OPPORTUNITIES FOR OPEN LOOP GEOEXCHANGE WATERLOO REGION

Prepared for WR Community Energy

WR COMMUNITY ENERGY

November, 2021

ACKNOWLEDGEMENTS

The work of WR Community Energy is directed by an innovative Governance Committee which includes high-level representatives from the Region of Waterloo, its three urban municipalities, and five local gas and electric utilities.

PURPOSE

This document is designed to start a conversation about the potential and risks of this technology specifically in Waterloo Region.

Geothermal opportunities exist across Canada. Waterloo Region, however, is unique in its capacity for a more energy efficient and ecologically preferable type of geoexchange system called, 'Open Loop geoexchange'. Open Loop Geoexchange is not well understood by all relevant sectors of our community. The purpose of this report is to bring forward existing knowledge on the subject and put it in context with similar technologies and our broader community.

Our goals are to increase open loop geoexchange developments and streamline regulations across our community in ways that support our environmental and community energy goals outlined in Transform WR and the Community Energy Investment Strategy. In particular:

- Reduce GHG emissions
- Reduce energy intensity costs
- Increase local energy generation and resilience
- Increase % of local energy dollars
- Increase value of energy conservation

Based on the resources in this report, WR Community Energy suggests that all developments with the following conditions look seriously at Open-Loop geoexchange systems:

- heated space greater than 5,000 m^2;
- a property size of 10,000 m^2, or more;
- outside a wellhead protection area (see map below)
- an estimated minimum well capacity greater than 10 L/s
- non-contaminated lands

As more open loop geoexchange systems are explored, designed, and built in our community there will be more opportunities to improve our collective knowledge of opportunities and risks of the technology locally. Consider this study the first step in improving our community-focused open-loop geothermal literacy.

HOW TO USE THIS REPORT

This resource includes two reports and a set of maps.

Part 1

Geothermal Energy Potential for Waterloo Region Building Sector is an introductory report written by the preeminent geothermal driller and consultancy in Canada: Beattie Geothermal. They have drilled and / or designed most of the open-loop and closed loop vertical geoexchange systems in Waterloo Region. This report introduces open and closed loop geothermal technology; its applications in Waterloo Region; notable local examples of these technologies; and makes policy recommendations.

Part 2

An addendum to Geothermal Energy Potential for Waterloo Region Building Sector is prepared by WR Community Energy. It expands on many of the conclusions from Part 1 with additional regulatory, local planning, energy, and GHG savings information. It ends with additional policy recommendations.

Part 3

Geothermal Maps for Waterloo Region were prepared in partnership with hydrogeologists at the Region of Waterloo.

Thank you for your interest in geothermal energy in Waterloo Region. Our community sits on a unique source of carbon-free energy in Ontario. Considering the greenhouse gas savings potential, several successful case studies, and financial viability, we believe this technology has the potential to be a game changer in Waterloo Region.

Part 1:

Geothermal Energy Potential for Waterloo Region Building Sector.
A report by Beattie Geothermal written for WR Community Energy 2021

GEOTHERMAL ENERGY POTENTIAL

for the

Waterloo Region Building Sector

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WR Community Energy

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Geothermal Energy Potential for the Waterloo Region Building Sector

August 18, 2021

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1. Energy Use in the Building Sector

The building sector in Waterloo Region consumes about one-third of the total energy demand. This sector includes homes, public and institutional buildings, farm buildings and greenhouses, commercial offices and industrial operations.

Fossil fuels are commonly used for space heating and indoor comfort during the fall, winter and spring seasons. In most areas, fossil fuels are also used to produce domestic hot water.

Indoor cooling during the summer months has become the norm over the past few decades for much of the building sector within Waterloo Region. The entire cooling load is supplied by electricity, which causes the summer peak electrical demand to be much greater than the winter peak demand.

According to the Region, building heating and cooling has become one of the largest sources of community greenhouse gas (GHG) emissions in Waterloo.

2. Geothermal Energy Resources in Waterloo Region

In Waterloo Region, the earth, groundwater and surface water features are all potential sources of geothermal energy. Geothermal systems use the heating and cooling properties of these resources to regulate building temperatures. Access to the various resources depends on a combination of engineering and resource characterizations. The geothermal resources that are available in Waterloo Region include:

- surface water features (including reservoirs, ponds, lakes, etc),
- groundwater aquifers, in overburden and bedrock,
- overburden materials below the water table, and
- bedrock formations.

All resources, except surface water and the surficial 3 m of overburden, require drilling to access the geothermal energy. The lack of surface water features in the Region limits this resource to just a few locations. The feasibility of the deeper geothermal resources depends on the heating and cooling loads of the building, and the degree of engineering required to access the energy source.

Sufficient energy can usually be obtained from shallow soils or private wells to heat and cool rural homes, agricultural buildings and small commercial buildings. In contrast, large commercial, institutional, and industrial buildings require up to 200 m deep drilling to access sufficient geothermal energy to meet the heating and cooling loads of the building.

