW			
Winter Space Heating		0 KWe	0 KWe	0.00
P-6 Supply pump to AHU-4	0.00 KW			
* Cooling Tower Load Reduction	0.00 KW			0.00
** Process Chiller - 1    70 Tr		)		
Process Chiller - 2    80 Tr		) Yet to complete to address implications of deleted chillers and towers?		
Process Chiller - 3    140 Tr		)		
<b>SUMMARY</b>	<b>Consumption 161.66 KW</b>	<b>Production 1299 KWe</b>	<b>Saving 1137 KWe</b>	<b>C.O.P 8.04</b>

Note: Assumes all water to air heat pumps are operational in same mode (i.e. either heating or cooling) which may not be the case. Adjustment may be necessary to address thi

- Notes
- \* If cooling by ground source only can be achieved the following can be ignored. Tower saving winter only unless cooling load can be met by ground source. Power, water and chemical consumption to establish to quantify savings.
  - \*\* If the ground source is able to meet the process cooling load year round at temperatures acceptable by the process requirements the chillers and their associated cooling towers could be omitted. This would however cancel 1167KW of winter space heating proposed to be recovered from the chiller condenser discharge. Offset would be applicable.

These figures represent instantaneous peak values at the stated temperatures and flow rates. Adjustments have yet to be established and applied for load and diversity factors along with operational hours of the various systems. When done, this will facilitate the production of reasonable indications of likely energy savings that could be achieved in use and along with budget capital and operational costs, the



## Existing Cooling System: Enermagic Tables

Enermagic projections of current cooling system efficiency

**BWAY PACKING CANADA  
SUMMARY**

**Introduction**

The following tables contain performance projections for the existing water to air geothermal space heating and cooling system and the fro the 3 process cooling chillers (i.e. the 70 tr, 80 tr and the 140 tr chillers including associated cooling towers and condenser circulating pumps). Projections for Winter and Summer operations have been included to illustrate the seasonal effect on cooling towers and the differing outputs of the water to air heat pumps when operating in heating (winter) and cooling (summer) modes.

**WINTER OPERATION**

ITEM	Energy Consumption	Gross Production	Net Production	System COP
Original Geo Thermal System (HP Supply)				
P-1 Submersible Pump	16.00 KW			
Existing Water to Air Heat Pumps		360 KWe	241 KWe	3.03
HP compressors and Fans	118.99 KW including 16KW from above			
Process Chiller - 1 70 Tr	42.00 KW	246 KWe	197 KWe	4.97
C-1 Cooling Tower & circ. pump	7.50 KW			
Process Chiller - 2 80 Tr	48.00 KW	281 KWe	226 KWe	5.06
C-2 Cooling Tower & circ. pump	7.50 KW			
Process Chiller -3 140 Tr	84.00 KW	492 KWe	394 KWe	5.02
C-3 & C-4 Cooling Towers & circ. pump	14.00 KW			
<b>SUMMARY</b>	<b>System Consumption 338 KW</b>	<b>Gross Total 1379 KWe</b>	<b>Net Total 1057 KWe</b>	<b>C.O.P 4.08</b>

**SUMMER OPERATION**

ITEM	Energy Consumption	Gross Production	Net Production	System COP
Original Geo Thermal System (HP Supply)				
P-1 Submersible Pump	16.00 KW			
Existing Water to Air Heat Pumps		252 KWe	133 KWe	2.12
HP compressors and Fans	118.99 KW including 16KW from above			
Process Chiller - 1 70 Tr	42.00 KW	246 KWe	192 KWe	4.56
C-1 Cooling Tower & circ. pump	12.00 KW			
Process Chiller - 2 80 Tr	48.00 KW	281 KWe	221 KWe	4.68
C-2 Cooling Tower & circ. pump	12.00 KW			
Process Chiller -3 140 Tr	84.00 KW	492 KWe	380 KWe	4.39
C-3 & C-4 Cooling Towers & circ. pump	28.00 KW			
<b>SUMMARY</b>	<b>System Consumption 361 KW</b>	<b>Production 1271 KWe</b>	<b>Net Production 926 KWe</b>	<b>C.O.P 3.52</b>

### **Power Factor Correction**

Details for Savings Calculation:

Present Maximum Demand: 2,493 kVA

Corrected Maximum Demand: 2,301 kVa

Reduction in Monthly Maximum Demand: 192 kVa

This given an assumed power factor of 0.9 which is realistically increased to 0.975 with the use of capacitor banks.

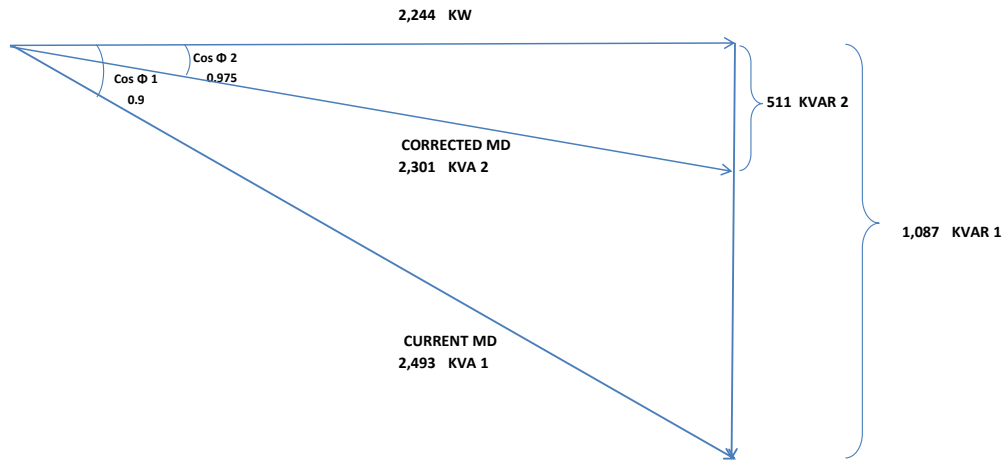
As a utility charge of \$11.95/kVA of maximum demand this equates to the following savings:

