GEOTHERMAL ENERGY TECHNICAL COORDINATOR

COMPILATION REPORT OF GEOTHERMAL AFFILIATED WORK

by

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Executive Summary

Springhill, Nova Scotia, is historically known for its extensive coal mining activities, which began in the 1830’s. The region now leverages its flooded and abandoned coal mines as a sustainable geothermal energy source, utilizing the mine water for heating and cooling applications. Since April of 2023, the Geothermal Energy Technical Coordinator has been working to advance the knowledge of geothermal energy in the Municipality of the County of Cumberland. This document outlines the significance of this geothermal initiative, the challenges faced, proposed solutions, and actionable next steps for further advancement.

Despite the long history of mine water geothermal energy usage in Springhill, it has not yielded widespread use due to a combination of factors, such as: 1) limited data on the thermal and hydraulic characteristics of mine water, including temperature stability and flow rates, 2) the upfront costs associated with drilling wells, installing heat pump systems, and developing the necessary infrastructure can be substantial, and 3) the existing successful applications are on a larger, more centralized scale, such that extending this to individual residential or smaller commercial buildings would require more distributed infrastructure and potentially higher per-unit costs.

To address these challenges, the following solutions were proposed in 2023 1) conduct detailed geological studies to map mine networks and assess temperature, water volumes, and water quality variations, 2) implement small-scale geothermal projects, such as a proposed community greenhouse, 3) foster awareness through regular meetings in Springhill with the multi-stakeholder Geothermal Research Advisory Committee, 4) collaborate with policymakers to establish a clear regulatory framework that defines geothermal operational guidelines, and 5) perform comprehensive cost analyses to evaluate the financial viability of geothermal projects, focusing on potential revenue streams

and government incentives. By following these steps, the Municipality of Cumberland can strengthen its geothermal initiatives, contributing to a sustainable energy future while addressing local economic and environmental challenges.

Springhill's rich history of coal mining, combined with its innovative use of geothermal energy, presents a unique opportunity for sustainable resource development. By addressing knowledge gaps, building on the geologic understanding, engaging the community, and developing a supportive regulatory framework, it is the hope that Springhill can fully realize the benefits of geothermal energy. The successful implementation of these initiatives can serve as a model for similar projects in Nova Scotia and across Canada.

This document also outlines the potential for mid-depth and deep geothermal energy in Cumberland County, Nova Scotia. Mid-depth geothermal, suitable for district heating, utilizes heat pumps to extract heat from depths of 400 to 2,500 m and temperatures of 40°C to 70°C. Deep geothermal, with potential for electricity generation, requires depths greater than 4 or 5 km and temperatures above 80°C, ideally over 150°C for electricity generation. The document highlights significant challenges for deep geothermal, including technological limitations, high costs, and reservoir uncertainty, making it a long-term prospect for electricity generation. It also differentiates between open-loop and closed-loop deep geothermal systems, with open-loop systems directly extracting hot fluids from permeable reservoirs, while closed-loop systems circulate a working fluid in sealed pipes through hot dry rock, offering broader applicability and reduced environmental impact. The Eavor-Loop^{TM} is presented as a Canadian-developed closed-loop system that overcomes geological limitations and provides baseload power without hydraulic fracturing.

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List of Abbreviations

Abbreviation	Meaning
AGS	Advanced Geothermal Systems
cm	centimetre
EGS	Enhanced Geothermal Systems
EkWh	equivalent kilowatt-hour
ft	feet (length)
ft^2	feet squared (area)
GIS	Geographic Information System
GJ	gigajoule
GOVRC	Golden Opportunities Vocational Rehabilitation Centre
GTW	Geothermal well
kg	kilogram
km	kilometre
kWh	kilowatt-hour
L	litre
m	metre (length)
m^2	metres squared (area)
MWh	Megawatt hour
N	North
No.	number
NSCC	Nova Scotia Community College
W	West

List of Symbols

Symbol	Meaning
%	percent
°C	degrees Celsius
°C/km	degrees Celsius per kilometre
ΔT	delta temperature

PART 1: INTRODUCTION

Chapter 1: Introduction to Summary Report

This report is a comprehensive, multi-part document that explores the geothermal energy potential in Springhill, Nova Scotia, and beyond. It begins with foundational context in Part 1 with Chapter 1 introducing this summary report and Chapter 2 providing a broad overview of geothermal energy concepts. Part 2 focuses on mine water geothermal energy, detailing the historical coal mining background of Springhill, the geothermal potential of its flooded mines, and the current state of boreholes and research. It also addresses knowledge gaps and briefly explores the presence of lithium in mine water. Part 3 expands the scope globally, analysing international mine water geothermal projects and technologies, drawing lessons applicable to Springhill. Part 4 shifts to geo-exchange systems in Nova Scotia, highlighting various local projects. Part 5 explores mid-depth and deep geothermal opportunities, particularly in the Cumberland Basin, emphasizing its long-term potential for electricity generation. Part 6 outlines funding initiatives, listing active and past programs that support geothermal development. Part 7 reviews policy and regulatory frameworks, comparing global approaches and suggesting pathways for Nova Scotia. The report concludes with a glossary, references, and six appendices that provide detailed documentation, borehole data, project examples, global inventories, mine plans, and technical data.

Chapter 2: Introduction to Geothermal Energy

Geothermal energy is broadly categorized into conventional systems and unconventional developments (Figure 2-1), each with distinct characteristics and methods of heat extraction. Conventional geothermal systems naturally possess heat, permeability, and fluid, requiring only drilling to depths of less than 3.5 km. They are classified by Khodayar and Björnsson (2024) based on temperature ranges:

1. **Low-Temperature (LT) Systems**
    - Temperature: Less than 100°C.
    - Depth: Generally less than 3 km.
    - Heat Source: Normal geothermal gradient or decaying radiogenic granite.
    - Primary Use: District heating.
    - Location: Can be found in various tectonic contexts.
2. **Medium-Temperature (MT) Systems**
    - Temperature: 100°C to 190°C.
    - Depth: Generally down to 3 km in continental crust and 2-3 km in oceanic crust.
    - Heat Source: Primarily hot intrusions, often volcanic.
    - Primary Use: Electricity generation using binary or flash hybrid power plants, and also heat.
    - Location: Mostly at plate boundaries.
3. **High-Temperature (HT) Systems**
    - Temperature: 190°C to 374°C.
    - Depth: Generally, down to 3 km, occasionally more than 3.5 km.
    - Heat Source: Active volcanism.
    - Primary Use: Primarily electricity generation using flash and hybrid power plants.
    - Location: Mostly in young porous volcanic rocks at active plate boundaries.

Unconventional Geothermal Alternatives have heat but lack natural permeability or fluid, necessitating man-made stimulations for heat extraction, mostly by conduction. They span a wide range of temperatures (8°C to 500°C) and depths (1 m to 20 km). The unconventional approaches can potentially be deployed globally. They are classified by Khodayar and Björnsson (2024) based on the following:

1. **Geothermal HVAC (Heating, Ventilation, and Air Conditioning) & Shallow Geothermal**
    - Depth: Geothermal HVAC operates at 1 to 2 m; shallow geothermal extends down to 500 m in wells.
    - Temperature: Typically captures temperatures below 25°C.
    - Primary Use: Heating and cooling for buildings.
    - Status: Widely functional.
2. **Enhanced Geothermal Systems (EGS)**
    - Concept: Also known as Hot Dry Rock (HDR), EGS involves pumping cold water into hot bedrock to create or enhance fractures, enabling heat capture by conduction and subsequent recovery of hot water.
    - Depth: 2 km to 7 km.
    - Temperature: 100°C to 300°C. Supercritical EGS can target up to 500°C.
    - Primary Aim: Electricity generation.
    - Characteristic: Uses fractures for heat exchange.
3. **Advanced Geothermal Systems (AGS)**
    - Concept: Developed by the Oil and Gas industry, these involve heat recovery from existing hydrocarbon wells or reservoirs. Hot water co-produced with hydrocarbons is used for electricity or heat, then reinjected.
    - Status: Proven in small pilot projects with low output.
4. **Superhot Rock (SHR) Geothermal**
    - Concept: Targets extremely high temperatures (up to 500°C or more) at depths

potentially reaching 20 km, sometimes utilizing millimeter-wave drilling technology.

- Primary Aim: Electricity generation.
- Status: Still experimental, facing significant technological and cost challenges to become fully commercial.

For more detailed information, you can refer to the full paper: "Conventional Geothermal Systems and Unconventional Geothermal Developments: An Overview" by Khodayar and Björnsson (2024).

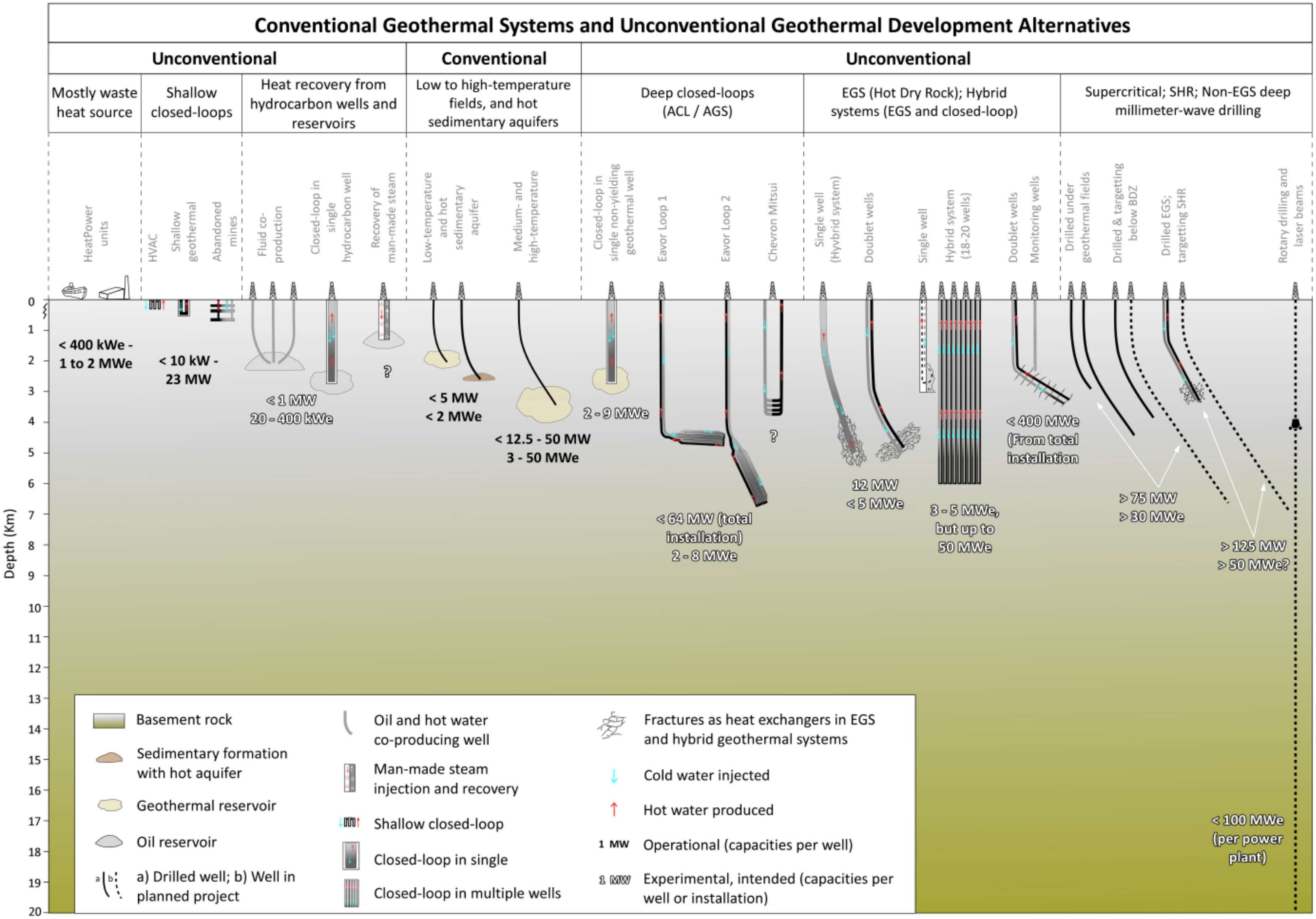

Figure 2-1: Summary of conventional and unconventional geothermal systems (Khodayar and Björnsson, 2024).

PART 2: MINE WATER GEOTHERMAL ENERGY

Chapter 3: Springhill Mine Water Geothermal Energy

There are four main geothermal resource types at play in Nova Scotia. This includes shallow geo-exchange, direct-use of heat from mid-depth aquifers (approximately less than 3 km), electrical generation from deeper geology (beyond 3 km) and lastly and most related to this research, heating and cooling from abandoned mines (known as mine water geothermal). Nova Scotia has an abundance of abandoned legacy mines in parts of Central and Northern regions of the province. Many of these mines have since naturally filled with water that has been warmed by the surrounding rock.

Of all these operations, the former underground coal mines in Springhill, Nova Scotia, have been known as one of the deepest mines in North America. Since the 1980's there have been many examples of local users attempting to capture that mine water energy. This report will compile decades of data, research, and knowledge gained since 2023 on the Springhill mine water opportunity so that it may be available through the Municipality of the County of Cumberland for future endeavors.

3.1 History of Coal Mining in Springhill

Springhill is renowned for its extensive coal seams, which have played a pivotal role in the region's history and development. The coal field in Springhill consists of approximately 60 seams, varying in thickness from as little as 5 cm to as much as 4.3 m (Calder et al., 1993). Among these, five seams (No. 1, No. 2, No. 3, No. 6, and No. 7) were particularly significant and extensively mined (Calder et al., 1993). The Rodney and McCarthy seams were mined on a smaller scale with the Rodney seam coal extracted from an open pit (Calder et al., 1993).

The coal mining activities in Springhill date back to the 1830's, with the area being initially explored by the geologist Abraham Gesner (Museum of Industry, 2025). The industry saw substantial growth with the advent of the Intercolonial and Springhill-to-Parrsboro railways in the 1870's, which facilitated the efficient transport of coal (Museum of Industry, 2025). Springhill's mines became some of the most important in Canada, contributing significantly to the industrialization of Nova Scotia. Today, the legacy of Springhill's coal mining history is preserved at the Springhill Coal Mining National Historic Site, which features a museum and preserved mining structures, offering a glimpse into the region's rich industrial past (Museum of Industry, 2025).

3.2 Overview of the Springhill Coal Seams and Mines

The coal seams in Springhill, Nova Scotia, are part of the Cumberland Coalfield, which contains two main detached coal-bearing areas. The Springhill area, located on the south limb of a westerly plunging syncline, is the more significant of the two. In the geologic cross-sections, the seams are ordered 3, 1, 2, 5, 7, and 6. Their order follows that of their commercial development; hence they are not numbered based on any geometric/stratigraphic reasoning (Ward, 1979). Also note that the seam numbers and mine numbers do not necessarily correspond exactly. An example is Mine No. 4 that worked seams 6 and 7. These bituminous coal seams were crucial to the region's economy, fueling railways and industries throughout the Maritimes and Quebec from the late 19th to the mid-20th centuries (Museum of Industry, 2025). The geological structure of the seams generally shows a westward dip that decreases with depth, though steep inclinations were present in certain areas.

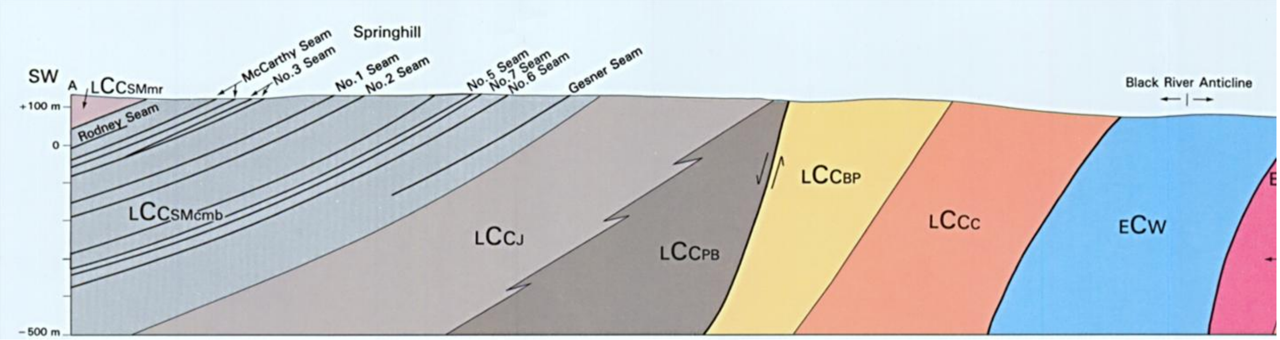

Figure 3-1: Example geologic cross-section showing the primary coal seams of the Springhill area (Calder, 1995). The No. 1, No. 2, No. 3, No. 6, and No. 7 seams are the only seams of the over 60 coal seams in the area to have been mined extensively.

There were 6 extensive underground coal mines (plus some much smaller operations and numerous bootleg coal mines):

- The No. 1 Mine worked coal seam No. 1
- The No. 2 Mine worked coal seam No. 2
- The No. 3 Mine worked coal seam No. 3
- The No. 4 Mine worked coal seams No. 6 and 7 (No. 4 workings typically lumped in with No. 6 and No. 7 seam workings)
- The No. 6 Mine worked coal seam No. 6
- The No. 7 Mine worked coal seam No. 7

Historical Accounts of the Dominion Coal Company Limited

The Louis Frost Notes is a comprehensive document prepared for the Dominion Coal Company Limited in the early to mid-1960’s by Louis Frost, a prominent mining engineer. The notes provide a detailed historical account of coal mining practices and conditions in Nova Scotia, covering over 65 individual mine sites and various general mining topics.

The document includes 172 pages of text, 60 pages of related data, and numerous maps and plans. Frost, who had extensive access to information from the Dominion Coal Company and other sources, compiled this information to create a valuable historical record. The notes have been transcribed to a website with minimal alterations to preserve their original integrity. The website containing this information is as follows: https://www.mininghistory.ns.ca/index2.htm#frost

No. 1 Mine

The Springhill No. 1 Mine, opened in 1872, was the first mine in Springhill and operated until 1896 when a fire led to its closure. The mine experienced a tragic explosion in 1891, resulting in the loss of 125 lives. The coal seam, initially 8 ft thick, split into two 4-foot layers separated by 30 ft of shale as mining progressed.

Despite the challenges, the mine produced high-quality coal. From 1896 to 1916, the lower seam was mined on a small scale, and from 1930 to 1935, both layers were worked using a longwall retreat system. The seam's quality deteriorated over time, leading to the cessation of mining activities in 1951 and 1954 for the upper and lower leaves, respectively. The last operations averaged 600 tons of coal per day.

No. 2 Mine

The Springhill No. 2 Mine in Nova Scotia was opened in 1873 and operated until its closure in October 1958. It was the most extensively worked colliery in the district, producing coal steadily throughout its operational life. The mine reached a record depth of 4,347 ft (1,325 m) vertically and extended 14,600 ft (4,450 m) horizontally from the surface.

Initially, the mining method was room and pillar, but due to increasing cover thickness and frequent heavy "bumps," the method was changed to Longwall Retreating in 1925. The mine faced challenges such as water inbreaks and gas and utilized compressed air and electric equipment for operations.

Despite its depth, the mine maintained low temperatures and produced an average of 1,800 tons of coal per day. The surface equipment served both No. 2 and No. 4 Slopes, with steam-driven hoists and a common wash plant. The colliery was partially electrified before its closure.

No. 3 Mine

The Cumberland Railway and Coal Company Ltd. No. 3 Mine was opened in 1882 and operated until 1916 when a fire led to its closure. Efforts to dewater and repair the mine were undertaken from 1916 to 1925, costing over $600,000. Despite partial dewatering, the mine encountered challenges such as spontaneous combustion and "bumps" due to the thick coal seams.

By 1930, the mine was officially abandoned, leaving significant unworked coal. The seam varied in thickness and quality, with troublesome stone partings in some areas. The mine's history reflects the difficulties and costs associated with deep coal mining operations.

No. 4 Mine

The Springhill No. 4 Mine in Nova Scotia worked the No. 6 and No. 7 Seams, with the main haulage located in the No. 7 Seam. The mine faced challenges with steep ground and dirty coal, leading to discontinuation of certain areas. The No. 7 Seam was particularly prone to bumps, recording 105 between 1943 and 1952. An explosion on November 1, 1956, resulted in the death of 39 miners, leading to the mine's closure and sealing. Rescue operations saved 52 trapped miners, but recovery of the remaining bodies was halted due to ongoing fire risks. The mine was permanently sealed on January 21, 1957.

No. 6 Mine

The Springhill No. 6 Mine was a slope mine on the No. 6 Seam, opened in 1918 to replace the output from the closed No. 3 Mine. It operated until 1929 as a separate colliery and later through No. 4 Mine. The seam was 5 ft 6 inches thick, split by a 3-inch stone band. The mine's inclination varied from 30 to 55 degrees, limiting further development. Most coal was extracted from the South side using room and pillar methods, later switched to retreating longwall. The mine closed on December 3, 1936, with an average daily output of 560 tons. The surface structure was simple, ventilated by a steam-driven fan, and supported by compressors from No. 2 Mine.

No. 7 Mine

The Louis Frost Notes detail the history and operations of the Cumberland Railway and Coal Company's No. 7 Mine, which began in 1919 to compensate for the closure of No. 3 Mine. The mine, located near No. 6 Mine, featured a 4 ft 8 inches thick seam with varying conditions on the north and south sides. Initially using the room and pillar method, the mine later adopted longwall mining techniques due to difficulties in pillar extraction. The mine was known for its wet and moderately gassy conditions, and it utilized electric cap lamps and compressed air-driven coal cutters. The average daily output was 530 tons, and the mine closed in 1933.

Chapter 4: Geothermal Potential of Springhill Mine Water

The geothermal potential for the Springhill Coal Mines is large and was quantified by the Phase 1 report (Comeau et al., 2020). A summary of the heating and cooling capacity potential of the coal mines in Springhill is shown in Table 4-1. Provincially, the No. 2 Mine in Springhill is within the top ten for heating and cooling capacity potential from abandoned mines, along with an underground coal mine from the Westville area and eight underground coal mines from Cape Breton.

Table 4-1: Summary of the six major coal mines in Springhill, Nova Scotia with the estimated heating and cooling capacities in MWh and GJ. The operating periods are provided by Frost (1962); the production amounts and thermal capacities are provided by Comeau et al. (2020).

Name	Operating Period	Total Production (tonnes)	Heating Capacity (MWh)	Heating Capacity (GJ)	Cooling Capacity (MWh)	Cooling Capacity (GJ)
No.1	1872-1954	3,052,000	4,594	16,538	1,342	4,831
No.2	1873-1958	10,822,000	16,289	58,640	4,760	17,136
No.3	1882-1930	258,000	388	1,397	136	490
No.4	1928-1956	3,509,000	5,282	19,015	1,543	5,555
No.6	1918-1936	1,376,000	2,071	7,456	675	2,430
No.7	1919-1933	925,000	1,392	5,011	473	1,703
	Totals	**19,942,000**	**30,016**	**108,057**	**8,929**	**32,145**

The graph below (Figure 4-1) shows the benefit of mine water over other heating/cooling methods, such as air source heat pumps. The graph displays 10 years of temperature data and the solid lines for the average mine water temperature and an indoor temperature of 20°C.

The idea is that with mine water, you are already starting at 15°C and must only increase the temperature to 20°C, as opposed to an air source heat pump, for example, that on a cold -10°C day would have to bump the temperature up to 20°C. The ΔT for mine water is 5°C; the ΔT for the air source heat pump would be 30°C.

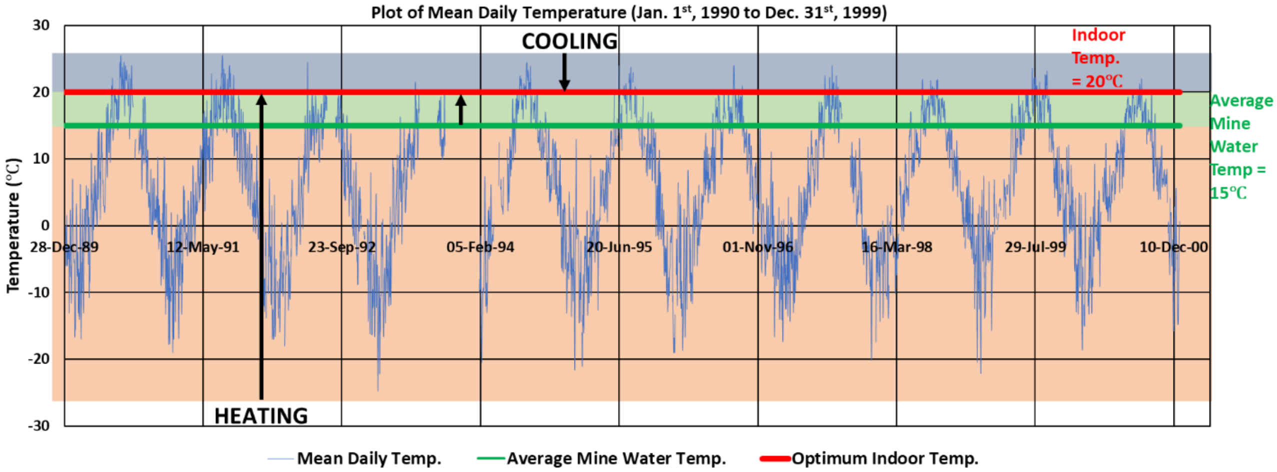

Figure 4-1: Plot of temperature data from Springhill spanning 10 years. The green line shows the average mine water temperature of 15°C and the red line shows the optimum indoor temperature of 20°C.

Geothermal heat pumps generally last significantly longer than regular (air-source) heat pumps (Schaible's Plumbing and Heating Inc., 2025). The indoor geothermal heat pump unit typically lasts approximately 20 to 25 years (Harnish, 2023). The underground ground-loop system (the buried piping system) can last much longer, often 50 years or more, with some estimates suggesting up to 100 years or even 200 years due primarily from being protected from the elements (International Ground Source Heat Pump Association, 2025). Regular air-source heat pumps, for example, generally last between 12 and 20 years, with an average of 15 years.

There are a number of reasons why geothermal heat pumps have greater longevity. One reason is that the main components of a geothermal system (the ground loops) are buried underground, shielding them from harsh weather, temperature fluctuations, and physical damage. Air-source heat pumps, for example, have outdoor units exposed to the elements (Harnish, 2023 and Kensa, 2025). A second reason is geothermal systems draw heat from the relatively constant temperature of the earth, which puts less stress on the system's components compared to air-source heat pumps that have to contend with widely varying outdoor air temperatures (U.S. Department of Energy, 2025). Additionally, because of the stable temperatures and protected environment, geothermal systems often experience less wear and tear, leading to a longer operational life.

While the upfront cost of a geothermal system is generally higher, its significantly longer lifespan and higher energy efficiency can lead to greater long-term savings (McGee Heating and Air, 2025).

4.1 Volumes and Recharge Rates

The flooded former coal mines of Springhill, Nova Scotia, contain more than 5 billion litres of water (Herteis, 2006). This water is hypothesized to circulate by convection (this has not been confirmed nor disproven) and may be recovered at the surface at a temperature generally warmer than typical groundwater (~ 5°C to 7°C) (Jessop et al., 1995). The recharge rates of these mines are likely influenced by various factors, including seasonal variations and the specific characteristics of the mine's geology.

The Springhill Coal Mines were known to be very wet as described by Louis Frost, a mining engineer who worked at these coal mines during their operation. The recharge rates for the No. 2 Mine and the No. 7 Mine were measured by Louis Frost, with the values listed in Table 4-2. The remaining mines recharge rates were inferred based on the measured rates from the No. 2 and No. 7 mines and the production tonnage (Figure 4-2). Understanding the recharge rates of abandoned mines is crucial for several reasons when developing mine water geothermal projects:

1. *Sustainability of Water Supply:* Recharge rates determine how quickly water can replenish in the mine naturally. This is essential to ensure a continuous and sustainable supply of mine water for heating and cooling applications (Tu et al., 2024). Most mine water projects, Springhill included, return the thermally spent water back to the mine, ensuring that the resource is not relying solely on the

natural recharge. A key concept is that current and future mine water operators do not exceed the carrying capacity of the water supply.

2. *System Efficiency:* Accurate knowledge of recharge rates helps in designing efficient geothermal systems. It allows for better prediction of the available thermal energy and helps in optimizing the performance of heat pumps (Morris, 2024).
3. *Pressure Management:* Recharge rates influence the injection pressure required to pump water back into the mine. Proper management of this pressure is vital to avoid system failures and ensure the longevity of the geothermal setup (Tu et al., 2024).
4. *Environmental Impact:* Monitoring recharge rates helps in assessing the environmental impact of geothermal projects. It ensures that the extraction and reinjection processes do not adversely affect the surrounding ecosystem (Morris, 2024).
5. *Economic Viability:* Knowing recharge rates can help in calculating the economic feasibility of the project. It aids in estimating operational costs and potential savings, making the project more attractive to investors (Morris, 2024). The natural recharge is responsible for bringing warm water into the system, thus adding to the mine water resources longevity.

These factors collectively contribute to the successful implementation and operation of mine water geothermal projects, making recharge rates a key parameter to monitor and manage.

Understanding Mine Water Volumes

The mine water volumes for all the Springhill mines have never been accurately calculated, at least not according to the literature reviewed. Jessop et al*.* (1995) calculated the volume of the No. 2 Mine to contain approximately 4 billion litres of water. In 2006, a more comprehensive calculation by Herteis estimated the water volume of the No. 2 Mine to be more than 5 billion litres. Based on the water volume from the No. 2 Mine and knowing the tonnages of coal produced from each of the other coal mines in Springhill, a rudimentary estimate was made of the water volumes of all other coal mines in Springhill (Table 4-2). This estimate was calculated to be approximately 10 billion litres. To accurately calculate the true mine water volume of all the Springhill coal Mines, a procedure similar to Herteis (2006) should be applied. In a similar manner, understanding the water volumes in abandoned mines is essential for several reasons when developing mine water geothermal projects:

1. *Heat Capacity:* The volume of water directly affects the heat capacity of the geothermal system. Larger volumes can store more thermal energy, making the system more efficient for heating and cooling applications (Ramos et al*.*, 2015). The "Assessment of Geothermal Resources in Onshore Nova Scotia" report, described in Chapter 1, contains a comprehensive list of the heating and cooling capacities of the abandoned mines in Nova Scotia.
2. *System Design:* Accurate water volume measurements are crucial for designing the geothermal system. They help in determining the size and capacity of heat exchangers and pumps needed to optimize the system (Hahn et al*.*, 2018).
3. *Sustainability:* Understanding water volumes ensures that the geothermal system can operate sustainably over the long term. It helps in predicting how

much water can be extracted and reinjected without depleting the resource (Morris, 2024). Considerable work was carried by Brian Herteis to characterize the water volume resource of the No. 2 Mine in Springhill. This is described in his report titled “Geothermal Resources Assessment No. 2 Seam Springhill, Nova Scotia”.

4. *Economic Viability:* Knowing the water volumes helps in assessing the economic feasibility of the project. It allows for better estimation of operational costs and potential savings, making the project more attractive to investors (Hahn et al., 2018).
5. *Environmental Impact:* Monitoring water volumes helps in assessing the environmental impact of geothermal projects. It ensures that the extraction and reinjection processes do not adversely affect the surrounding ecosystem (Morris, 2024).

These factors collectively contribute to the successful implementation and operation of mine water geothermal projects, making water volumes a key parameter to monitor and manage. From the literature review of the larger and successful mine water projects, a commonality is the ability of these projects to have good approximations for the volume of water available. This directly affects the size of the mine water project.

Table 4-2: Measured and calculated Springhill mine water volumes.

Mine	Production (tonnes)[1]	Recharge Rate (L/day)	Recharge Rate (L/hour)	Mine Water Volume (L)	Notes
No. 1	3,052,000	743,980	30,999	1,574,390,924	Calculated based on No. 2
No. 2	10,822,000	1,570,775[2]	65,449	5,582,588,000	Measured; stated in the Louis Frost Notes
No. 3	258,000	446,815	18,617	133,090,714	Calculated based on No. 2
No. 4	3,509,000	792,586	33,024	1,810,136,878	Calculated based on No. 2
No. 6	1,376,000	565,724	23,572	790,817,140	Calculated based on No. 2
No. 7	925,000	517,788[2]	21,575	477,166,319	Measured; stated in the Louis Frost Notes
Total	**19,942,000**	**4,637,668**	**193,236**	**10,368,189,975**	

[1] From Phase 1 Report

[2] Stated in the Louis Frost Notes

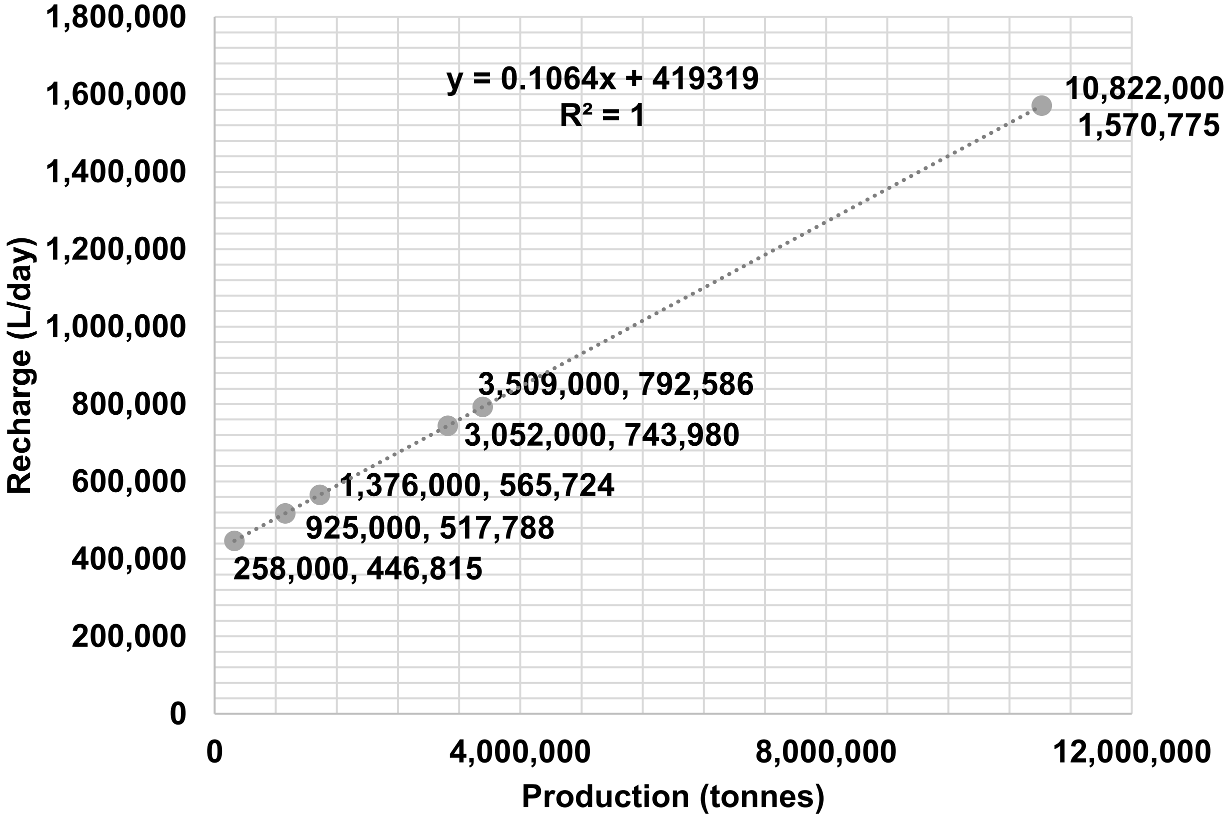

Figure 4-2: Plot of recharge versus coal production for estimating mine recharge rates.

4.2 Summary of Mine Water Geothermal Use in Springhill

Springhill is considered a pioneer in using flooded abandoned coal mines as a geothermal energy source. The first reported mine water heat pump system using water from abandoned underground mines was installed in 1989 in Springhill. This marked the beginning of recognizing the feasibility and economic viability of this approach globally. By the early to mid-1990's, several businesses and facilities in Springhill had adopted this technology for space heating and cooling. This included industrial users like Ropak Can-Am Ltd. (now Mauser Packaging but will refer to Ropak as it was the name used in the legacy reports) and Surette Battery Ltd., as well as other commercial entities and businesses.

Over time, the number of users grew, with approximately 40 geothermal boreholes drilled by the early 2010's. Usage of mine water geothermal peaked in Springhill in the 1990's. The Municipality of Cumberland maintains and operates boreholes for the Dr. Carson & Marion Murray Community Centre. The Nova Scotia Community College (NSCC) Cumberland Campus also utilizes this resource for heating some of its facilities and as a learning tool for its Refrigeration and Air Conditioning program.

Chapter 5: Overview of Relevant Geothermal Research

This section presents a comprehensive compilation of selected geothermal reports spanning several years, underscoring the potential and developments in geothermal energy. The information is beneficial for showcasing the quantity and quality of geothermal work carried out in the province of Nova Scotia, specifically in the Springhill area of Cumberland County. The geothermal report list is shown in Table A1 of Appendix A and summarizes the date of completion, title, author, and number of pages. The compilation includes reports from various stakeholders including academic institutions, engineering firms, and governmental agencies. It highlights significant investigations, proposals, and studies that focus on harnessing geothermal energy, particularly from abandoned coal mines, and outlines potential opportunities for greenhouse and agri-food businesses leveraging geothermal technology.

This research collectively spans from 1975 to 2023 (although a geothermal greenhouse action plan is forthcoming in 2025), providing a chronological account of research and findings. Many earlier reports emphasize the groundwork laid for current geothermal initiatives, illustrating the evolution of knowledge and technology in this sector.

This compilation serves as a resource for policymakers and stakeholders to better understand the trajectory of geothermal energy development in Nova Scotia and to shape future strategic decisions. By leveraging the insights gained from these reports, government staff can more effectively promote sustainable energy solutions and facilitate transition towards greener practices within the community.

A synopsis of key reports that have been produced since the mid 1990’s include:

Springhill Geothermal Greenhouse Action Plan (2025) by the Municipality of the County of Cumberland, Nova Scotia Community College, and the Nova Scotia Department of Energy

The Springhill Geothermal Greenhouse Action Plan was created through a partnership between the Nova Scotia Community College Applied Energy Research Group, the Municipality of the County of Cumberland, and the Nova Scotia Department of Energy. The plan outlines a strategy for using geothermal resources from abandoned and flooded underground coal mines in Springhill, Nova Scotia. The initiative aims to use warm water from the No. 2 Mine to support local food production and demonstrate the potential of mine water geothermal energy in Nova Scotia. The No. 2 Mine contains over 5 billion litres of warm water, and the other coal mines in Springhill increase the potential resource collectively to over 10 billion litres.