Two of the geothermal resources that are unique to Waterloo Region include major bedrock and overburden aquifer systems. The overburden aquifers are generally less that 100 m deep and are accessible by conventional drilling rigs. The bedrock aquifers can be accessed by 100 to 200 m deep water wells. The bedrock is typically limestone or dolostone, which are relatively easy to drill.

In the next few decades, the transition to global decarbonization will see a gradual reduction in the use of fossil fuel to heat buildings. As society transforms to a clean energy future, geothermal energy is poised to become the holy grail of heating and cooling. It is a constant source of carbon-free energy that is available in the ground beneath virtually every building site.

In Toronto, the City's Green Development Standard has resulted in a rapid increase in geothermal installations for residential towers and campus buildings. Enwave's deep lake geothermal cooling system for downtown Toronto office buildings is one of the largest in the world.

3. Harnessing the Geothermal Energy Resource

In spite of the abundance of geothermal energy resources in Waterloo Region, there are a number of limitations that property owners must be aware of. Most are related to the historical use of groundwater for municipal use and the impact of some industrial plants on groundwater aquifers.

Recent amendments to the Regional Official Plan (ROP) preclude the development of geothermal systems within certain Well Head Protection Areas (WHPAs). WHPAs encompass the capture zones of the municipal wells and well fields.

In addition to the WHPA restriction, contaminated aquifers in the vicinity of a few old industrial plants are not candidates for geothermal energy. This is due to the risk of expanding the zone of contamination. One of the largest contaminated sites is in Elmira, where chemicals from a former chemical plant have migrated into a widespread overburden aquifer in the area.

Outside of the restricted WHPAs and contaminated areas, the two primary sources of geothermal energy in the Region are the overburden and bedrock formations and the groundwater aquifers.

Recovery of the energy required for heating and cooling the building sector involves the installation of either borehole fields for closed loop systems or water wells for open loop systems.

3.1 Open Loop Water Well Systems

Open loop technology is used to harness the geothermal energy stored in groundwater aquifers. This technology preceded development of the closed loop system and was initially developed in the 1950's. For example, local dairies and farmers first used well water to cool milk production. In the 1970's large industrial plants such as Uniroyal Rubber Ltd (now Air Boss), Kuntz Electroplating Inc. and Strudex Fibres Limited installed the first high-capacity open loop wells in Kitchener and Waterloo. These initial open loop systems were used for cooling only, and did not return the water to the aquifer.

Development of heat pump technology in the 1980's expanded the capability of open loop systems to provide both heating and cooling to buildings. Some of the first heating and cooling open loop systems in Ontario were installed in London, Woodstock and Georgetown in the 1990's. By the late 2010's, two of the largest open loop geothermal systems were installed in Waterloo: 1) the "HUB" residential towers on Columbia St. and 2) the "evolv 1" office complex on Wes Graham Way.

The modern open loop systems have made one major advancement over the early cooling-only systems: the groundwater must be returned back to the aquifer. During the past 30 years, injection wells, which recirculate the water back to the aquifer, have become a fundamental component of all open loop systems. With no net withdrawal of water from the aquifers, open loop systems conserve, rather than deplete the groundwater energy resource.

The water injected back to an aquifer after use in open loop systems is either a little warmer (eg – 8 to 14^{o}C when cooling) or a few degrees cooler (~6^{o}C when heating) than the ambient groundwater temperature. In order to prevent annual overheating or overcooling of the aquifer, the open loop building should have fairly balanced annual heating and cooling energy loads. This allows the summer pulse of warm water to be offset by a winter pulse of cool water.

The move to open loop geothermal installations relies on a thorough understanding of the hydrogeological setting in the vicinity of each project. Current open loop designers must be conversant

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in aquifer mapping and local groundwater uses, groundwater flow patterns, water well terminology, well capacity testing, Provincial water well regulations and municipal groundwater policies.

3.2 Closed Loop Vertical Borehole Systems

Closed loop technology is used to harness geothermal energy stored in the overburden and bedrock formations. This technology was mostly developed in Sweden in the 1980's and 90's. It involves circulating a fluid through a network of high-density polyethylene loops installed in horizontal trenches or vertical boreholes. Heat pumps either extract heat from the loops for heating the building or reject heat to the loops for cooling.

The closed loop industry started in Ontario in the 1990's, as heat pump technology improved. Initially, it became popular in the rural residential building sector, due to the high cost of propane and heating oil.

By the early 2000's, the closed loop drilling industry expanded to the commercial and institutional building sector. The increased demand for large borehole fields resulted in the development of specialized track-mounted drilling rigs that could operate in more-confined urban settings. Geothermal designers started placing borehole fields beneath building towers to maximize the heating and cooling capacity of properties with limited open space around the building footprint.

In the last two decades, the heating and cooling capacity of closed loop borehole fields increased dramatically. The size of closed loop fields increased from a few dozen to several hundred boreholes. At the same time, drilling depths increased from 100 to 300 m. Plans are currently being developed in Ontario to install large-scale closed loop systems, consisting of several thousand deep boreholes.

4. The Choice between Open and Closed Loop Technologies in Waterloo Region

Considering the general hydrogeological conditions in Waterloo Region, two geothermal technologies have emerged with the greatest potential: 1) closed loop systems in rural areas underlain by thick overburden, and 2) open loop systems in both rural and urban areas located above bedrock aquifers.