Monthly Savings: \$2,300

Yearly Savings: \$27,500

**BWAY PACKING CANADA - SPRING HILL FACILITY**

**Power Factor Correction from  
0.9 lagging (estimated) to 0.975 lagging**



Cos Θ	Deg
0.975	12.84
0.95	18.19
0.85	31.79
0.75	41.41

From the Pythagorean theorem  
 $KVA^2 = KW^2 + KVAR^2$

KVA <sup>2</sup>	KW <sup>2</sup>	KVA <sup>2</sup> - KW <sup>2</sup>	Sq Rt
6215049	5034189.69	1180859	1086.67
5295663	5034189.69	261473.4	<u>511.34</u>
Correction to be applied			575.33
Rounded down to			<b>570 KVAR</b>

**Methodology**

- Step -1 KVA 1 established from historical electricity account at 2,493 KVA.
- Step -2 Cos Φ 1 established from manufacturers data for large motors operating without power factor correction which typically vary between 0.5 for motors operating under no load or cyclic load conditions up to 0.85 lagging when operating on full load. An average figure of 0.7 was selected for the purpose of calculation.
- Step -3 KW established from the formula  $KW = KVA 1 \times \text{Cos } \Phi 1 = 2,244 \text{ KW}$
- Step -4 KVAR 1 established from the Pythagorean theorem ( $KVAR 1 = \sqrt{KVA^2 - KW^2} = 1,087 \text{ KVAR}$ )
- Step -5 Cos Φ 2 Is the target Power Factor which has been set at 0.975 lagging.
- Step -6 KVAR 2 repeat Step -4 for No 2 values ( $KVAR 2 = \sqrt{KVA 2^2 - KW^2} = 511 \text{ KVAR}$ )
- Step -7 Result  $KVAR 1 - KVAR 2 = \text{Capacitive Correction to be added to the system to improve the power factor from 0.90 to 0.975 lagging} = 570 \text{ KVAR}$   
**producing a reduction in the monthly demand of 192 KVA**

Utility charge per KVA	\$11.95	=	<b>\$2,291.64 Saving per month</b>
			<b>\$27,499.71 Saving per annum</b>
Equipment Cost	\$ 90.00	per KVAR installed	
<b>Total Installed Cost</b>	<b>\$ 51,300</b>		
<b>Payback</b>	<b>22.39 months</b>		

**Note:**  
 An optimally designed power factor correction system should pay for itself in less than two years

## Appendix B: Energy Benchmarking Supporting Documents

The following data was used in the energy benchmarking analysis carried out for participating facilities in the Springhill Industrial park.

### Community Centre

#### Electricity Rates

The electrical service provider for the Community Centre is Nova Scotia Power (NSP). Based on current consumption, the Community Centre is billed under NSP's Commercial General Tariff (11M). Current demand and energy rates are as follows:

##### Demand charge

- \$10.497 per month per kilowatt of maximum demand

##### Energy Charge

- \$0.11784 per kilowatt hour for the first 200 kilowatt hours per month per kilowatt of maximum demand
- \$0.08505 per kilowatt hour for all additional kilowatt hours

#### Electricity Usage

Electricity usage (kWh) at the Community Centre is displayed in the table and chart below and are based on NSP metered data (meter # 104664).

	2014	2015	2016	2017
January	148,320	112,680	105,120	92,520
February	104,400	104,760	113,760	89,640
March	113,400	123,480	122,760	95,040
April	71,280	85,320	61,425	78,480
May	82,800	75,600	62,244	62,640
June	36,360	65,880	40,131	46,080
July	41,040	38,520	34,560	
August	87,120	113,040	115,920	
September	142,200	150,120	153,360	
October	140,400	129,960	142,200	
November	135,000	130,320	135,360	
December	132,120	119,520	100,080	
<b>Total</b>	<b>1,234,440</b>	<b>1,249,200</b>	<b>1,186,920</b>	<b>-</b>

Table: Community Centre - Electrical Energy Consumption (2014-2017 YTD)

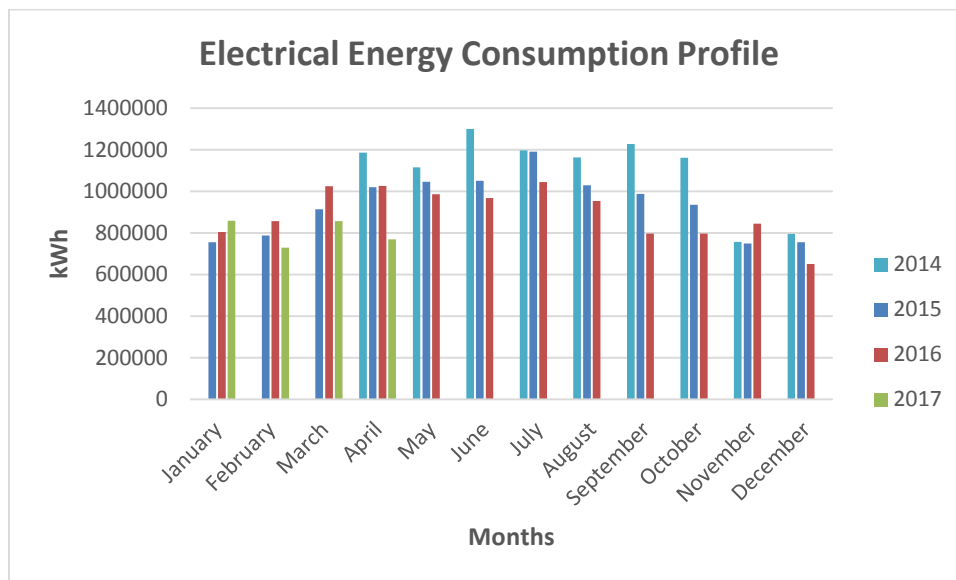


Chart: Community Centre - Electrical Consumption Profile (2014-2017 YTD)