The Action Plan proposes three scenarios for geothermal greenhouse development, ranging from small to large-scale, and evaluates how well each scenario satisfies the objectives of the plan. The plan also includes action items focused on improving project readiness, data collection and resource management, and researching and seeking funding and investment. The Action Plan is a part of the much broader and ongoing Cumberland geothermal research project.

Geothermal Community Greenhouse Pilot Project report, Nova Scotia Community College by Ryan (2023) of the Nova Scotia Community College

The Springhill Geothermal Community Greenhouse Pilot Project report presents a viewpoint for convergence of historical context and modern sustainability efforts. The proposal aims to leverage the previously underutilized geothermal energy resources of abandoned coal mines to address food insecurity and promote local economic development.

Key themes of the commentary include innovation, community engagement, and the integration of clean energy with food production. The proposed greenhouse would use geothermal energy to cultivate fresh produce for local schools and food banks, directly addressing rising food insecurity in Cumberland County—evidenced by a 27% increase in food bank visits early in 2023. The report recognizes the socioeconomic challenges facing communities, particularly regarding poverty and nutrition, and positions itself as a solution while honoring the region's history.

The collaborative model proposed aimed to create learning opportunities for students at various academic levels and revitalize the local economy by establishing Cumberland as a center for geothermal energy innovation. The proposed initiative would be a "living lab," linking theoretical knowledge with practical application, thereby benefiting local stakeholders and fostering a culture of exploration within the energy and agricultural sectors.

This report resonates with broader themes relevant to climate change, renewable energy development, and food security, highlighting the pressing need for innovative solutions in response to current challenges. As communities grapple with the dual crises of economic instability and food insecurity, the proposed project stands as a promising example of turning historical legacies into pathways for sustainable futures.

Opportunities for Greenhouse & Agri-Food Businesses in- Springhill, Nova Scotia by Brownell (2022) of Acadia University

In April 2022, Ashlyn Brownell authored a report for the Municipality of the County of Cumberland, focusing on the geothermal potential in Springhill, Nova Scotia, particularly concerning its applications in greenhouse and agri-food businesses.

The report outlines several key points. First, it defines geothermal energy as the naturally occurring heat from the Earth’s crust, particularly relevant in Springhill where mine water temperatures range from 8°C to 15°C. The versatility of geothermal applications in the agri-food industry is emphasized, noting its capacity to replace fossil fuels in diverse processes such as cultivation and food processing. The successful precedent set by established businesses like BWAY Packaging and Surrette Battery, both of which have used geothermal resources since 1989, serves to underline the practicality and reliability of this energy source.

A notable quote from the report states, “The potential for geothermal to contribute to the energy transition is recognized by international organizations,” highlighting the global recognition of geothermal energy's role in reducing greenhouse gas emissions. The report also discusses the socio-economic dimensions, noting that geothermal energy could create sustainable jobs and retain youth in the region.

In conclusion, the findings of the report illustrate a timely opportunity for Springhill to enhance its economic viability through geothermal development. Given the growing emphasis on sustainability in the face of climate change, as well as consumer demand for eco-friendly products, the insights provided are highly relevant. As communities worldwide strive for greener futures, Springhill's geothermal initiatives could serve as a model for similar developments elsewhere.

Direct Use of Geothermal Heat in Nova Scotia by Dunsky Energy (2022)

The report titled "Direct Use of Geothermal Heat in Nova Scotia" provides an in-depth analysis of the potential for utilizing deep geothermal heat directly in the province. The study was conducted by Dunksy Energy to explore the feasibility of deep geothermal systems as an alternative to traditional heating methods.

The primary goal was to evaluate the business case for deep geothermal systems by assessing their cost-effectiveness as a low-carbon heat source. The report characterizes three geological regions in Nova Scotia: Cumberland Sub-Basin, Stellarton Sub-Basin, and Windsor-Kennetcook Sub-Basin. These regions were selected based on their geological profiles and potential for geothermal heat extraction.

The study developed archetypes for three typical facilities where deep geothermal heat could be used: greenhouses, aquaculture facilities, and district heating systems. Each archetype includes detailed energy use profiles and current operational costs to compare with geothermal heating. Scenario modeling and sensitivity analysis were conducted to assess the economic viability of deep geothermal systems compared to alternatives like heating oil, propane, biomass, and natural gas. The analysis included factors such as system size, load factors, and operational expenses.

The report found that deep geothermal systems could be a cost-effective and sustainable heating solution for certain applications in Nova Scotia. It highlighted the potential for significant greenhouse gas emission reductions and long-term energy cost savings. The report recommends further research and investment to de-risk potential geothermal projects, including detailed studies and exploratory drilling. It also suggests areas where additional information is needed to fully realize Nova Scotia's geothermal potential. This comprehensive assessment aims to demonstrate the feasibility and benefits of direct geothermal heat use in Nova Scotia, paving the way for future renewable energy projects in the region.

Nova Scotia Geothermal Investigation Proposal by Thompson (2022) of Borealis Geothermal

The report titled "Nova Scotia Geothermal Investigation Proposal" from Borealis Geothermal outlines a strategic plan for exploring and developing geothermal resources in the province. The report aims to gather more subsurface data to further de-risk mid-depth geothermal resources in Nova Scotia. It focuses on identifying geologically preferred settings and commercially viable locations for drilling exploration wells. The report emphasizes the need for detailed geological studies to identify potential geothermal sites. It highlights the importance of understanding the geological formations and geothermal gradients in the region.

The report includes plans for drilling one or more exploration wells to gather critical subsurface data. These wells are intended to confirm the presence and viability of geothermal resources in targeted areas. The report provides an economic analysis of geothermal energy projects, including cost considerations and potential benefits. It also includes technical assessments to ensure the feasibility and efficiency of geothermal systems. The report recommends specific activities to support a successful drilling campaign, such as detailed site studies and exploratory drilling. It suggests further research and investment to fully realize the geothermal potential in Nova Scotia.

The report emphasizes the importance of engaging with stakeholders, including local communities, government agencies, and industry partners. It highlights the need for collaboration to ensure the successful development of geothermal projects. This document aims to pave the way for future geothermal energy projects in Nova Scotia by providing a clear roadmap for exploration and development.

Assessment of Geothermal Resources in Onshore Nova Scotia by Comeau et al. (2020) of Institut National de la Recherche Scientifique and Enki GeoSolutions Inc.

The report titled "Assessment of Geothermal Resources in Onshore Nova Scotia" provides a comprehensive evaluation of the geothermal potential in the region. The report reviews the general types of geothermal resources available in Nova Scotia, excluding shallow resources used by ground-source heat pumps. It references key examples from regional, national, and global contexts.

The document provides a preliminary evaluation of the potential and favorability for geothermal electricity generation and heat production across the province, including an assessment of geothermal gradients and the heating-cooling capacity of various sites. The document also describes the economic case for exploring and developing geothermal resources in Nova Scotia. This includes potential benefits, cost considerations, and the economic impact of geothermal energy projects.

Recommendations are made for further de-risking targeted areas. This involves identifying specific locations with high potential and suggesting detailed studies and exploratory drilling to confirm geothermal resources. The report includes various data sets and tools used in the assessment, such as geothermal gradients, surface temperatures, and heating-cooling capacity maps.

The report aims to set the stage for future geothermal energy projects in Nova Scotia by demonstrating the value and feasibility of geothermal resources in the region. It highlights the importance of continued research and investment to unlock the potential of this renewable energy source.

Springhill Geothermal Business Park: District Energy System Design Brief Byrnes (2020) of Pinchin Ltd.

The report titled “Springhill Geothermal Business Park: District Energy System Design Brief” from Pinchin Ltd.” aims to design a district energy system utilizing geothermal energy from the Springhill Mines and explores the significant geothermal potential due to the heat stored in the mine water. The report assumes mine water temperatures between 15°C to 20°C, suitable for low-temperature heating applications. The proposed system includes heat pumps, distribution networks, and heat exchangers. These would extract heat from the mine water and distribute it to buildings in the business park. A network of insulated pipes would carry the heated water to various buildings.

Initial capital costs, operational costs, and maintenance costs are detailed. The proposed geothermal system would be expected to reduce heating costs significantly compared to conventional heating methods. The proposed system would reduce greenhouse gas emissions by decreasing reliance on fossil fuels. The project supports Nova Scotia’s goals for renewable energy and sustainability. A phased approach is recommended for the implementation. Additional studies on the long-term sustainability and efficiency of the system are suggested.

Technical Memorandum Geothermal Mine Water Harness Evaluation, Springhill Business Park Springhill, Nova Scotia by Quibell (2020) of Falcon Engineering

The technical memorandum produced by Falcon Engineering Ltd. evaluates the geothermal potential of mine water harnessed from the Springhill mines. The document outlines the extensive underground workings of the mines, particularly the No. 2 Mine, located at considerable depth, emphasizing how it could potentially serve as a significant source of geothermal energy.

Key objectives of the analysis include reviewing mine water temperature data, assessing the required extraction flows for heating and cooling loads, and determining optimal locations for extraction and injection boreholes. The suitability of an open-loop geothermal system is central to the discussion, where mine water is extracted, heat exchanged and then injected back into the mine. This method requires careful planning in the arrangement of wells for thermal and hydraulic stability.

Notably, the report infers the available mine water temperature to be around 12°C, due to some 2018 data suggesting cooler temperatures due to potential mixing with upper groundwater due to lack of sealing of the well casing. The memorandum estimates that, to meet the peak heating load of 4,638 kW, a flow rate of 159 L/sec is necessary, necessitating multiple wells due to pumping capacity constraints.

Significant concerns are raised about well construction, including the need for reliable casing and grouting to avoid contamination from cooler water, as past projects faced challenges that have rendered some temperature readings unreliable and some wells inoperable. The report also underscores the importance of sustainable well design and construction practices to ensure long-term geothermal system viability.

This analysis is pertinent in the context of increasing interest in renewable energy sources, particularly geothermal energy, as communities seek sustainable solutions to heating and cooling demands while addressing climate change. The findings underscore the complexities and potential of utilizing historical mining sites for contemporary energy solutions.

Microgrid Study of Springhill Business Park by Hutcheson and Arborus Consulting (2020)

The document titled “Microgrid Study of Springhill Business Park” by Arborus Consulting provides a comprehensive analysis of the potential for implementing a microgrid system in the Springhill Business Park.

The study aims to evaluate the feasibility and benefits of a microgrid system to enhance energy reliability and sustainability in the business park. It explores various renewable energy sources, including solar, wind, and geothermal, to power the microgrid. Detailed technical assessments are provided, including grid integration, energy storage solutions, and load management strategies.

The report includes a cost-benefit analysis, highlighting potential savings and return on investment for the business park. The study emphasizes the environmental benefits, such as reduced carbon emissions and improved energy efficiency and concludes with strategic recommendations for implementing the microgrid, including phased deployment and potential funding sources.

Springhill Geothermal Energy Use Study by Efficiency One Services (2017)

The purpose of the document titled “Springhill Geothermal Energy Use Study” was to analyze energy and cost savings from using geothermal energy in Springhill, Nova Scotia. The document performed energy audits for the Dr. Carson & Marion Murray Community Centre, Golden Opportunities Vocational Rehabilitation Centre (GOVRC), Public Works, and BWAY Packaging.

For the energy audit of the community centre, the document identified opportunities like lighting retrofits and low emissivity ceilings, leading to significant energy and cost savings. For the GOVRC, the energy audit focussed on lighting retrofits, resulting in energy reductions and cost savings. The energy audit of the public works facility highlighted lighting upgrades with potential savings. Finally, the BWAY Packaging energy audit suggested lighting retrofits, free cooling for production, and power factor correction for substantial energy and cost benefits.

Energy benchmarking for the community centre determined the current Energy Use Intensity (EUI) is 15.3 ekWh/ft², which is better than the median. Energy benchmarking for the GOVRC determined the current Energy Use Intensity (EUI) is 19.1 ekWh/ft², which is also better than the median. Energy benchmarking for BWAY Packaging determined the current Energy Use Intensity (EUI) is 1,806 ekWh/ton, which is outperforming similar facilities. The existing geothermal system at the community centre is considered more efficient than alternative systems. The geothermal system at BWAY Packaging significantly outperforms air-sourced heat pumps and oil-fired systems.

As for recommendations, the document suggested promoting the geothermal resource to attract energy-intensive industries. It also suggested funding from sources like the Green Municipal Fund and Efficiency Nova Scotia for further development.

Mine Workings Spatial Analysis Review and Deep Well Test Boreholes (2017) by MacLeod and Morykot of CBCL Ltd.

The document titled “Mine Workings Spatial Analysis Review and Deep Well Test Boreholes” from CBCL Limited aims to analyze the spatial distribution of mine workings and assess the feasibility of deep well test boreholes for geothermal energy extraction. The document utilized historical mine maps, geological surveys, and recent geophysical data and identified key zones with high potential for geothermal energy based on the density and depth of mine workings. The criteria included proximity to existing infrastructure, geological stability, and accessibility.

Researching the Geothermal Potential of the Former Springhill Mine by MacAskill and Power (2015) of the Verschuren Centre for Sustainability in Energy and the Environment

The report titled “Geothermal Potential of Springhill Mines” from the Verschuren Centre provides an in-depth analysis of the geothermal energy potential in the Springhill Mines area. The report includes detailed measurements of water temperatures and flow rates within the mine tunnels. Estimates of the total geothermal energy available are provided, highlighting the significant potential for heating and cooling applications.

The report discusses the technical aspects of extracting geothermal energy, including the necessary infrastructure and technology. Potential challenges such as water quality, system maintenance, and initial investment costs are addressed. Examples of successful geothermal energy projects in similar settings are provided to illustrate the viability and benefits of such initiatives. Insights and lessons from these case studies are discussed to inform future projects in Springhill.

Recommendations for policy measures and support mechanisms to promote geothermal energy development are outlined. Areas for further research and development are identified to enhance the understanding and utilization of geothermal resources.

Geothermal Green Industrial Park Initiative by Chen et al. (2015) from Dalhousie University Management Without Borders

The document titled “Geothermal Green Industrial Park Initiative” from Dalhousie University Management without Borders explores the potential of geothermal energy in the Springhill Mines. They consider a green industrial park powered by geothermal energy, promoting economic growth and environmental sustainability. It includes detailed technical studies on the feasibility and design of geothermal systems.

The report emphasizes the economic advantages, such as job creation, cost savings on energy, and attracting green businesses to the region.

The document also detailed the methodology for drilling and testing boreholes, including safety measures and environmental considerations. The deep test boreholes recorded temperature gradients indicating significant geothermal potential and assessed the quality of water extracted from boreholes, ensuring it meets environmental standards.

The document suggested further detailed studies and pilot projects to validate findings and highlighted the need for supportive policies to promote geothermal energy development in the region. The document concludes that the Springhill Mines area holds promising potential for geothermal energy, with recommended next steps for further exploration and development.

Geothermal Energy Resource Potential of Canada by Grasby et al. (2011) of Numerous Institutions

The report "Geothermal Energy Resource Potential of Canada" by the Geological Survey of Canada presents an in-depth examination of the abundant geothermal resources across the country, which remain largely untapped. Currently, Canada does not engage in geothermal electrical production; however, the report indicates that the geothermal potential could significantly exceed the national energy requirements, potentially offering a robust renewable energy source.

The report categorizes geothermal resources into high-temperature hydrothermal systems and Enhanced Geothermal Systems (EGS). It details the geographic distribution of these resources, focusing on significant areas such as the Canadian Cordillera, sedimentary basins, and notably, the Canadian Shield. The potential for utilizing abandoned mines for geothermal energy also receives attention, marking a novel avenue for energy extraction.

Significantly, the estimated geothermal resources are formidable, reaching into quintillions of joules. The report underscores the critical need for continued research, citing over 500 pressure measurements from depths between 1,000 and 4,195 m to understand better the geothermal systems in Canada. It highlights the importance of investing in regulatory frameworks and industry partnerships to facilitate the economic development of these resources. Moreover, it points out that "temperatures exceeding 150°C are found along the western edge of the Western Canadian Sedimentary Basin," suggesting viable prospects for geothermal energy production.

Environmental considerations are a pivotal theme, emphasizing the necessity of managing impacts on groundwater and ecosystems during development. This echoes broader concerns regarding sustainable energy practices. The bibliography included in the report contributes to a multidisciplinary approach, showcasing collaborative research efforts ranging from geological analyses to modeling of heat transport.

As Canada seeks avenues to reduce its carbon footprint, understanding and developing geothermal energy resources is increasingly relevant. This report not only illuminates the potential of geothermal energy as a clean alternative but also serves as a call to action for research, investment, and conscientious environmental management in the energy sector.

Geothermal Resources Assessment No. 2 Seam Springhill, Nova Scotia by Herteis (2006)

The document focuses on assessing the geothermal resource within the flooded No. 2 Seam near Springhill. This assessment involved mapping the No. 2 Seam's workings in relation to the town and existing geothermal boreholes and estimating the mine's water storage capacity and temperatures. The goal was to provide the Town of Springhill with data to support the development and promotion of this geothermal resource.

The coal mining history in Springhill is detailed in the report, explaining that the No. 2 Mine was the most extensively mined seam in the area. The assessment utilized various data formats, including AutoCAD files, TIF images, ESRI shapefiles, and hardcopy maps, to create maps showing the relationship between the mine workings, surface features, and geothermal boreholes.

The report also estimates the water storage capacity of the No. 2 Seam by categorizing the workings into six types and calculating the overall volume of the mine openings. Factors that could affect the storage volume, such as seam interconnections, overlying seam collapse, geological conditions, and barriers, were also considered. Mine water temperature is identified as a key factor in developing the geothermal resource, and the report includes an analysis of available temperature data.

In conclusion, the report provides a comprehensive assessment of the geothermal potential of the flooded No. 2 Seam in Springhill, Nova Scotia, and offers recommendations for further development of this resource.

Geothermal Energy from Abandoned Mines: A Methodology for an Inventory and Inventory Data for Abandoned Mines in Quebec and Nova Scotia by Arkay (2000) of the Geological Survey of Canada

The Arkay (2000) document discusses the potential of using abandoned underground mines as a source of low-temperature geothermal energy in Canada. It details a project that developed a methodology for creating an inventory of these mines and conducted pilot inventories in Quebec and Nova Scotia. The project aimed to identify mines with potential for geothermal energy use.

The document notes that abandoned mines can be both an environmental and safety hazard, but also a valuable resource. One such resource is low-temperature geothermal energy from flooded mines, which is already being utilized in Springhill.

The methodology for the inventory involved designing a data form with parameters focused on location, size, depth, underground workings, and geology of the mines. Inventories were then conducted in Quebec and Nova Scotia, identifying 165 abandoned underground mines in Quebec (all metallic) and 392 in Nova Scotia (including metallic, industrial mineral, and coal mines).

The report concludes that numerous abandoned mines in both provinces show potential for geothermal energy use, varying in scale from large sources for district heating to smaller ones for individual residences. It emphasizes the need for further work to assess geothermal potential, promote the use of this resource, and address related legal and environmental issues.

Clean Energy from Abandoned Mines at Springhill, Nova Scotia by Jessop et al. (1995)

The report "Clean Energy from Abandoned Mines at Springhill, Nova Scotia by Jessop et al. presents an in-depth overview of the mine water geothermal potential in the community of Springhill. The authors suggest that water circulates through the mine slopes via convection and can be accessed to provide heating and cooling for local buildings. The utilization of this geothermal energy source offers an alternative to traditional fossil fuel-based systems, presenting both economic and environmental advantages.

The geological setting of Springhill features a complex of coal seams within the Athol Syncline, further complicated by secondary folds. The old mines, which follow these seams to depths of up to 1,325 m, now act as a reservoir of thermal energy. Calculations based on both the mine's physical dimensions and historical coal production data corroborate the estimate of the water volume, highlighting the potential for significant heat extraction.

Several businesses in Springhill have already adopted heat pump systems to tap into this geothermal resource. These systems extract heat from the mine water during the winter for heating and release heat back into the water during the summer for cooling. While the initial investment in heat pump systems may be higher than that for conventional oil furnaces, the lower operating costs and additional benefits, such as improved climate control, result in substantial long-term savings.

Moreover, utilizing geothermal energy from the mine water offers a distinct environmental advantage. Unlike burning fossil fuels, this system produces no combustion gases or chemical residues. By reducing the reliance on electricity generated from coal-burning power plants, the geothermal systems also contribute to lowering carbon dioxide emissions. This makes it a more sustainable energy solution. The success of the Springhill project suggests that abandoned mines in other regions could also serve as viable geothermal energy sources.

Chapter 6: Overview of Mine Plans

In 2023, the former Springhill Capital Projects Engineer visited the Nova Scotia Department of Energy (formerly the Nova Scotia Department of Natural Resources and Renewables). He brought with him approximately 100 mine plans and drawings related to the Springhill Coal Mines. The paper copies were sent out to be scanned in high-resolution by Precision Digital Imaging Services. Table E1 in Appendix E provides a list of the scanned mine plans currently in digital possession of the Nova Scotia Department of Energy. The mine plans have been returned to the Natural Science Library at the Nova Scotia Department of Natural Resources.

The mine plans include essential information about the layout and structure of the mine, helping to identify the most suitable locations for geothermal mine water extraction. The mine plans mapped out unstable areas or areas of the mine where equipment would have been left in place, reducing the drilling risk. For example, the hoist room halfway down the No. 2 Mine slope could potentially contain much of the old equipment. If drilling operations were to encounter this equipment, it may cause adverse effects on drilling equipment and personnel at the surface.

Detailed plans help optimize the design and implementation of geothermal systems, ensuring efficient use of resources and maximizing energy output. Accurate mine plans support economic decision-making by providing data on the feasibility and potential return on investment for geothermal projects. The mine plans played a critical role in the development of the Springhill Geothermal Greenhouse Action Plan, particularly with helping select the most-likely drilling location for a new geothermal supply borehole.

Chapter 7: Overview of Mine Water Geothermal Boreholes

The mine water geothermal borehole inventory for the community of Springhill was revised to include numerous newly identified sites. There locations were also mapped in ArcGIS Pro. Table B1 and Table B2 in Appendix B contains the list of all known geothermal boreholes drilled in the community with some key information for each, including coal seam target and depth. The advantages of performing the geothermal borehole inventory review include the following:

- Updating the inventory of geothermal boreholes helps in effectively managing geothermal resources by providing detailed information on the location, depth, and characteristics of each borehole.
- A comprehensive catalogue makes data easily accessible to researchers, policymakers, and industry professionals, facilitating informed decision-making.
- It aids in monitoring the performance and health of boreholes, allowing for timely maintenance and reducing the risk of failure.
- By tracking any environmental impacts of geothermal activities, it ensures that operations are sustainable and comply with regulations.
- It supports research and development by providing a rich dataset for analyzing trends, improving technologies, and optimizing geothermal energy extraction.
- The efficient cataloguing can lead to cost savings by identifying the most productive boreholes and optimizing resource allocation.

It creates a historical record of geothermal exploration and usage, which can be valuable for future reference and planning.

7.1 Overview of Borehole Data from Springhill

The following chapter presents the data collected from certain geothermal boreholes in Springhill. Not every geothermal borehole drilled in Springhill has data associated with it, or at least none that could be found. The data include temperature and, in some instances, resistance and water output. This data was found within numerous legacy reports dating back to the original work. Brian Herteis (a former Capital Projects Engineer at the Municipality of Cumberland) also performed several recent temperature measurements. The tables and figures in Appendix F detail this information. The mine water temperature is important for numerous reasons, including:

- *Efficiency and Performance:* The temperature of the water directly affects the efficiency of the geothermal system (Kutun et al., 2014). Higher temperatures generally mean more energy can be extracted, making the system more efficient and cost-effective (Kutun et al., 2014).
- *Reservoir Characterization:* Temperature profiles help in understanding the characteristics of the geothermal reservoir (Palabiyik et al., 2013). They can indicate the presence of different zones within the reservoir, each with varying temperatures and properties (Palabiyik et al., 2013).
- *System Design and Safety:* Accurate temperature data is essential for designing the geothermal system, including selecting appropriate materials and equipment that can withstand the temperatures and water chemistry encountered (Steingrimsson, 2018). It also helps in ensuring the safety and longevity of the system (Steingrimsson, 2018).
- *Environmental Impact:* Monitoring the temperature helps in assessing the environmental impact of the geothermal operation (Palabiyik et al., 2013). It

ensures that the extraction process does not adversely affect the surrounding environment (Palabiyik et al., 2013).

- *Operational Stability:* Temperature measurements are used to monitor the stability of the geothermal well during production and injection operations (Kutun et al., 2014). This helps in maintaining optimal operating conditions and preventing potential issues (Kutun et al., 2014).

Several of the geothermal boreholes had mine water resistance measurements collected. The resistance measurements are important for various reasons, including:

- *Purity Assessment:* Water resistivity helps in assessing the purity of water. Higher resistivity indicates fewer dissolved salts and impurities, making the water purer (Atlas Scientific, 2024 and Sensorex, 2025).
- *Industrial Applications:* In industries like pharmaceuticals, electronics, and power generation, ultra-pure water is essential. Measuring resistivity ensures the water meets the required standards (Atlas Scientific, 2024).
- *Environmental Monitoring:* Resistivity measurements are used to monitor water quality in natural bodies of water, helping to detect pollution and its impact on aquatic ecosystems (Atlas Scientific, 2024).
- *Water Treatment:* In water treatment processes, resistivity measurements help in evaluating the effectiveness of purification systems (Sensorex, 2025).
- *Correlation with Conductivity:* Resistivity is inversely related to conductivity. By measuring resistivity, one can infer the water's conductivity, which is crucial for various scientific and industrial applications (Sensorex, 2025).

7.2 Additional Borehole Specific Notes

Wells GTW-11 and GTW-12

These two geothermal wells were drilled as a mine water supply well (GTW-12) and a mine water return well (GTW-11) back in the late 1980's. They supplied mine water to a facility located immediately to the northeast of the wells. The building is shown with a white roof on the attached drawing. Most recently, the facility was the Springhill Tavern Bar and Grill, but it closed and was torn down approximately 10 years ago. The wells have been inactive for years. The water levels and temperatures were monitored in GTW-11 for a few years. GTW-11 is the deepest and intersects both the No. 6 and No. 7 seam workings. GTW-12 ends in the No. 7 seam workings. A plan showing the depths of the two wells exists.

SHCML Wells

These two wells were drilled by Springhill Coal Mines Ltd (SHCML) prior to the excavation of their coal bulk sample pit to serve as monitoring wells. SHCML MW-1 intersected the No. 1 seam workings and SHCML MW-2 intersected both the No. 1 and No. 2 seam workings. Their purpose was to monitor the mine water levels and the bulk sample pit broke into the coal seam workings. Water levels and water temperatures of these two wells were also monitored for a few years. They are now abandoned.

Deep Wells No. 1 and No. 2

These two boreholes were drilled in 2018 to test the water quantities and temperatures at a depth below any of the previous drilled wells. Deep Well No. 1 was the deepest of the two and intersected the No. 3 seam workings at about 230 m depth. Deep Well No. 2 was drilled to the northeast of Deep Well No. 1 and was located to intersect three seams: No. 3, No. 1 and No. 2, in that order. It was successful in passing through No. 3 seam but were unable to get through the No. 1 seam workings probably because of the steep dip of the footwall (floor). The drill bit just skipped along the hard sandstone floor and would not penetrate. The total depth of this borehole was about 220 m. A drawing showing the location and depth of the boreholes along with which seam(s) were intersected exists.

Regarding the two deep wells that were drilled, Geothermal Well No. 1 was targeted to intersect the No. 3 Seam and was successful in doing so. There were some delays and problems related to overcoming the high hydrostatic head of the water in the borehole, but the No. 3 Seam was intersected. Deep Geothermal Well No. 2 was targeted to pass through the No. 1 Seam and intersect the No. 2 Seam mine workings. This borehole did not get past the No. 1 Seam. The bore hole intersected the No. 1 Seam mine workings but because of the relatively steep dip of the workings at that elevation, we were not successful at getting the drill bit through the sloping, sandstone floor to extend the borehole down to the No. 2 Seam.

Town Loop

There is currently no one using the town loop. GOVRC was the last user, but they disconnected about a year ago and now use heat pumps. Previously there were two other users, but they also disconnected about 10 years ago. The pump has been removed so the well is currently inactive. The power supply is assumed to still be there.

Additional Knowledge Gained 2010 - 2018

Over the past couple of years, meetings were held and numerous emails exchanged with the former Capital Projects Engineer. The goal of these various interactions was to gain a first-hand account of the geothermal work conducted in Springhill from someone who was initiating and following through with the work. The Engineer used data loggers to measure water levels in various boreholes between 2015 and 2018 and recorded temperatures in these wells.

A pronounced drop in the water level graph occurred in 2016 due to a bulk sample pit (i.e. test open pit mining) breaking into the legacy mine workings. This drop confirmed community concerns about potential water loss from open pit mining of coal reserves. The GOVRC pump was turned off in the GOVRC borehole because Brian's graph trend indicated the borehole would lose water due to the bulk pit; however, after the pit was filled, the water level returned to normal. The bulk sampling pit affected the No. 1 and No. 2 seam water balance. Brian also has data measuring feed water temperature in the boreholes.

Temperatures of 12°C and greater were recorded in or near the main mine slopes. These mine slopes were designed to be durable and are likely still intact. Most boreholes in Springhill, excluding two deep boreholes drilled in 2018, are probably a maximum of 100 m deep. The lower cluster of points represents water temperatures from the general mine workings. Points to the far right were taken after drilling the deep 8-inch boreholes, before breaking through into the mine workings. Brewster Well Drilling did the drilling using regular rotary drilling.

The Cumberland Energy Authority (CEA) existed for 5 years. The CEA proposed drilling deep wells to assess temperature and water availability outside the boreholes along the upper mine workings, costing approximately two hundred thousand dollars. Drilling was challenging due to a mild winter causing the drilling rig to sink into the ground. They were not able to complete the second borehole. Hub Drilling did the drilling. Data loggers were used in the boreholes to measure geothermal gradient, showing a positive trend in an isolated, room and pillar coal mine. Videos were taken down the boreholes, but one is missing, showing rubble and the mined-out coal seam.

Chapter 8: Springhill Mine Water Geothermal Knowledge Inadequacies and Potential Solutions

Understanding the geological characteristics of a region helps in identifying areas with high geothermal potential, ensuring that resources are allocated efficiently. Gap analysis highlights missing data and uncertainties, allowing researchers to address these gaps and reduce the risks associated with geothermal exploration and development. By focusing on target geology, researchers can prioritize areas with the highest potential, optimizing exploration efforts and increasing the chances of successful geothermal projects. Identifying gaps and targeting specific geological features can lead to more cost-effective exploration and development, as resources are directed towards the most promising areas. Gap analysis can reveal the need for new technologies or methodologies, driving innovation and improving the overall efficiency of geothermal exploration. Understanding the geological context helps in assessing and mitigating the environmental impacts of geothermal projects, promoting sustainable practices. Examples of knowledge gaps related to the Springhill mine water geothermal resource and potential solutions include:

1. **Resource Characterization and Assessment:**
    - *Accurate Mapping of Mine Networks:* Detailed 3D mapping of abandoned mine workings is often lacking, making it difficult to accurately assess the volume and flow paths of mine water (Banks et al., 2022). An example of this would be the uncertainty in the interconnectedness of different mine sections and how that can affect the sustainability of water extraction and reinjection.
    - *Long-term Temperature and Flow Rate Prediction:* While initial temperature data might be available, predicting long-term temperature stability and flow rates under operational conditions is challenging. An example of this is how

operational schemes can alter groundwater flow patterns and potentially impact the temperature of the extracted water over time. A solution to this, as offered by Comeau et al. (2020), is to acquire temperature profiles, in both summer and winter, of the most promising sites using existing facilities and accessible boreholes to evaluate a more accurate geothermal gradient and properly assess changes in water temperature over the operation of a system. The Phase 1 report also suggests sampling the rock surrounding the mine and analyzing its thermal properties, in addition to refining heat balance calculations to assess geothermal potential using mine plans for geometry and backfilling of mine workings (Comeau et al., 2020).

- *Hydrochemical Variability:* Mine water chemistry can vary significantly between different mines and even within the same mine over time (The Global Acid Rock Drainage Guide, 2017). Predicting and managing these variations is crucial to prevent scaling, corrosion, and environmental issues. An example of this being the typically high iron content in mine water that ultimately can lead to ochre precipitation, clogging heat exchangers and reducing system efficiency (Walls et al., 2021). As suggested by the Phase 1 report (Comeau et al., 2020), by compiling available chemistry data and, where needed, sampling water to calculate saturation indices to assess corrosion and scale potential, it should be possible to address these issues.

2. **System Design and Optimization:**

- *Optimal Extraction and Reinjection Strategies:* Determining the most efficient locations and methods for water extraction and reinjection to maximize heat recovery and maintain reservoir sustainability requires further research (Walls et al., 2021). An example of this would be that poorly placed reinjection wells can lead to thermal short-circuiting, where cooled water is drawn back into the extraction wells too quickly (Walls et al., 2021).

- *Heat Exchanger Performance and Fouling:* Understanding and mitigating fouling (e.g., mineral scaling, microbial growth) on heat exchangers in mine water systems is essential for long-term performance (Walls et al., 2021). An example could be that the complex chemical composition of mine water can accelerate the buildup of deposits on heat transfer surfaces, reducing efficiency.
- *Integration with Existing Infrastructure:* Developing cost-effective methods to integrate mine water geothermal systems with existing heating and cooling networks, especially in urban areas, needs further investigation. An example of this could be that retrofitting existing buildings to utilize low-temperature heat from mine water requires careful design of heat pump systems and distribution networks.

3. **Environmental Impact and Sustainability:**

- *Impacts on Groundwater Quality and Flow:* Thorough assessments are needed to understand the potential impacts of mine water extraction and reinjection on surrounding aquifers and surface water bodies. An example could be changes in groundwater pressure or flow direction that could affect the water supply for ecosystems or nearby communities. From the bulk sample pit study conducted several years ago, it was noted that mine water withdrawal was affected. The Phase 1 report by Comeau et al. (2020) suggested a mine water pumping pilot project to develop an energy system for a specific operation using detailed energy needs data, to better simulate the available resource over time.

- *Induced Seismicity:* While generally considered low risk for low-enthalpy systems, the potential for induced seismicity from large-scale mine water injection needs to be carefully evaluated in specific geological settings. An example of this could be the high-volume injection in areas with pre-existing faults, thereby potentially triggering minor seismic events. In Springhill, this is not an issue given the low rates of water reinjection. If the mine water resource was exploited to a much heavier extent, it is something that would have to be recognized.
- *Long-term Reservoir Management:* Strategies for the sustainable management of mine water geothermal resources over decades, considering potential changes in water levels, temperature, and chemistry, are still under development. Ensuring the long-term thermal recharge of the mine water reservoir is crucial for the sustainability of the energy source.

4. **Economic and Social Considerations:**

- *Cost-Effectiveness Analysis:* Comprehensive economic analyses comparing mine water geothermal to other heating and cooling technologies, considering upfront investment, operational costs, and potential revenue streams, are needed to attract investment. An example of this could be that the high initial drilling costs for accessing deep mine workings can be a barrier to project development.
- *Public Perception and Acceptance:* Raising awareness and addressing potential public concerns related to the safety and environmental aspects of mine water geothermal is important for project acceptance. An example of this could be that the concerns about potential contamination or ground stability issues need to be

addressed through transparent communication and robust safety measures. A solution is to maintain the regular Research Advisory Meetings going forward to ensure community representatives stay informed.

Addressing these knowledge gaps through targeted research, pilot projects, and data sharing is crucial for unlocking the full potential of mine water geothermal energy as a sustainable and reliable low-carbon resource. Examples of ongoing research initiatives and successful projects (like those in Heerlen, Netherlands, and various projects in the UK and Canada) are providing valuable insights and helping to bridge these gaps.

In conclusion, while mine water geothermal energy presents a compelling pathway towards decarbonizing heating and cooling, addressing the identified knowledge gaps is paramount for realizing its full potential. Targeted research, well-designed pilot projects, and robust mechanisms for data sharing across disciplines and regions are essential steps. Overcoming these challenges in resource characterization, technical and engineering aspects, environmental and regulatory considerations, economic and social factors, and modeling and simulation will pave the way for the widespread and sustainable adoption of this innovative and locally available renewable energy source.

Chapter 9: Lithium in Springhill Mine Water

The question was posed as to whether lithium could be extracted from the mine water in Springhill, Nova Scotia. In response to this question, several assumptions and calculations were made to arrive at an answer as to the economics of lithium extraction from the mine water. Lithium extraction from flooded mines is an emerging and innovative approach to sourcing this critical element. Flooded mines, often considered environmental liabilities, can be repurposed as valuable resources for lithium extraction. This process involves pumping water from these mines, which often contains dissolved lithium, and then using advanced filtration and chemical processes to isolate and extract the lithium ions.

One of the key advantages of this method is its potential to reduce the environmental impact associated with traditional mining techniques, as it utilizes existing water sources rather than disturbing new land areas. Additionally, this approach can help mitigate the environmental hazards posed by abandoned mines, turning them into productive sites for lithium recovery. As the demand for lithium continues to grow, especially for use in electric vehicle batteries and renewable energy storage, innovative extraction methods like these are becoming increasingly important for sustainable resource management.

Assumptions and Calculations

The lithium concentration measured by Grace Dearborn Inc. (1993) from the No. 2 Mine (GTW borehole on Ropak's property) was measured at a value of 0.141 ppm = 0.141 mg/l = 0.000000141 kg/L. For this calculation, let's assume we want to know how much it will cost to get 1 kg of lithium from the mine water in Springhill. At 0.000000141 kg/L, to get 1 kg of lithium would require 7,092,199 L of mine water

$$\#\ of\ litres\ of\ mine\ water = \frac{1.0\ kg}{0.000000141\,\frac{kg}{L}} = 7{,}092{,}199\ L$$

For the water pump, let’s assume a 4-inch diameter pump with a total head (H) of 150 ft, which gives a gallons per minute rating of ~ 400 gpm; pump is rated at 20 kW.

7,092,199 L = 1,873,561 US gallons

$$\# \; of \; minutes \; to \; pump \; water = \frac{1{,}873{,}561 \; gal}{400 \, \frac{gal}{min}} = 4{,}684 \; minutes = 78 \; hours = 3.25 \; days$$

Electricity consumption (kWh) = Total load (kW) x Hours of operation per day x # Days

Assuming the pump operates continuously, the calculation would be:

Electricity consumption = 20 kW x 24 hours/day x 3.25 days

Electricity consumption = 20 kW x 78 hours

Electricity consumption = 1,560 kWh

Cost of electricity in Nova Scotia is 17.7 cents per kWh = 0.177 dollars per kWh

Electricity cost to pump 7,092,199 L of mine water is therefore:

$ 0.177 / kWh * 1,560 kWh = $ 276.00

Conclusion

Producing 1 kg of lithium worth $ 14.212 / kg from mine water in Springhill would require spending $ 276.00 on electricity for pumping. Obviously, there are other associated costs as well (e.g., filter systems, evaporation systems, etc.). As an example, geothermal brine from the Salton Sea in California is as much as 400 mg/L compared to 0.141 mg/L for Springhill mine water (Ventura et al., 2020).