	Annual Consumption (kWh)	Annual Utility Cost (CAD \$)
2014	1,234,440	\$144,037
2015	1,249,200	\$151,777
2016	1,186,920	\$140,423
2017 (YTD)	464,400	\$60,388

Table: Annual community center consumptions and costs

## GOVRC

### Electricity Rates

The electrical service provider for GOVRC is Nova Scotia Power (NSP). Based on current consumption, the GOVRC is billed under NSP's Domestic Service Tariff (4B). Energy rates are as follows:

#### Energy Charge

- \$0.15063 per kilowatt hour

### Oil Usage

Oil usages at GOVRC are displayed in the tables and charts below.

	Annual Oil Consumption (L)
2012	1,867
2013	1,208
2014	3,142
2015	2,351
2016	2,688

Table: GOVRC (Greenhouse) – Oil Consumption (2012-2016)

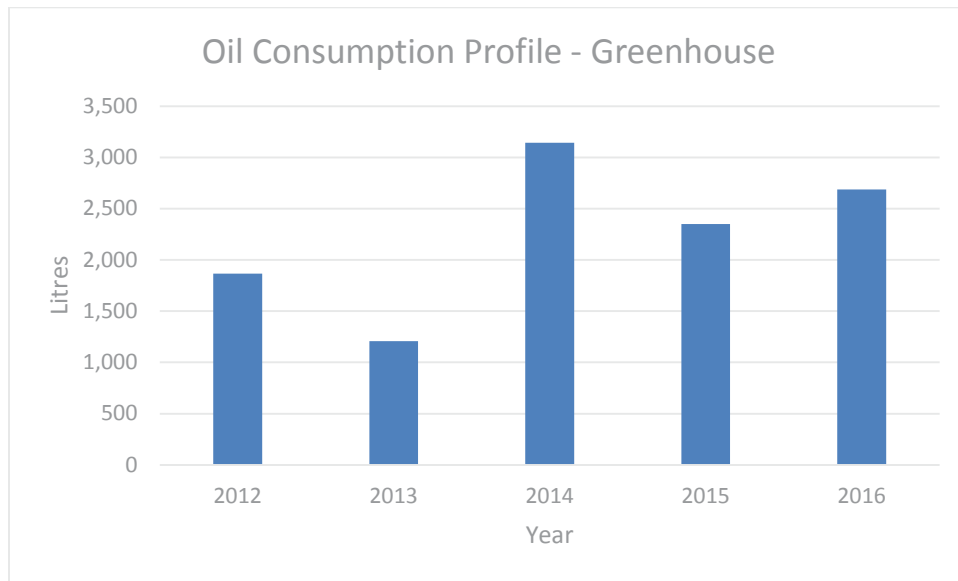


Chart: GOVRC (Greenhouse) - Oil Consumption Profile (2012-2016)

	Oil Consumption (L)
2012	1,829
2013	2,616
2014	1,537
2015	1,427
2016	637

Table: GOVRC (Main Building) – Oil Consumption (2012-2016)

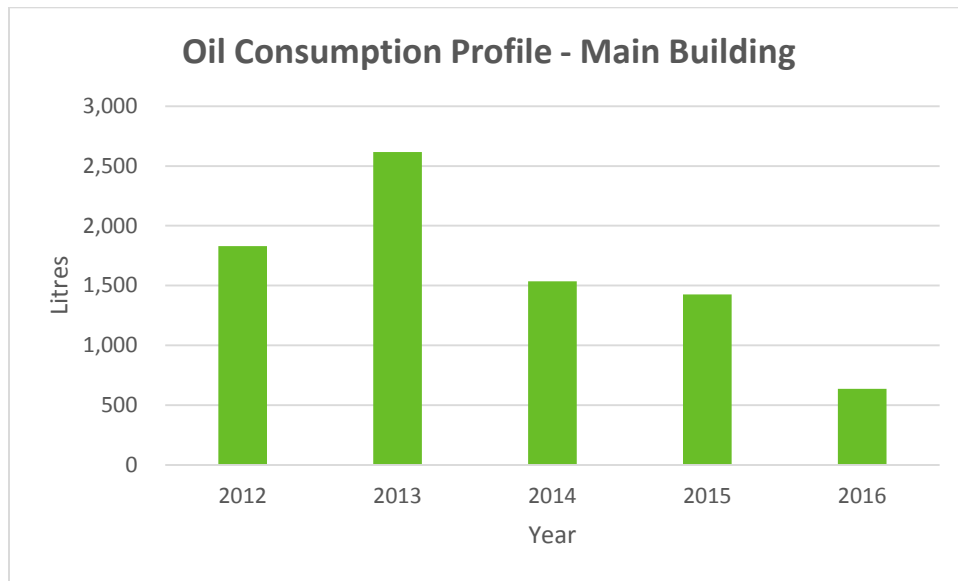


Chart: GOVRC (Main Building) - Oil Consumption Profile (2012-2016)

## Electricity Usage

Electricity usage (kWh) at GOVRC is displayed in the tables and charts below and is based on NSP metered data (meter # 0359734-1, 0475078-2, 1293952-6).