PART 3: GLOBAL MINE WATER PROJECTS, LEARNINGS, AND TECHNOLOGY

Chapter 10: Global Mine Water Geothermal Projects

The Springhill mine water geothermal system is referenced in the literature in excess of 200 times. A database of mine-related geothermal systems currently in place is shown in Table D1 of Appendix D. Most of the table entries were originally compiled by Chu et al. (2021).

Some of the other well-known mine water geothermal projects include:

- *Heerlen, Netherlands:* The Mijnwater Project in Heerlen is one of the most well-known mine water geothermal projects (European Commission, 2024). It uses water from abandoned coal mines to provide heating and cooling for buildings in the area (European Commission, 2024).
- *Shettleston, Glasgow, Scotland:* The Shettleston project uses water from old mine workings to provide heating for a housing estate.
- *Asturias, Spain:* The Barredo shaft in Mieres, Asturias, uses mine water for district heating.
- *Bochum, Germany*: The Bochum project uses mine water from the abandoned Zeche Robert Müser coal mine to heat a university campus.
- *Gateshead, England:* A geothermal system extracts underground heat reserves from abandoned mine workings to provide low-carbon heating to homes, offices, a college, and an arts center.
- *Marywood University, Scranton, Pennsylvania, USA:* Uses mine water for heating and cooling at the School of Architecture.

- *City Hall Building, Park Hills, Missouri, USA:* Utilizes mine water for heating and cooling.
- *Michigan Technological University, Houghton, Michigan, USA:* Uses mine water for heating and cooling at the Keweenaw Research Center.
- *Kingston, Pennsylvania, USA:* Closed facilities use mine water for heating and cooling

Researching and gathering information on other mine water geothermal projects globally has many benefits, some of which include the following:

- The exchange of information and best practices among researchers, developers, and policymakers, promoting innovation and improvement in geothermal technologies (e.g., direct communication with mine water geothermal stakeholders in the United Kingdom and The Netherlands has been established).
- A comprehensive list helps in tracking and managing geothermal resources more effectively, ensuring sustainable and efficient use.
- It provides potential investors with valuable insights into existing projects, helping them make informed decisions about where to allocate their resources.
- Policymakers can use the data to develop supportive regulations and incentives for geothermal energy, fostering the growth of the sector.
- Understanding the scope and distribution of projects can help in assessing and mitigating the environmental impacts of geothermal energy extraction.
- It encourages collaboration and networking among stakeholders, leading to new partnerships and joint ventures.
- A compiled list serves as a valuable educational resource for students, researchers, and the general public, raising awareness about the potential of

geothermal energy (making this information publicly available would be beneficial; publishing on this topic may also be a relevant path).

10.1 Learnings from Global Mine Water Projects Relevant to Springhill

Information compiled from global mine water geothermal projects can offer significant insights and lessons relevant to the mine water geothermal system in Springhill, Nova Scotia. Here are some key areas of learning:

1. **Resource Assessment and Characterization:**

- *Variability of Mine Workings:* Global projects highlight the uniqueness of each mine in terms of its depth, extent, geological setting, mining techniques used, and the current state of flooding and water quality. Springhill can benefit from detailed spatial analysis, as suggested in past RFPs, to accurately map and understand the interconnectedness and volume of its underground mine workings. The NSDoE geoscience intern has been working to digitize the mine workings. Upon completion, these digitized mine plans could be utilized for water volume capacity estimates. The water volume methodology used to calculate the No. 2 Mine water volume by Brian Herteis (2006) could be applied to the remaining mines in Springhill.
- *Temperature Profiles:* Understanding the temperature gradient and distribution within the flooded mines is crucial. Data from other projects can inform the expected temperature ranges at different depths and the factors influencing these temperatures (e.g., natural geothermal gradient, chemical reactions). Springhill already has temperature data from existing wells, but comparisons with global data can help validate these findings and identify potential anomalies.

Additionally, there are plans for the summer of 2025 to measure water temperature values in some of the abandoned geothermal boreholes throughout Springhill.

- *Water Quality:* Mine water can vary significantly in its chemical composition, including salinity, pH, and metal content. Experiences from other projects, such as those in Germany and the UK, emphasize the need for thorough water quality analysis in Springhill to anticipate potential corrosion, scaling, or environmental concerns. Closed-loop systems or in-ground heat exchangers, as used in some global examples, might be relevant to prevent direct contact with potentially contaminated mine water.

2. **System Design and Technology:**

- *Heat Extraction Methods:* Global projects employ various heat extraction techniques, including direct pumping with heat exchangers and in-ground heat exchangers. The choice depends on factors like water quality, flow rates, and temperature requirements. Springhill can learn from the efficiency and suitability of these different methods in similar settings.
- *Heat Pump Integration:* Heat pumps are commonly used to upgrade the relatively low temperatures of mine water for heating purposes. The performance and optimization of heat pump systems in other mine water projects can provide valuable guidance for Springhill, especially with respect to district heating networks or serving new types of users with different temperature needs.
- *Thermal Energy Storage:* Some advanced global projects are exploring the potential of using flooded mines for thermal energy storage, either seasonally or for shorter periods. While Springhill's current focus is on direct heat use,

understanding these technologies could unlock future possibilities for optimizing energy use and integrating with other renewable sources.

3. **Operational Considerations:**

- *Pumping Strategies:* Efficient and sustainable pumping is essential for mine water geothermal systems. Lessons from other projects can inform best practices for well design, pump selection, and managing water levels within the mine to ensure a consistent heat source without depleting the resource or causing hydraulic issues.
- *Maintenance and Monitoring:* Long-term operational data from global projects highlight the importance of regular monitoring of water flow, temperature, pressure, and water quality to detect any changes or potential problems. Maintenance protocols for pumps, heat exchangers, and distribution networks are also crucial for the longevity and reliability of the system in Springhill.
- *Addressing Corrosion and Scaling:* As mentioned earlier, mine water chemistry can lead to corrosion and scaling in system components. Experiences from projects dealing with similar water quality issues can provide insights into appropriate materials selection, pre-treatment methods, and maintenance strategies to mitigate these problems in Springhill.

4. **Economic and Social Aspects:**

- *Capital Costs and Funding:* Global projects often face high upfront capital costs for drilling, infrastructure development, and heat pump systems. Learning about the funding models, incentives, and economic feasibility assessments used in successful international projects can be beneficial for planning future expansions in Springhill.

- *Community Engagement and Public Perception:* The success of geothermal projects often depends on community support. Experiences from other mining regions transitioning to geothermal energy can offer strategies for engaging the local community in Springhill, addressing concerns, and highlighting the benefits of this renewable resource, such as economic development and reduced carbon emissions.
- *Policy and Regulatory Frameworks:* Understanding the policies and regulations governing geothermal energy development and mine water use in other countries can inform potential improvements to the regulatory landscape in Nova Scotia to further support projects like the one in Springhill.

In conclusion, the wealth of experience gleaned from global mine water geothermal projects offers invaluable lessons for the ongoing development and potential expansion of the system in Springhill, Nova Scotia. Studying the diverse experiences and lessons learned from mine water geothermal projects around the world, Springhill can optimize its existing system, plan for sustainable expansion, and potentially explore new applications for this unique renewable energy resource. By carefully considering the variability of mine workings, temperature profiles, and water quality characteristics observed internationally, Springhill can refine its resource assessment and ensure a robust understanding of its unique underground environment.

Furthermore, insights into diverse heat extraction methods, heat pump integration, and even advanced concepts like thermal energy storage from global precedents can inform the optimization of Springhill's system design and technology choices. Operational considerations, particularly regarding efficient pumping strategies, proactive maintenance and monitoring, and effective methods for addressing corrosion and scaling, are critical for the long-term viability and reliability of the Springhill project. Finally, the economic and social dimensions, including funding models, community engagement strategies, and supportive policy frameworks from successful international endeavours, provide crucial guidance for ensuring the sustainable growth and broad acceptance of mine water geothermal energy in Springhill. By integrating these global learnings with ongoing site-specific investigations and analysis, Springhill can continue to pioneer the use of this unique renewable resource, contributing to local economic development and a transition towards a lower-carbon future for the region.

Chapter 11: Mine Water Geothermal Technology

Mine water geothermal systems utilize the heat stored in water within abandoned mines to provide efficient heating and cooling. These systems typically involve either closed-loop or open-loop configurations (Matas-Escamilla et al., 2023 and Walls et al., 2021). In a closed-loop system, a network of pipes filled with a heat transfer fluid is submerged in the mine water, absorbing heat and carrying it to the surface (Matas-Escamilla et al., 2023 and Walls et al., 2021). In an open-loop system, mine water is pumped to the surface, where it passes through a heat exchanger to transfer heat to a secondary fluid (Matas-Escamilla et al., 2023 and Walls et al., 2021). This heat is then concentrated by a heat pump and distributed throughout the building via radiant floor heating, radiators, or forced-air systems. During warmer months, the process can be reversed to provide cooling.

Geothermal heat pumps are highly efficient, often delivering three to five times the energy they consume, resulting in significant cost savings and reduced greenhouse gas emissions (Morris, 2023). By repurposing abandoned mines, these systems turn potential environmental hazards into valuable resources, showcasing an innovative approach to sustainable energy.

Closed-loop and open-loop geothermal systems each have distinct advantages. Closed-loop systems are highly reliable and require less maintenance because they use a sealed network of pipes filled with a heat transfer fluid, which is not exposed to external contaminants. This makes them suitable for a wide range of geological conditions and ensures consistent performance over time. Additionally, closed-loop systems do not deplete groundwater resources, making them environmentally friendly.

On the other hand, open-loop systems can be more efficient in transferring heat because they use groundwater directly, which typically has a higher thermal conductivity than the fluids used in closed-loop systems. This can result in lower installation costs and higher efficiency in certain conditions.

However, open-loop systems require a sustainable source of groundwater and may involve more complex permitting and regulatory requirements. Both systems offer significant energy savings and environmental benefits, but the choice between them depends on site-specific factors and project goals.

PART 4: GEO-EXCHANGE

Chapter 12: Geo-exchange Projects in Nova Scotia

Table 12-1 summarizes 50+ geo-exchange projects that have been completed or are being considered within the province of Nova Scotia. This is by no means a list of every geothermal-related project in Nova Scotia. There are many more examples, but they are just not well-documented, particularly with respect to the residential applications. Appendix C provides additional details of each example from Table 12-1.

The majority of the projects utilize ground-loop geothermal systems, either as a shallow, laterally expansive loop or as a deeper (~max. 200 m) vertical loop system with dozens of boreholes (borehole field). In Cumberland County, the geothermal projects have been strictly mine water related, which relies upon the circulation of warm, flooded mine water in deep (~1,300 m) abandoned coal mines.

The list also includes the use of ocean water in what could be called marine geothermal. Many buildings in downtown Halifax have opted to utilize the ocean water to help lower their carbon footprint. A brief description (generally, not much detail seems to have been documented) of these projects follows below.

The motivation for researching and gathering information of geothermal projects within the Province of Nova Scotia include the following:

- It informs about the latest technological advancements and trends in the geothermal energy sector.
- It has the potential to help investors identify promising projects and make informed decisions about where to allocate their resources.
- Staying updated on current projects can inform policymakers and regulators, helping them create supportive frameworks for the development of geothermal

energy.

- It provides opportunities for collaboration and networking among researchers, industry professionals, and stakeholders.
- Understanding ongoing projects can highlight the environmental benefits and challenges associated with geothermal energy, promoting sustainable practices.
- It serves as a valuable resource for educators and students, offering real-world examples of geothermal applications and their impacts.

Table 12-1: Summary of projects in Nova Scotia that can be grouped under the geothermal category. In the project column, GL = ground-loop, OW = ocean water, and MW = mine water.

County	Address	City/Town	Project
Annapolis	462 Main St.	Middleton	**GL** - Soldiers Memorial Hospital Primary Healthcare Centre
Antigonish	283 Main St.	Antigonish	**GL** - Antigonish Town and County Library
	2332 Notre Dame Ave.	Antigonish	**GL -** Mulroney Hall
Cape Breton	95 Maillard St.	Membertou	**GL** - Membertou Sport and Wellness Centre
	151 Lower N St.	Glace Bay	**GL** - Bayplex Recreation Centre
	175 King St.	North Sydney	**GL** - Emera Centre Northside
	1190 Westmount Rd.	Sydney	**OW** - Canadian Coast Guard College Mechanical Systems Upgrade
	1250 Grand Lake Rd.	Sydney	**GL -** Verschuren Centre
	n/a	Sydney	**GL -** Centre for Discovery and Innovation
Colchester	625 Abenaki Rd.	Truro	**GL** - Rath Eastlink Community Centre
	170 Main St.	Tatamagouche	**GL** - Tatamagouche Public Library
	180 James Street	Truro	**GL** – Nova Institution for Women
Cumberland	6 Main St.	Springhill	**MW** - Dr. Carson and Marion Murray Community Centre
	29 Memorial Cres.	Springhill	**MW** - Ropak Northeastern Limited
	58 Lisgar St.	Springhill	**MW** - Surrette Battery Company Ltd.
		Springhill	**MW** - Fitness Centre

County	Address	City/Town	Project
	1 Main St.	Springhill	**MW** - Nova Scotia Community College
		Springhill	**MW** - Springhill Loop Supply
	32 Miners Memorial Dr.	Springhill	**MW** - GOVRC Workshop
		Springhill	**MW** - Eel Farm
Digby	4577 NS-340	Weymouth	**GL** - Waterfront Library
Halifax	80 Mawiomi Place	Dartmouth	**GL** - Nova Scotia Community College (NSCC) Ivany Campus
	6100 South St.	Halifax	**GL** - MacAdams Project
	Dartmouth Waterfront	Dartmouth	**OW** - Alderney 5 Experimental Seawater Project
	1209 Marginal Rd.	Halifax	**GL** - Seaport Market
	1223 Lower Water St.	Halifax	**OW** - Nova Scotia Power Headquarters
	1869 Upper Water St.	Halifax	**OW** - Historic Properties
	1871 Upper Water St.	Halifax	**OW** - RBC Waterside Centre
	1919 Upper Water St.	Halifax	**OW** - Halifax Marriott Harbourfront Hotel
	1919 Upper Water St.	Halifax	**OW** - Purdy’s Wharf
	1983 Upper Water St.	Halifax	**OW** - Casino Nova Scotia
	1 Challenger Dr.	Dartmouth	**OW** - Bedford Institute of Oceanography
	2141 Prospect Rd.	Hatchet Lake	**GL** - Prospect Road Community Centre
	50 Caledonia Rd.	Dartmouth	**GL** - East Dartmouth Community Centre
	1359 Fall River Rd.	Fall River	**GL** - Gordon R. Snow Community Centre
	1715 Lower Water St.	Halifax	**OW** - Queen's Marque
	1345 Norma Eddy Ln.	Halifax	**GL** - Emera IDEA and Design Buildings
	n/a	Halifax	**GL** - Northwest Arm Residences
	36 Logan Rd.	Dutch Settlement	**GL** - Dutch Settlement Fire Station
	1583 Beaver Bank Rd.	Beaver Bank	**GL** - Beaver Bank Kinsac Community Centre
	645 Cutler Ave.	Dartmouth	**GL** - Ikea Halifax
	2854 Robie St.	Halifax	**GL** - The Elevation

County	Address	City/Town	Project
	60 Walter Havill Dr.	Halifax	**GL** - The Waterton Condominiums
Hants	174 Falmouth Dyke Rd.	Falmouth	**GL** - Windsor Elms Village
Kings	Canard St.	Canard	**GL** - 4 single family dwellings
	35 Gary Pearl Dr.	Kentville	**GL** - Kings County Academy
	n/a	Wolfville	**GL** - Acadia University Biology Building
Lunenburg	135 N Park Street	Bridgewater	**GL** - Lunenburg County Lifestyle Centre
Pictou	19 Maple St.	Pictou Landing	**GL** - Pictou Landing Health Centre
	280 Haliburton Rd.	Pictou	**GL** - Shiretown Nursing Home
	11 Centennial Dr.	Trenton	**GL** - Ivey's Terrace Nursing Home
	10202 Sherbrooke Rd.	New Glasgow	**GL** - Northeast Nova Scotia Correctional Facility
Richmond	606 Reeves Street	Port Hawkesbury	**GL** - Port Hawkesbury Civic Centre
	325 Sitmuk Awti	Potlotek	**GL** - Geothermal Greenhouse
Shelburne	2367 Port Latour Rd.	Upper Port La Tour	**GL** - Coastal Grove Farm
Yarmouth	932 Nova Scotia Trunk 1	Hebron	**GL** - District of Yarmouth Municipal Building

PART 5: MID-DEPTH AND DEEP GEOTHERMAL ENERGY

Chapter 13: Mid-Depth and Deep Geothermal Opportunities

13.1 Mid-Depth Geothermal

Apart from the shallow geo-exchange and mine water geothermal opportunities in Cumberland County, there also exists strong potential for mid-depth and deep geothermal systems. Mid-depth and deep geothermal systems both extract heat energy from the Earth, but at different depths and temperatures. Mid-depth geothermal typically uses heat pumps to extract heat from water at depths of 400 to 2,500 m and temperatures of 40°C to 70°C. Mid-depth geothermal is primarily used for district heating, supplying energy to multiple homes or buildings. The technology involves large heat pumps that are used to extract heat from the thermal water and transfer it to the district heating network.

The Cumberland Basin in Nova Scotia shows promising potential for mid-depth geothermal energy. The presence of deep faults, such as the Cobequid-Chedabucto fault system, can create pathways for heat flow from deeper within the Earth. The mid-depth temperatures expected in the Cumberland Basin are suitable for direct use applications, offering a lower-carbon alternative to traditional heating sources like oil and natural gas. The favorable geological characteristics, coupled with the successful existing geothermal applications in the region and ongoing research efforts, suggest a promising future for this renewable energy source in the area.

13.2 Deep Geothermal

The Cumberland Basin is identified as having the greatest potential within Nova Scotia for electricity generation from deep aquifers (depths greater than 4 or 5 km). This is due to geological formations that could potentially host high-temperature geothermal resources.

Electricity generation necessitates accessing geothermal resources with temperatures exceeding 80°C, ideally above 150°C for high-enthalpy systems.

In Nova Scotia, achieving these temperatures typically requires drilling to depths greater than 3 km, and for electricity generation specifically, beyond 5 km. This means reaching high temperatures requires significantly deeper drilling. There might be localized areas with higher temperatures at shallower depths due to geological formations like faults acting as conduits for deep, hot fluids, salt domes with high thermal conductivity, or radiogenic heat from granitic bodies. However, these are highly localized and require further investigation.

The challenges and considerations that must be understood and overcome relate to the technological limitations, high costs, reservoir uncertainty, economic viability, limited research, and risk assessment. Drilling to depths of 5 km or more is technologically challenging and extremely expensive. Current drilling technologies and costs make deep geothermal electricity generation economically unfeasible in most parts of the world, including Nova Scotia, under present conditions. The characteristics of deep geothermal reservoirs in Cumberland County (temperature, permeability, fluid flow rates, and water chemistry) are largely unknown and require extensive and costly exploration, including deep drilling and testing. The high upfront capital costs associated with deep drilling and power plant construction, coupled with the uncertainty of the resource, make it challenging for deep geothermal projects to compete economically with other energy sources in Nova Scotia at this time. Compared to shallow and mid-depth geothermal resources, there has been limited research specifically focused on the deep geothermal potential of Cumberland County.

More comprehensive geological and geophysical studies are needed to better understand the resource. Deep geothermal projects inherently carry higher risks related to reservoir productivity and overall project feasibility. The deep geothermal opportunity in Cumberland County for electricity generation is currently considered a long-term prospect. While geological potential exists, significant technological and economic hurdles need to be overcome.

The immediate focus remains on developing the more accessible shallow and mid-depth geothermal resources for heating and cooling. However, ongoing research and advancements in deep drilling and reservoir stimulation could potentially unlock the deeper geothermal resources of the Cumberland Basin in the future, offering a clean and reliable source of electricity. For the present, detailed investigation and substantial investment would be required to move beyond preliminary assessments of this deep resource.

Much of the mid-depth and deep geothermal information about Cumberland County and the rest of Nova Scotia can be found in the 2020 report titled “Assessment of geothermal resources in onshore Nova Scotia (Phase 1)” by Comeau et al.

Closed-Loop and Open-Loop Deep Geothermal Systems

The deep geothermal systems can be subdivided into closed-loop and open-loop. The fundamental difference between open-loop and closed-loop deep geothermal systems lies in how they interact with the Earth's subsurface fluids.

Open-loop deep geothermal systems directly extract hot water (or steam) from naturally occurring underground reservoirs (aquifers) that are permeable and contain hot fluids (British Geological Survey, 2025). This hot fluid is pumped to the surface, its heat is extracted (for electricity generation or direct heating), and the cooled fluid is then reinjected back into the same aquifer (U.S. Department of Energy, 2025). In the Cumberland Basin, there exists a knowledge gap pertaining to the deep geology of the area. Based on our current understanding, the required geology for open-loop geothermal systems is lacking in the Cumberland Basin. Further exploration would be required to determine the deep geological characteristics of the basin. The main characteristics of open-loop deep geothermal systems are:

- *Direct fluid exchange:* The system uses the natural geothermal fluid found in the Earth.
- *Requires permeable reservoirs:* It relies on the presence of hot water/steam in porous and permeable rock formations.
- *High efficiency (potentially):* Due to direct contact with the hot water, open-loop systems can be very efficient, especially for electricity generation, as water is an excellent thermal conductor (Kocher's Water Pumps & Tanks Inc., 2023).
- *Water quality concerns:* The extracted water can contain minerals and dissolved solids that may cause scaling or corrosion in equipment, requiring treatment (U.S. Fish & Wildlife Service, 2025).
- *Environmental considerations:* Requires careful management of groundwater resources to avoid depletion or contamination. Local regulations often play a significant role (Fiveable, 2025).
- *Applications:* Primarily used for large-scale electricity generation, district heating, and industrial processes where suitable hydrothermal resources exist.

Closed-loop deep geothermal systems do not directly use Earth's natural fluids. Instead, they involve drilling a sealed loop of pipes deep into hot, dry rock formations (often granite or other crystalline rocks that are not naturally permeable). A working fluid (typically water or a water-antifreeze mixture, or even CO_2) is circulated through these sealed pipes, absorbing heat from the surrounding rock through conduction (Eavor, 2025). The heated fluid is then brought to the surface, and its heat is extracted before being recirculated back into the loop (Sustainability Directory, 2025). The main characteristics of open-loop deep geothermal systems are:

- *No direct fluid exchange with the ground:* The working fluid is contained within the sealed pipes and does not mix with groundwater or interact with the subsurface environment (Eavor, 2025).
- *Doesn't require permeable reservoirs:* Can be deployed in areas with hot dry rock, which is a much more widespread resource than natural hydrothermal reservoirs. This significantly expands the potential for geothermal energy (Muir, 2020).
- *Relies on conduction:* Heat transfer occurs through the rock to the pipes, which can be slower than direct convection in open-loop systems (Muir, 2020).
- *Reduced environmental impact:* Minimizes concerns about water depletion, groundwater contamination, and induced seismicity (earthquakes) often associated with injecting and extracting fluids directly into the ground (Sustainability Directory, 2025).
- *Higher upfront costs:* Drilling deep, complex, and sometimes multi-lateral wells for closed-loop systems can be expensive (McClure, 2023).
- *Technological advancements:* Newer technologies like the Eavor-Loop^{TM} are aiming to improve efficiency and reduce costs through innovative well designs (e.g., U-tube or tube-in-tube configurations, and leveraging thermosiphon effects for natural circulation) (Barnard, 2025).
- *Applications:* Becoming increasingly viable for utility-scale commercial and

industrial energy production, including electricity generation and direct heating (e.g., district heating) (U.S. Department of Energy, 2025).

A summary of the main features of open-loop deep geothermal systems and closed-loop deep geothermal systems is shown in Table 13-1.

Table 13-1: Summary of the primary features of open-loop deep geothermal systems and closed-loop deep geothermal systems.

Feature	Open-Loop Deep Geothermal	Closed-Loop Deep Geothermal
Fluid Interaction	Extracts and reinjects natural groundwater/steam	Circulates a contained working fluid in sealed pipes
Resource Needs	Requires permeable, hot underground aquifers	Can use hot dry rock formations (more widespread)
Heat Transfer	Direct convection (fluid movement)	Conduction through rock to pipes
Environmental Impact	Potential for groundwater issues, induced seismicity	Minimal impact on groundwater, reduced seismic risk
Complexity	Simpler in principle, but dependent on specific geology	More complex drilling and well designs, but less geological constraint
Cost	Can be lower initial cost if suitable resource exists	Higher initial drilling costs, but potentially more broadly applicable
Typical Use	Large-scale power generation, district heating	Utility-scale power generation, direct heating for various applications

Closed-Loop Deep Geothermal System Example

A Canadian company known as Eavor has developed a closed-loop deep geothermal system (Shown in Figure 1-1) that aims to overcome the geological limitations of traditional geothermal energy. The technology is known as the Eavor-Loop^{TM} and is essentially an underground radiator.

To create this underground radiator, two deep (typically several kilometres) vertical wells are drilled into hot, dry rock formations. From the bottom of these vertical wells, numerous horizontal wellbores are drilled and connected, forming horizontal sections that can extend for several kilometres, creating a deep underground radiator-style network. The wellbores are sealed and working fluid is utilized within the system. This working fluid circulates through the hot rock, where it absorbs heat through conduction. The working fluid, now heated, is brought to the surface where its heat is extracted through a heat exchanger and recirculated back through the system. The extracted heat can be used for district heating and/or electricity generation. The advantages of this type of deep geothermal system are that:

- *Geothermal Anywhere:* Not dependent on specific geological conditions like hot, permeable aquifers, making it potentially deployable in a much wider range of locations, such as the Cumberland Basin.
- *Closed-Loop:* No interaction with groundwater, eliminating concerns about water quality, depletion, or contamination (Directorate-General for Climate Action, 2023).
- *No Fracing:* Does not require hydraulic fracturing, thus avoiding associated seismic activity concerns (Beard, 2020).
- *Baseload and Dispatchable Power:* Provides a continuous, 24/7 source of heat and/or electricity, unlike intermittent renewables like solar or wind. The working fluid flow rate can be adjusted to "store" heat in the ground and dispatch it on demand.
- *Low Environmental Impact:* Minimal surface footprint, no GHG emissions during operation, and minimal water usage (Directorate-General for Climate Action, 2023).

PART 6: FUNDING INITIATIVES

Chapter 14: Geothermal Funding Programs

A portion of the overall work plan for the Geothermal Energy Technical Coordinator is to identify potential funding sources that could be utilized by the municipality to advance geothermal-related projects. The potential funding sources were identified and profiled to validate the mid-depth resources opportunity (e.g., federal programs, research funding, low-emission community projects, etc.) and compiled a list of these potential funding sources. A collaboration with numerous individuals was successful in the submission of an Expression of Interest for the Renewable Energy Demonstrations – Stream 1 opportunity. Additionally, a draft was completed for the Agricultural Clean Technology Program - Research and Innovation Stream funding application, which is provided by Agriculture and Agri-Food Canada. Identifying and applying for funding initiatives has numerous benefits including:

- Funding initiatives can accelerate the development and deployment of geothermal technologies by providing crucial financial support. There are many examples of this, including a home grown in Canada example. The Calgary company known as Eavor benefited from funding allowing them to build a demonstration project utilizing their technology. The Clean Growth Program contributed $2.5 million towards the project (NRCAN, 2024).
- Financial backing helps mitigate the risks associated with geothermal exploration and development, making it more attractive for investors and developers.
- Funding initiatives often support research and development, leading to technological advancements and more efficient geothermal systems.
- Investment in geothermal projects can stimulate local economies by creating

jobs and attracting further investment.

- By supporting clean energy projects, funding initiatives contribute to reducing greenhouse gas emissions and promoting sustainable energy practices.
- Identifying funding opportunities can help policymakers design effective incentives and regulations to support the growth of the geothermal sector.
- Funding initiatives can foster international collaboration, sharing knowledge and best practices across borders.

The following is a list of the potential funding programs that could be leveraged for geothermal initiatives in the community of Springhill and the broader Cumberland County. The funding programs that are currently closed, may become active again in the near future.

1. **Green Municipal Fund (https://greenmunicipalfund.ca/)**
2. **Sustainable Communities Challenge Fund (https://nschallengefund.ca/)**
3. **Low Carbon Communities Program (https://novascotia.ca/low-carbon-communities/)**
4. **Low Carbon Economy Fund (https://www.canada.ca/en/environment-climate-change/services/climate-change/low-carbon-economy-fund.html)**
5. **Smart Renewables and Electrification Pathways Program (https://natural-resources.canada.ca/climate-change/green-infrastructure-programs/sreps/23566)**
6. **Emerging Renewable Power Program (https://natural-resources.canada.ca/climate-change/green-infrastructure-programs/emerging-renewable-power/20502)**
7. **Clean Technology Investment Tax Credit for Geothermal Energy**
8. **Energy Innovation Program (https://natural-resources.canada.ca/science-and-data/funding-partnerships/opportunities/grants-incentives/energy-innovation-program/18876)**

9. **Smart Grid Program**
(https://natural-resources.canada.ca/climate-change/green-infrastructure-programs/smart-grids/19793)

10. **Net Zero Accelerator Initiative**
(https://ised-isde.canada.ca/site/strategic-innovation-fund/en/net-zero-accelerator-initiative)

11. **Greener Neighbourhoods Pilot Program**
https://natural-resources.canada.ca/science-and-data/funding partnerships/opportunities/grants-incentives/greener-neighbourhoods-pilot program-demonstration-projects-call-for-proposals-applic/greener-neighbourhoods-pilot-programc

12. **Wah-ila-toos (Clean Energy in Indigenous, Remote and Rural Communities Hub)**
https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/reducing-reliance-diesel.html

Table 14-1: Summary table of potential geothermal funding programs.While the majority are currently closed to applications, they may become active again at some point.

Fund/Tax Incentive	Timeline	Dollar Amounts
Green Municipal Fund	Applications accepted year-round	Highly variable depending on category
Sustainable Communities Challenge Fund	Opening soon	Between $75k and $1 million
Low Carbon Communities Program	Opening next year	Max $50k for education Max $75k for rest of categories
Low Carbon Economy Fund	Opening soon	Highly variable
Smart Renewables and Electrification Pathways Program	Currently open	Max of 30% of eligible costs for geothermal
Emerging Renewable Power Program	Currently closed	Unknown
Clean Technology Investment Tax Credit	Currently open	30%
Energy Innovation Program	Currently closed	Unknown
Smart Grid Program	Currently closed	Unknown
Net Zero Accelerator Initiative	Currently closed	Unknown
Greener Neighbourhoods Pilot Program	Currently open	$1 million to $10 million
Wah-ila-toos (Clean Energy in Indigenous, Remote and Rural Communities Hub)	Currently open	≤ $100k to ≥ $1 million

***Funding programs that are closed may reopen in the future.

14.1 Examples of Funded Projects

Table 14-2: Projects funded by the Green Municipal Fund

Initiative	Location	Grant Value	Project Value	Sector	Status
Capital Project	Springhill, NS	$793,495	$7,200,000	Building - New - Energy efficiency	Completed

Table 14-3: Summary of projects funded by the Smart Renewables and Electrification Pathways Program.

Project Name	Community Geothermal Resource - Capacity Assessment and Training program (GeoCAT)	Latitude 53 Geothermal Project
Organization Name	Net Zero Atlantic	Latitude 53 Hinton Inc.
Project Location	Nova Scotia	Alberta
Deployment or Capacity Building	Capacity Building	Capacity Building
NRCan Funding	$1,335,819	$4,999,000
Total Project Costs	$1,453,826	$6,576,397
Announcement Date	2022-11-09	2022-06-16

Table 14-4: Summary of projects funded by the Emerging Renewable Power Program (Green Infrastructure Stream).

Date	Funding
11 Jan. 2019	$25.6 million in support for the DEEP Earth Energy Production geothermal project in Saskatchewan, through the Emerging Renewable Power Program
23 Aug. 2019	$25.4 million in support for the Terrapin and Greenview Alberta No. 1 Geothermal project in Alberta, through the Emerging Renewable Power Program
12 Mar. 2021	$40.5 million for Clarke Lake Geothermal Development Project

Table 14-5: Summary of the geothermal projects funded by the Energy Innovation Program.

Project Title	Lead Proponent	Location	NRCan Funding	Total Value	Announcement Date
Williston Basin Geothermal Power Generation	DEEP Earth Energy Production Corp	SK	350K	3.4M	2019-01-11
Canada’s Geothermal Village – “Sustainaville” GeoPark	Borealis GeoPower Inc.	BC	1.32M	2.64M	2018-04-10

PART 7: POLICY AND REGULATION

Chapter 15: Jurisdictional Geothermal Review

A geothermal jurisdictional review involves analyzing the legal and regulatory frameworks governing the exploration, development, and utilization of geothermal resources within a specific geographic area. Some time was spent performing a cursory review of this information from various countries around the world. It demonstrated a wide variability in how geothermal was treated. Some countries have geothermal-specific regulations while others group it into mineral regulations or water regulations, for example.

Nova Scotia does have a regulatory framework for geothermal energy development, and it falls primarily under the Mineral Resources Act. While there is not a single "Geothermal Regulations" document, the Mineral Resources Act (specifically Sections 2(h) and 2(ha)) designates "geothermal resource areas" and defines what a geothermal resource is. This means that the exploration and exploitation of geothermal resources are governed by this act.

Should geothermal-specific regulations be developed for Nova Scotia, it would seem reasonable to choose a jurisdiction with as many similarities as possible and refine them specifically for Nova Scotia needs. A regulatory review of geothermal energy in various jurisdictions worldwide was performed for the following reasons:

- Understanding the regulatory framework helps ensure that geothermal projects comply with local, national, and international laws, reducing the risk of legal issues and project delays.
- Knowledge of regulations can streamline the permitting process, making it more efficient and less time-consuming. This is particularly important for any companies that become interested in geothermal-related work in the province.

- It provides developers and investors with the information needed to make informed decisions about project feasibility, potential risks, and returns on investment.
- Research can inform policymakers, helping them create supportive regulations and incentives that promote the growth of the geothermal sector. In Nova Scotia, the idea of creating geothermal-specific regulations remains a possibility. Current regulations are grouped into the Minerals Act.
- Regulations often include guidelines for environmental protection, ensuring that geothermal projects are developed sustainably and with minimal impact on the environment.
- Understanding existing regulations can highlight best practices and areas where innovation is needed, driving technological advancements and improving project outcomes.
- Researching regulations across different regions can facilitate international collaboration, sharing knowledge and best practices to advance the global geothermal industry.

Conclusion

In conclusion, the global landscape of geothermal energy reveals a growing recognition of its potential, albeit with a current installed capacity that is modest compared to other renewables. While countries with favorable geological conditions lead in geothermal power generation, advancements in technologies like EGS and AGS offer pathways for significant expansion in previously unviable regions. Direct-use applications are also experiencing notable growth, highlighting the versatility of geothermal resources beyond electricity generation.

Within this global context, the Cumberland Basin in Nova Scotia emerges as a promising region for geothermal development, particularly for direct heat applications leveraging its unique geological features and the legacy of abandoned coal mines. The success of the Springhill geothermal system provides a tangible example of this potential. However, realizing this potential requires addressing existing knowledge gaps through detailed subsurface assessments, pilot projects, and robust community engagement. Overcoming potential impediments such as high upfront costs, exploration risks, and the need for a clear regulatory framework will be crucial.

The identification and pursuit of diverse funding opportunities, as outlined, represent a vital step in advancing geothermal projects in Cumberland County. These initiatives can help mitigate financial risks, support technological innovation, and stimulate local economic growth. Furthermore, a thorough understanding of jurisdictional geothermal regulations can inform the development of effective and supportive policies in Nova Scotia. Ultimately, a strategic and collaborative approach, building upon existing knowledge, and actively addressing challenges, will be essential to harness the geothermal resources of the Cumberland Basin and contribute to a more sustainable energy future for the region.

Glossary

Advanced Geothermal Systems (AGS) – advanced Geothermal Systems" is a broad term encompassing innovative technologies and approaches aimed at expanding the use and efficiency of geothermal energy. It often refers to methods that go beyond conventional hydrothermal resources, which rely on naturally occurring hot water or steam reservoirs.

Binary Geothermal Power Plant – a type of geothermal power plant that generates electricity from geothermal resources by transferring heat from the hot geothermal fluid to a secondary working fluid with a much lower boiling point than water.

Bituminous Coal – a type of sedimentary rock and a middle rank of coal that forms from the compaction and heating of plant material over millions of years. It is one of the most abundant types of coal and is primarily used as a fuel in electricity generation and industrial processes.

Bootleg Coal Mine – generally defined as a small, often illegal or unauthorized mine, typically dug and operated by individuals or small groups, often on land owned by someone else, such as a coal company.

Borehole – a narrow shaft or hole drilled into the ground, either vertically or horizontally. It is created for a variety of purposes, making it a versatile tool in various industries.

Bump – also known as a coal bump, mine bump, mountain bump, or rock burst, is a sudden and violent release of energy in an underground coal mine. It is a seismic event that occurs due to the explosive failure of coal pillars or the surrounding rock strata.

Circulation – when water is heated, it becomes less dense and rises. Cooler, denser water sinks to take its place, creating a continuous circular flow. This is a natural process driven by temperature differences and gravity.

Colliery – a term traditionally used to describe a coal mine and all its associated structures and equipment. It includes not just the underground mine itself, but also the surface buildings and facilities.

Continental Crust – one of the two main types of Earth's crust (the other being oceanic crust). It forms the landmasses we live on, including the continents and the shallow seabed areas immediately surrounding them, known as continental shelves.

Delta Temperature – the difference of temperatures between two measuring points.

Enhanced Geothermal System (EGS) – a human-engineered reservoir created to extract heat from hot, dry rock formations that lack the natural permeability or fluid saturation found in conventional hydrothermal geothermal systems. EGS technology expands the potential for geothermal energy production to many locations worldwide.

Flash Geothermal Power Plant – the most common type of geothermal power plant in operation today. It harnesses high-temperature geothermal water (also known as brine) from deep underground reservoirs to generate electricity.

Geothermal Energy – heat energy stored beneath the Earth's surface. It's a renewable source of energy that can be harnessed for both heating and electricity generation.

Geothermal gradient – is the rate at which the temperature increases with depth below the Earth's surface. It is a measure of how temperature changes as you go deeper into the Earth's crust. The geothermal gradient is typically expressed in degrees Celsius per kilometre (°C/km).

Gigajoule – a unit of measurement of energy consumption; equal to one billion joules.

Heat Exchanger – a device that transfers heat between two or more fluids (liquids or gases) without mixing them. It's widely used in heating, cooling, and energy recovery systems across industries like HVAC, power generation, chemical processing, and geothermal energy.

Heat Transfer Fluid – a liquid or gas used to transfer thermal energy (heat or cold) from one place to another in a system. These fluids are essential in a wide range of applications, enabling efficient heating and cooling processes.

Hydrocarbons – a class of organic chemical compounds that are composed exclusively of hydrogen (H) and carbon (C) atoms.

Kilowatt-hour – a non-SI unit of energy equal to 3.6 megajoules (MJ) in SI units, which is the energy delivered by one kilowatt of power for one hour.

Latitude – the angular distance of a place north or south of the earth's equator, or of a celestial object north or south of the celestial equator, usually expressed in degrees and minutes.

Longitude – the angular distance of a place east or west of the meridian at Greenwich, England, or west of the standard meridian of a celestial object, usually expressed in degrees and minutes.

Longwall Retreating – refers to the process where the coal face is mined backward (retreating) from a previously developed set of tunnels or roadways. The mining begins at the far end of the panel and progresses toward the main entry.

Megawatt Hour – a non-SI unit of energy equal to 3.6 gigajoules (MJ) in SI units, which is the energy delivered by one megawatt of power for one hour.

Millimeter-Wave Drilling – a revolutionary, non-mechanical drilling technology that utilizes high-power millimeter waves to bore through rock. It's a form of "direct energy drilling," meaning it uses energy directly to disintegrate the material rather than relying on the physical force of a drill bit.

Mine Water Geothermal – refers to the utilization of the Earth's natural heat stored in the water that fills abandoned underground mines. When mining operations cease and the pumps are turned off, these mines gradually flood with groundwater. The surrounding rock formations, heated by the Earth's geothermal gradient, warm this water to a relatively stable temperature. This warmed mine water can then be extracted and used as a sustainable source of energy for heating and cooling.

Mine Workings – refer to all the excavated areas and structures created during the process of mining. These include both underground and surface features that are part of the extraction and transportation of minerals.

Oceanic Crust – Earth's outermost solid layer that lies beneath the oceans. It is fundamentally different from continental crust in its composition, thickness, density, and age.

Radiogenic Heat – Earth's interior is heated in part by the decay of radioactive isotopes like uranium, thorium, and potassium. This "radiogenic heat" is a crucial energy source that drives processes like mantle convection and plate tectonics.

Recharge Rate – refers to the rate at which water accumulates within a mine, typically an abandoned or flooded mine.

Reinjection – for mine water geothermal systems refers to the process of returning used geothermal water back into the underground mine reservoir after it has been utilized for heating or energy purposes.

Room and Pillar – an underground mining method where miners excavate a series of "rooms" into the ore body, leaving behind "pillars" of unmined material to support the roof of the mine.

Seam – refers to a thin layer or stratum, often of a valuable mineral like coal (a "coal seam").

Shapefile – a popular geospatial vector data format developed by Esri for geographic information systems (GIS) software. It is used to store the geometric location and attribute information of geographic features such as points, lines, and polygons.

Slope – an entrance to a mine driven down through an inclined coal seam. An inside slope in a mine is a passage in the mine driven from one system of workings down through a seam, to bring up coal from a lower system of workings.

Spontaneous Combustion – a dangerous phenomenon where coal seams or stockpiles self-heat to the point of ignition without an external heat source. This occurs due to a slow process of oxidation when coal is exposed to air.

Syncline – a type of fold in rock layers that forms when the layers are bent downward into a trough-like shape. The youngest rock layers are typically found at the core (center).

Tectonics – refers to the scientific study of the deformation of the Earth's crust and the forces that produce such deformation. It's a fundamental concept in geology that explains how our planet's surface is shaped and changes over time.

Terajoule – a unit of measurement of energy consumption; equal to one trillion joules.

Well Collapse – occurs when the structural integrity of a well is compromised, leading to a partial or complete failure of the well casing or surrounding materials. This can result in reduced water flow or contamination of the water supply.

References

Acadia University. 2023. Biology Building. Retrieved from the world wide web: https://biology.acadiau.ca/acadias-biology-building-6310.html.

Atlas Scientific. 2024. The Resistivity of Water Explained. Retrieved from the world wide web: https://atlas-scientific.com/blog/resistivity-of-water/.

Banks, D., Steven, J., Black, A. and Naismith, J., 2022. Conceptual modelling of two large-scale mine water geothermal energy schemes: Felling, Gateshead, UK. International Journal of Environmental Research and Public Health, 19(3), p.1643.

Barnard, M. 2025. Is Closed-Loop Geothermal The Future of Heat & Power, or Just a Niche Play? Retrieved from World Wide Web: https://cleantechnica.com/2025/03/17/is-closed-loop-geothermal-the-future-of-heat-power-or-just-a-niche-play/.

Beard, J.C. 2020. Heat Beat: The Scoop on Closed-Loop: A Chat with John Redfern, CEO of Eavor. Retrieved from the world wide web: https://eavor.com/featured-articles/heat-beat-the-scoop-on-closed-loop-a-chat-with-john-redfern-ceo-of-eavor/.

Berman, P. 2018. Queen's Marque project to use water from Halifax harbour for heating, cooling. CBC News. Retrieved from the world wide web: https://www.cbc.ca/news/canada/nova-scotia/queen-s-marque-heat-pump-seawater-harbour-heating-cooling-1.4869012.

Bertani, R., 2016. Geothermal power generation in the world 2010–2014 update report. Geothermics, 60, pp.31-43.

Blankenship, D., Gertier, C., Kamaludeen, M., O’Connor, M. and Porse, S. 2024. Pathways to Commercial Liftoff: Next-Generation Geothermal Power. United States Department of Energy, Retrieved from World Wide Web: https://liftoff. energy. gov/wp-content/uploads/2024/03/LIFTOFF_DOE_NextGen_Geothermal_v14. pdf.

British Geological Survey. 2025. Geothermal technologies. Retrieved from World Wide Web: https://www.bgs.ac.uk/geology-projects/geothermal-energy/geothermal-technologies/#:~:text=Open%2Dloop%20systems%20extract%20heat,mine%20in%20mine%20water%20geothermal).

Calder, J.H. 1995. Geology Map of the Springhill Coalfield. Map 95-1. Nova Scotia Department of Natural Resources. Retrieved from the world wide web: https://novascotia.ca/natr/meb/data/mg/map/pdf/map_1995-001_200_cln.pdf.

Canmet Energy. 2009. Community Energy Case Studies: Port Hawkesbury Civic Centre. CanmetENERGY of Natural Resources Canada. Retrieved from the world wide web: https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/Port HawkesburyCivicCentreGeothermalSystem(ENG).pdf.

Cape Breton University (CBU). 2023. Sustainability Initiatives at CBU. Retrieved from the world wide web: https://www.cbu.ca/about-cbu/sustainability/sustainability-initiatives/.

Cape Breton University (CBU). 2023. Canada and Nova Scotia invest in a new energy-efficient academic building for Cape Breton University. Retrieved from the world wide web: https://www.cbu.ca/newsroom/releases/canada-and-nova-scotia-invest-in-a-new-energy-efficient-academic-building-for-cape-breton-university/.

Coastal Grove Farm. 2023. Coastal Grove Farm. Retrieved from the world wide web: https://www.coastalgrove.ca/

Consulting Engineers of Nova Scotia. 2023. The Waterton High Rise Condominium. Retrieved from the world wide web: https://www.cens.org/project-spotlight-waterton.

Comeau, F.A., Sèjournè, S, Raymond, J. 2020. Assessment of geothermal resources in onshore Nova Scotia (Phase 1). Institut national de la Recherche Scientifique (INRS) and Enki GeoSolutions Inc. Retrieved online: https://netzeroatlantic.ca/research/phase-i-assessment-geothermal-resources-onshore-nova-scotia.

Delmar Construction Ltd. 2023. Weymouth Library. Retrieved from the world wide web: https://www.delmarconstruction.ns.ca/institutional-construction.

Directorate-General for Climate Action. 2023. The EAVORLOOP story: harnessing the Earth's energy for a greener transition. Retrieved from the world wide web: https://climate.ec.europa.eu/news-your-voice/news/eavorloop-story-harnessing-earths-energy-greener-transition-2023-11-06_en.

Eastward Energy. 2022. Sustainable Living for New IKEA Halifax Store. Retrieved from the world wide web: https://eastwardenergy.com/sustainable-living-for-new-ikea-halifax-store/.

Eavor. 2025. Technology: Closed-Loop Geothermal Technology for a 24/7 Carbon-free and Secure Energy Future. Retrieved from the world wide web: https://eavor.com/technology/#:~:text=Closed%2Dloop%20geothermal%20is%20an,deep%20in%20the%20earth%20to.

Efficiency Nova Scotia. 2023. Taking Geothermal to New Heights in Halifax. Retrieved from the world wide web: https://www.efficiencyns.ca/success_story/taking-geothermal-to-new-heights-in-halifax/.

European Commission: Directorate-General for Energy. 2024. The use of mine water in district heating systems – An example from Heerlen, Netherlands, Publications Office of the European Union. Retrieved from World Wide Web: https://data.europa.eu/doi/10.2833/962328

Fiveable. 2025. Geothermal Systems Engineering Review: Types of Geothermal Systems. Retrieved from World Wide Web: https://library.fiveable.me/geothermal-systems-engineering/unit-1/types-geothermal-systems/study-guide/dpTBqc4Mo0JXRGGx.

Hahn, F., Bussmann, G., Jagert, F., Ignacy, R., Bracke, R., and Seidel, T. 2018. Reutilization of mine water as a heat storage medium in abandoned mines. In 11th ICARD IMWA Conf (pp. 1057-1062).

Harnish, K. 2023. 10 Geothermal Heat Pump FAQs. Retrieved from World Wide Web: https://www.ultimatecomforthc.com/blog/9-geothermal-heat-pump-faqs.

Huang, Y., Kong, Y., Cheng, Y., Zhu, C., Zhang, J. and Wang, J., 2023. Evaluating the long-term sustainability of geothermal energy utilization from deep coal mines. Geothermics, 107, p.102584.

International Energy Agency. (2019). Innovation Gaps – Renewable Power. International Energy Agency, Paris. https://www.iea.org/reports/innovation-gaps/renewable-power.

International Ground Source Heat Pump Association. 2025. What Is the Life Expectancy of a Ground Heat Exchanger/Ground Loop for a Geothermal Heat Pump? Retrieved from World Wide Web: https://igshpa.org/igshpa-blog/what-is-the-life-expectancy-of-a-ground-heat-exchanger-ground-loop-for-a-geothermal-heat-pump/.

Kensa. 2025. Air Source vs. Ground Source Heat Pumps. Retrieved from World Wide Web: https://kensa.co.uk/ground-source-heat-pumps/ground-source-heat-pump-vs-air-source.

Khodayar, M. and Björnsson, S. (2024) Conventional Geothermal Systems and Unconventional Geothermal Developments: An Overview. Open Journal of Geology, 14, 196-246. https://doi.org/10.4236/ojg.2024.142012.

Kocher’s Water Pumps & Tanks Inc. 2023. Different Types of Geothermal Systems: Closed-loop vs. Open-loop — A Comprehensive Guide. Retrieved from the world wide web: https://kochergeowelldrilling.com/different-types-of-geothermal-systems/.

Kube Solutions. 2023. Case Study: Bayplex Recreation Centre. Retrieved from the world wide web: http://www.thekubesolutions.com/index.php/arenas/case-studies/bayplex-recreation-centre.

Kube Solutions. 2023. Case Study: Port Hawkesbury Civic Centre. Retrieved from the world wide web: http://www.thekubesolutions.com/index.php/arenas/case-studies/port-hawksbury-civic-centre.

Kutun, K., Tureyen, O.I., and Satman, A. 2014. Temperature Behavior of Geothermal Wells During Production, Injection and Shut-in Operations. Proceedings, Thirty-Ninth Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California.

Retrieved from the world wide web: https://pangea.stanford.edu/ERE/pdf/IGAstandard/SGW/2014/Kutun.pdf.

Long, D.L. (2022). Technology Gaps. Dawnbreaker Incorporated. https://mrr.dawnbreaker.com/portals/energy/energy-sources/geothermal/technology-gaps.

Matas-Escamilla, A., Álvarez, R., García-Carro, F., Álvarez-Alonso, L., Cienfuegos, P., Menéndez, J. and Ordóñez, A., 2023. Mine water as a source of energy: an application in a coalfield in Laciana Valley (León, NW Spain). Clean Technologies and Environmental Policy, 25(8), pp.2747-2760.

McClue, M. 2023. Technical barriers for deep closed-loop geothermal. Retrieved from the world wide web: https://www.resfrac.com/blog/technical-barriers-for-deep-closed-loop-geothermal.

McGee Heating and Air. 2025. Everything You Need to Know About Geothermal HVAC Technology. Retrieved from the world wide web: https://mcgeehvac.com/blog/everything-need-know-about-geothermal-hvac-technology/.

Monaghan, A.A., Adams, C.A., Bell, R.A., Lewis, M.A., Boon, D., González Quirós, A., Starcher, V., Farr, G., Wyatt, L.M., Todd, F. and Walker-Verkuil, K., 2025, November. Geological factors in the sustainable management of mine water heating, cooling and thermal storage resources in the UK. In Geological Society, London, Energy Geoscience Conference Series (Vol. 1, No. 1, pp. egc1-2023). The Geological Society of London.
Morris, J. 2024. Geothermal Energy on Abandoned Mine Lands. West Virginia University. Retrieved from the world wide web: https://scitechpolicy.wvu.edu/science-and-technology-notes-articles/2024/01/08/geothermal-energy-in-abandoned-mine-lands.

Muir, J.S. 2020. New Opportunities and Applications for Closed-Loop Geothermal Energy Systems. Geothermal Rising. Retrieved from World Wide Web: https://geothermal.org/our-impact/blog/new-opportunities-and-applications-closed-loop-geothermal-energy-systems.

Museum of Industry. 2025. Cumberland County Coal Mines. Retrieved from the World Wide Web: https://museumofindustry.novascotia.ca/nova-scotia-industry/nova-scotia-coal-mining-tragedies/cumberland-county-coal-mines.

Natural Resources Canada. 2024. Eavor-Loop Demonstration Project. Natural Resources Canada - Funding and partnerships. Retrieved from the world wide web: https://natural-resources.canada.ca/funding-partnerships/eavor-loop-demonstration-project.

Nova Scotia Department of Environment and Climate Change (NSDECC). 2023. Success Stories: Nova Scotia Community College Waterfront Campus. Retrieved from the world wide web: https://www.novascotia.ca/nse/cleantech/docs/NSCC.Waterfront.pdf.

Nova Scotia Department of Environment and Climate Change (NSDECC). 2023. Success Stories: Halifax Seaport Farmers' Market. Retrieved from the world wide web: https://www.novascotia.ca/nse/cleantech/docs/SeaportFarmersMarket.pdf.

Palabiyik, Y., Tureyen, O.I., Onur, M., and Deniz, M. 2013. A Study on Pressure and Temperature Behaviors of Geothermal Wells in Single-Phase Liquid Reservoirs. Proceedings, Thirty-Eighth Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California. Retrieved from the world wide web: https://pangea.stanford.edu/ERE/pdf/IGAstandard/SGW/2013/Palabiyik.pdf.

Public Services and Procurement Canada. 2019. Government of Canada awards major contract for infrastructure upgrades at Canadian Coast Guard College. Government of Canada. Retrieved from the world wide web: https://www.canada.ca/en/public-services-procurement/news/2019/01/government-of-canada-awards-major-contract-for-infrastructure-upgrades-at-canadian-coast-guard-college.html.

QUEST. 2023. Alderney 5 Experimental Seawater Project Cools Municipal Buildings in Halifax. Retrieved from the world wide web: https://districtenergy.questcanada.org/alderney-5-experimental-seawater-project-cools-municipal-buildings-in-halifax/.

Renz, A., Rühaak, W., Schätzl, P. and Diersch, H.J., 2009. Numerical modeling of geothermal use of mine water: challenges and examples. Mine Water and the Environment, 28(1), pp.2-14.

Ramos, E.P., Breede, K. and Falcone, G., 2015. Geothermal heat recovery from abandoned mines: a systematic review of projects implemented worldwide and a methodology for screening new projects. Environmental Earth Sciences, 73, pp.6783-6795.

Roberts, J.J., Gooding, L., Ford, R. and Dickie, J., 2023. Moving from "Doing to" to "Doing with": Community Participation in Geoenergy Solutions for Net Zero—The Case of Minewater Geothermal. Earth Science, Systems and Society, 3, p.10071.

Schaible's Plumbing and Heating Inc. 2025. How Long Can I Expect My Geothermal System to Last? Retrieved from the world wide web: https://www.schaiblesplumbing.com/blog/geothermal-service/how-long-can-i-expect-my-geothermal-system-to-last/#:~:text=The%20extended%20lifespan%20of%20geothermal,and%20reduces%20wear%20and%20tear.

Sensorex. 2025. Understanding the Resistivity of Water. Retrieved from the world wide web: https://sensorex.com/resistivity-of-water/.

Simmons, C., Donovan, M.E., and Slight, P. 2015. Homegrown Success: Nova Scotia's Smart Energy Inventory. QUEST - Quality Urban Energy Systems of Tomorrow. Retrieved from the world wide web: https://energy.novascotia.ca/sites/default/files/Smart%20Energy%20FINAL%20 Oct%2016%202015.pdf.

St. Francis Xavier (St. FX) University. 2022. St. FX's Mulroney Hall Certified LEED Gold. Retrieved from the world wide web: https://www.stfx.ca/about/news/Mulroney-Hall-LEED-Gold.

Steingrimsson, B. 2018. Geothermal Well Logging: Temperature and Pressure Logs. Presented at SDG Short Course III on Geothermal Reservoir Characterization: Well Logging, Well Testing and
Chemical Analysis, Santa Tecla, El Salvador. Retrieved from the world wide web: https://rafhladan.is/bitstream/handle/10802/16517/UNU-GTP-SC-26-07.pdf?sequence=1.

Sustainability Directory. 2025. Closed-Loop Geothermal Systems. Retrieved from the world wide web: https://energy.sustainability-directory.com/term/closed-loop-geothermal-systems/.

Tu, K.; Pan, X., Zhang, H., Li, X., and Zhao, H. 2024. An Analytical Solution for Characterizing Mine Water Recharge of Water Source Heat Pump in Abandoned Coal Mines. Water, 16, 2781. Retrieved from the world wide web: https://doi.org/10.3390/w16192781.

U.S. Department of Energy. 2025. Electricity Generation. Retrieved from the world wide web: https://www.energy.gov/eere/geothermal/electricity-generation.

U.S. Department of Energy. 2025. Geothermal Heat Pumps. Retrieved from the world wide web: https://www.energy.gov/energysaver/geothermal-heat-pumps. Retrieved from the world wide web: https://www.energy.ca.gov/sites/default/files/2021-05/CEC-500-2020-020.pdf#:~:text=It%20is%20estimated%20that%20the%20Salton%20Sea,lithium%20carbonate%20price%20of%20$12%2C000%20per%20ton.&text=Extraction%20of%20lithium%20from%20geothermal%20brines%20from,concentrations%20are%20as%20high%20as%20400%20mg/L.

U.S. Fish & Wildlife Service. 2025. Geothermal Energy. Retrieved from the world wide web: https://www.fws.gov/node/265252.

Ventura, S, Bhamidi, S., Hornbostel, M., and Nagar, A. 2020. Selective Recovery of Lithium from Geothermal Brines. California Energy Commission, Energy Research and Development Division.

Walls, D.B., Banks, D., Boyce, A.J. and Burnside, N.M., 2021. A review of the performance of mine water heating and cooling systems. Energies, 14(19), p.6215.

Appendix A: Summary of Geothermal-Related Documentation

Table A1: Summary of the numerous geothermal-related documents that have been produced on geothermal-related topics in Nova Scotia. Most of these documents pertain to the mine water geothermal opportunities in Springhill, Nova Scotia.

Year	Title	Prepared by	# Pages	Digital File Name
2025	Springhill Geothermal Greenhouse Action Plan	NSCC w/ NSDOE & Cumberland County	127	(2025) Springhill Geothermal Greenhouse Action Plan.pdf
2023	Geothermal Community Greenhouse Pilot Project, Nova Scotia Community College	Jen Ryan (NSCC)	14	(2023) Geothermal Community Greenhouse Pilot Project {Ryan}.pdf
2022	Opportunities for Greenhouse & Agri-Food Businesses in Springhill, Nova Scotia	Ashlyn Brownell (Acadia University)	27	(2022) Opportunities for Greenhouse and Agri-Food Businesses in Springhill, Nova Scotia {Brownell}.pdf
2022	Nova Scotia Geothermal Investigation Proposal	Borealis GeoPower (Geothermal) Inc.	12	(2022) Nova Scotia Geothermal Investigation Proposal {Borealis Geothermal Inc.}.pdf
2021	Direct Use of Geothermal Heat in Nova Scotia	Dunsky Energy + Climate Advisors	96	(2022) Direct Use of Geothermal Heat in Nova Scotia {Dunsky Energy}.pdf
2020	Assessment of Geothermal Resources in Onshore Nova Scotia	Institut National de la Recherche Scientifique	216	(2020) Assessment of Geothermal Resources in Onshore Nova Scotia {INRS}.pdf
2020	Springhill Business Park: Microgrid Study	Arborus Consulting & Robin Hutcheson	39	(2020) Microgrid Study of Springhill Business Park {Arborus Consulting}.pdf
2020	Springhill Geothermal Business Park – District Energy System Design Brief	Pinchin Ltd.	62	(2020) Springhill Geothermal Business Park District Energy System Design Brief {Pinchin}.pdf
2020	Geothermal Minewater Harness Evaluation, Springhill Business Park, Springhill, Nova Scotia	Falcon Engineering	16	(2020) Geothermal Minewater Harness Evaluation {Falcon Engineering}.pdf
2018	Mine Workings Spatial Analysis Review and Deep Well Test Boreholes	CBCL Ltd.	12	(2018) Mine Workings Spatial Analysis Review and Deep Well Test Boreholes {CBCL}.pdf
2017	Springhill Geothermal Energy Use Study	EfficiencyOne Services	61	(2017) Springhill Geothermal Energy Use Study {EfficiencyOne}.pdf

Year	Title	Prepared by	# Pages	Digital File Name
2015	Researching the Geothermal Potential of the Former Springhill Mine	Verschuren Centre	24	(2015) Researching the Geothermal Potential of the Former Springhill Mine {Verschuren Centre} .pdf
2015	Cumberland Energy Authority: Geothermal Green Industrial Park Initiative	Dalhousie University	51	(2015) Geothermal Green Industrial Park Initiative {Dal Management without Borders}.pdf
2011	Geothermal Energy Resource Potential of Canada - GSC Open File 6914	Grasby et al. (Geological Survey of Canada)	322	(2011) Geothermal Energy Resource Potential of Canada - GSC Open File 6914 {Grasby et al.}.pdf
2006	Geothermal Resources Assessment, No. 2 Seam, Springhill, Nova Scotia	Brian Herteis	31	(2006) Geothermal Resource Assessment No. 2 Seam Springhill, Nova Scotia {Herteis}.pdf
2004	Hy-Grade Geoscience - Springhill Geothermal Project - Preliminary Report	Hy-Grade Geoscience	14	(2004) Hy-Grade Geoscience - Springhill Geothermal Project - Preliminary Report.pdf
2000	Geothermal Energy from Abandoned Mines: A Methodology for an inventory and inventory data for abandoned mines in Quebec & Nova Scotia	K. Arkay (Geological Survey of Canada)	388	(2000) Geothermal Energy from Abandoned Mines - GSC Open File 3825 {Arkay}.pdf
1996	Springhill Geothermal Resources Special License 4/96: Work Program Report for 1994 and Information to Support an Application for a Special Mine Lease for Geothermal Resources Volume 1 AR-96-096	Town of Springhill	35	(1996) Springhill Geothermal Resources Special License 4-96 Report AR96-096.pdf
1995	Clean Energy from Abandoned Mines at Springhill, Nova Scotia	A.M. Jessop	15	(1995) Clean energy from abandoned mines at Springhill, Nova Scotia-Canada {Jessop et al.}.pdf
1995	Assessment Work Report AR-ME-1995-088	Springhill Coal Mines Ltd.	39	(1995) Springhill Coal Mines Ltd. - Assessment Work Report AR_ME_1995-088.pdf

Year	Title	Prepared by	# Pages	Digital File Name
1995	Geothermal Energy from Old Mines at Springhill	A.M. Jessop	15	(1995) Geothermal Maintenance Problems.pdf
1995	Geothermal Maintenance Problems	Unknown	4	(1994) Springhill Geothermal Resources Special License 4-94 Report AR94-077.pdf
1994	Springhill Geothermal Resources Special License 4/94: Work Program Report for 1994 and Information to Support an Application for a Special Mine Lease for Geothermal Resources Volume 1 AR-94-077	Town of Springhill	637	(1994) Report of Work Term Project - Mine Water Geothermal Energy Development and Utilization in the Town of Springhill.pdf
1994	Mine Water Geothermal Energy Development and Utilization in the Town of Springhill	William Bagnell	36	(1994) A Report of Work for Year 1 AR_ME_1994-074.pdf
1994	A Report of Work for Year 1: Special License to Explore for Coal 1/93 AR-94-074	Allister Peach Geo-Consulting Ltd.	39	(1993) Comments on Temperature Data from Boreholes Supplied by John Leslie.pdf
1993	Comments on Temperature Data from Boreholes Supplied by John Leslie	John Leslie	40	(1993) Development and Application of Geothermal Minewater Energy from the Abandoned Coal Mines in the Springhill Coal Fields.pdf
1993	Development and Application of Geothermal Minewater Energy from the Abandoned Coal Mines in the Springhill Coal Fields	Ralph Ross & Chris Kavanaugh	16	(1993) Geothermal Capacity Estimate by K.R. Warren.pdf
1993	Geothermal Capacity Estimate by K.R. Warren	K.R. Warren	6	(1993) Mine Water Analysis by GRACE Dearborn for Ralph Ross.pdf
1993	Mine Water Analysis by GRACE Dearborn for Ralph Ross	GRACE Dearborn Inc. for Ralph Ross	6	(1992) 1st Springhill Geothermal Energy Conference - GSC Open 2773 File {Arkay}.pdf
1992	1st Springhill Geothermal Energy Conference Summary Report - GSC Open 2773 File	K. Arkay (Geological Survey of Canada)	80	(1992) Well Drilling Log.pdf

Year	Title	Prepared by	# Pages	Digital File Name
1992	Well Drilling Log – Mine Water Geothermal Study	Ron White Well Drilling	16	(1992) Report on Geothermal Wells GTW 14, GTW 15, GTW 16A, and GTW 16B.pdf
1992	Report on Geothermal Wells GTW 14, GTW 15, GTW 16A, and GTW 16B	Ralph Ross	16	(1990) Springhill Coal Exploration Project AR_ME_1990-026 {Esso Resources}.pdf
1990	Springhill Coal Exploration Project AR-ME-1990-026	David F. Hallas of Esso Resources	266	(1990) Geothermal Mine Water Project, Commercial Application, Pizza Delight Site, Springhill, Nova Scotia - No. 11 and 12 Geothermal Well Report.pdf
1990	Geothermal Mine Water Project, Commercial Application, Pizza Delight Site, Springhill, Nova Scotia - No. 11 and 12 Geothermal Well Report	Ralph Ross	29	(1990) Geothermal Mine Water Project, HVAC District Heating Scheme - Phase 2, District Heating Wells.pdf
1990	Geothermal Mine Water Project, HVAC District Heating Scheme - Phase 2, District Heating Wells	Ralph Ross	25	(1990) Geothermal Mine Water Project, HVAC District Heating Scheme - Phase 2, Return Well.pdf
1990	Geothermal Mine Water Project, HVAC District Heating Scheme - Phase 2, Return Well	Ralph Ross	18	(1989) Town of Springhill Geothermal Demonstration Project (Phase 2) - Report on Production Wells 8, 9, and 10 for Surrette Battery.pdf
1989	Town of Springhill Geothermal Demonstration Project (Phase 2) - Report on Production Wells 8, 9, and 10 for Surrette Battery	Ralph Ross	36	(1988) Well No. 6 Pump Test and Summary Report for Ropak Corporation.pdf
1988	Well No. 6 Pump Test and Summary Report for Ropak Corporation	Ralph Ross	25	(1988) Town of Springhill Geothermal Demonstration Project Reported on NSPC Test Drilling and Pumping Test Results Project No. 4215.pdf

Year	Title	Prepared by	# Pages	Digital File Name
1988	Town of Springhill Geothermal Demonstration Project Reported on NSPC Test Drilling and Pumping Test Results Project No. 4215	Jacques Whitford & Associates Ltd.	29	(1987) Town of Springhill Preliminary Geothermal Demonstration Project.pdf
1987	Town of Springhill Preliminary Geothermal Demonstration Project	Jacques Whitford & Associates Ltd.	88	(1987) Well No. 4 (NSLP Yard) Summary.pdf
1987	Well No. 4 (NSLP Yard) Summary	Unknown	2	(1987) Well Pump Test
1987	Well Pump Test	Unknown	8	(1985) Geothermal Measurements in the Deep Holes in NS - Internal Report 85-11 {Drury}.pdf
1985	Geothermal Measurements in the Deep Holes in NS - Internal Report 85-11	Malcolm J. Drury (Energy, Mines, and Resources Canada)	10	(1984) Survey of Geothermal Energy in the Maritime Provinces - Open File 84-13 {Acres Consulting}.pdf
1984	Survey of Geothermal Energy in the Maritime Provinces – Open File 84-13	Acres Consulting Service Ltd.	143	(1984) Regulatory and Commercial Aspects of Geothermal Energy Development - Open File 84-12 {Acres Consulting}.pdf
1984	Regulatory and Commercial Aspects of Geothermal Energy Development - Open File 84-12	Acres Consulting Service Ltd.	379	(1984) Investigation of Geothermal Energy Resources Atlantic Provinces - Open File 84-5 {Leslie and Associates}.pdf
1984	Investigation of Geothermal Energy Resources Atlantic Provinces - Open File 84-5	John A. Leslie and Associates (Energy, Mines, and Resources Canada)	41	(1984) Investigation of Geothermal Energy Resources Atlantic Provinces - Open File 85-8 {Leslie and Associates}.pdf
1984	Investigation of Geothermal Energy Resources Atlantic Provinces - Open File 85-8	John A. Leslie and Associates (Energy, Mines, and Resources Canada)	69	(1984) Groundwater Flow Patterns in Carboniferous Sediments of Atlantic Canada - Open File 84-29 {Nolan, Davis and Assoc.}.pdf
1984	Groundwater Flow Patterns in Carboniferous Sediments of Atlantic Canada - Open File 84-29	Nolan, Davis, and Associates Ltd. (Energy, Mines, and Resources Canada)	101	(1983) Investigation of Geothermal Energy Resources Atlantic Provinces - Open File 83-20 {Leslie and Associates}.pdf

Year	Title	Prepared by	# Pages	Digital File Name
1983	Investigation of Geothermal Energy Resources Atlantic Provinces - Open File 83-20	John A. Leslie and Associates (Energy, Mines, and Resources Canada)	38	(1983) Geothermal Investigations Map.pdf
1983	Map – Geothermal Investigations: Atlantic Provinces	R.R. Potter (Mineral Resources Branch: New Brunswick Department of Natural Resources)	1	(1982) Geothermal Investigations Map.pdf
1982	Map – Geothermal Investigations: Atlantic Provinces	R.R. Potter (Mineral Resources Branch: New Brunswick Department of Natural Resources)	1	(1981) The Geothermal Energy Programme - A Review {Jessop}.pdf
1981	The Geothermal Energy Programme – A Review	A.M. Jessop (Division of Seismology & Geothermal Studies: Earth Physics Branch)	23	(1981) Preliminary Evaluation of Information on the Rodney Seam Area in the Springhill Coal Field AR_ME_21H09D_10-E-41_11_435236.pdf
1981	Preliminary Evaluation of Information on the Rodney Seam Area in the Springhill Coal Field	NOVACO & Norwest Resource Consultants Ltd.	29	(1981) Investigation of Geothermal Energy Resources in NS and PEI {Leslie and Associates}.pdf
1981	Investigation of Geothermal Energy Resources – Nova Scotia and Prince Edward Island	John A. Leslie and Associates Ltd.	125	(1981) Geothermal Investigations Map.pdf
1981	Map – Data Locations: Geothermal Investigations, Atlantic Provinces	Unknown	1	(1980) Geothermal Investigations Map.pdf
1980	Map – Geothermal Investigations, Nova Scotia & PEI	Unknown	1	(1975) Geothermal Series 4 {Jessop}.pdf
1975	Energy R & D Program Statement – Task V: Exploit Renewable Energy Resources (Program 4: Geothermal Energy)	A.M. Jessop (Energy, Mines, and Resources Canada)	18	

Appendix B: Summary of Springhill Geothermal Boreholes

Table B1: Geothermal, test, monitoring, and observation borehole summary for Springhill showing the well locations, eastings, and northings.

#	Borehole Name	Year	Well Location	Easting	Northing
1	GTW-01	1987	Ropak Can Am (29 Memorial Crescent)	416888.83	5055153.44
2	GTW-02	1987	Community Arena (across from 16 Queen Street)	417123.30	5055777.64
3	GTW-03	1987	Industrial Park (Near Ropak); Town Loop	416890.54	5055188.67
4	GTW-04	1987	NSPL Paved Yard (behind 10/12 Queen Street)	417070.75	5055819.55
5	GTW-05	1987	NSPL Storage Yard (behind 10/12 Queen Street)	417054.14	5055851.40
6	GTW-05.1	1987	Springhill Tavern (25 Main Street)	417436.89	5055583.15
7	GTW-06	1988	Ropak Can Am (29 Memorial Crescent)	416751.77	5055266.39
8	GTW-07	1988	Ropak Can Am (29 Memorial Crescent)	416705.02	5055284.67
9	GTW-08	1989	Surrette Battery (58 Lisgar Street)	417031.10	5056072.77
10	GTW-09	1989	Surrette Battery (58 Lisgar Street)	417018.68	5056064.63
11	GTW-10	1989	Surrette Battery (58 Lisgar Street)	417015.82	5056092.78
12	GTW-11	1990	Pizza Delight/JB's Bar and Grill (40 Main Street)	417338.45	5055632.68
13	GTW-12	1990	Pizza Delight/JB's Bar and Grill (40 Main Street)	417345.28	5055635.42
14	GTW-13	1990	Industrial Park; Town Loop	416860.49	5055107.86
15	GTW-14	1991	Industrial Park; Town Loop	416888.81	5055094.36
16	GTW-15	1991	Industrial Park; Town Loop	416876.04	5055065.41
17	GTW-16	1991	Leckie Street? (coordinates near Herrett Road)	416922.86	5054947.95
18	GTW-17	1993	Parkview Center (6 McFarlane Street)	417466.60	5055520.25
19	GTW-18	1993	Parkview Center (6 McFarlane Street)	417433.62	5055506.90
20	GTW-19	1993	NSPL Site (off Queen Street)	417079.77	5055803.45
21	GTW-20	1993	AH Brown Funeral Home (5 McFarlane Street)	417390.09	5055398.23
22	GTW-21	1993	AH Brown Funeral Home (5 McFarlane Street)	417395.01	5055435.11
23	GTW-21.1	1995	Behind Ropak (29 Memorial Crescent)	416735.68	5055276.82
24	GTW-22	1996	Public Works (62 Lisgar Street)	417188.31	5056251.50
25	GTW-23	1996	Public Works (62 Lisgar Street)	417184.73	5056239.80
26	GTW-23.1	1998	Springhill Fire Department (5 Main Street)	417340.00	5055458.00
27	GTW-23.2	1998	Springhill Fire Department (5 Main Street)	417340.00	5055458.00
28	GTW-23.3	2000	New well; behind Ropak (29 Memorial Crescent)	416700.34	5055287.01
29	Well-01	2003	Between Ropak & Community Centre	417030.74	5055464.01
30	Well-02	2003	Between Ropak & Community Centre	416903.42	5055307.94
31	Well-03	2003	Between Ropak & Community Centre	416861.43	5055372.74

#	Borehole Name	Year	Well Location	Easting	Northing
32	Well-04	2003	Between Ropak & Community Centre	416819.45	5055454.43
33	Well-05	2004	Between Ropak & Community Centre	416860.00	5055332.00
34	NSCC-01	2010	NSCC Cumberland Campus (1 Main Street)	417302.73	5055407.18
35	NSCC-02	2010	NSCC Cumberland Campus (1 Main Street)	417346.05	5055363.74
36	Well-06	2010	Between Ropak & Community Centre	416815.00	5055370.00
37	Well-07	2011	Between Ropak & Community Centre	416767.00	5055403.00
38	GTW-24	2014	Surrette Battery (58 Lisgar Street)	417012.00	5056109.00
39	SHCML MW-1	2015	West of Highway 142/Highway 2 intersection	416972.00	5056612.00
40	SHCML MW-1	2015	West of Highway 142/Highway 2 intersection	416966.00	5056603.00
41	Deep Well No. 1	2018	West of Ropak	416509.00	5055370.00
42	Deep Well No. 2	2018	West of Ropak	416203.00	5055295.00
43	GTW-25	2024	New Fire Station	416821.36	5055012.98

Table B2: Geothermal, test, monitoring, and observation borehole summary for Springhill showing seam targets, remarks, and hole depth.