	2013	2014	2015	2016
Mid January - Mid March	2,768	3,462	2,274	3,703
Mid March - Mid May	3,762	3,258	3,769	4,664
Mid May - Mid July	3,645	3,685	3,704	
Mid July - Mid Sept	3,992	2,761	3,748	
Mid Sept - Mid Nov	2,701	2,570	2,688	
Mid Nov - Mid Jan	2,114	1,907	2,070	
<b>Total</b>	<b>18,982</b>	<b>17,643</b>	<b>18,253</b>	<b>-</b>

Table: GOVRC (Greenhouse) - Electrical Consumption (2013-2016)

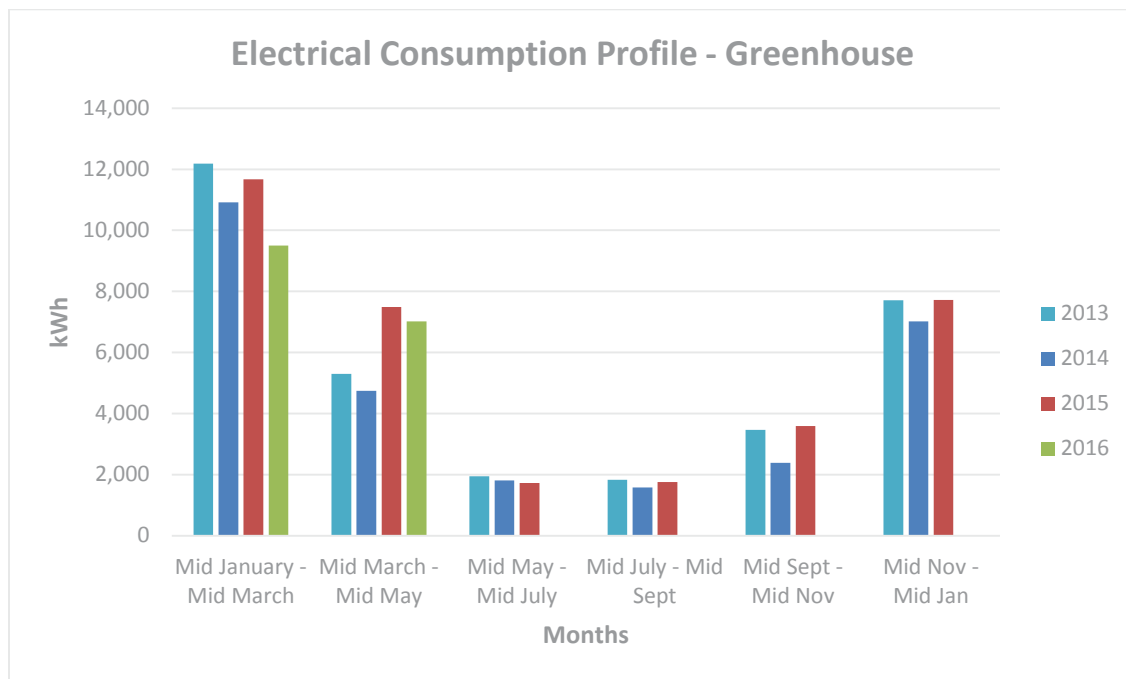


Chart: GOVRC (Greenhouse) - Electrical Consumption Profile (2013-2016)

	2013	2014	2015	2016
Mid January - Mid March	15,709	9,675	13,025	11,841
Mid March - Mid May	15,532	8,475	12,135	11,931
Mid May - Mid July	4,162	1,634	6,990	-
Mid July - Mid Sept	506	3,168	5,057	-
Mid Sept - Mid Nov	3,642	4,095	3,654	-
Mid Nov - Mid Jan	8,976	10,491	7,887	-
<b>Total Row</b>	<b>48,527</b>	<b>37,538</b>	<b>48,748</b>	<b>-</b>

Table: GOVRC (Main Building) - Electrical Consumption (2013-2016)

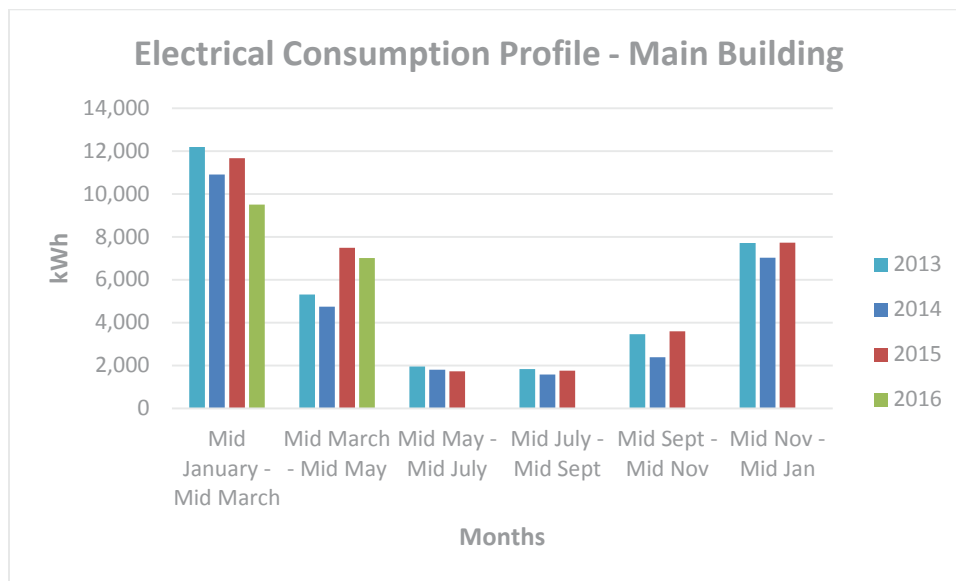


Chart: GOVRC (Main Building) - Electrical Consumption Profile (2013-2016)