#	Borehole Name	Year	Seam Target	Remarks	Hole Depth (m)
1	GTW-01	1987	2	Target missed	82.3
2	GTW-02	1987	2	Target missed	50.9
3	GTW-03	1987	2	Town Loop supply; Dist. heating	44.2 (40.4)[1]
4	GTW-04	1987	2,1	Return well for NSPL	79.9
5	GTW-05	1987	2	Supply well for NSPL	82.3
6	GTW-05.1	1987	Most likely 6	Supply for heat pump	99.1
7	GTW-06	1988	2	Ropak supply well; collapsed in 2000	137.5 (136.3)[1]
8	GTW-07	1988	3	Ropak return well	29.7
9	GTW-08	1989	1	Surrette return well	63.4
10	GTW-09	1989	2	Target missed	103.9
11	GTW-10	1989	2	Surrette supply well	95.4
12	GTW-11	1990	6 & 7	Pizza Delight return well	148.1 (150.3)[1]
13	GTW-12	1990	7	Pizza Delight supply well	117.4 (119.2)[1]
14	GTW-13	1990	2	Poor well; Town Loop return	114.3
15	GTW-14	1991	4	Slope; diamond drilled	43.3 (49.0)[2]
16	GTW-15	1991	4	Air slope; diamond drilled	64.3 (68.0)[2]
17	GTW-16	1991	4	Mine; diamond drilled	Unknown
18	GTW-17	1993	6	Supply well; on property?	58.5
19	GTW-18	1993	6	Return well; on property?	73.8
20	GTW-19	1993	6	New return; replaced GTW-04	50.3
21	GTW-20	1993	6	Supply or return; on property?	61.0
22	GTW-21	1993	7	Supply or return; on property?	64.0
23	GTW-21.1	1995	Most likely 2	Other Ropak wells target Seam 2	161.8
24	GTW-22	1996	6 or 7	Formerly Thermocell Recycling	73.2 (68.6)[3]
25	GTW-23	1996	6 or 7	Formerly Thermocell Recycling	73.2 (68.6)[3]
26	GTW-23.1	1998	Most likely 6	Supply or return	70.1
27	GTW-23.2	1998	Most likely 6	Supply or return	128.0
28	GTW-23.3	2000	Most likely 2	New supply well	41.1
29	Well-01	2003	2	Community Centre observation (test) well	34.7
30	Well-02	2003	1	Community Centre observation (test) well	32
31	Well-03	2003	1	Community Centre supply well	64

#	Borehole Name	Year	Seam Target	Remarks	Hole Depth (m)
32	Well-04	2003	1	Community Centre return well; decommissioned	68.6
33	Well-05	2004	1	Community Centre supply well	91.4
34	NSCC-01	2010	6	Supply or return; front of NSCC	115.8
35	NSCC-02	2010	6	Supply or return; behind NSCC	78.6
36	Well-06	2010	3	Community Centre recharge well	114.3
37	Well-07	2011	3	Replacement return well for Community Centre	125.0
38	GTW-24	2014	Most likely 1	New Surrette return well	71.9
39	SHCML MW-1	2015	1	Monitoring well (bulk sample pit)	31.1
40	SHCML MW-1	2015	1 & 2	Monitoring well (bulk sample pit)	73.7
41	Deep Well No. 1	2018	3	Test borehole (water flows and temperatures)	230.0
42	Deep Well No. 2	2018	3, 1, 2	Test borehole (water flows and temperatures)	220.0
43	GTW-25	2024	2, 7	Supply well	67.0

Appendix C: Examples of Geothermal Projects in Nova Scotia

Annapolis County

Soldiers Memorial Hospital Primary Healthcare Centre (Ground Loop)

The Soldiers Memorial Hospital Primary Healthcare Centre in Middleton, Nova Scotia utilizes a closed-loop geothermal heat pump system to provide heating and cooling (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

Antigonish County

Antigonish Town and County Library (Ground Loop)

The Antigonish Town and County Library in Antigonish, Nova Scotia utilizes a closed-loop geothermal heat pump system to provide heating and cooling (Simmons et al. 2015). No additional information regarding the specifications of the setup have been found.

Mulroney Hall (Ground Loop)

Mulroney Hall in Antigonish, Nova Scotia utilizes a geothermal field on the south side of the building (St. FX 2022). A geothermal heat pump system (60 wells were drilled 600 ft into the ground) heats and cools Mulroney Hall and Nicholson Tower, providing a more consistent temperature for improved efficiency compared to air-source heat pumps (St. FX 2022). The geothermal field is designed to be a reliable, long-term sustainable heating and cooling source (St. FX 2022).

Cape Breton County

Membertou Sport and Wellness Centre (Ground Loop)

The Membertou Sport and Wellness Centre in Membertou utilizes the Ice Kube System, which is an energy efficient geothermal chiller that has cold storage in the rink slab (Canmet Energy, 2009). The heating system works in reverse such that rather than cooling down the ice, it removes heat from it (Canmet Energy, 2009). The heat generated during the icemaking process is recovered and used throughout the facility as radiant heating (Canmet Energy, 2009). Warm water is circulated through a heat exchanger to create hot water for showers, melt snow shavings removed from the ice, and melt snow on the sidewalk around the buildings (Canmet Energy, 2009). Excess heat is stored in a horizontal earth loop under the parking lot (Canmet Energy, 2009). Forced air heat pumps provide heating and air conditioning by drawing or rejecting the heat to the earth loop (Canmet Energy, 2009). It has a similar setup to that of the Port Hawkesbury Civic Centre, Bayplex Recreation Centre, Dr. Carson and Marion Murray Community Centre, and the Emera Centre Northside (Simmons et al. 2015).

Bayplex Recreation Centre (Ground Loop)

The Bayplex Recreation Centre in Glace Bay, Nova Scotia utilizes the Ice Kube System as well (Simmons et al. 2015). Up until 2010, the arena made use of an ammonia refrigeration plant and boiler to make ice and heat dressing rooms (Kube Solutions 2023). In the fall of 2011, the ammonia system was removed and replaced with the Kube system (Kube Solutions 2023). Six Kubes were installed to produce ice and heat the building with operational cost savings anticipated at 60% (Kube Solutions 2023). Once the building is heated, the remaining heat is distributed into the ground for storage (Kube Solutions 2023). It has a similar setup to that of the Port Hawkesbury Civic Centre, Membertou Sport and Wellness Centre, Dr. Carson and Marion Murray Community Centre, and the Emera Centre Northside (Simmons et al. 2015).

Emera Centre Northside (Ground Loop)

The Emera Centre Northside in North Sydney, Nova Scotia utilizes the Ice Kube System as well (Simmons et al. 2015). The Kubes produce ice while concurrently taking heat out of the ice that is sent throughout the building (Kube Solutions 2023). This makes it possible for the arena to operate 365 days a year because the steady temperature of the earth (geothermal) provides the energy source for the rink (Kube Solutions 2023). The arena features radiant heating throughout the bleacher seats, rink apron, front lobby, and walking track for spectator comfort (Kube Solutions 2023). The arena area can be air conditioned with the Kubes for concerts and shows (Kube Solutions 2023). It has a similar setup to that of the Port Hawkesbury Civic Centre, Membertou Sport and Wellness Centre, Dr. Carson and Marion Murray Community Centre, and the Bayplex Recreation Centre (Simmons et al. 2015).

Canadian Coast Guard College (Ocean Water)

The Canadian Coast Guard College in Sydney, Nova Scotia uses a seawater-source geothermal heat pump plant to provide space heating and cooling (M and R Engineering 2015). The plant is piped to allow full heat recovery and electrifies the heating system preparing the building for a zero-carbon future (M and R Engineering 2015). The work includes the installation of state-of-the-art heat pump technology that will use ocean water from Sydney Harbour to provide heating and cooling to the entire campus (Public Services and Procurement Canada 2019). The system is expected to reduce energy consumption and greenhouse gas emissions by approximately 20% per year and reduce annual operating costs by 25% (Public Services and Procurement Canada 2019).

Verschuren Centre (Ground Loop)

The Verschuren Centre in Sydney, Nova Scotia utilizes a ground-loop geothermal system for heating and cooling (CBU 2023). No additional information regarding the specifications of the setup have been found.

Centre for Discovery and Innovation (Ground Loop)

The Centre for Discovery and Innovation at Cape Breton University in Sydney, Nova Scotia will utilize a geothermal closed loop system for heating and cooling. No additional information regarding the specifications of the setup have been found.

Colchester County

Rath Eastlink Community Centre (Ground Loop)

The Rath Eastlink Community Centre in Truro, Nova Scotia utilizes air handling equipment with energy recovery from exhaust air (M and R Engineering 2015). Full heat recovery is possible from the ice plant for space and ventilation air heating (M and R Engineering 2015). Any excess heat from the ice plant is rejected to a ground loop (geothermal) heat exchanger (M and R Engineering 2015). Geothermal heat pumps provide space cooling along with space heating, pool heating, and water heating (M and R Engineering 2015).

Tatamagouche Public Library (Ground Loop)

The Tatamagouche Public Library in Tatamagouche, Nova Scotia utilizes a ground source geothermal heat pump to supply heated water to an in-floor radiant heating system (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

Nova Institution for Women (Ground Loop)

The Federally Sentenced Women's Facility in Truro, Nova Scotia, is a 41,300 ft² complex constructed in 1994 to support Correctional Service of Canada's Green Plan initiatives. The facility comprises 12 buildings, including residential units, a gymnasium, a recreation building, an education building, office areas, health/food services, and an enhanced security building. It accommodates approximately 35 inmates and staff. The facility features a closed-loop ground-source heat pump system with radiant floor heating, chosen for security purposes. This system is supplemented by propane heating provided by solar hot water (SHW) boilers.

The ground-source heat pump system includes twenty 3-ton water-to-water heat pumps connected in series with ground heat exchangers. These heat pumps provide hot water for radiant floor space heating and duct heating coils. The system also incorporates solar hot water systems and propane service water heaters for supplemental heating. The ground heat exchangers cool about 30% of the complex, including administration areas, while the rest of the complex, such as the gymnasium and inmate quarters, is not cooled. Ventilation air is provided by heat recovery ventilators (HRVs) with supplemental heating from hot water coils.

The total cost of the HVAC system, including ground coupling, water-to-water heat pumps, solar hot water system, service water heaters, and cooling coils, was approximately $247,600 (Canadian). This is compared to an estimated $170,000 for a conventional system, resulting in an incremental cost of $77,600 for the ground-source heat pump system. The system provides annual energy savings of $8,340, with a simple payback period of approximately 9.0 years. The facility consumes 460,000 kWh of electricity and 3,823 therms of propane annually.

Despite initial installation issues with the EMS control program and control valves for the radiant floor heating, the system has experienced few difficulties since. Two compressors and a starting capacitor required replacement, and a preventive maintenance program is in place. Correctional Service Canada is very satisfied with the system, noting its effectiveness in meeting CO_2 reduction targets.

Cumberland County

Municipal Geothermal Project (Mine Water)

The depths of the mines make underground water as much as 11°C higher than normal groundwater temperatures (Simmons et al. 2015). The water can be used to heat buildings, then returned underground to be reheated by natural processes (Simmons et al. 2015). As of February 2015, approximately 40 geothermal wells had been drilled, of which 13 are currently used by businesses/facilities for heating, cooling, and production purposes (Simmons et al. 2015).

- Community Centre (2 Municipal Wells)
- Ropak Northeastern Limited (2 Private Wells)
- Surrette Battery Inc. (3 Private Wells)
- Fitness Centre (2 Private Wells)
- Community College (2 Private Wells)
- Springhill Loop Supply (2 Municipal Wells)
- GOVRC Workshop
- Eel Farm

Digby County

Weymouth Waterfront Library (Ground Loop)

The Weymouth Waterfront Library includes a geothermal heating system (Delmar Construction Ltd. 2023). No additional information regarding the specifications of the setup have been found.

Halifax County

NSCC Ivany (Waterfront) Campus (Ground Loop)

The NSCC Ivany (Waterfront) Campus utilizes a geothermal well field consisting of 36 boreholes that are 150 m (500 ft) deep (NSDECC 2023). This meets 100% of the buildings mechanical cooling needs and 50% of the annual heating load (NSDECC 2023). The building also has an integrated building automation system that allows for integration of HVAC, lighting, security, and CCTV to provide Smart Building technology monitoring of more than 1,800 points (NSDECC 2023).

MacAdams Project (Ground Loop)

The MacAdams project in Halifax, Nova Scotia has a system that provides heating to a 4 multi-unit residential building, replacing 100,000 litres of oil (Simmons et al. 2015). It currently has 3 fuel options: a pellet boiler with an automatic 3,000 kg feed system, a geothermal system consisting of 10 boreholes that are 90 ft deep and 4 inches in diameter combined with a 5-tonne heat pump, and natural gas backup (Simmons et al. 2015).

Alderney 5 Experimental Seawater Project (Ocean Water)

This report is a business case study of the Alderney 5 Energy Project, an integrated community energy solution (ICES) in Halifax, Nova Scotia. The project, initiated by the Halifax Regional Municipality (HRM), aimed to develop a seawater-based cooling system for a municipal building complex.

The project involved the use of traditional technologies, such as new lighting and heating systems, and new technologies, including a system that utilizes the cooling effect of seawater. The seawater is used directly when temperatures allow and indirectly through a borehole field that stores “cold energy.”

The report discusses the project's objectives, which included reducing energy costs and greenhouse gas (GHG) emissions, and the innovative approach to cooling the Alderney 5 complex. It also details the technical aspects of the project, such as the use of a seawater-based heat exchange system and the Underground Thermal Energy Storage (UTES) system.

The report further examines the project's governance and institutional context, the financing and economics, and the analysis and discussions. It also touches on the stakeholder engagement, environmental assessment, design and construction expertise, ease of replication, and risk management.

In conclusion, the report highlights the project's success in demonstrating an integrated community energy solution and its potential for broader application, while also acknowledging the risks associated with implementing new technologies.

Seaport Farmers Market (Ground Loop)

The Seaport Farmers Market utilizes 17 boreholes that are 200 m deep to store excess heat in summer for use in winter (seasonal storage) (NSDECC 2023). This seasonal storage helps maintain a consistent temperature within the building. Four commercial water-to-water heat pumps are installed on the second level of the building. The pumps are powered by wind and photovoltaics (NSDECC 2023). These pumps contribute to a 75% reduction in the power required compared to a typical market building. The geothermal system works in conjunction with other sustainable features, such as solar evacuated tube collectors, wind turbines, and a green roof. This integrated approach maximizes energy efficiency and minimizes environmental impact.

Queen’s Marque (Ocean Water)

The Queen’s Marque project is expected to be 55% more efficient than what would have been designed 20 years ago (Berman 2018). The heating and cooling system is integrated with ocean water (Berman 2018). A heat pump system is installed in the parking garage and connected to pipes that extend out into the harbour (150 m offshore; 14 m underwater) (Berman 2018). In the wintertime heat is extracted from the water and in the summertime, heat is released into the water (Berman 2018). The heat pump plant is modular and there's room to grow if other buildings in the downtown want to come online and share the technology (Berman 2018).

This seawater is then pumped through titanium plate heat exchangers. The seawater heat exchange system is expected to be 52% more efficient than the requirements under the National Energy Code. It eliminates the need for conventional mechanical cooling, cooling towers, and fossil fuels, relying instead on electricity from the building grid. The system significantly reduces emissions, with the only emission being heat rejected into the water during summer1. It also incorporates features like fish screens and anti-fouling coatings to prevent the growth of barnacles and other sea creatures.

Emera IDEA and Design Buildings (Ground Loop)

The Dalhousie University Emera IDEA and Design Buildings utilizes water-to-water heat pumps to provide space heating and cooling and are piped for full heat recovery (M and R Engineering 2015). A 60-borehole field located under the parking lot provides a heat source and heat sink for this project and other areas of campus (M and R Engineering 2015). I have not found any additional information about the setup.

Nova Scotia Power Headquarters (Ocean Water)

The Nova Scotia Power headquarters in Halifax, Nova Scotia utilizes water-to-water heat pumps that make use of ocean water as a heat source and sink to provide space heating and cooling (M and R Engineering 2015). The system draws cold seawater from Halifax Harbour and pumps it through titanium plate heat exchangers to prevent corrosion. This seawater is used to cool the building's closed-loop chilled water system. The seawater loop system achieved all 19 energy points in the LEED rating system, contributing to the building's LEED Platinum certificatio1. The system also utilizes Active Chilled Beams (ACB) for space cooling, a first in Atlantic Canada. By leveraging the natural thermal properties of seawater, the system reduces the building's reliance on traditional cooling methods and minimizes its environmental footprint. This system is part of Nova Scotia Power's broader commitment to sustainability and energy efficiency, transforming a former coal-fired power station into a modern, eco-friendly office space. I have not found any additional information about the setup.

Northwest Arm Residences (Ground Loop)

Two residences in the Northwest Arm area of Halifax, Nova Scotia are heated and cooled by ground-source geothermal heat pump systems (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

RBC Waterside Centre (Ocean Water)

The RBC Waterside Centre in Halifax, Nova Scotia makes use of ocean water from Halifax Harbour to provide approximately 90% of the cooling for the building (M and R Engineering 2015). This seawater is pumped through titanium plate heat exchangers to prevent corrosion. The building achieved LEED Gold certification, with energy cost savings of 57% compared to the baseline standard. The system also includes high-efficiency gas boilers and variable speed drives on circulation pumps and fans to save electricity. The use of seawater for cooling reduces the building's reliance on traditional cooling methods and minimizes its environmental footprint. No additional information regarding the specifications of the setup have been found.

Dutch Settlement Fire Station (Ground Loop)

The Dutch Settlement Fire Station in Dutch Settlement, Nova Scotia utilizes water-to-water and water-to-air heat pumps connected to a vertical borehole geothermal field (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

East Dartmouth Community Centre (Ground Loop)

The East Dartmouth Community Centre in Dartmouth, Nova Scotia utilizes water-to-water and water-to-air heat pumps connected to a vertical borehole geothermal field (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

Gordon R. Snow Community Centre and Fire Station (Ground Loop)

The Gordon R. Snow Community Centre and Fire Station in Fall River, Nova Scotia uses water-to-water and water-to-air heat pumps connected to a vertical borehole geothermal field (M and R Engineering 2015). This system provides efficient heating and cooling throughout the building. In-floor heating is installed in the gymnasium and apparatus bay, ensuring a comfortable environment and reducing energy use. Three heat recovery ventilators (HRVs) are used to recover heat from exhaust air, further enhancing energy efficiency. The energy model for the building indicated a 52% savings against the energy code (1997 MNECB). No additional information regarding the specifications of the setup have been found.

Beaver Bank Kinsac Community Centre (Ground Loop)

The Beaver Bank Kinsac Community Centre uses a ground source heat pump system with variable refrigerant flow (VRF) units, which provide efficient heating and cooling throughout the building (M and R Engineering 2015). The energy model indicated a 68% savings (M and R Engineering 2015). The facility also uses carbon dioxide (CO_2) sensors to reduce outdoor airflow based on occupancy, heat recovery ventilators (HRVs) to recover heat from exhaust air, and occupancy and daylight sensors to reduce lighting energy when spaces are unoccupied or when daylight is sufficient. No additional information regarding the specifications of the setup have been found.

Ikea Halifax (Ground Loop)

The Ikea Halifax facility utilizes ground-source geothermal for heating and cooling needs (Eastward Energy 2022). No additional information regarding the specifications of the setup have been found.

Historic Properties (Ocean Water)

The Historic Properties in Halifax, Nova Scotia make use of ocean water from Halifax Harbour to provide heating and cooling for the building (Simmons et al*.* 2015). Historic Properties in Halifax, Nova Scotia, utilizes a seawater heat exchange system to enhance its energy efficiency. This system works by drawing cold seawater from Halifax Harbour and pumping it through heat exchangers to cool the building's closed-loop chilled water system. This approach leverages the natural thermal properties of seawater, providing a sustainable and cost-effective cooling solution. It helps reduce the reliance on traditional cooling methods and contributes to overall energy savings. No additional information regarding the specifications of the setup have been found.

Halifax Marriott Harbourfront Hotel (Ocean Water)

The Halifax Marriott Harbourfront Hotel in Halifax, Nova Scotia makes use of ocean water from Halifax Harbour to provide heating and cooling for the building (Simmons et al. 2015). The Halifax Marriott Harbourfront Hotel has implemented an innovative seawater heat exchange system as part of its efforts to enhance energy efficiency and sustainability. This system utilizes the thermal properties of seawater to provide heating and cooling for the hotel, significantly reducing its reliance on traditional energy sources. Additionally, the hotel has integrated an AI-driven HVAC system from EcoPilot Canada, which optimizes energy use in real-time. This has resulted in a 24.5% reduction in natural gas consumption and a 3% drop in electricity use. No additional information regarding the specifications of the setup have been found.

Casino Nova Scotia (Ocean Water)

Casino Nova Scotia in Halifax, Nova Scotia makes use of ocean water from Halifax Harbour to provide heating and cooling for the building (Simmons et al*.* 2015). Casino Nova Scotia utilizes an innovative seawater heat exchange system to enhance its energy efficiency. This system draws cold ocean water from the bottom of Halifax Harbour through a polyethylene suction line and pumps it through titanium plate heat exchangers. The cold seawater is used to cool the building's closed-loop chilled water system, providing a sustainable and cost-effective cooling solution. This approach leverages the natural thermal properties of seawater, reducing the casino's reliance on traditional cooling methods and contributing to its overall energy savings. No additional information regarding the specifications of the setup have been found.

Purdy’s Wharf (Ocean Water)

Purdy’s Wharf in Halifax, Nova Scotia makes use of ocean water from Halifax Harbour to provide heating and cooling for the building (Simmons et al*.* 2015). Purdy's Wharf in Halifax, Nova Scotia, features an innovative seawater heat exchange system that significantly enhances its energy efficiency. The system pumps cold seawater from the depths of Halifax Harbour through titanium plate heat exchangers. This cold seawater is used to cool the building's closed-loop chilled water system. For most of the year, this system provides free cooling. During the colder months, electric chillers are used, but heat rejection is still managed through the seawater exchangers, eliminating the need for traditional cooling towers. To handle the seawater, the system uses special materials like PVC piping and titanium heat exchangers, which are resistant to corrosion and fouling. This system not only reduces energy consumption but also minimizes the environmental impact by leveraging the natural thermal properties of seawater. No additional information regarding the specifications of the setup have been found.

Bedford Institute of Oceanography (Ocean Water)

The Bedford Institute of Oceanography (BIO) in Dartmouth, Nova Scotia makes use of ocean water from Halifax Harbour to provide heating and cooling for the building (Simmons et al*.* 2015). A seawater heat exchange system as part of its energy-efficient infrastructure. This system draws cold seawater from the Bedford Basin and pumps it through heat exchangers to cool the building's closed-loop chilled water system. The seawater heat pump system is part of a broader initiative to reduce greenhouse gas emissions and enhance sustainability at the BIO campus. Recent renovations, including the installation of this system, have significantly reduced the building's greenhouse gas emissions by an estimated 75%. No additional information regarding the specifications of the setup have been found.

Prospect Road Community Centre (Ground Loop)

The Prospect Road Community Centre in Hatchet Lake, Nova Scotia utilizes water-to-water and water-to-air heat pumps connected to a vertical borehole geothermal field (Simmons et al*.* 2015). No additional information regarding the specifications of the setup have been found.

The Elevation (Ground Loop)

The Elevation will use a system of closed-loop geothermal boreholes for heating and cooling (Efficiency Nova Scotia 2023). In fact, it will be the first vertical geothermal field located underneath a multi-storey building, in all of Nova Scotia (Efficiency Nova Scotia 2023). What makes this geothermal system so unique is that, in addition to its exceptional heating and cooling capabilities, once the building is completed there will be no access to the system’s boreholes (Efficiency Nova Scotia 2023). The system was intentionally designed to be entirely contained underneath the building, out of view (Efficiency Nova Scotia 2023).

The Waterton Condominiums (Ground Loop)

The Waterton Condominiums are fully heated in the winter and cooled in the summer, using a geothermal system consisting of 35 boreholes over 300 ft deep (Consulting Engineers of Nova Scotia 2023).

Hants County

Windsor Elms Village (Ground Loop)

The Windsor Elms Village in Falmouth, Nova Scotia has a system that includes three separate closed-loop geothermal systems - one per wing - providing heating and cooling (M and R Engineering 2015).

Kings County

4-Single Family Dwellings (Ground Loop)

The Canard area of the Annapolis Valley is characterized as having abundant groundwater, which four property owners have exploited for geothermal usage (Simmons et al. 2015). One property owner uses a regular well to pump water out of the ground, run it through his heat pump and then dispose of it into a drainage ditch (Simmons et al. 2015). Another property owner uses a two well system which is 180 ft deep and cost about $20,000 (Simmons et al. 2015). The heat pump cost about $4,000, and another $1,000 to install, bringing the overall cost to an estimated $25,000 (Simmons et al. 2015). It has the option of returning the water to the ground using the first well, or the outflow can be run into a drainage ditch (Simmons et al. 2015). A third owner has a single well and a drainage ditch because that is the cheapest option. Savings are estimated at half the cost of an oil furnace (Simmons et al. 2015).

Kings County Academy (Ground Loop)

Kings County Academy in Kentville, Nova Scotia uses a groundwater heat pump system (open-loop geothermal system) for space heating/cooling, ventilation, and domestic water heating (M and R Engineering 2015). This system circulates groundwater through heat pumps to provide heating and cooling. No additional information regarding the specifications of the setup have been found.

Acadia University Biology Building (Ground Loop)

The Acadia University Biology Building in Wolfville, Nova Scotia utilizes a ground-loop geothermal system for heating and cooling (Acadia University 2023). No additional information regarding the specifications of the setup have been found.

Lunenburg County

Lunenburg County Lifestyle Centre (Ground Loop)

The Lunenburg County Lifestyle Centre in Bridgewater utilizes geothermal heat pumps to provide space cooling along with space heating, pool heating, and water heating (M and R Engineering 2015). Full heat recovery is possible from the ice plant for space and ventilation air heating (M and R Engineering 2015). Excess heat from the ice plant is rejected to a ground loop (geothermal) heat exchanger (M and R Engineering 2015).

Pictou County

Pictou Landing Health Centre (Ground Loop)

The Pictou Landing Health Centre in Pictou Landing is heated and cooled using geothermal energy from a decommissioned municipal well (60 m deep, 6-inch diameter), using 43% less energy than a conventional building of comparable size (Simmons et al. 2015).

Shiretown Nursing Home (Ground Loop)

The Shiretown Nursing Home in Pictou has a system includes a closed-loop geothermal system providing heating and cooling (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

Ivey's Terrace Nursing Home (Ground Loop)

The Ivey's Terrace Nursing Home in Trenton, Nova Scotia has a system that includes a closed-loop geothermal system providing heating and cooling (M and R Engineering 2015). No additional information regarding the specifications of the setup have been found.

Northeast Nova Scotia Correctional Facility (Ground Loop)

The Northeast Nova Scotia Correctional Facility in New Glasgow, Nova Scotia uses geothermal water-to-water heat pumps to provide in-floor heating and preheat domestic water (M and R Engineering 2015). Geothermal water-to-air heat pumps are incorporated into the air handling units to provide heating and cooling (M and R Engineering 2015). In total, there are 51 closed loop boreholes, each 180 m deep that provide heat exchange with the earth (M and R Engineering 2015).

Richmond County

Port Hawkesbury Civic Centre (Ground Loop)

The facility has been highly regarded worldwide for its sustainable design, including a designation as one of the world’s 10 greenest buildings by the US magazine Business Week (Kube Solutions 2023). The arena is equipped with the Ice Kube System, an energy efficient geothermal chiller that has cold storage in the rink slab (Kube Solutions 2023). The heating system works in reverse (Kube Solutions 2023). Rather than cooling down the ice; it is removing heat from it. The heat generated during the icemaking process is recovered and used throughout the facility as radiant heating (Kube Solutions 2023). Warm water is circulated through a heat exchanger to create hot water for showers, melt snow shavings removed from the ice and melt snow on the sidewalk around the buildings (Kube Solutions 2023). Excess heat is stored in a horizontal earth loop under the parking lot. Forced air heat pumps provide heating and air conditioning by drawing or rejecting the heat to the earth loop. Excess heat is shared with the high school next door to heat the swimming pool (Kube Solutions 2023).

Potlotek First Nations Greenhouse (Ground Loop)

The Potlotek First Nations Greenhouse is a geothermal greenhouse, which can grow produce year-round with the help of a geothermal climate battery (ground loop) that uses the Earth’s core to heat the space. This system provides consistent and sustainable heating, ensuring that the greenhouse can produce fresh food even during the colder months. No additional information regarding the specifications of the setup have been found.

Shelburne County

Coastal Grove Farm (Ground Loop)

Coastal Grove Farm in Nova Scotia utilizes a geothermal system to enhance its agricultural operations. The farm operates two geothermal greenhouses, including a 2,500 ft^2 permanent soil greenhouse. These greenhouses allow the farm to grow citrus and other tropical crops, extending the growing season and improving crop yields. The geothermal system helps minimize the farm's carbon footprint. The farm also harvests seaweed from the shore to use as compost, further enhancing soil fertility. Coastal Grove Farm is committed to organic farming practices, being the only certified organic commercial tea grower in Canada and one of the few certified organic saffron growers.

Yarmouth County

District of Yarmouth Municipal Building (Ground Loop)

The District of Yarmouth Municipal Building utilizes water-to-water and water-to-air heat pumps connected to a horizontal geothermal field located under a soccer field (M and R Engineering 2015). The building is equipped with in-floor heating to ensure a comfortable environment while reducing energy consumption. Four HRVs are installed to recover heat from exhaust air, enhancing ventilation efficiency. An energy study revealed that the building achieves a 58% energy cost savings compared to conventional construction methods. No additional information regarding the specifications of the setup have been found.

Appendix D: Global Mine Water Inventory

Table D1: Global mine-related geothermal inventory.Most of the information was originally tabulated by Chu et al. (2021). U – underground; OP – open pit; I – inactive; A – active; n/d – no data

No.	Year	Location	Element	Type	Stage	Energy Source	Depth	Temp.	End-User
1	1955	Creighton Mine, ON	Ni, Cu	U	A	exhaust air, mine H_2O	n/d	return air is ~ 16.1°C	mine heating
2	1968	Strathcona Mine, ON	Fe, Ni, Cu	U	A	exhaust air, mine H_2O	n/d	n/d	mine heating
3	1980's	Henderson Mine, CO	Mo	U	A	mine H_2O	n/d	29.4°C H_2O	mine heating
4	1981	Kingston, PA	C	U	I	mine H_2O	58 m	n/d	building heat and cool
5	1984	Heinrich Mine, DE	C	U	I	mine H_2O	n/d	n/d	building
6	1987	Kiena Mine, QC	Au	U	A	exhaust air	n/d	n/d	mine heating
7	1989	Springhill, NS	C	U	I	mine H_2O	140 m	18°C H_2O	buildings
8	1980's	Kidd Creek Mine, ON	Zn, Cu	OP-U	A	fractured rock	n/d	n/d	heat/cool mine
9	1980's	Creighton Mine, ON	Ni, Cu	OP-U	A	fractured rock	800 m	n/d	heat/cool mine
10	1994	Sachsen, DE	Sn	U	I	mine H_2O	n/d	n/d	school
11	1995	Park Hills, MO	Pb	U	I	mine H_2O	122 m	14°C H_2O	building
12	1995	Williams Mine, ON	Au	U	A	exhaust air, mine H_2O	n/d	n/d	n/d
13	1997	Sachsen, DE	Sn	U	I	mine H_2O	n/d	n/d	buildings
14	1998	Folldal Mine, NO	Cu	U	I	mine H_2O	600 m	6°C H_2O	buildings
15	1999	Scotland, UK	C	U	I	mine H_2O	100 m	12°C H_2O	buildings
16	2000	Scotland, UK	C	U	I	mine H_2O	172.5 m	15°C H_2O	buildings
17	2000	Zollverin Mine, DE	C	U	I	mine H_2O	n/d	n/d	building
18	2005	Kongsberg Mine, NO	Ag	U	I	mine H_2O	342 m	16.4°C H_2O	buildings
19	2005	Gaspe, QC	Cu	U	I	mine H_2O	42 m	6.7°C mine H_2O	n/d

No.	Year	Location	Element	Type	Stage	Energy Source	Depth	Temp.	End-User
20	2006	Saint-Bruno-De, Montarville, CA	gravel	OP	I	mine H_2O	n/d	n/d	buildings
21	2006	Xiezhuang Mine, CN	C	U	A	mine H_2O	n/d	9 - 12°C	mine heating
22	2007	Sachsen, DE	U	U	I	mine H_2O	144 m	12°C	swimming pool
23	2007	Jiahe Mine, CN	C	U	I	mine H_2O	~ 1,000 m	36°C	mine cool; building heat
24	2007	Sanhejian Mine, Xuzhou, CN	C	U	A	mine H_2O; river H_2O	~ 1,000 m	25 - 30°C	mine cool; building heat
25	2007	Zhangshuanglou Mine, CN	C	U	A	mine H_2O	~ 1,000 m	36 - 37°C	mine cool; building heat
26	2008	Cornwall, UK	Sn	U	I	mine H_2O	n/d	n/d	buildings
27	2008	Dongpang Mines, CN	C	U	A	exhaust air, mine H_2O	n/d	18°C	mine heating
28	2009	Novoshakhtinsk, Rostov, RU	C	U	I	mine H_2O	50 - 150 m	12 - 13°C	buildings
29	2009	Quincy Mine, MI	Cu	U	I	mine H_2O	91 m	12.8°C	buildings
30	2009	Freiberg, Saxony, DE	Ag	U	I	mine H_2O	60 m	10.2°C	buildings
31	2009	Heerlen, NL	C	U	I	mine H_2O	700/250 m	28°C @ 700 m; 16°C @ 250 m	buildings
32	2009	Saxony, DE	n/d	n/d	I	mine H_2O	n/d	n/d	school
33	2010	Scranton, PA	C	U	I	mine H_2O	122 m	13.9 - 16.1°C	university
34	2010	Asturian Basin, ES	C	U	I	mine H_2O	n/d	17 - 23°C	buildings
35	2011	Durham, UK	C	U	I	mine H_2O	n/d	n/d	buildings
36	2012	Markham Colliery, UK	C	U	I	mine H_2O	235 m	15.4°C	building

No.	Year	Location	Element	Type	Stage	Energy Source	Depth	Temp.	End-User
37	2013	Wutongzhuang Mines, CN	C	U	A	exhaust air, mine H_2O	700 m	return air 23°C	mine heat/cool
38	2013	Saxony, DE	C	U	I	mine H_2O	283 m	13°C	building
39	2014	Shandong, CN	C	U	A	mine H_2O	860 m/1 km	26°C	mine heat/cool
40	2015	Caphouse Mine, UK	C	U	I	mine H_2O	134 m	14 - 15°C	building
41	2016	Henan, CN	n/d	OP	I	mine H_2O	n/d	15°C	buildings
42	2016	Jisman Mine, CN	C	U	A	mine H_2O	556 m	22°C	mine heat/cool
43	2016	Daquan Lake, Xinjiang, CN	C	U	A	coal fire	2 - 10 m	126 - 154°C	power generation
44	N/D	North Rhine, DE	C	U	I	mine H_2O	890 m	26°C	buildings
45	2020	Durham, UK	C	U	I	mine H_2O	?	18 - 20°C	buildings

Appendix E: Summary of Springhill Coal Mine Plans

Table E1: A catalogue of mine plans and maps from the Springhill area.The maps were originally created by the various mining companies who owned/operated the coal mines in Springhill. At some point, the plans/maps were in the possession of the DNRR Mines Branch. At some point they were turned over to Brian Herteis so he could facilitate the task of georeferencing the plans/maps and determining the water volumes/capacities for mine water geothermal.