	2013	2014	2015	2016
Mid January - Mid March	12,183	10,912	11,671	9,497
Mid March - Mid May	5,305	4,741	7,495	7,017
Mid May - Mid July	1,948	1,806	1,727	-
Mid July - Mid Sept	1,830	1,575	1,760	-
Mid Sept - Mid Nov	3,464	2,385	3,587	-
Mid Nov - Mid Jan	7,713	7,019	7,725	-
<b>Total Row</b>	<b>32,443</b>	<b>28,438</b>	<b>33,965</b>	<b>-</b>

Table: GOVRC(Main Building) - Electrical Consumption (2013-2016)

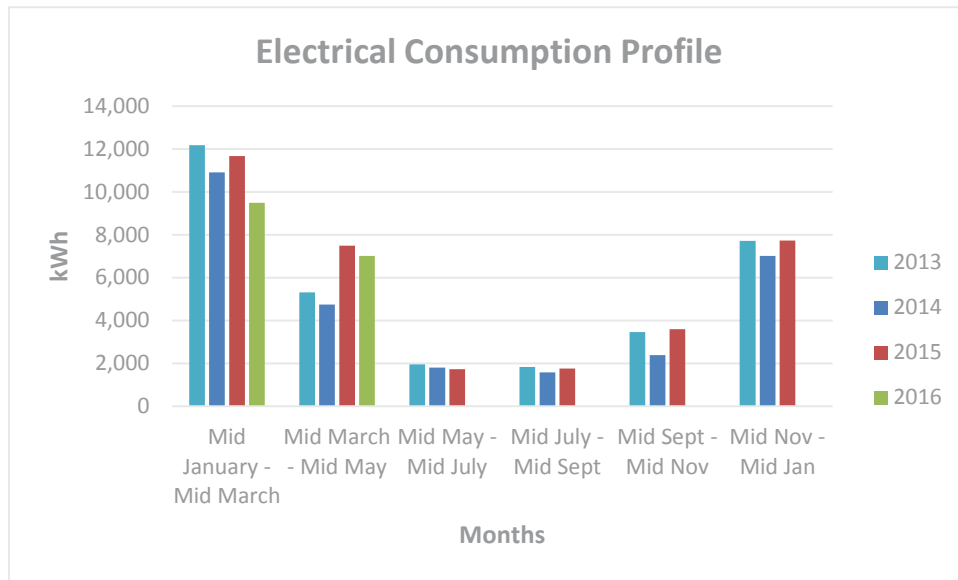


Chart: GOVRC(Workshop) - Electrical Consumption Profile (2013-2016)

## BWAY Packaging

### Electricity Rates

The electrical service provider for BWAY Packaging is Nova Scotia Power (NSP). Based on current consumption, the BWAY Packaging is billed under NSP's Large Industrial Tariff (23M) and Interruptible Rider (25M). Energy rates are as follows:

#### Demand charge

- \$11.995 per month per kilovolt ampere of maximum demand of the current month or the maximum actual demand of the previous December, January or February occurring in the previous eleven (11) months. Interruptible service will receive a \$3.43 per month per kilovolt ampere reduction in demand charge for billed interruptible demand.

#### Energy Charge

- \$0.07683 per kilowatt hour for interruptible customers.

### Electricity Usage

Electricity usage (kWh) at BWAY Packaging is displayed in the table and chart below and are based on NSP metered data (meter # 358008).

	2014	2015	2016	2017
January		756,120	804,528	858,312p
February		787,752	856,728	729,600
March		914,424	1,024,800	857,736
April	1,186,272	1,020,000	1,027,248	769,560
May	1,116,000	1,046,400	986,376	
June	1,300,800	1,050,624	967,560	
July	1,197,600	1,190,880	1,044,456	
August	1,164,000	1,029,696	954,360	
September	1,228,800	988,680	796,704	
October	1,162,584	935,232	796,896	
November	757,368	749,544	844,800	
December	796,152	755,568	651,288	
<b>Total</b>	-	11,224,920	10,755,744	-

Table: BWAY Packaging - Electrical Energy Consumption (2014-2017)

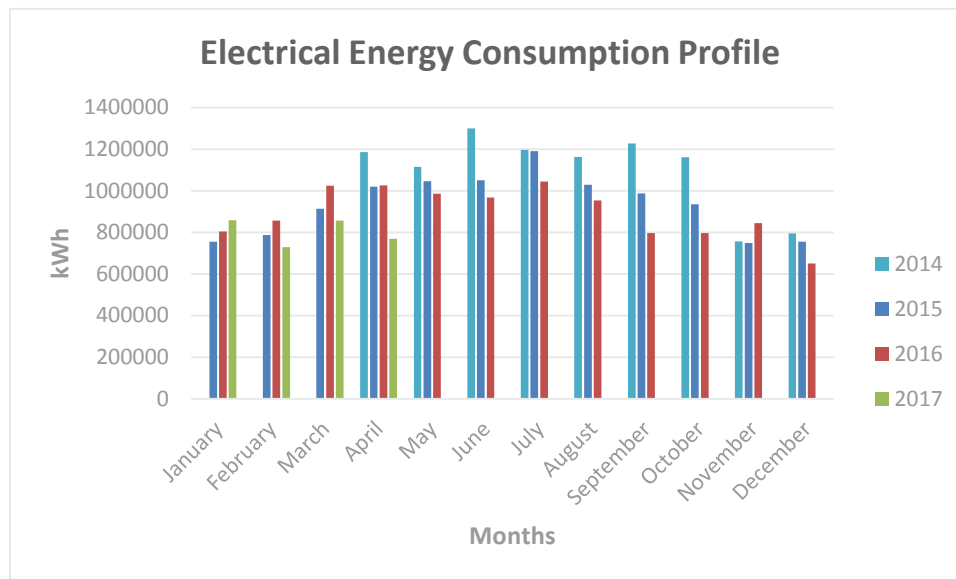


Chart: BWAY Packaging - Electrical Consumption Profile (2014-2017)



## Appendix D: Study Team

### Errol Pereira – M. Eng. – Manager of Engineering

Errol is the Engineering Manager at EfficiencyOne where he manages a team of Onsite Energy Managers and provides engineering expertise to programs. He previously managed a suite of three commercial and industrial energy efficiency programs, and a team of engineering project coordinators. During his career, Errol has conducted energy audits, and designed and implemented measurement and verification plans for commercial, industrial and institutional clients. He has also worked in the utility industry and at a large pulp and paper mill where he was involved in baseline assessments and implementation of process ventilation efficiency upgrades.