#	Category	Title	Scale	Date	Other Identifiers
1	General U/G mining detail	No. 2 Mine 5700 ft level; details on the bump @ 2:55	1"=10'	12 Apr. 1928	n/a
2	General U/G mining detail	Cumberland Railway and Coal Ltd.; Proposed Dam for 500' Head	1"=2'	20 Jul. 1951	No. 504-T
3	General U/G mining detail	Dominion Coal Company Ltd.; No. 2 and No. 3 Mine - Panel Work	1"=100'	n/a	No. 228-T
4	General U/G mining detail	6900' Bottom No. 2 Mine	1"=20'	n/a	SP-7^{D}; #13
5	General U/G mining detail	Sketch showing position of packs longwall face No. 2 Mine	n/a	n/a	SP-12^{F}; #101
6	General U/G mining detail	Dominion Coal Company Ltd.; Longwall No. 1 Seam	1"=4'	n/a	No. 599-Z
7	General U/G mining detail	Cumberland Railway and Coal Ltd.; No. 2 Colliery; Method of grouting in casing pipe in drilling to No. 3 seam from No. 2 seam at 4700' lodgement	1.5"=1'	n/a	No. 428-Z
8	General U/G mining detail	Dominion Coal Company Ltd.; No. 1 Seam showing chock system	1"=?	n/a	No. 597-Z
9	General U/G mining detail	Dominion Coal Company Ltd.; Ventilation Fan Blueprints	1"=1'	n/a	591-Z; G7712
10	General U/G mining detail	Plan - Longwall Face No. 2 Mine; 5700' and 5900' Level; Location and design of softwood and hardwood packs	1"=20'	3 Jul. 1928	B-11
11	General U/G mining detail	Plan - Longwall Face No. 2 Mine; 5700' and 5900' Level; Location and design of softwood and hardwood packs	1"=20'	18 Apr. 1928	n/a
12	No. 1 Seam Top Workings	Workings in top coal No. 1 Seam	1"=200'	n/a	#40

#	Category	Title	Scale	Date	Other Identifiers
13	No. 1 Seam Top Workings	Workings in top coal No. 1 Seam	1"=200'	n/a	n/a
14	No. 1 Seam Top Workings	Plan of No. 1 Seam showing workings in top coal	1"=200'	n/a	No. 35
15	No. 1 Seam Top Workings	Plan of No. 1 Seam showing workings in top coal	1"=200'	n/a	n/a
16	No. 1 Seam Top Workings	Plan of No. 1 Seam showing workings in top coal	1"=2 chains	n/a	#11
17	No. 1 Seam Top Workings	Springhill Collieries plan of workings in No. 1 Seam	1"=400'	Nov. 1956	n/a
18	No. 1 Seam Top Workings	Plan of No. 1 Seam showing workings	1"=100'	n/a	n/a
19	No. 1 Seam Bottom Workings	No. 1 Seam showing workings in bottom coal	1"=200'	n/a	n/a
20	No. 1 Seam Bottom Workings	No. 1 Seam showing workings in bottom coal	1"=200'	n/a	n/a
21	No. 1 Seam Bottom Workings	No. 1 Seam showing workings in bottom coal	1"=200'	n/a	n/a
22	No. 1 Seam Bottom Workings	No. 1 Seam showing workings in bottom coal	1"=200'	n/a	n/a
23	No. 1 Seam Bottom Workings	No. 1 Seam Under-seam	1"=400'	n/a	n/a
24	No. 1 Seam - Both Workings	Projected levels No. 1 Seam	1"=200'	n/a	SP-6^{F}
25	No. 1 Seam - Both Workings	Development of upper and lower levels - No.1 Seam from No. 2 Slope	1"=132'	6 Jun. 1932	SP-15^{DD}
26	No. 1 Seam - Both Workings	Plan of No. 1 Workings	1"=2'	22 Sept. 1924	n/a

#	Category	Title	Scale	Date	Other Identifiers
27	No. 2 Mine Slopes	Profile Pipe Slope No. 2 Mine from 3300' mineboard to 6500' lodgement	1"=100'	n/a	SP-3^{A}
28	No. 2 Mine Slopes	Profile Pipe Slope No. 2 Mine from surface to 3300' lodgement	1"=100'	n/a	SP-7^{AA}
29	No. 2 Mine Slopes	Section along No. 2 Slope	1"=100'	n/a	#11; C-7
30	No. 2 Mine Slopes	Profile Pipe Slope No. 2 Mine and No. 4 Slope	1"=100'	n/a	K83
31	No. 2 Mine Slopes	Section along No. 2 Slope	1"=200'	n/a	n/a
32	No. 2 Mine Slopes	Profile Hoisting Slope	1"=10'	Apr. 1931	SP-2^{H}; C-9
33	No. 2 Mine Slopes	Section No. 2 Slope	1"=300'	n/a	n/a
34	No. 2 Mine Slopes	Section along No. 2 Slope	1"=400'	28 Nov. 1936	n/a
35	No. 2 Mine Slopes	Section along No. 2 Slope	1"=400'	17 Nov. 1927	n/a
36	No. 2 Mine Slopes	Section on line No. 2 Slope	1"=100'	1926	n/a
37	No. 2 Mine Slopes	Vertical section along strike @ 4700' Level, No. 2 Mine	H: 1"=400'; V: 1"=200'	17 Nov. 1927	10-M^{5}
38	No. 2 Mine Slopes	Strata Overlying No. 2 Seam	H: 1"=200'; V: 1"=20'	n/a	GL-21^{A}
39	No. 2 Mine Slopes	Proposed Tunnel - No. 2 Slope	1"=30'	n/a	SP-3^{E}; #4
40	No. 2 Mine Slopes	Longitudinal Section of No. 2 Slope	1"=80'	n/a	C-4
41	No. 2 Mine Slopes	Profile No. 2 Auxiliary Slope; Slope distance 7100'-14200'	1"=100'	n/a	n/a
42	No. 2 Mine Workings	Part Plan No. 2 Mine; 4700' to 11400' Level	n/a	n/a	n/a
43	No. 2 Mine Workings	No. 2 Mine 9800' to 14200' Level	n/a	n/a	n/a
44	No. 2 Mine Workings	Springhill No. 2 Mine Plan; 3300' Level	1"=132'	n/a	n/a

#	Category	Title	Scale	Date	Other Identifiers
45	No. 2 Mine Workings	Springhill No. 2 Mine Plan; 4700' to 7400' Level	n/a	n/a	n/a
46	No. 2 Mine Workings	No. 2 Mine Slope Workings West Side	1"=100'	Apr. 1922	SP-4^{Y}
47	No. 2 Mine Workings	Plan of No. 2 Mine	1"=200'	n/a	n/a
48	No. 2 Mine Workings	No. 2 Mine Plan; 5400' to 11400' Level	n/a	n/a	SP-8^{R}
49	No. 3 Seam Top Workings	Plan of No. 3 Slope Workings	1"=2 chains	n/a	n/a
50	No. 3 Seam Top Workings	Plan of No. 3 Slope Workings	1"=2 chains	n/a	File 0009; 1331
51	No. 3 Seam Top Workings	Geological Projection of the No. 3 Top Seam in No. 3 Colliery	n/a	n/a	n/a
52	No. 3 Seam Top Workings	Longitudinal Section of No. 3 Slope	1"=100'	Jan. 1906	SP-4^{K}
53	No. 3 Seam Top Workings	Longitudinal Section of No. 3 Slope	1"=100'	Jan. 1908	n/a
54	No. 3 Seam Top Workings	Geological Projection of the No. 3 Top Seam in No. 3 Colliery	n/a	n/a	n/a
55	No. 3 Seam Bottom Workings	Plan of No. 3 Slope Workings - Bottom Coal; 3800' to 5000' Levels	1"=100'	Jan. 1916	n/a
56	No. 3 Seam Bottom Workings	Bottom Coal; 3200' to 3800' Levels	n/a	n/a	SP-13^{BB}
57	No. 3 Seam Bottom Workings	Bottom Coal; 3800' Level	n/a	n/a	SP-13^{Y}
58	No. 3 Seam Bottom Workings	Workings in Bottom Coal No. 3 Mine; 1800' to 2600' levels	n/a	n/a	SP-7^{K}
59	No. 3 Seam Bottom Workings	Plan of workings in Bottom Coal No. 3 Slope	1"=2 chains	n/a	#132
60	No. 3 Seam Bottom Workings	Plan of workings in Bottom Coal No. 3 Slope; 1900' to 3800' levels	n/a	Dec. 1907	SP-10^{K}

#	Category	Title	Scale	Date	Other Identifiers
61	No. 3 Seam Bottom Workings	Plan of workings in Bottom Coal No. 3 Slope; 1900' to 3800' levels	1"=2 chains	n/a	SP-6^D
62	No. 3 Seam Bottom Workings	Plan of workings in Bottom Coal No. 3 Slope; 1900' to 3800' levels	1"=2 chains	n/a	#116
63	No. 3 Seam Bottom Workings	Plan of workings in Bottom Coal No. 3 Slope; 3200' to 4800' levels	1"=132'	n/a	SP-4^P
64	No. 4 Mine/No. 6 Seam Workings	Geological Projection of the No. 6 Seam in No. 4 Colliery	n/a	n/a	n/a
65	No. 4 Mine/No. 6 Seam Workings	Plan of No. 6 Seam, No. 4 Mine	1"=400'	n/a	n/a
66	No. 4 Mine/No. 6 Seam Workings	Plan of No. 6 Seam	1"=200'	n/a	n/a
67	No. 4 Mine/No. 6 Seam Workings	No. 6 Mine/No. 6 Seam	n/a	n/a	n/a
68	No. 4 Mine/No. 6 Seam Workings	Plan of No. 6 Seam	1"=100'	n/a	n/a
69	No. 4 Mine/No. 7 Seam Workings	Workings in No. 7 Seam, No. 4 Mine; Sheet 2 of 2	n/a	n/a	n/a
70	No. 4 Mine, No. 7 Seam	No. 4 Mine, No. 7 Seam	n/a	n/a	n/a
71	No. 4 Mine, No. 7 Seam	Profile of No. 7 Seam online of main incline No. 4 Colliery	1"=100'	26 Jan. 1935	n/a
72	No. 4 Mine, No. 7 Seam	Plan of workings in No. 7 Seam, No. 4 Mine	1"=200'	n/a	n/a
73	No. 4 Mine, No. 7 Seam	Plan of No. 4 Mine showing workings in No. 7 Seam	1"=200'	n/a	n/a

#	Category	Title	Scale	Date	Other Identifiers
74	No. 4 Mine, No. 7 Seam	Plan of workings in No. 7 Seam, No. 4 Mine Showing Old Workings; Old Workings of No. 7 Mine, 1920-1933	1"=400'	n/a	SP-8^{G}; #5
75	No. 4 Mine, No. 7 Seam	Untitled	n/a	n/a	n/a
76	No. 4 Mine, No. 7 Seam	No. 4 Mine, No. 7 Seam	1"=100'	n/a	#1
77	No. 4 Mine, No. 7 Seam	Profile No. 4 Haulage Slope and Fan Slope from Surface to 3200' Level; Plan Stone Slopes and Tunnels, No. 4 Mine	1"=200'	n/a	SP-16^{C}
78	No. 4 Mine, No. 7 Seam	Profile of Slope in No. 7 Seam below the 3200' Level, No. 4 Colliery	1"=50'	13 Jul. 1934	SP-7^{EE}
79	No. 4 Mine, No. 7 Seam	Geological Projection of the No. 7 Seam in No. 4 Colliery	n/a	Mar. 1956	17A
80	No. 4 Mine, No. 6 and 7 Workings	3300' Bottom No. 4 Mine	1"=20'	n/a	K-53
81	No. 4 Mine, No. 6 and 7 Workings	No. 4 Springhill Plan and Profile 3300' Bottom	H: 1"-20' V: 1"=4'	n/a	SP-7^{KK}
82	No. 4 Mine, No. 6 and 7 Workings	Plan of Workings in No. 6 and 7 Seams Showing Old Workings in No. 7 Mine 1920-1933	1"=400'	n/a	n/a
83	No. 6 Mine Workings	Plan of No. 6 Seam	1"=200'	n/a	n/a
84	No. 6 Mine Workings	Springhill Collieries Profile of No. 6 Slope	1"=50'	n/a	15-X-Z; SP-7^{Y}
85	No. 6 Mine Workings	Section No. 6 Slope	1"=10'	Jul. 1919	15-X-3
86	No. 6 Mine Workings	Section No. 6 Slope	1"=30'	n/a	n/a
87	No. 6 Mine Workings	No. 6 Seam East Sheet	1"=200'	n/a	n/a
88	No. 6 Mine Workings	Workings in No. 6 Mine, No. 6 Seam	1"=200'	n/a	n/a
89	No. 6 Mine Workings	Plan of No. 6 Mine Springhill	1"=400'	Nov. 1936	n/a
90	No. 7 Mine Workings	Plan of No. 7 Mine, 800' to 2800' Level	1"=100'	n/a	n/a

#	Category	Title	Scale	Date	Other Identifiers
91	No. 7 Mine Workings	Plan of No. 7 Mine, 600' to 2500' Level	1"=100'	n/a	n/a
92	No. 7 Mine Workings	Projection Longwall in No. 7 Mine, 1000' to 2000' Levels	1"=100'	26 Aug. 1927	SP-17^{CC}
93	No. 7 Mine Workings	Coal Areas at Springhill Showing Location of No. 7 Mine	4"=1Mile	Sept. 1920	SP-17^{CC}
94	No. 7 Mine Workings	Plan showing the Expected Position of the Aberdeen Fault in No. 7 Seam	1"=400'	n/a	n/a
95	No. 7 Mine Workings	Plan of No. 7 Mine	1"=400'	Nov. 1936	#14
96	No. 7 Mine Workings	Springhill Collieries Profile of No. 7 Slope	1"=50'	n/a	15-Y-L
97	No. 7 Mine Workings	Plan Showing Projected Workings No. 7 Mine	1"=100'	Sept. 1920	15-Y-3
98	No. 7 Mine Workings	Springhill Collieries Plan of No. 7 Slope	1"=100'	n/a	n/a
99	No. 7 Mine Workings	No. 7 Seam Bottom East	1"=200'	n/a	n/a

Figure E1: Satellite image of Springhill showing geothermal borehole locations, the No. 1 coal seam upper and lower workings and the No. 1 coal seam contour elevations.

Figure E2: Satellite image of Springhill showing geothermal borehole locations, the No. 2 coal seam workings and the No. 2 coal seam contour elevations.

Figure E3: Satellite image of Springhill showing geothermal borehole locations, the No. 3 coal seam workings and the No. 3 coal seam contour elevations.

Figure E4: Satellite image of Springhill showing geothermal borehole locations, the No. 6 coal seam workings and the No. 6 coal seam contour elevations.

Figure E5: Satellite image of Springhill showing geothermal borehole locations, the No. 7 coal seam workings and the No. 7 coal seam contour elevations.

Appendix F: Inventory of Springhill Geothermal Borehole Data

GTW-01 – 15 hours after drilling

Borehole GTW-01 was drilled in front of the Ropak Can Am building in 1987 to a depth of 82.3 m. The borehole targeted the No. 2 Seam workings but unfortunately missed the target. Temperature measurements were recorded from the borehole 15 hours after the completion of drilling activities (Table F1). The temperature versus depth was plotted on Figure F1. It looks like the first three temperature measurements are anomalous and are therefore not considered reliable.

Table F1: Temperature data for borehole GTW-01 collected 15 hours after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Remarks
0.0	0.0	61.2	16.2	Anomalous; not the normal trend
16.4	5.0	57.6	14.2	Anomalous; not the normal trend
32.8	10.0	58.6	14.8	Anomalous; not the normal trend
49.2	15.0	51.1	10.6	Part of the normal trend line
65.6	20.0	51.4	10.8	Part of the normal trend line
82.0	25.0	51.6	10.9	Part of the normal trend line
98.4	30.0	52.0	11.1	Part of the normal trend line
114.8	35.0	52.2	11.2	Part of the normal trend line
131.2	40.0	52.5	11.4	Part of the normal trend line
147.6	45.0	52.7	11.5	Part of the normal trend line
164.0	50.0	52.9	11.6	Part of the normal trend line
180.4	55.0	53.1	11.7	Part of the normal trend line
196.9	60.0	53.1	11.7	Part of the normal trend line
213.3	65.0	53.2	11.8	Part of the normal trend line
229.7	70.0	53.1	11.7	Part of the normal trend line
246.1	75.0	52.9	11.6	Part of the normal trend line
262.5	80.0	52.7	11.5	Part of the normal trend line
269.4	82.1	52.7	11.5	Part of the normal trend line

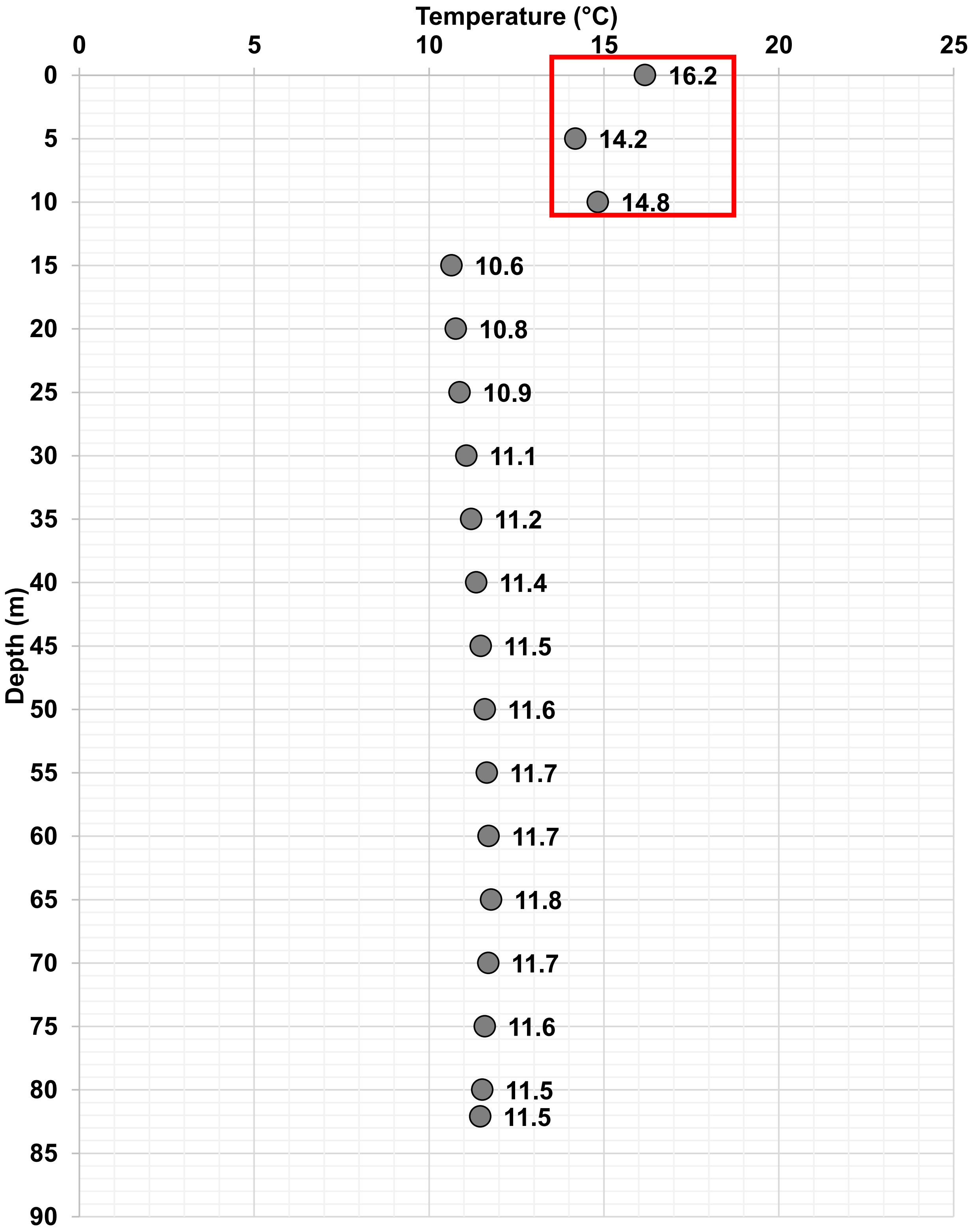

Figure F1: Plot of temperature versus depth for borehole GTW-01 collected 15 hours after the completion of drilling activities.

GTW-01 – 24 hours after drilling

Temperature measurements were recorded from the borehole 24 hours after the completion of drilling activities (Table F2). The temperature versus depth was plotted on Figure F2. It looks like the first six temperature measurements are anomalous and are therefore not considered reliable.

Table F2: Temperature data for borehole GTW-01 collected 24 hours after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Remarks
0.0	0.0	n/a	n/a	n/a
16.4	5.0	69.6	20.9	Anomalous; not the normal trend
32.8	10.0	66.9	19.4	Anomalous; not the normal trend
49.2	15.0	66.0	18.9	Anomalous; not the normal trend
65.6	20.0	63.1	17.3	Anomalous; not the normal trend
82.0	25.0	62.1	16.7	Anomalous; not the normal trend
98.4	30.0	61.7	16.5	Anomalous; not the normal trend
114.8	35.0	51.8	11.0	Part of the normal trend line
131.2	40.0	52.3	11.3	Part of the normal trend line
147.6	45.0	52.5	11.4	Part of the normal trend line
164.0	50.0	52.9	11.6	Part of the normal trend line
180.4	55.0	52.9	11.6	Part of the normal trend line
196.9	60.0	53.1	11.7	Part of the normal trend line
213.3	65.0	53.2	11.8	Part of the normal trend line
229.7	70.0	53.1	11.7	Part of the normal trend line
246.1	75.0	52.9	11.6	Part of the normal trend line
262.5	80.0	52.9	11.6	Part of the normal trend line
269.4	82.1	52.7	11.5	Part of the normal trend line

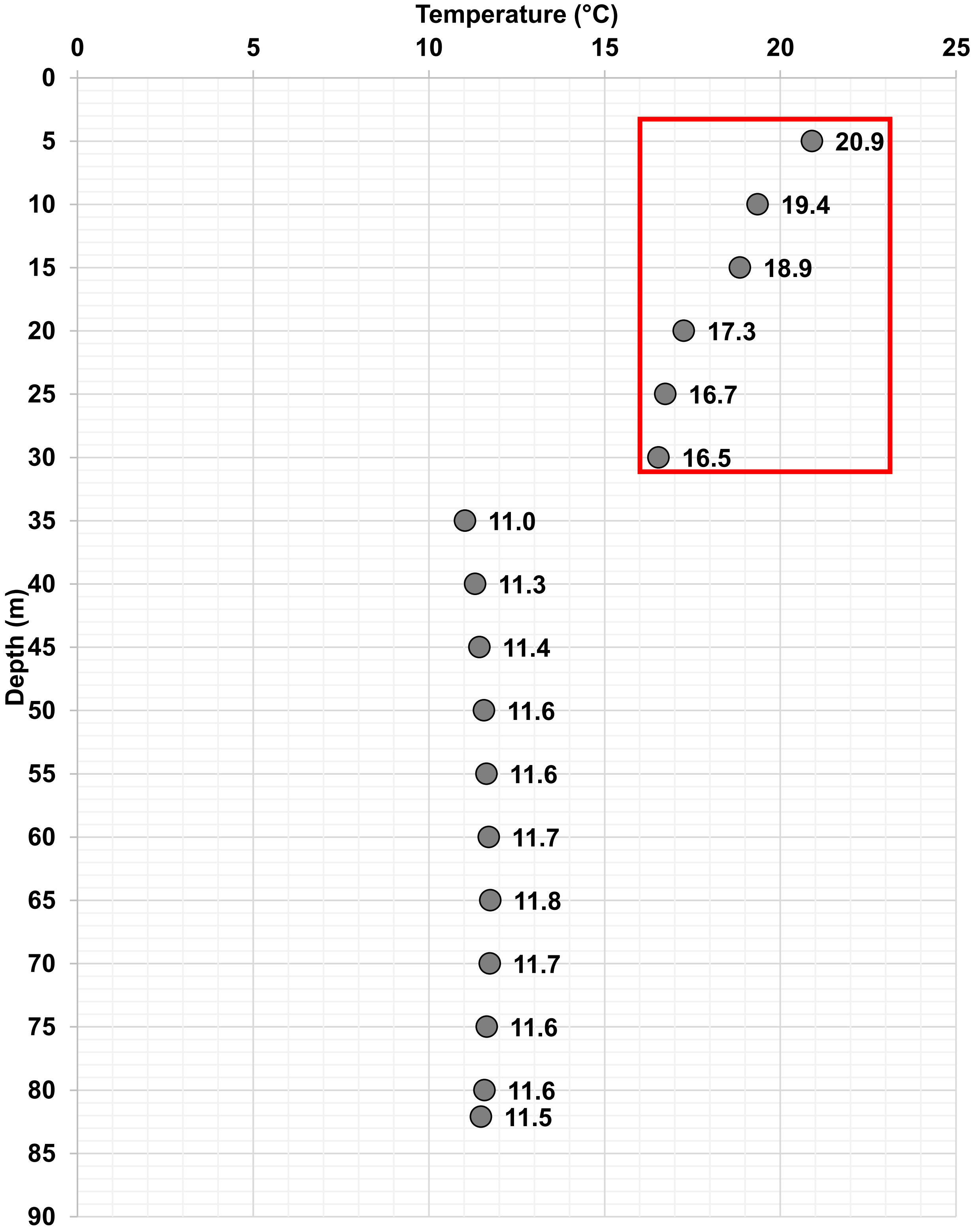

Figure F2: Plot of temperature versus depth for borehole GTW-01 collected 24 hours after the completion of drilling activities.

GTW-02 – 24 hours after GTW-03 pump test

Borehole GTW-02 was drilled off Queen Street for the former community arena in 1987 to a depth of 50.9 m. The borehole targeted the No. 2 Seam workings but unfortunately missed the target. Temperature measurements were recorded from the borehole 24 hours after the pump test for GTW-03 was completed (Table F3). The temperature versus depth was plotted on Figure F3. It looks like the first ten temperature measurements are anomalous and are therefore not considered reliable.

Table F3: Temperature data for borehole GTW-02 collected 24 hours after the pump test on borehole GTW-03 was completed.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Remarks
0.0	0.0	64.4	18.0	Anomalous; not the normal trend
8.2	2.5	62.6	17.0	Anomalous; not the normal trend
16.4	5.0	59.4	15.2	Anomalous; not the normal trend
24.6	7.5	57.9	14.4	Anomalous; not the normal trend
32.8	10.0	55.9	13.3	Anomalous; not the normal trend
41.0	12.5	55.9	13.3	Anomalous; not the normal trend
49.2	15.0	55.0	12.8	Anomalous; not the normal trend
57.4	17.5	54.7	12.6	Anomalous; not the normal trend
65.6	20.0	54.3	12.4	Anomalous; not the normal trend
73.8	22.5	54.0	12.2	Anomalous; not the normal trend
82.0	25.0	48.2	9.0	Part of the normal trend line
90.2	27.5	48.0	8.9	Part of the normal trend line
98.4	30.0	48.0	8.9	Part of the normal trend line
106.6	32.5	48.0	8.9	Part of the normal trend line
114.8	35.0	48.2	9.0	Part of the normal trend line
123.0	37.5	48.2	9.0	Part of the normal trend line
131.2	40.0	48.2	9.0	Part of the normal trend line
139.4	42.5	48.2	9.0	Part of the normal trend line
147.6	45.0	48.2	9.0	Part of the normal trend line
155.8	47.5	48.4	9.1	Part of the normal trend line
164.0	50.0	48.9	9.4	Part of the normal trend line

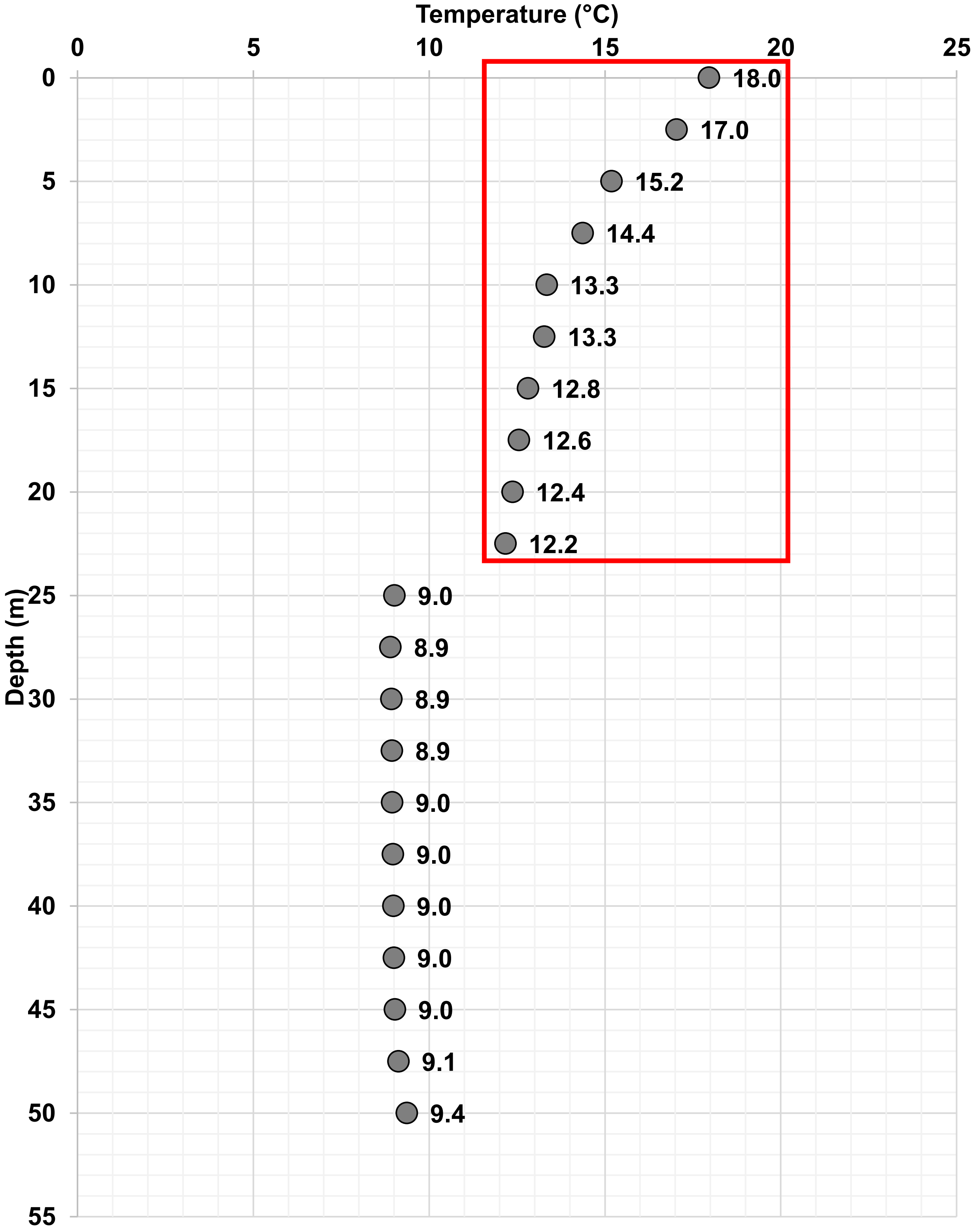

Figure F3: Plot of temperature versus depth for borehole GTW-02 collected 24 hours after the pump test on borehole GTW-03 was completed.

GTW-02 – 40 hours after GTW-03 pump test

Temperature measurements were recorded from the borehole 40 hours after the pump test for GTW-03 was completed (Table F4). The temperature versus depth was plotted on Figure F4. It looks like the first ten temperature measurements are anomalous and are therefore not considered reliable.

Table F4: Temperature data for borehole GTW-02 collected 40 hours after the pump test on borehole GTW-03 was completed.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Remarks
0.0	0.0	74.3	23.5	Anomalous; not the normal trend
8.2	2.5	69.1	20.6	Anomalous; not the normal trend
16.4	5.0	65.1	18.4	Anomalous; not the normal trend
24.6	7.5	63.1	17.3	Anomalous; not the normal trend
32.8	10.0	60.8	16.0	Anomalous; not the normal trend
41.0	12.5	59.2	15.1	Anomalous; not the normal trend
49.2	15.0	60.1	15.6	Anomalous; not the normal trend
57.4	17.5	57.2	14.0	Anomalous; not the normal trend
65.6	20.0	55.4	13.0	Anomalous; not the normal trend
73.8	22.5	54.7	12.6	Anomalous; not the normal trend
82.0	25.0	48.0	8.9	Part of the normal trend line
90.2	27.5	48.0	8.9	Part of the normal trend line
98.4	30.0	48.0	8.9	Part of the normal trend line
106.6	32.5	48.0	8.9	Part of the normal trend line
114.8	35.0	48.2	9.0	Part of the normal trend line
123.0	37.5	48.2	9.0	Part of the normal trend line
131.2	40.0	48.2	9.0	Part of the normal trend line
139.4	42.5	48.2	9.0	Part of the normal trend line
147.6	45.0	48.2	9.0	Part of the normal trend line
155.8	47.5	48.6	9.2	Part of the normal trend line
164.0	50.0	48.7	9.3	Part of the normal trend line

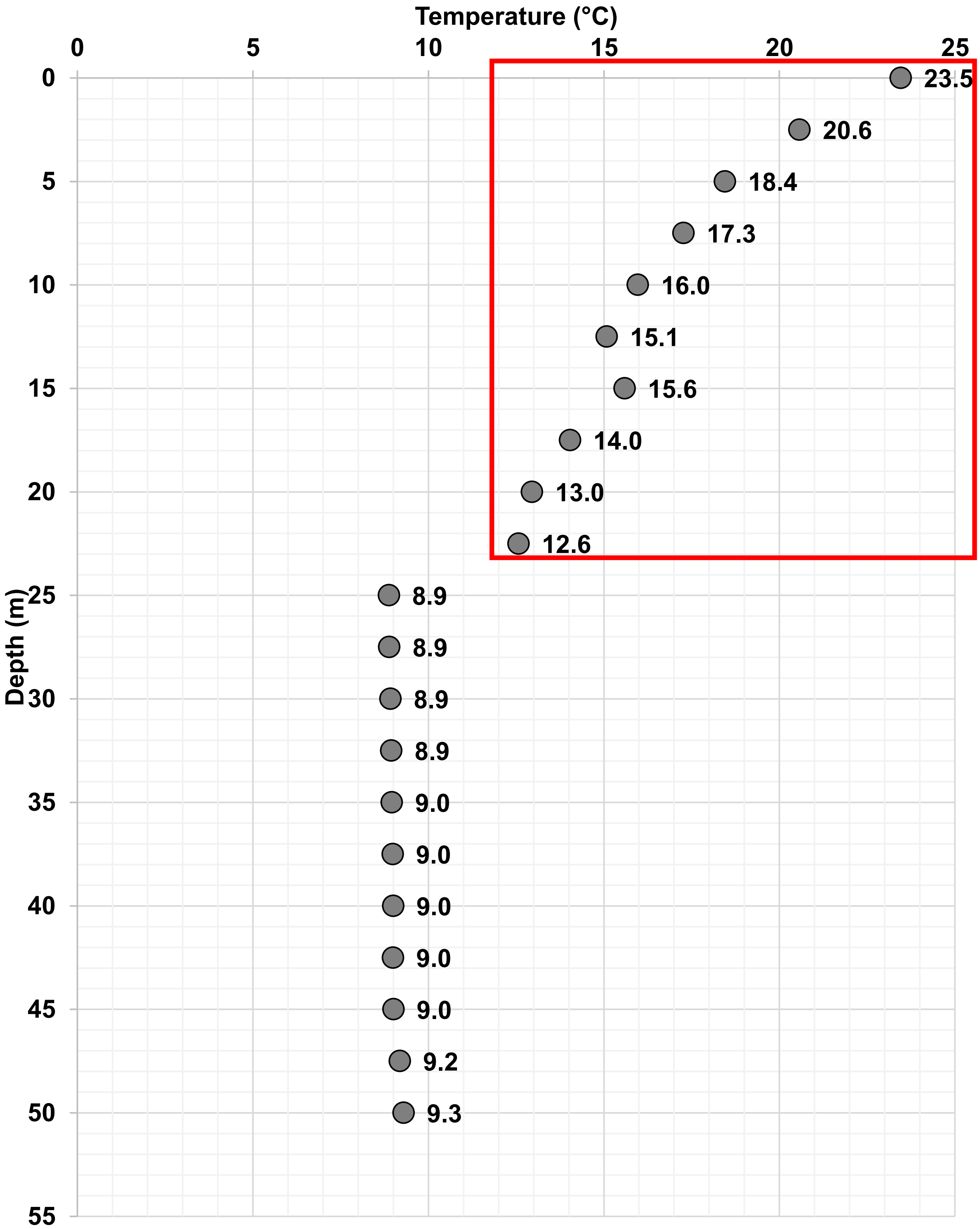

Figure F4: Plot of temperature versus depth for borehole GTW-02 collected 40 hours after the pump test on borehole GTW-03 was completed.

GTW-03 – 1 hour after drilling

Borehole GTW-03 was drilled in front of Ropak Can Am as part of the industrial park loop in 1987 to a depth of 44.2 m. The borehole targeted the No. 2 Seam workings. Temperature measurements were recorded from the borehole 1 hour after the completion of drilling activities (Table F5). The temperature versus depth was plotted on Figure F5. It looks like the first twelve temperature measurements are anomalous and are therefore not considered reliable.

Table F5: Temperature data for borehole GTW-03 collected 1 hour after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Remarks
0.0	0.0	n/a	n/a	n/a
8.2	2.5	72.5	22.5	Anomalous; not the normal trend
16.4	5.0	71.1	21.7	Anomalous; not the normal trend
24.6	7.5	69.8	21.0	Anomalous; not the normal trend
32.8	10.0	68.2	20.1	Anomalous; not the normal trend
41.0	12.5	67.1	19.5	Anomalous; not the normal trend
49.2	15.0	66.2	19.0	Anomalous; not the normal trend
57.4	17.5	65.5	18.6	Anomalous; not the normal trend
65.6	20.0	64.6	18.1	Anomalous; not the normal trend
73.8	22.5	63.9	17.7	Anomalous; not the normal trend
82.0	25.0	63.5	17.5	Anomalous; not the normal trend
90.2	27.5	62.2	16.8	Anomalous; not the normal trend
98.4	30.0	61.3	16.3	Anomalous; not the normal trend
106.6	32.5	56.1	13.4	Part of the normal trend line
114.8	35.0	56.1	13.4	Part of the normal trend line
123.0	37.5	56.1	13.4	Part of the normal trend line
131.2	40.0	56.1	13.4	Part of the normal trend line
137.1	41.8	55.9	13.3	Part of the normal trend line

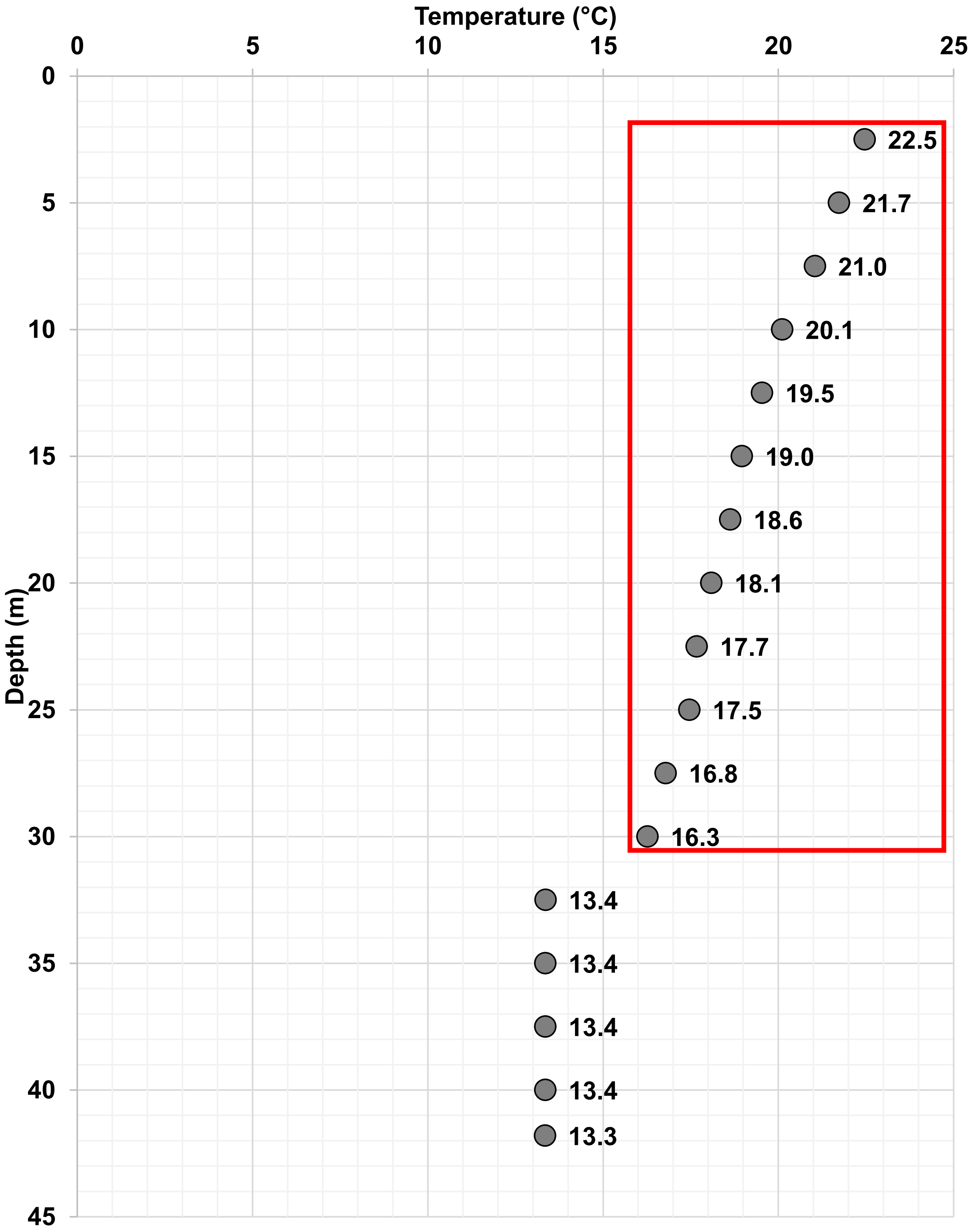

Figure F5: Plot of temperature versus depth for borehole GTW-03 collected 1 hour after the completion of drilling activities.

GTW-06 – During drilling

Borehole GTW-06 was drilled immediately behind the Ropak Can Am facility in 1988 to a depth of 137.5 m. The borehole targeted the No. 2 Seam workings. Temperature measurements were recorded from the borehole during drilling operations (Table F6). The temperature versus depth was plotted on Figure F6. It appears as though two different trends are shown in the data. Also, the temperature value of 22°C is probably an anomalous value and is therefore not considered reliable.

Table F6: Resistance, temperature, and water output data for borehole GTW-06 collected during drilling activities.