Errol is a Mechanical Engineer, and holds a Master's in Engineering, focusing on power generation, renewable technologies and nonlinear control systems, from the University of Toronto. He is also a Certified Energy Manager, a Certified Energy Auditor, and a Certified Measurement and Verification Professional.

Errol was project lead and supervised the engineering team on this project.

### David Brushett – P. Eng. – Engineering Manager (Cape Breton Regional Municipality)

David is a professional engineer with EfficiencyOne having prior experience as an energy consultant to the private sector. He holds a Mechanical Engineering degree from Dalhousie University. He has spent the past two years developing a strategic energy efficiency plan, identifying opportunities and managing efficiency projects at Cape Breton Regional Municipality (CBRM). The impact of his work at CBRM is electrical utility savings of greater than \$400,000 per year.

David worked as part of the engineering team contributing to the energy management opportunity analysis, energy benchmarking analysis and measurement analysis at BWAY Packaging and the Community Centre.

### David Bligh – P. Eng. – Engineering Manager (Nova Scotia Health Authority)

David has been an Onsite Energy Manager for EfficiencyOne since 2012, working with the Nova Scotia Health Authority (NSHA), the largest healthcare organization on Canada's east coast. As the primary liaison between NSHA and Efficiency Nova Scotia, he manages energy efficiency programs and projects at more than 80 buildings across 48 hospital sites. David is an experienced energy auditor of healthcare, institutional, and other commercial buildings and regularly conducts ASHRAE Level 2 and 3 audits. During his three-year term at NSHA, David has delivered to his client a US\$1.5 million per year reduction in utility costs with total capital spending of US\$2.4 million. He has also managed employee engagement and communication programs designed to reduce cost associated with utilities and waste.

David holds a Master's of Applied Science degree, specializing in Mechanical Engineering, from Dalhousie University, and a Certificate of Applied Science from Acadia University. He is a Professional Engineer, a Certified Energy Manager, and a Certified Measurement and Verification Professional.

David worked as part of the engineering team on this project contributing to the energy auditing and measurement analysis at BWAY Packaging and the Community Centre.

### Ahmed Zaki – P. Eng. – Engineering Manager (Canadian Forces Base Halifax)

Ahmed is a professional engineer and an Onsite Energy Manager at EfficiencyOne where he is embedded at the Canadian Forces Base in Halifax in the province of Nova Scotia. He is responsible for energy management planning, conducting energy audits and the implementation of energy efficiency projects.

Ahmed is an Electrical Engineer and holds a Master's in Engineering from Dalhousie University. He is also a Certified Energy Manager, a Certified Energy Auditor, a Certified Measurement and Verification Professional, and an Existing Building Commissioning Professional.

Ahmed worked as part of the engineering team on this project contributing to the energy benchmarking analysis and reporting.

### Charles (Chuck) Faulkner, P. Eng. – General Manager, EfficiencyOne Services

Chuck is the General Manager of EfficiencyOne Services. He is a professional engineer who has specialized in the field of energy efficiency since 1991. During his career, Chuck has been involved in many facets of energy efficiency, including commercial/industrial/institutional energy auditing, retrofitting large facilities, optimizing retrofit savings, and developing and managing utility programs.

Chuck holds a Bachelor's degree in Engineering (Mechanical) from the Technical University of Nova Scotia (now Dalhousie University). He also holds a Certificate in Applied Science from Acadia University. Chuck earned the designation of Professional Engineer in 1993.

Chuck's role on this project was to provide management and technical advice to the project team.

## Appendix E: Corporate Qualifications

### About EfficiencyOne Services

Based in Nova Scotia, Canada, EfficiencyOne Services is a subsidiary of EfficiencyOne (efficiencyone.com). With annual revenues of approximately CAD \$50 million, EfficiencyOne employs 90 professionals and more than 100 trade partners to operate the Efficiency Nova Scotia franchise (efficiencyns.ca). The franchise is Canada's first regulated energy efficiency utility, offering a suite of energy conservation services to residential, commercial and industrial clients in Nova Scotia.



EfficiencyOne's corporate philosophies embody continual innovation, achieving verified energy savings and sustaining a high level of customer satisfaction. Its success has garnered wide recognition and established the company as an energy efficiency industry leader.

Through EfficiencyOne Services, EfficiencyOne markets its expertise and services to governments, utilities and private sector customers outside of Nova Scotia.

**Cumberland Public Libraries  
Brief Report- County  
February, 2021**

**3.1**

**April Public Meeting**

The Board will hold its annual Public Meeting on April 27, 2021 via Facebook live. Information on how to attend will be posted closer to the date.

**Library Tour**

Chief Librarian, Denise Corey would invites Councillors and staff to book a (socially distanced) tour of any of the County libraries. Please contact her to book your time.

**River Hebert Library**

The River Hebert Library remains closed due to Covid-19 restrictions. Patrons can pick up items at the Four Fathers Library in Amherst or have items mailed to them for free through the library's Borrow by Mail program. WiFi is still active at the River Hebert branch and patrons used 426 hours in December.