Depth (ft)	Depth (m)	Resistance (Ω)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
180.0	54.9	n/a	n/a	n/a	n/a	n/a
200.0	61.0	n/a	n/a	n/a	n/a	n/a
319.0	97.3	n/a	n/a	n/a	n/a	n/a
326.0	99.4	n/a	n/a	n/a	n/a	n/a
340.0	103.7	9640	57.6	14.2	n/a	n/a
350.0	106.7	9640	57.6	14.2	n/a	n/a
360.0	109.8	9655	58.1	14.5	n/a	n/a
375.0	114.3	9665	58.5	14.7	n/a	n/a
380.0	115.9	9670	58.6	14.8	n/a	n/a
385.0	117.4	9680	59.0	15.0	n/a	n/a
390.0	118.9	9700	59.7	15.4	n/a	n/a
400.0	122.0	9720	60.4	15.8	n/a	n/a
420.0	128.0	9662	58.4	14.7	60	3.79
430.0	131.1	9680	59.0	15.0	60	3.79
435.0	132.6	9690	59.3	15.2	60+	3.79
438.0	133.5	9710	60.0	15.6	100+	6.31
440.0	134.1	9740	61.0	16.1	150+	9.46
447.0	136.3	9768	62.0	16.7	200+	12.62
450.0	137.2	9780	62.4	16.9	200+	12.62
451.0	137.5	9840	71.6	22.0	300+	18.93

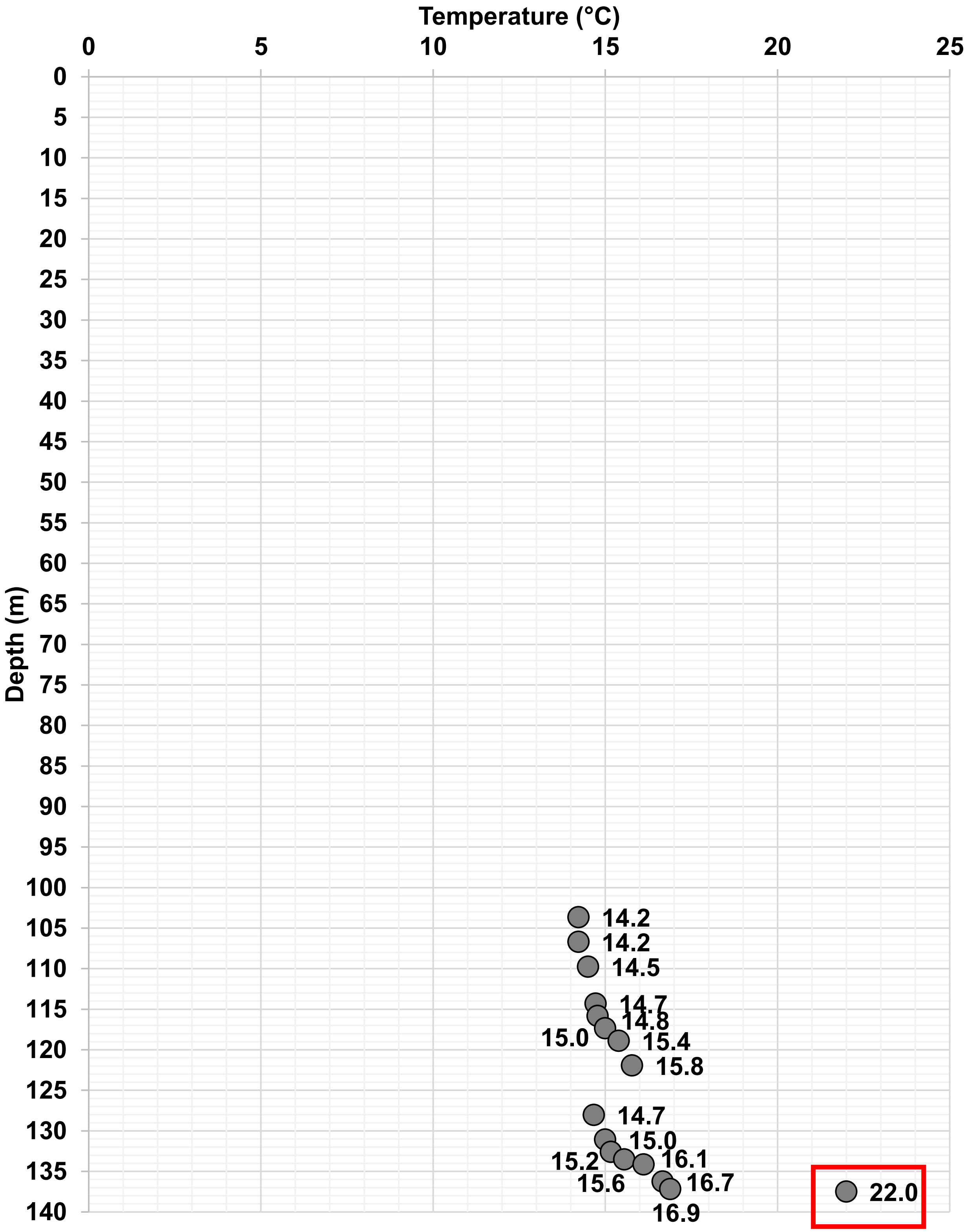

Figure F6: Plot of temperature versus depth for borehole GTW-06 collected during drilling activities.

GTW-06 – After drilling

Temperature measurements were recorded from the borehole during drilling operations (Table F7). The temperature versus depth was plotted on Figure F7. All temperature points appear to be following a normal trend.

Table F7: Temperature data for borehole GTW-06 collected after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Remarks
100.0	30.5	48.2	9.0	Part of the normal trend line
110.0	33.5	53.8	12.1	Part of the normal trend line
120.0	36.6	56.6	13.7	Part of the normal trend line
130.0	39.6	56.9	13.8	Part of the normal trend line
140.0	42.7	58.3	14.6	Part of the normal trend line
150.0	45.7	57.3	14.0	Part of the normal trend line
160.0	48.8	59.0	15.0	Part of the normal trend line
170.0	51.8	58.0	14.4	Part of the normal trend line
180.0	54.9	57.3	14.0	Part of the normal trend line
190.0	57.9	57.3	14.0	Part of the normal trend line
200.0	61.0	57.3	14.1	Part of the normal trend line
210.0	64.0	58.3	14.6	Part of the normal trend line
220.0	67.1	58.3	14.6	Part of the normal trend line
230.0	70.1	59.3	15.2	Part of the normal trend line
240.0	73.2	59.0	15.0	Part of the normal trend line
250.0	76.2	58.6	14.8	Part of the normal trend line
260.0	79.3	59.3	15.2	Part of the normal trend line
270.0	82.3	59.3	15.2	Part of the normal trend line
280.0	85.4	60.4	15.8	Part of the normal trend line
290.0	88.4	60.0	15.6	Part of the normal trend line
300.0	91.5	60.3	15.7	Part of the normal trend line
310.0	94.5	59.7	15.4	Part of the normal trend line
320.0	97.6	60.4	15.8	Part of the normal trend line
330.0	100.6	60.1	15.6	Part of the normal trend line
340.0	103.7	60.3	15.7	Part of the normal trend line
350.0	106.7	61.1	16.1	Part of the normal trend line
360.0	109.8	60.4	15.8	Part of the normal trend line
370.0	112.8	61.1	16.1	Part of the normal trend line
380.0	115.9	61.1	16.1	Part of the normal trend line
390.0	118.9	61.7	16.5	Part of the normal trend line
400.0	122.0	61.4	16.3	Part of the normal trend line
410.0	125.0	62.1	16.7	Part of the normal trend line
420.0	128.0	62.1	16.7	Part of the normal trend line
430.0	131.1	63.2	17.3	Part of the normal trend line
440.0	134.1	65.9	18.8	Part of the normal trend line

Figure F7: Plot of temperature versus depth for borehole GTW-06 collected after the completion of drilling activities.

GTW-08 – During drilling

Borehole GTW-06 was drilled immediately behind the Ropak Can Am facility in 1988 to a depth of 63.4 m. The borehole targeted the No. 1 Seam workings. Temperature measurements were recorded from the borehole during drilling operations (Table F8). The temperature versus depth was plotted on Figure F8. There does not seem to be any anomalous values shown in the plot; however, there are questions as to the reliability since these were taken during the process of drilling.

Table F8: Resistance, temperature, and water output data for borehole GTW-08 collected during drilling activities.

Depth (ft)	Depth (m)	Resistance (Ω)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
100.0	30.5	9700	59.7	15.4	2	0.13
110.0	33.5	9765	61.9	16.6	2	0.13
120.0	36.6	9780	62.4	16.9	2	0.13
130.0	39.6	9780	62.4	16.9	2	0.13
140.0	42.7	9860	65.2	18.4	3	0.19
150.0	45.7	9706	59.9	15.5	5	0.32
160.0	48.8	9770	62.1	16.7	5	0.32
170.0	51.8	9770	62.1	16.7	6	0.38
180.0	54.9	9780	62.4	16.9	6	0.38
190.6	58.1	9515	53.3	11.8	300+	18.93
208.0	63.4	9515	53.3	11.8	300+	18.93

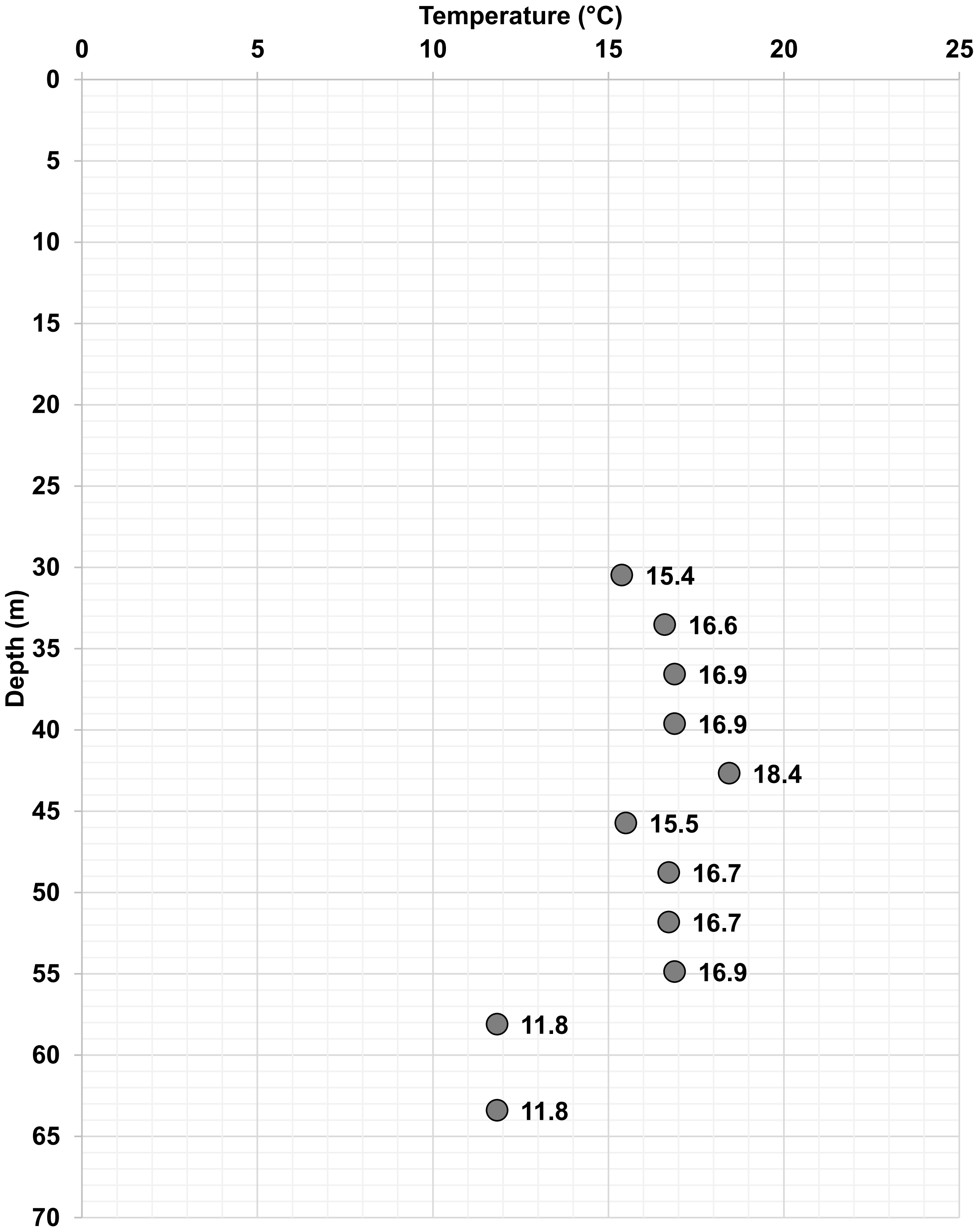

Figure F8: Plot of temperature versus depth for borehole GTW-08 collected during drilling activities.

GTW-09 – During drilling

Borehole GTW-09 was drilled near Surrette Battery in 1989 to a depth of 103.9 m. The borehole targeted the No. 2 Seam workings. Temperature measurements were recorded from the borehole during drilling operations (Table F9). The temperature versus depth was plotted on Figure F9. There are two obvious trends in the data as shown below. There are questions as to the reliability since these were taken during the process of drilling.

Table F9: Resistance, temperature, and water output data for borehole GTW-09 collected during drilling activities.

Depth (ft)	Depth (m)	Resistance (Ω)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
100.0	30.5	9750	61.4	16.3	0	0
110.0	33.5	9770	62.1	16.7	2	0.13
120.0	36.6	9780	62.4	16.9	2	0.13
130.0	39.6	9780	62.4	16.9	2	0.13
140.0	42.7	9770	62.1	16.7	3	0.19
150.0	45.7	9790	62.8	17.1	2	0.13
160.0	48.8	9770	62.1	16.7	3	0.19
170.0	51.8	9770	62.1	16.7	3	0.19
180.0	54.9	9750	61.4	16.3	5	0.32
190.0	57.9	9750	61.4	16.3	5	0.32
200.0	61.0	9780	62.4	16.9	5	0.32
210.0	64.0	9750	61.4	16.3	15	0.95
223.0	68.0	9850	64.8	18.2	15	0.95
234.0	71.3	9850	64.8	18.2	15	0.95
238.0	72.6	9520	53.5	11.9	100	6.31
250.0	76.2	9540	54.2	12.3	200	12.62
260.0	79.3	9540	54.2	12.3	300+	18.93
270.0	82.3	9550	54.5	12.5	3	0.19
280.0	85.4	9610	56.6	13.7	3	0.19
290.0	88.4	9610	56.6	13.7	2	0.13
300.0	91.5	9595	56.1	13.4	30	1.90
310.0	94.5	9595	56.1	13.4	30	1.90
319.0	97.3	9625	57.1	13.9	30	1.90
329.0	100.3	9625	57.1	13.9	30	1.90
341.0	104.0	9625	57.1	13.9	30	1.90

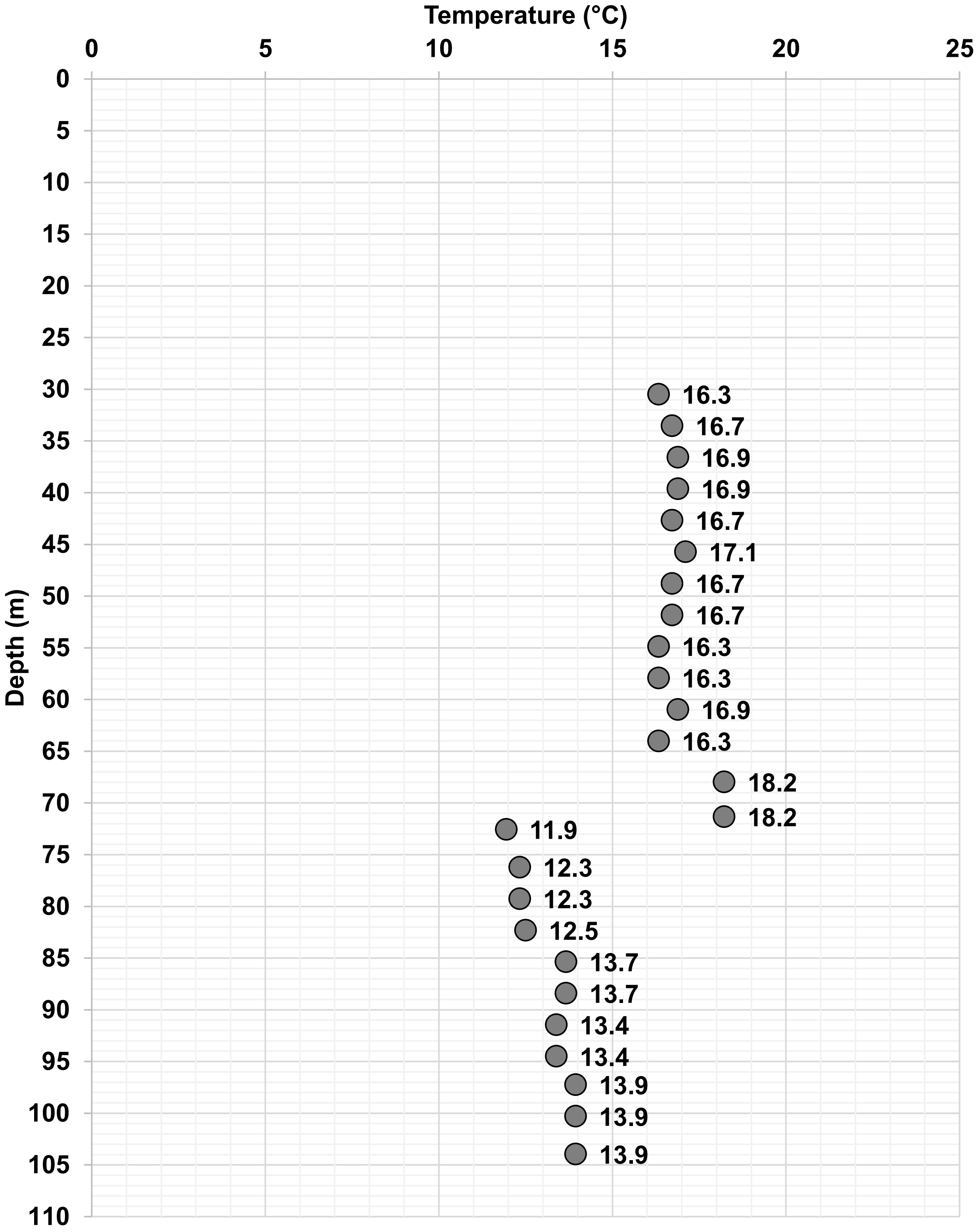

Figure F9: Plot of temperature versus depth for borehole GTW-09 collected during drilling activities.

GTW-10 – During drilling

Borehole GTW-10 was drilled near Surrette Battery in 1989 to a depth of 95.4 m. The borehole targeted the No. 2 Seam workings. Temperature measurements were recorded from the borehole during drilling operations (Table F10). The temperature versus depth was plotted on Figure F10. There are two obvious trends in the data as shown below. There are questions as to the reliability since these were taken during the process of drilling.

Table F10: Resistance, temperature, and water output data for borehole GTW-10 collected during drilling activities.

Depth (ft)	Depth (m)	Resistance (Ω)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
100.0	30.5	9605	56.4	13.6	20	1.26
110.0	33.5	9615	56.7	13.7	20	1.26
120.0	36.6	9620	56.9	13.8	20	1.26
130.0	39.6	9620	56.9	13.8	20	1.26
140.0	42.7	9625	57.1	13.9	20	1.26
150.0	45.7	9610	56.5	13.6	25	1.58
160.0	48.8	9590	55.9	13.3	30	1.90
170.0	51.8	9590	55.9	13.3	30	1.90
180.0	54.9	9600	56.2	13.4	30	1.90
190.0	57.9	9600	56.2	13.4	30	1.90
200.0	61.0	9600	56.2	13.4	30	1.90
210.0	64.0	9605	56.4	13.6	30	1.90
220.0	67.1	9630	57.3	14.1	30	1.90
230.0	70.1	9630	57.3	14.1	30	1.90
240.0	73.2	9635	57.4	14.1	30	1.90
250.0	76.2	9640	57.6	14.2	30	1.90
260.0	79.3	9610	56.5	13.6	35	2.21
270.0	82.3	9500	52.8	11.6	80	5.05
280.0	85.4	9540	54.2	12.3	100	6.31
290.0	88.4	9560	54.8	12.7	120	7.57
300.0	91.5	9560	54.8	12.7	120	7.57
310.0	94.5	9555	54.7	12.6	200	12.62
313.0	95.4	9550	54.5	12.5	300+	18.93
324.0	98.8	9555	54.7	12.6	300+	18.93

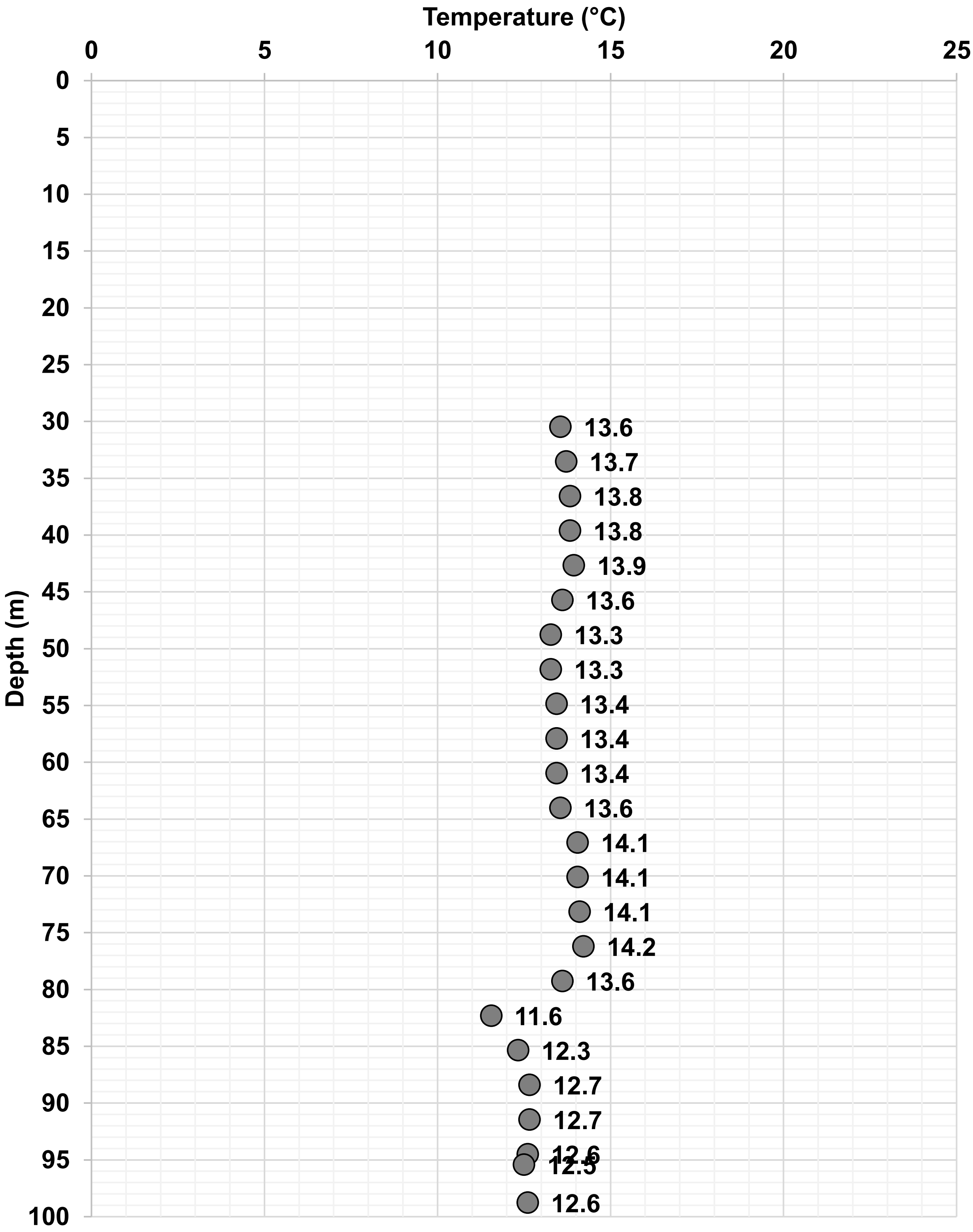

Figure F10: Plot of temperature versus depth for borehole GTW-10 collected during drilling activities.

GTW-11 – 2 hours after drilling

Borehole GTW-11 was drilled near 40 Main Street in 1990 to a depth of 148.1 m. The borehole targeted the No. 6 and No. 7 seam workings. Temperature measurements were recorded from the borehole two hours after cessation of drilling operations (Table F11). The temperature versus depth was plotted on Figure F11. These data points appear to follow the expected trend of increasing temperature with depth. I would not classify any anomalous values in this data set.

Table F11: Temperature and water output data for borehole GTW-11 collected 2 hours after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
20.0	6.1	n/a	n/a	n/a	n/a
40.0	12.2	n/a	n/a	1.5	0.09
51.0	15.5	47.1	8.4	20	1.26
60.0	18.3	47.1	8.4	20	1.26
80.0	24.4	47.1	8.4	20	1.26
100.0	30.5	47.0	8.3	20	1.26
120.0	36.6	47.8	8.8	20	1.26
140.0	42.7	48.1	8.9	20	1.26
160.0	48.8	48.6	9.2	20	1.26
180.0	54.9	49.1	9.5	20	1.26
200.0	61.0	49.3	9.6	20	1.26
220.0	67.1	50.5	10.3	20	1.26
240.0	73.2	51.2	10.7	20	1.26
260.0	79.3	52.1	11.2	20	1.26
280.0	85.4	53.1	11.7	20	1.26
300.0	91.5	53.1	11.7	20	1.26
320.0	97.6	53.2	11.8	20	1.26
340.0	103.7	53.2	11.8	20	1.26
360.0	109.8	53.5	12.0	20	1.26
373.0	113.7	54.9	12.7	30	1.90
380.0	115.9	55.9	13.3	30	1.90
389.0	118.6	55.9	13.3	125+	7.89
396.0	120.7	56.0	13.3	125+	7.89
420.0	128.0	55.8	13.2	125+	7.89
440.0	134.1	55.8	13.2	125+	7.89
460.0	140.2	55.8	13.2	125+	7.89
480.0	146.3	55.8	13.2	200	12.62

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
486.0	148.2	55.9	13.3	300+	18.93
493.0	150.3	55.9	13.3	300+	18.93

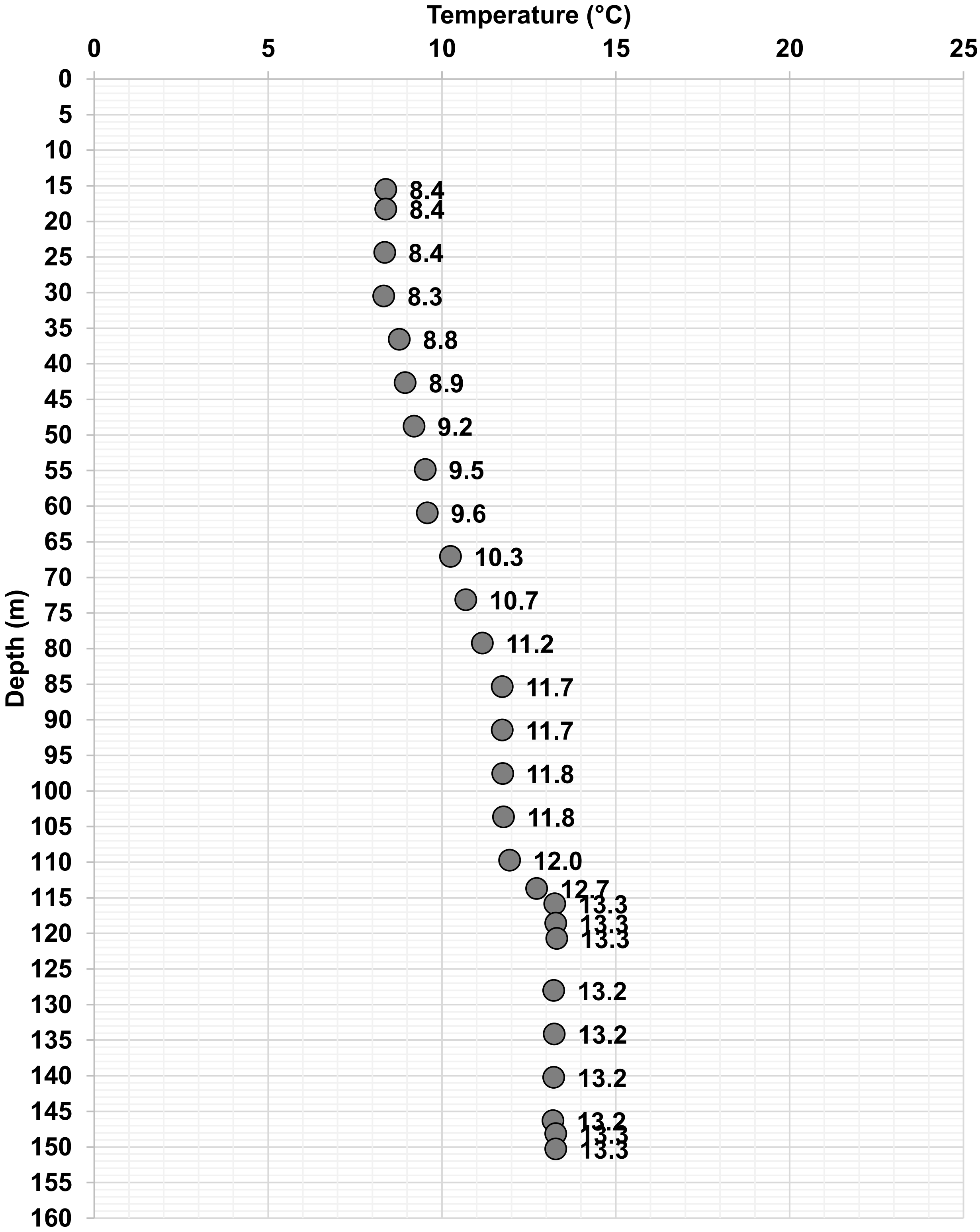

Figure F11: Plot of temperature versus depth for borehole GTW-11 collected 2 hours after the completion of drilling activities.

GTW-12 – 2 hours after drilling

Borehole GTW-12 was drilled near 40 Main Street in 1990 to a depth of 117.4 m. The borehole targeted the No. 7 seam workings. Temperature measurements were recorded from the borehole two hours after cessation of drilling operations (Table F12). The temperature versus depth was plotted on Figure F12. These data points appear to follow the expected trend of increasing temperature with depth. I would not classify any anomalous values in this data set.

Table F12: Temperature and water output data for borehole GTW-12 collected 2 hours after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
20.0	6.1	n/a	n/a	n/a	n/a
40.0	12.2	n/a	n/a	n/a	n/a
51.9	15.8	48.2	9.0	1	.06
60.0	18.3	50.0	10.0	1	.06
80.0	24.4	50.7	10.4	1	.06
100.0	30.5	50.7	10.4	1	.06
120.0	36.6	50.9	10.5	1	.06
140.0	42.7	52.1	11.2	1	.06
160.0	48.8	53.0	11.6	1	.06
180.0	54.9	53.2	11.8	1+	.06
200.0	61.0	53.5	11.9	1+	.06
220.0	67.1	54.0	12.2	5	0.32
240.0	73.2	54.0	12.2	5	0.32
260.0	79.3	54.2	12.3	8	0.50
280.0	85.4	55.1	12.8	8	0.50
300.0	91.5	55.9	13.3	8	0.50
320.0	97.6	57.8	14.3	8	0.50
340.0	103.7	59.8	15.4	8	0.50
360.0	109.8	61.5	16.4	20	1.26
380.0	115.9	62.0	16.7	100+	6.31
385.0	117.4	62.0	16.7	300+	18.93
391.0	119.2	62.2	16.8	300+	18.93

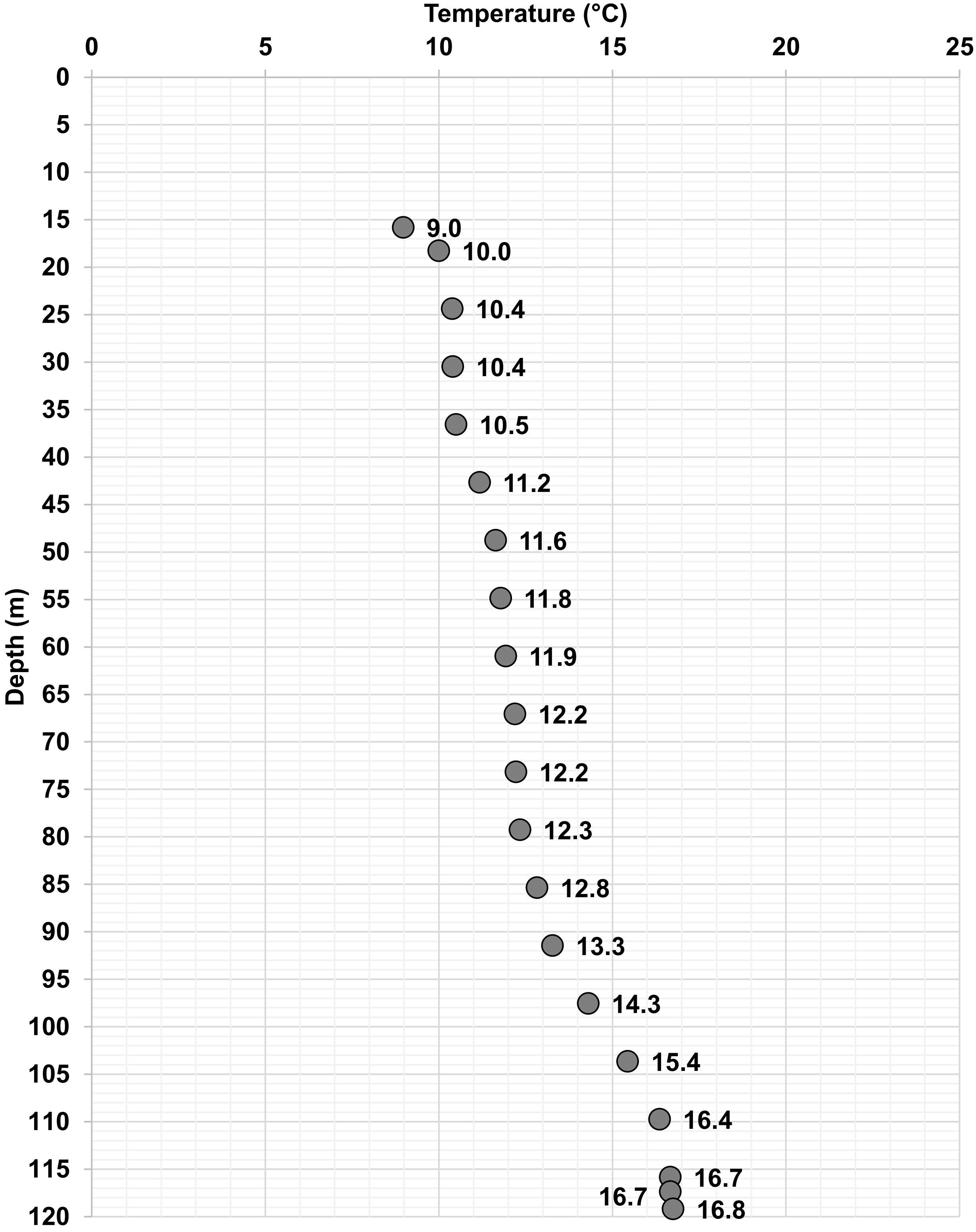

Figure F12: Plot of temperature versus depth for borehole GTW-12 collected 2 hours after the completion of drilling activities.

GTW-12 – 72 hours after drilling

Temperature measurements were recorded from the borehole seventy-two hours after cessation of drilling operations (Table F13). The temperature versus depth was plotted on Figure F13. These data points appear to follow the expected trend of increasing temperature with depth. I would not classify any anomalous values in this data set.

Table F13: Temperature and water output data for borehole GTW-12 collected 72 hours after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)	Water Output (GPM)	Water Output (L/s)
20.0	6.1	n/a	n/a	n/a	n/a
40.0	12.2	n/a	n/a	n/a	n/a
51.9	15.8	47.2	8.4	1	.06
60.0	18.3	48.2	9.0	1	.06
80.0	24.4	48.3	9.1	1	.06
100.0	30.5	48.9	9.4	1	.06
120.0	36.6	49.0	9.4	1	.06
140.0	42.7	50.2	10.1	1	.06
160.0	48.8	50.6	10.3	1	.06
180.0	54.9	50.7	10.4	1+	.06
200.0	61.0	50.7	10.4	1+	.06
220.0	67.1	51.1	10.6	5	0.32
240.0	73.2	51.4	10.8	5	0.32
260.0	79.3	51.7	10.9	8	0.50
280.0	85.4	52.0	11.1	8	0.50
300.0	91.5	52.1	11.1	8	0.50
320.0	97.6	52.6	11.4	8	0.50
340.0	103.7	53.8	12.1	8	0.50
360.0	109.8	54.9	12.7	20	1.26
380.0	115.9	56.0	13.3	100+	6.31
385.0	117.4	56.0	13.3	300+	18.93
391.0	119.2	56.1	13.4	300+	18.93

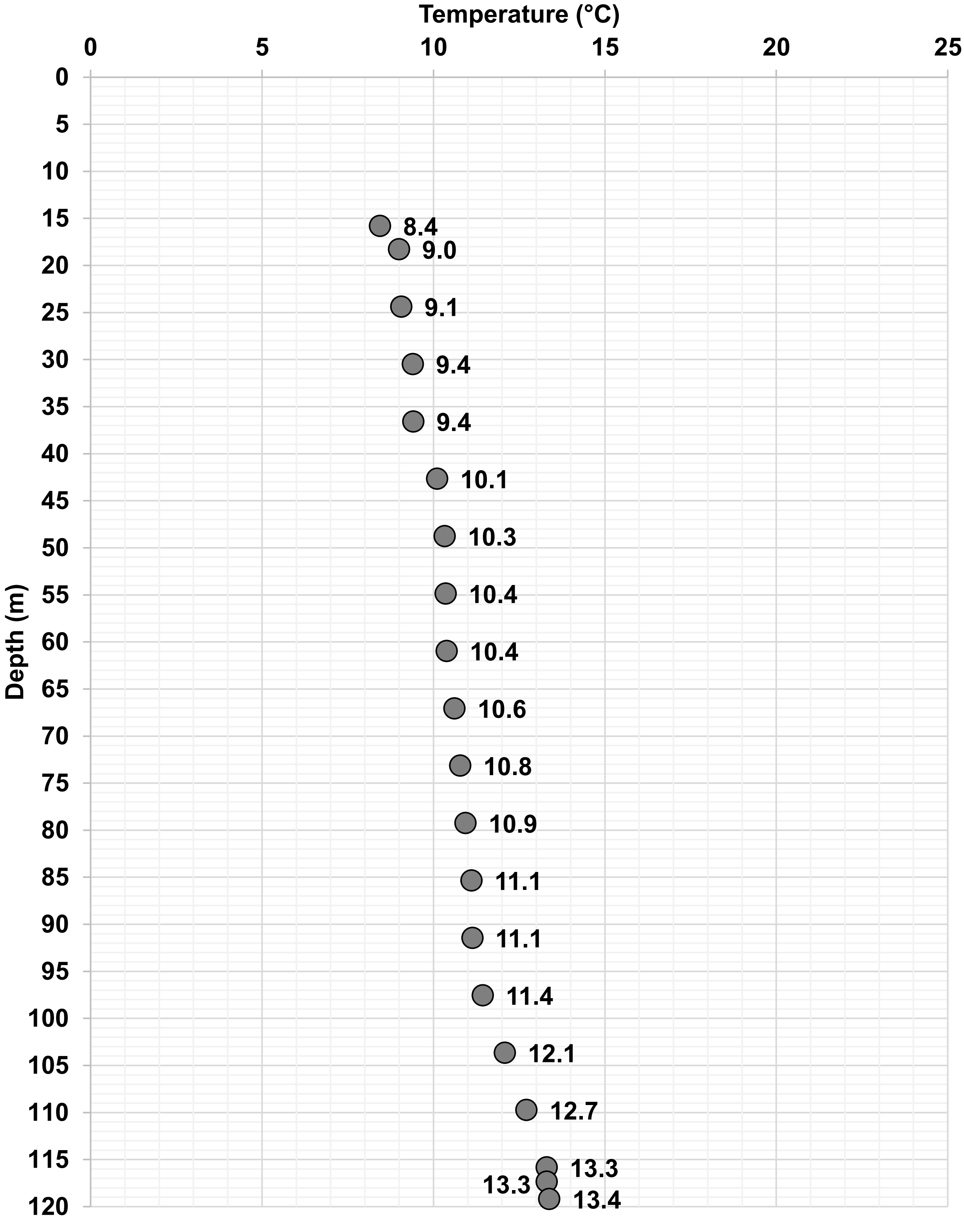

Figure F13: Plot of temperature versus depth for borehole GTW-12 collected 72 hours after the completion of drilling activities.