**Statistics**

In the month of December, Cumberland Public Libraries signed out over 5,483 items. This includes books, movies, TV shows, magazines and more. The county library's checked out 1,318 items.

Also, in December Cumberland Public Libraries offered 30 virtual programs with 409 views and distributed 111 Take and Make crafts.

**Next Board meeting April 8, 2021.**

## MEMORANDUM

**TO:** Council  
**FROM:** Jennifer Moore  
**DATE:** February 2, 2021  
**RE:** Tax Collection Memo for January 2021

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4.1

### **Tax Collection Report**

Total outstanding receivables as of January 31, 2021 are \$2,956,252 as compared to \$3,293,856 January 31, 2020.

The finance team collected \$250,975 in revenue during the month of January 2021. Overall collections continue to be positive.

### **Tax Sale Update**

Finance staff have scheduled a tax sale by tender for March 16, 2021. This is advertised on our website and those requesting to be notified of upcoming tax sales have been e-mailed. As this sale is a sealed tender bid the phones have been busy with inquiries and we are already receiving sealed tenders. Three of the accounts scheduled have been paid off in full and removed from the sale. There are 45 accounts remaining on the list with a total of \$266,553.98 in outstanding receivables. Of the 45 accounts remaining, there are 29 accounts for which council has authorized a minimum bid of \$100. I am hopeful that we receive bids higher than the \$100 however am more hopeful to get these accounts active once again. The other 16 accounts are ones that are remaining from the April 28, 2020 sale that was postponed due to covid-19.

The 2019 Preliminary tax sale list that was compiled on November 24, 2020 and comprised 1008 accounts and \$2,062,804.93 in outstanding receivables is shrinking due to payments of accounts. We now sit at a total of 528 accounts with an outstanding receivables balance of \$1,145,981.

Our office will send out a second preliminary notice to the remaining accounts in the near future before sending them for title search.

**Municipality of the County of Cumberland**  
**Tax Collection Report**  
**January 31, 2021**

	Current Year				Prior Year	
	Current Month		Previous Month		January-20	
	January-21	%	December-20	%	January-20	%
Current	1,284,160	43%	1,442,048	45%	1,603,187	49%
One Year	555,582	19%	614,427	19%	821,917	25%
Two Year	410,274	14%	430,740	13%	240,273	7%
Three Years	166,680	6%	172,984	5%	167,374	5%
Four Years & Older	539,555	18%	547,027	17%	461,105	14%
<b>Parrsboro</b>						
<b>Total Outstanding</b>	<b>2,956,252</b>	<b>100%</b>	<b>3,207,226</b>	<b>100%</b>	<b>3,293,856</b>	<b>100%</b>

Difference Between This Month and Last Month (250,975)

Difference Between This Year and Last Year (337,605)

Difference Between 2019/20 & 2020/21 Tax Levy (489,136)

**Collection Rates**

**Differences between this year and last year - Current taxes**

Current Year Taxes Outstanding	1,284,160	5.8%	1,603,187	7.0%
Total Tax Levy	22,290,873		22,780,009	

**Total Collection Rate 94.2%**

**93.0%**

**Differences between this year and last year - Arrears taxes**

Arrears Taxes Outstanding	1,672,091	7.5%	1,690,670	7.4%
Total Tax Levy	22,290,873		22,780,009	

**Total Collection Rate 92.5%**

**92.6%**

**Differences between this month and last month**

Monthly Outstanding	2,956,252	13.3%	3,207,226	14.4%
	22,290,873		22,290,873	

**Collection Rate 86.7%**

**85.6%**

**Municipality of the County of Cumberland**  
**Tax Collection Report**  
**31-Jan-21**

	<u>31-Jan-21</u>	<u>31-Jan-20</u>
<b>Tax Receivable</b>		
Current	1,284,160	1,603,187
Arrears	1,672,092	1,690,669
<b>Total Outstanding</b>	<u>2,956,252</u>	<u>3,293,856</u>
<b>Current Tax Levy</b>	<u>22,290,873</u>	<u>22,780,009</u>
<b>Arrears Balance March 31st</b>	<u>2,722,633</u>	<u>2,877,996</u>
<b>Percent of Current Tax Levy Collected</b>	<u>94.24%</u>	<u>92.96%</u>
<b>Percent of Arrears Collected</b>	<u>39%</u>	<u>41%</u>
<b>Total Outstanding Taxes as % of Levy</b>	<u>13%</u>	<u>14%</u>

<b>Age of Arrears</b>		
One Year	555,582	821,917
Two Year	410,274	240,273
Three Years	166,680	167,374
Four Years & Older	539,556	461,105
	<u>1,672,092</u>	<u>1,690,669</u>

**Taxes Receivable Analysis****31/01/2021**

	# Properties	\$ Outstanding
Current Taxes	4596	436,026
Current Tax Sale - March 16 2021	45	266,554
April 28 2020 postponed sale	20	52,214
2019 Preliminary Tax Sale list	528	1,145,981
Payment Arrangements	80	195,470
Pre-authorized payment accounts	27	3,086
Inactive and B/O Accounts	40	-2,983
Owner Unknown	53	56,535
NS Farm Loan Board	6	3,644
Municipal Properties	23	165,905
Provincial Properties	12	50,122
Federal Properties	0	0
Title Problems/Issue Accounts	133	512,072
Survey req'd	19	71,626
<b>Total Cumberland Receivables as of January 31, 2021</b>	<b>5582</b>	<b>2,956,251</b>

District	\$ Outstanding	% Outstanding Per district
1	289,416.85	9.79%
2	153,017.41	5.18%
3	139,714.53	4.73%
4	265,726.53	8.99%
5	166,723.15	5.64%
6	228,090.80	7.72%
7	92,202.21	3.12%
8	228,141.61	7.72%
9	470,927.35	15.93%
10	280,484.07	9.49%
11	282,085.97	9.54%
12	286,870.05	9.70%
13	75,833.63	2.57%
No District	(2,982.52)	-0.10%
<b>As of January 31, 2021</b>	<b>2,956,251.64</b>	<b>100.0%</b>

## MEMORANDUM

**TO:** Council  
**FROM:** Jennifer Moore  
**DATE:** March 3, 2021  
**RE:** Tax Collection Memo for February 2021

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4.2

### **Tax Collection Report**

Total outstanding receivables as of February 28, 2021 are \$2,771,499 as compared to \$3,114,656 for February 29, 2020.

The finance team collected \$184,754 in revenue during the month of February 2021. Overall collections continue to be positive.

Staff are currently working on Parrsboro Sewer project, preparing for the March 16, 2021 tax sale and reconciling the new districts and all the area rates to be ready for the 2021 tax levy.

### **Tax Sale Update**

The tax sale by tender for March 16, 2021 is approaching quickly. We are now down to 42 accounts for this tax sale. We are working on a process to make this sale run smoothly and will be performing the sale via zoom for transparency to the public. Residents are used to public auctions for tax sales and although we are performing the sale via tender process due to Covid-19 it is important for public to see this process.

The 2019 Preliminary tax sale list that was compiled on November 24, 2020 and comprised 1008 accounts and \$2,062,804.93 in outstanding receivables is shrinking due to payments of accounts. We now sit at a total of 505 accounts with an outstanding receivables balance of \$1,084,744.

Our office will send out a second preliminary notice to the remaining accounts in the near future before sending them for title search.

**Municipality of the County of Cumberland**  
**Tax Collection Report**  
**January 31, 2021**

	Current Year				Prior Year	
	Current Month		Previous Month		January-20	
	January-21	%	December-20	%		%
Current	1,284,160	43%	1,442,048	45%	1,603,187	49%
One Year	555,582	19%	614,427	19%	821,917	25%
Two Year	410,274	14%	430,740	13%	240,273	7%
Three Years	166,680	6%	172,984	5%	167,374	5%
Four Years & Older	539,555	18%	547,027	17%	461,105	14%
<b>Parrsboro</b>						
<b>Total Outstanding</b>	<b>2,956,252</b>	<b>100%</b>	<b>3,207,226</b>	<b>100%</b>	<b>3,293,856</b>	<b>100%</b>

Difference Between This Month and Last Month (250,975)

Difference Between This Year and Last Year (337,605)

Difference Between 2019/20 & 2020/21 Tax Levy (489,136)

**Collection Rates**

**Differences between this year and last year - Current taxes**

Current Year Taxes Outstanding	1,284,160	5.8%	1,603,187	7.0%
Total Tax Levy	22,290,873		22,780,009	

**Total Collection Rate 94.2%**

**93.0%**

**Differences between this year and last year - Arrears taxes**

Arrears Taxes Outstanding	1,672,091	7.5%	1,690,670	7.4%
Total Tax Levy	22,290,873		22,780,009	

**Total Collection Rate 92.5%**

**92.6%**

**Differences between this month and last month**

Monthly Outstanding	2,956,252	13.3%	3,207,226	14.4%
	22,290,873		22,290,873	

**Collection Rate 86.7%**

**85.6%**

**Municipality of the County of Cumberland**  
**Tax Collection Report**  
**28-Feb-21**

	<u>28-Feb-21</u>	<u>29-Feb-20</u>
<b>Tax Receivable</b>		
Current	1,148,054	1,470,330
Arrears	1,623,445	1,644,326
<b>Total Outstanding</b>	<u>2,771,499</u>	<u>3,114,656</u>
<b>Current Tax Levy</b>	<u>22,290,873</u>	<u>22,780,009</u>
<b>Arrears Balance March 31st</b>	<u>2,722,633</u>	<u>2,877,996</u>
<b>Percent of Current Tax Levy Collected</b>	<u>94.85%</u>	<u>93.55%</u>
<b>Percent of Arrears Collected</b>	<u>40%</u>	<u>43%</u>
<b>Total Outstanding Taxes as % of Levy</b>	<u>12%</u>	<u>14%</u>

<b>Age of Arrears</b>		
One Year	525,986	788,918
Two Year	401,707	232,828
Three Years	162,745	165,562
Four Years & Older	533,007	457,018
	<u>1,623,445</u>	<u>1,644,326</u>

**Taxes Receivable Analysis****28/02/2021**

	# Properties	\$ Outstanding
Current Taxes	4682	376,693
Adjorned Tax Sale	1	9,607
Current Tax Sale - March 16 2021	42	257,146
2019 Preliminary Tax Sale list	505	1,084,744
Payment Arrangements	80	177,924
Pre-authorized payment accounts	30	1,012
Inactive and B/O Accounts	40	-2,980
Owner Unknown	53	56,838
NS Farm Loan Board	6	3,682
Municipal Properties	23	168,605
Provincial Properties	3	51,099
Federal Properties	0	0
Title Problems/Issue Accounts	133	515,047
Survey req'd	19	72,082
<b>Total Cumberland Receivables as of February 28, 2021</b>	<b>5617</b>	<b>2,771,499</b>

District	\$ Outstanding	% Outstanding Per district
1	268,480.90	9.69%
2	146,928.19	5.30%
3	114,418.50	4.13%
4	241,359.26	8.71%
5	133,998.30	4.83%
6	211,214.57	7.62%
7	81,195.69	2.93%
8	219,369.91	7.92%
9	466,607.96	16.84%
10	264,599.00	9.55%
11	272,105.19	9.82%
12	259,155.22	9.35%
13	95,044.96	3.43%
No District	(2,979.66)	-0.11%
<b>As of February 28, 2021</b>	<b>2,771,497.99</b>	<b>100.0%</b>