SH-99 – 14 days after drilling

Mineral borehole SH-99 was drilled in the Springhill area to a depth of 275.0 m. Temperature measurements were recorded from the borehole fourteen days after cessation of drilling operations (Table F14). The temperature versus depth was plotted on Figure F14. These data points appear to follow the expected trend of increasing temperature with depth. I would not classify any anomalous values in this data set.

Table F14: Temperature data for borehole SH-99 collected 14 days after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)
0.0	0.0	58.7	14.8
16.4	5.0	56.0	13.3
32.8	10.0	54.8	12.7
49.2	15.0	54.1	12.3
65.6	20.0	53.7	12.1
82.0	25.0	50.2	10.1
98.4	30.0	50.2	10.1
114.8	35.0	50.3	10.2
131.2	40.0	50.3	10.2
147.6	45.0	50.3	10.2
164.0	50.0	50.4	10.2
180.4	55.0	50.3	10.2
196.9	60.0	50.4	10.2
213.3	65.0	50.2	10.1
229.7	70.0	50.1	10.1
246.1	75.0	50.0	10.0
262.5	80.0	50.0	10.0
278.9	85.0	49.8	9.9
295.3	90.0	49.8	9.9
311.7	95.0	49.8	9.9
328.1	100.0	49.7	9.9
344.5	105.0	49.7	9.8
360.9	110.0	47.9	8.9
377.3	115.0	49.7	9.8
393.7	120.0	49.7	9.9
410.1	125.0	49.8	9.9
426.5	130.0	49.8	9.9
442.9	135.0	49.9	9.9
459.3	140.0	50.2	10.1
475.7	145.0	50.3	10.2
492.1	150.0	50.4	10.2
508.5	155.0	50.4	10.2
524.9	160.0	50.6	10.3
541.3	165.0	50.6	10.3
557.7	170.0	50.8	10.4
574.1	175.0	51.0	10.5
590.6	180.0	51.0	10.5
607.0	185.0	51.1	10.6
623.4	190.0	51.3	10.7
639.8	195.0	51.4	10.8
656.2	200.0	51.6	10.9
672.6	205.0	51.7	11.0
689.0	210.0	51.9	11.1
705.4	215.0	52.0	11.1
721.8	220.0	52.1	11.1
738.2	225.0	52.1	11.2
754.6	230.0	52.1	11.2
771.0	235.0	52.5	11.4
787.4	240.0	52.8	11.6
803.8	245.0	53.1	11.7
820.2	250.0	53.3	11.9
836.6	255.0	53.5	11.9
853.0	260.0	53.9	12.2
869.4	265.0	54.1	12.3
885.8	270.0	54.2	12.3
902.2	275.0	54.3	12.4

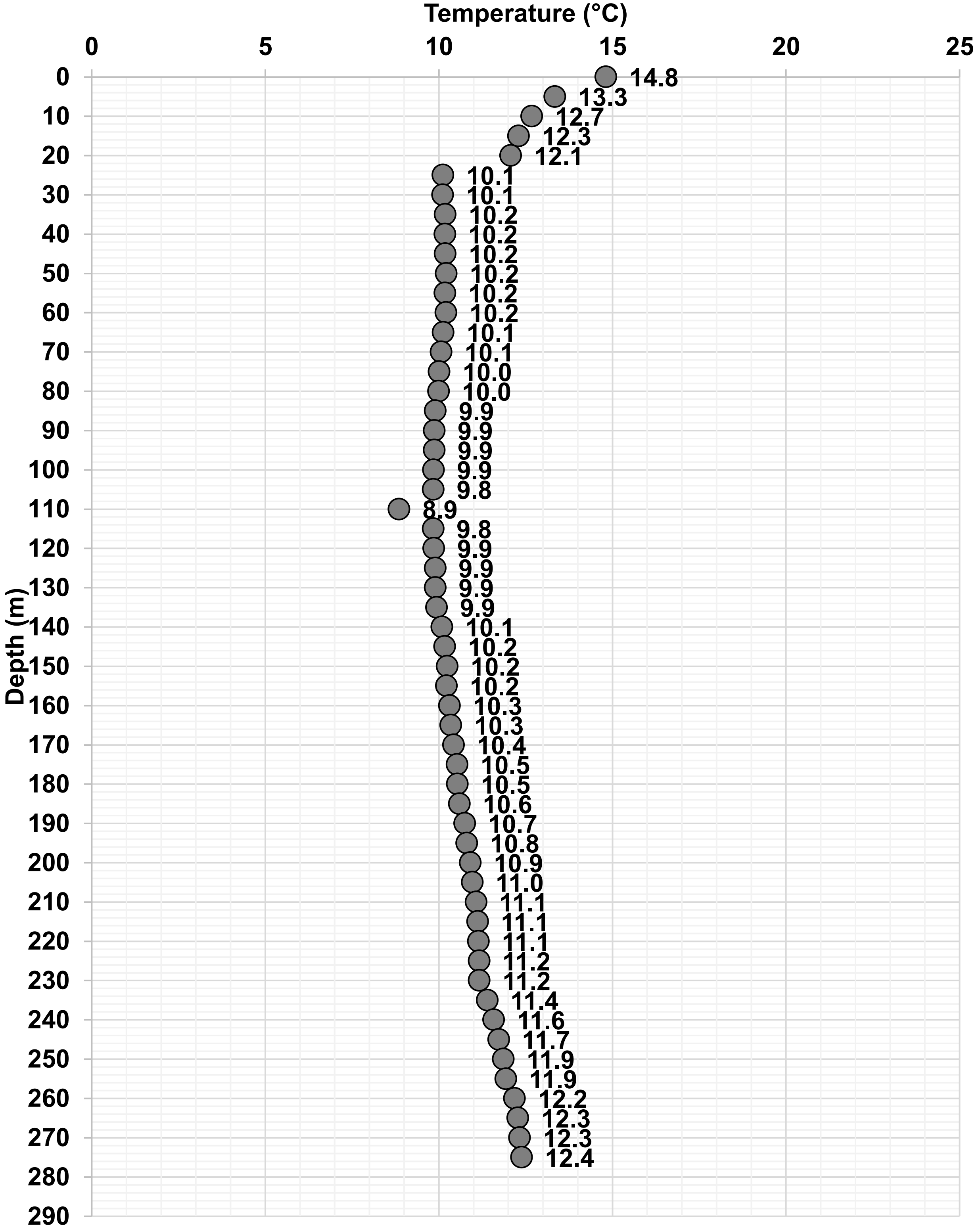

Figure F14: Plot of temperature versus depth for borehole SH-99 collected 14 days after the completion of drilling activities.

SH-99 – 183 days after drilling

Temperature measurements were recorded from the borehole 183 days after cessation of drilling operations (Table F15). The temperature versus depth was plotted on Figure F15. These data points appear to follow the expected trend of increasing temperature with depth. I would not classify any anomalous values in this data set.

Table F15: Temperature data for borehole SH-99 collected 183 days after the completion of drilling activities.

Depth (ft)	Depth (m)	Temp (°F)	Temp (°C)
0.0	0.0	43.0	6.1
16.4	5.0	43.7	6.5
32.8	10.0	45.1	7.3
49.2	15.0	46.0	7.8
65.6	20.0	46.6	8.1
82.0	25.0	48.6	9.2
98.4	30.0	50.2	10.1
114.8	35.0	50.2	10.1
131.2	40.0	50.3	10.2
147.6	45.0	50.3	10.2
164.0	50.0	50.3	10.2
180.4	55.0	50.3	10.2
196.9	60.0	50.3	10.2
213.3	65.0	50.3	10.1
229.7	70.0	50.2	10.1
246.1	75.0	50.1	10.1
262.5	80.0	50.1	10.1
278.9	85.0	50.0	10.0
295.3	90.0	49.9	9.9
311.7	95.0	49.8	9.9
328.1	100.0	49.8	9.9
344.5	105.0	49.8	9.9
360.9	110.0	49.8	9.9
377.3	115.0	49.8	9.9
393.7	120.0	49.8	9.9
410.1	125.0	49.8	9.9
426.5	130.0	49.9	9.9
442.9	135.0	49.9	9.9
459.3	140.0	50.0	10.0
475.7	145.0	50.2	10.1
492.1	150.0	50.4	10.2
508.5	155.0	50.5	10.3
524.9	160.0	50.6	10.3
541.3	165.0	50.7	10.4
557.7	170.0	50.9	10.5
574.1	175.0	51.0	10.6
590.6	180.0	51.2	10.6
607.0	185.0	51.3	10.7
623.4	190.0	51.4	10.8
639.8	195.0	51.5	10.9
656.2	200.0	51.6	10.9
672.6	205.0	51.7	11.0
689.0	210.0	51.9	11.0
705.4	215.0	51.9	11.1
721.8	220.0	52.0	11.1
738.2	225.0	52.1	11.1
754.6	230.0	52.1	11.2
771.0	235.0	52.2	11.2
787.4	240.0	52.6	11.4
803.8	245.0	52.9	11.6
820.2	250.0	53.2	11.8
836.6	255.0	53.4	11.9
853.0	260.0	53.6	12.0
869.4	265.0	54.1	12.3
885.8	270.0	54.2	12.3
902.2	275.0	54.4	12.4

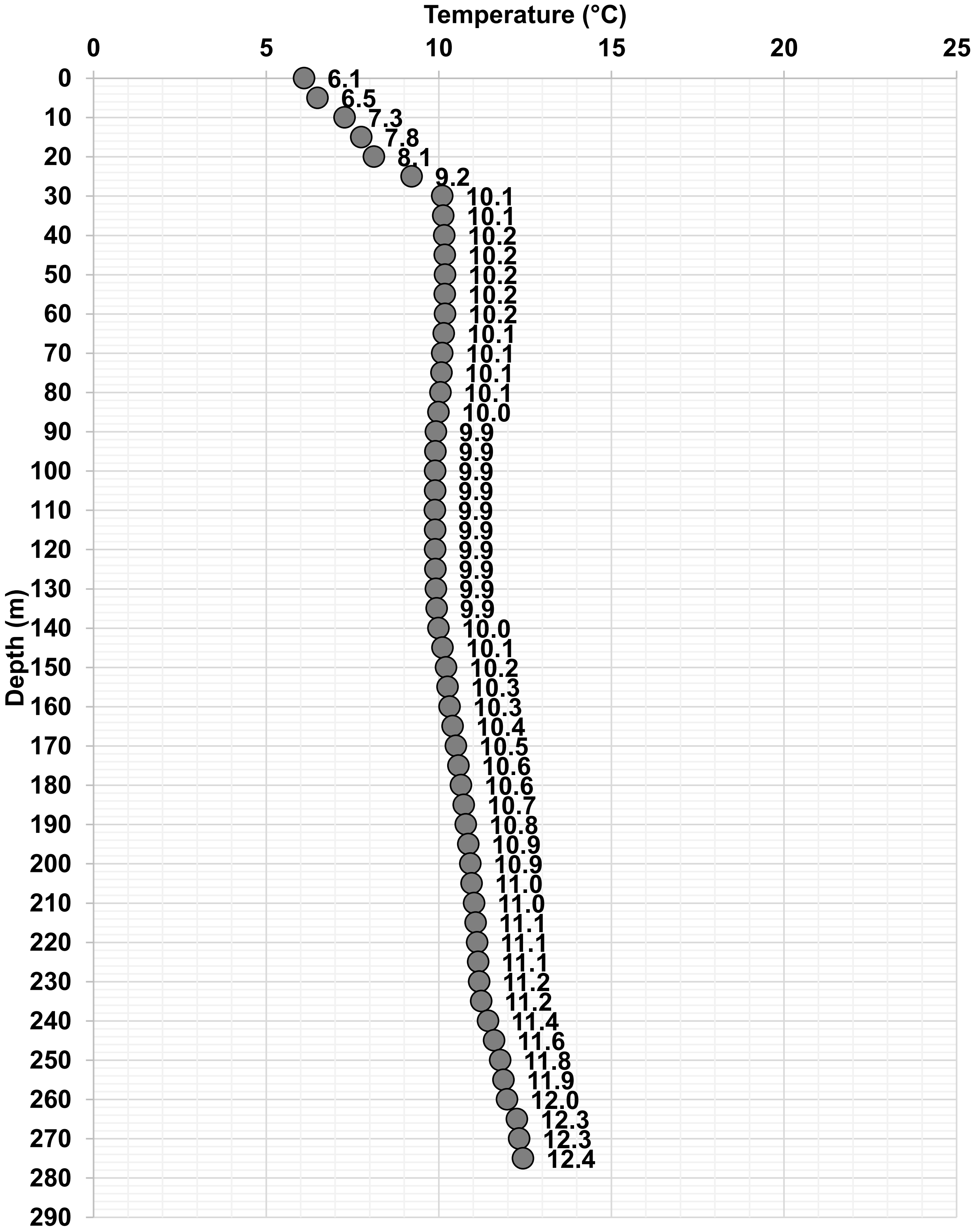

Figure F15: Plot of temperature versus depth for borehole SH-99 collected 183 days after the completion of drilling activities.

Additional Facility Mine Water Temperatures and Flow Rates

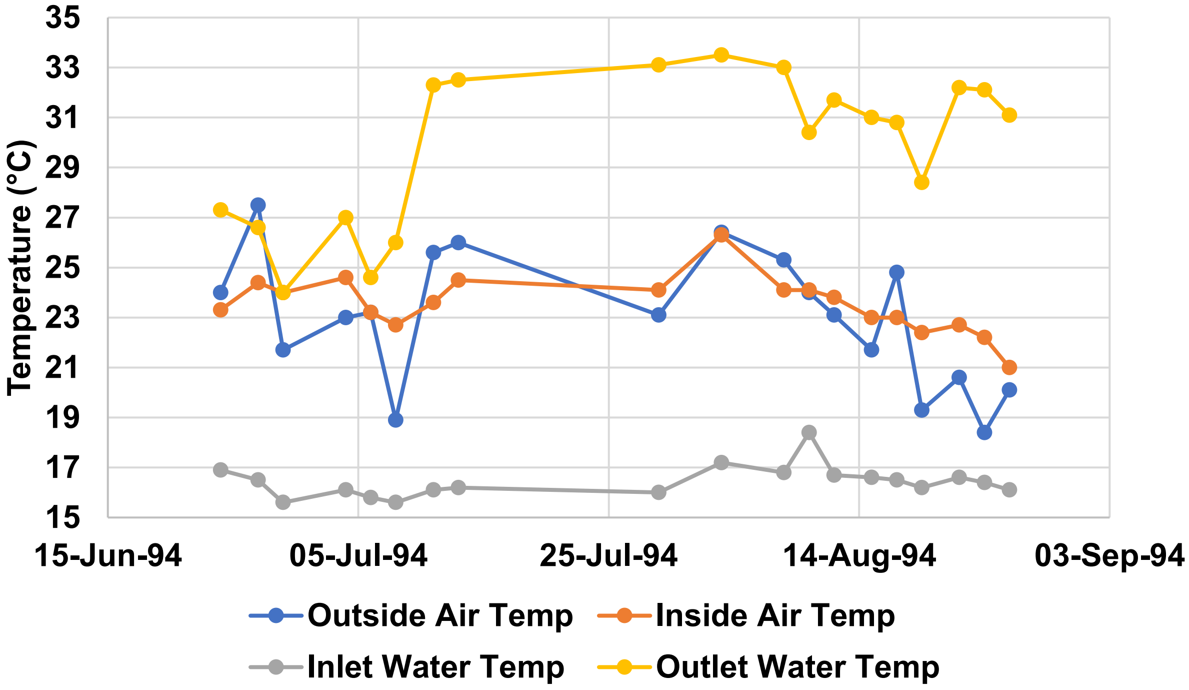

Figure F16: Temperatures collected from the Ropak Can-Am facility (Bagnell, 1994).

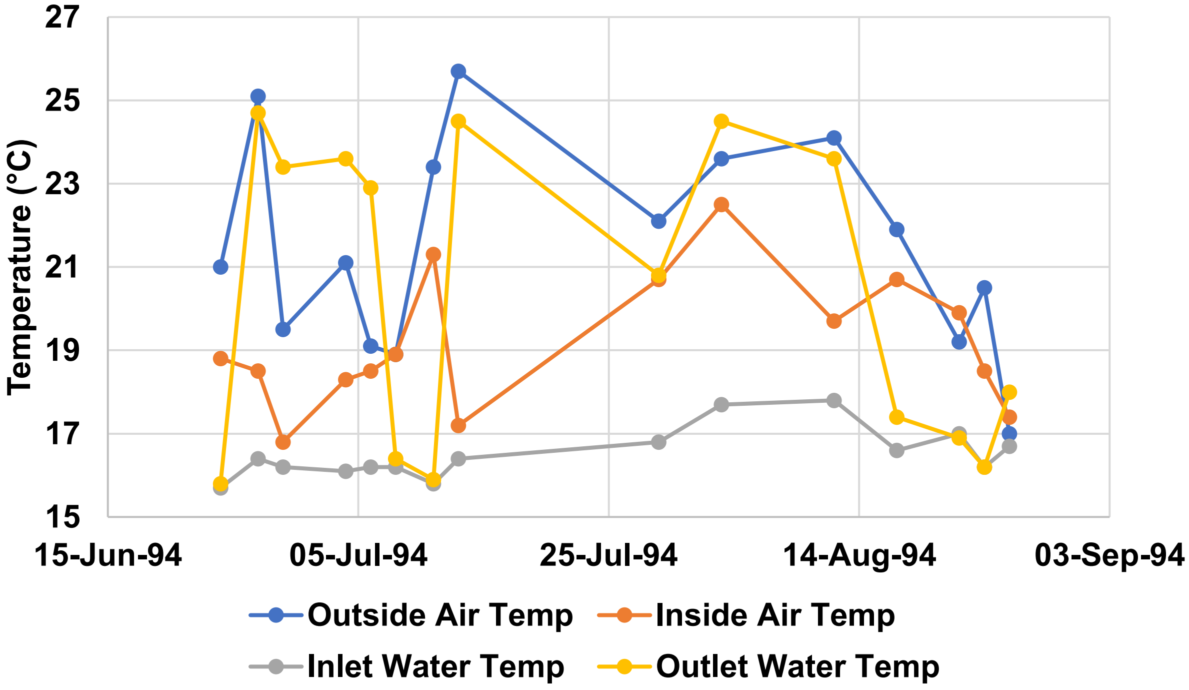

Figure F17: Temperatures collected from the MBB TreCan facility (Bagnell, 1994).

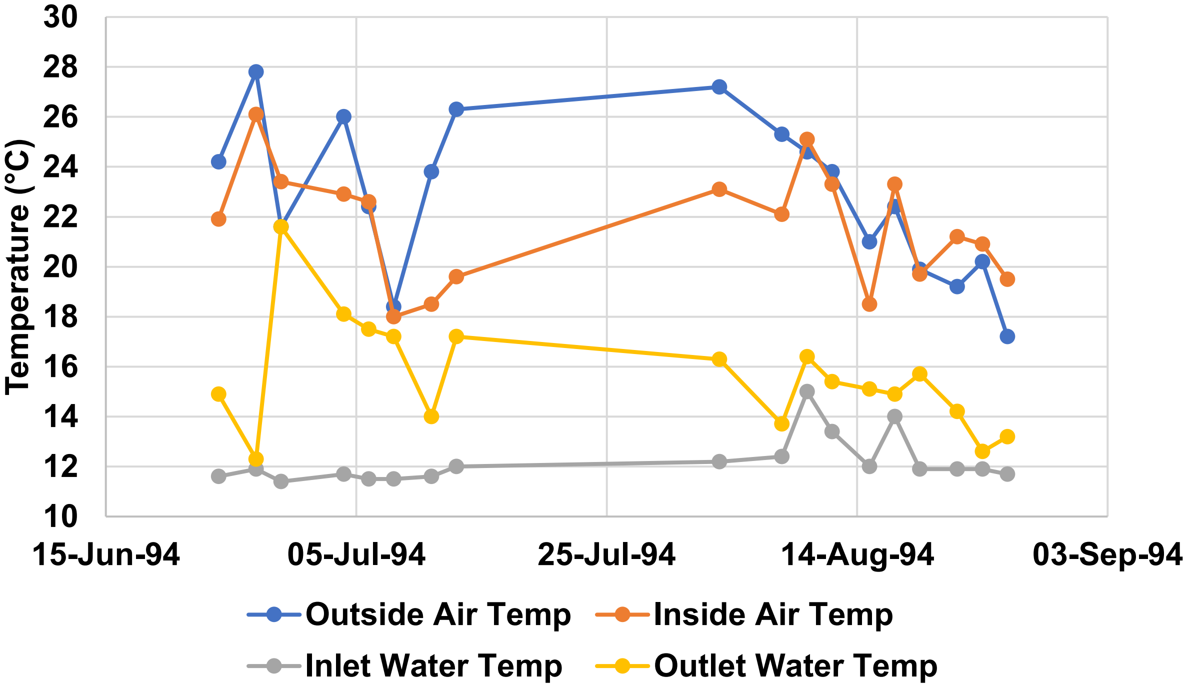

Figure F18: Temperatures collected from the Surrette Battery facility (Bagnell, 1994).

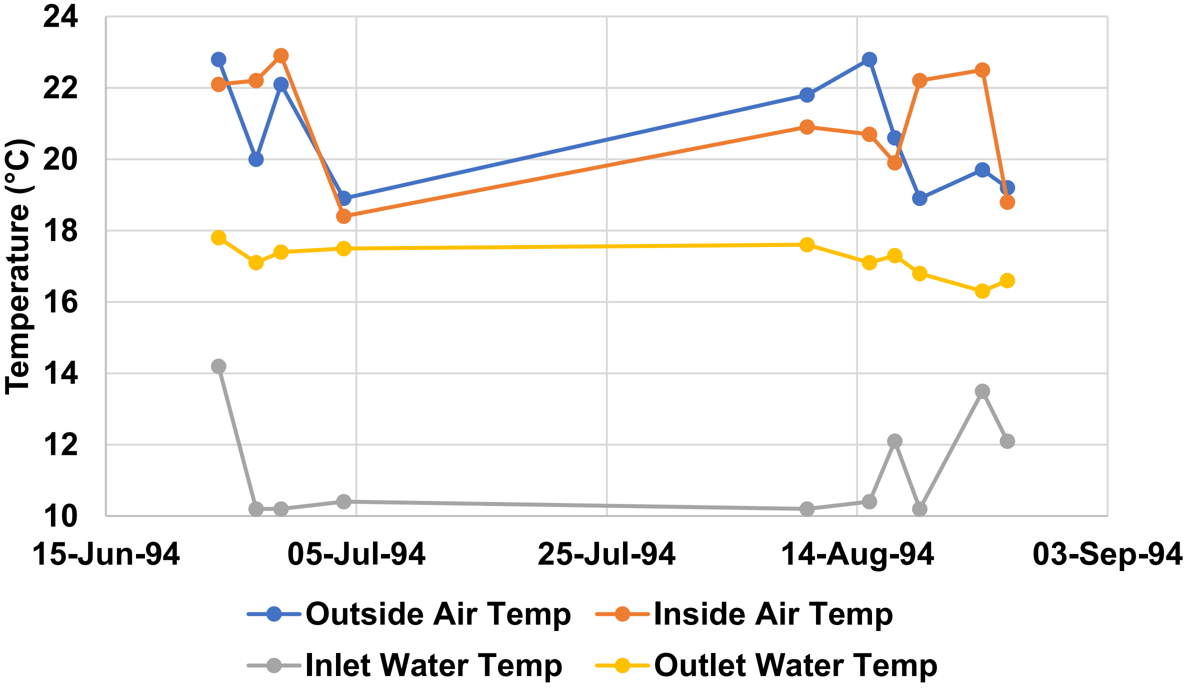

Figure F19: Temperatures collected from the Park View Medical facility (Bagnell, 1994).

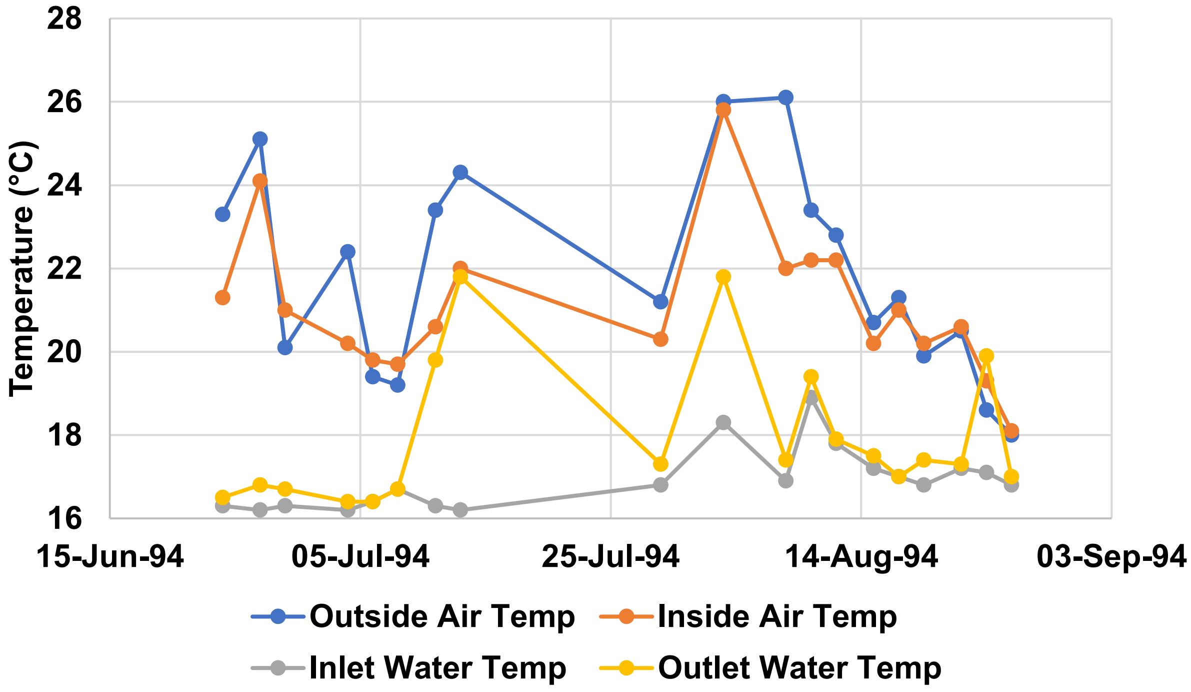

Figure F20: Temperatures collected from the GOVRC facility (Bagnell, 1994).

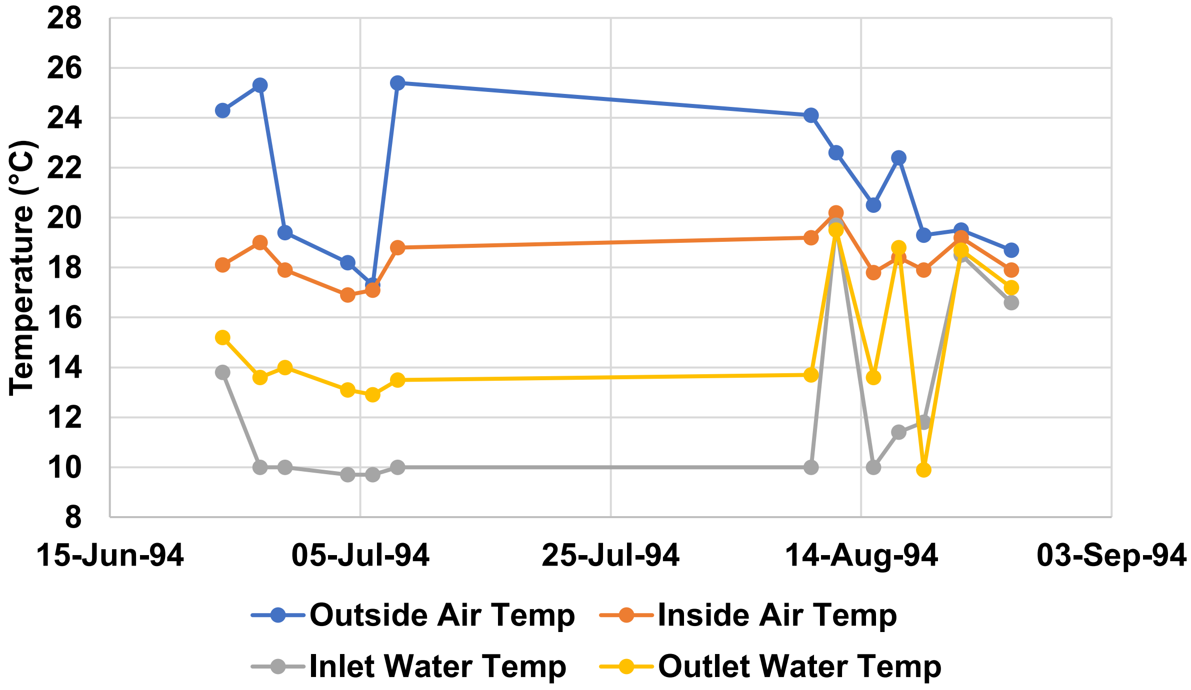

Figure F21: Temperatures collected from the Browns Funeral Home facility (Bagnell, 1994).

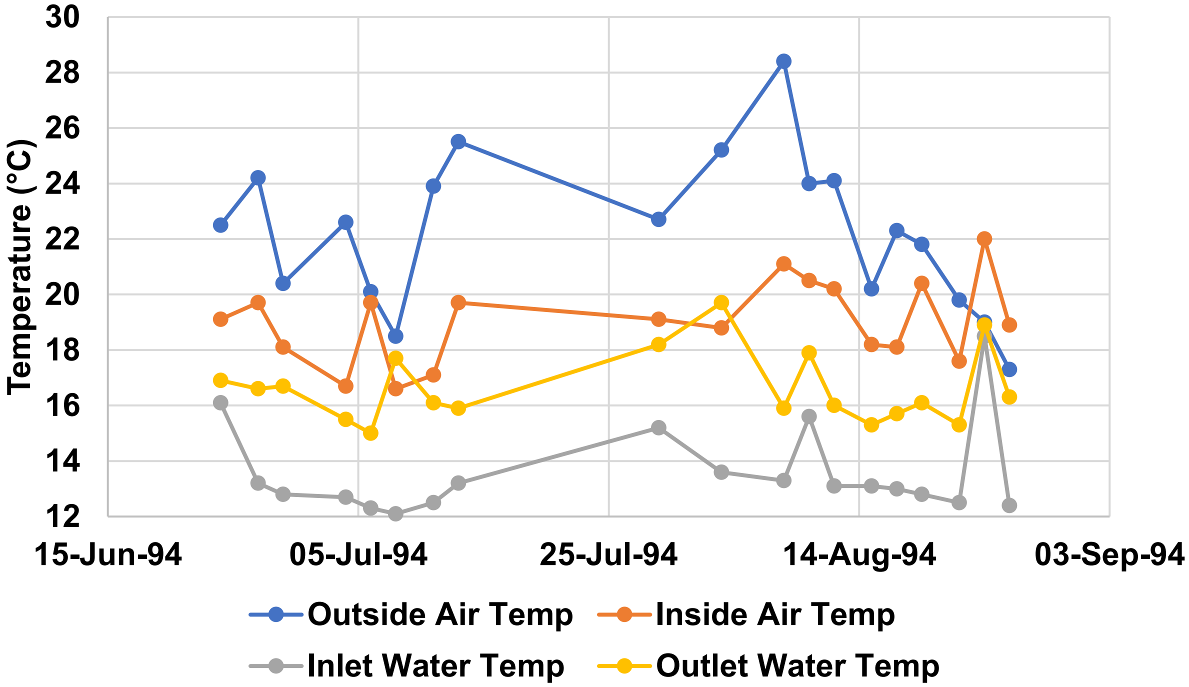

Figure F22: Temperatures collected from the Nova Scotia Power facility (Bagnell, 1994).

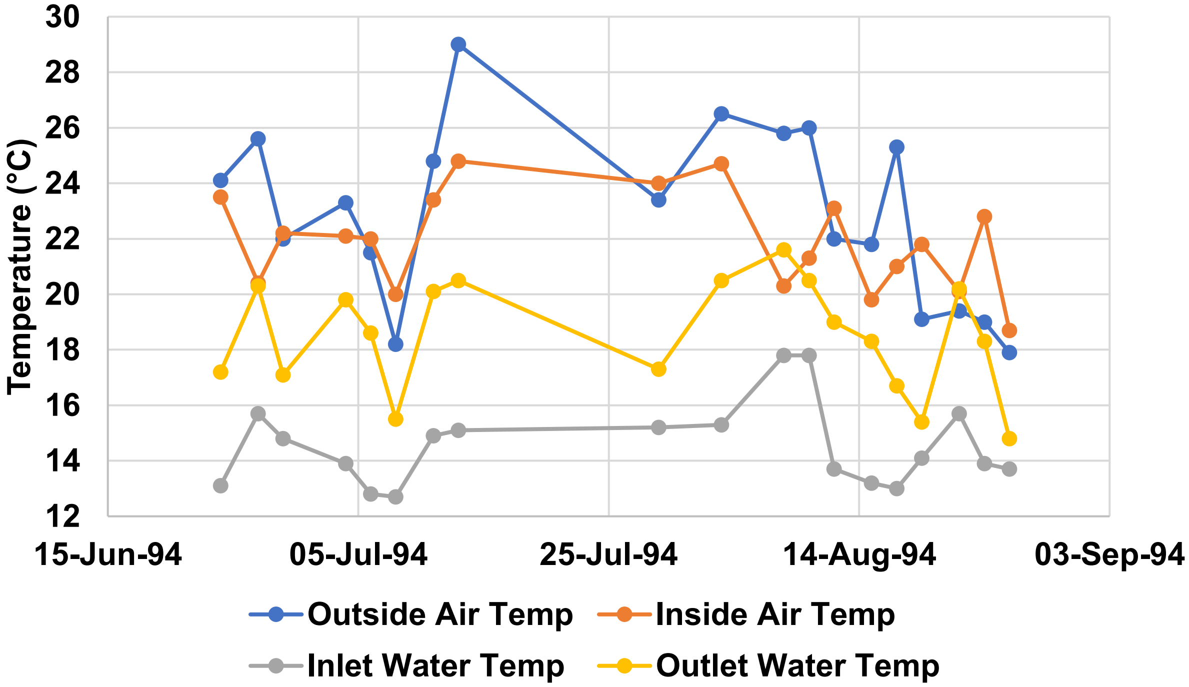

Figure F23: Temperatures collected from the Pizza Delight facility (Bagnell, 1994).

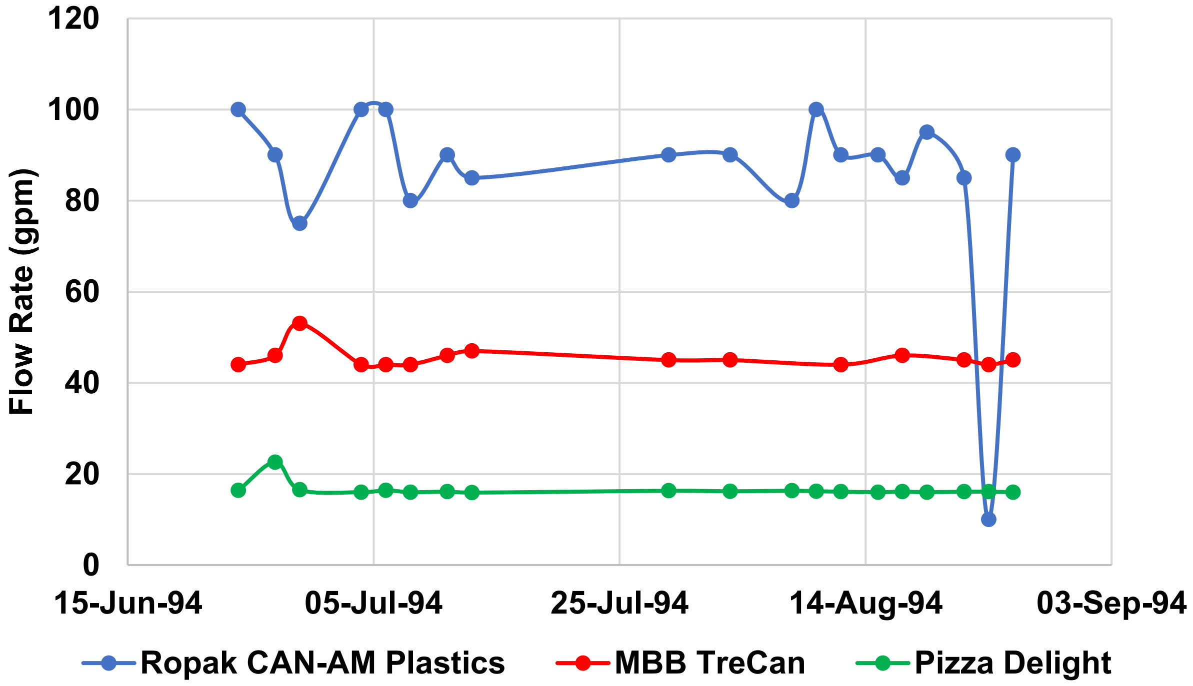

Figure F24: Flow rates collected from three of the facilities in Springhill (Bagnell, 1994).

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