The basic design of each option requires an analysis of the hourly heating and cooling energy loads for the building and a thorough understanding of the subsurface geological and groundwater conditions.

The building loads are available from mechanical consultants, however, information on the subsurface hydrogeology is often sparse. Fortunately, in the case of Waterloo Region, there is a vast data-base on aquifer mapping and test drilling programs in the more-populated urban communities. In the less-populated rural areas, 1000's of drill logs are available from domestic water well records. The latter provides information on the local geologic conditions, as well as potential well yields.

The choice between open and closed loop technologies depends largely on the size of the building, the availability of land for drilling and the hydrogeological conditions beneath the property. A brief review of the conditions that might favour an open loop system over a closed loop system, and vice-versa is given in the following sections.

4.1 The Case for Open Loop Systems

The recent installation of the Hub and evolv1 open loop systems in North Waterloo tapped into two mineralized bedrock aquifers which are found below local sand and gravel aquifers. The mineralized quality of the deeper bedrock groundwater makes this water unsuitable for domestic use.

The two bedrock aquifers, known as the Guelph and Gasport Aquifers, are widely distributed throughout the Region. It is noted, however, that the Gasport Aquifer south of Hwy 401 is generally less mineralized and is the main source of water supply for the Cambridge area.

The feasibility of open loop geothermal systems always requires an investigation of the bedrock aquifer conditions. The required water supply is determined from test well installations, since rules-of-thumb do not apply to bedrock well capacity, due to local variations in aquifer conditions.

Typical well capacities in the Guelph and Gasport Aquifers range from 5 to 40 L/s. At a year-round temperature of 10°C, this range of water supply is adequate to heat and cool small commercial buildings, as well as larger building complexes. A preliminary determination of potential well capacities in a particular study area can be done by reviewing Ministry of the Environment, Conservation and Parks (MECP) well records. They include a record of the site geology, well depth and a short pumping test.

There are over 120 municipal wells located throughout the Waterloo Region and each has a Wellhead Protection Area (WHPA) zone. Open loop systems are not allowed within a few hundred metres of each municipal well. Most of the WHPAs north of Hwy 401 are centered around sand and gravel wells, while those in the Cambridge area are centered around bedrock wellfields.

The general potential for open loop systems outside the restricted area around the municipal wells in Waterloo Region could provide a carbon-free alternative for space heating and cooling in the building sector. Opportunities for open loop systems range from rural homes, to commercial urban buildings and district energy developments.

In Waterloo Region, the cost of open loop geothermal systems is usually much lower than the equivalent size of closed loop systems, due to the abundance of groundwater. For a given heating and cooling load, multiple closed loop boreholes can be reduced to only 1 or 2 open loop wells.

The widespread distribution of major bedrock aquifers in Waterloo Region makes the open loop geothermal option a logical first choice. However, a few factors that can adversely affect the viability of an open loop system must be considered. They include the following:

- the building is not energy-efficient due to age and construction methods;
- the annual heating and cooling loads are badly out of balance;
- the presence of artesian conditions (eg – flowing wells);
- the groundwater quality is unacceptable;
- the property around the building is too small to install both supply and injection wells; and
- restrictions on the installation of open loop systems near municipal supply wells; etc

Given the above limitations, experience has shown that open loop systems are usually viable for newer buildings in most areas outside the restricted WHPAs. The suggested minimum threshold for open loop heating and cooling of buildings in the commercial, industrial and institutional sector includes:

- a building size of at least 5000 m^2;
- a property size of 10,000 m^2, or more; and
- a minimum well capacity in the order of 10 L/s

4.2 The Case for Closed Loop Systems

Closed loop systems use the ground itself (rather than groundwater) as the source or sink for heat pump operation. Horizontal shallow loops can be used for rural residential, agricultural and small building applications. In built-up urban areas however, vertical boreholes are usually required to tap the deep subsurface earth materials beneath the project site, due to the more limited land area that is available for the geothermal installation.

The primary advantage of vertical closed loop systems is that they can be installed in most locations. However, one constraint for closed loop installation in Waterloo Region is the challenge of drilling in high-capacity bedrock and artesian aquifers. The groundwater conditions in bedrock aquifers usually result in reduced drilling speeds and higher installation costs. Another constraint is a Regional policy that prohibits closed loop drilling in all Source Water Protection Areas. As a result, the closed loop option is generally limited to urban areas where drilling is unrestricted and the rural communities where greater space is available for the borehole fields.

The cost of closed loop borehole systems is usually considerably more than the open loop option, provided that a high-capacity aquifer is available beneath the property. Borehole drilling in the high-capacity bedrock aquifers found beneath much of the Region can add significant costs to closed loop borehole installations.

The installation of closed loop systems in the vicinity of groundwater aquifers requires strict adherence to the regulations and standards that apply to protection of the groundwater resource. Rigorous inspection protocols are required to ensure that borehole sealing measures are enforced to prevent potential contamination of water supply aquifers

5. Examples of Geothermal Installations in Waterloo Region

5.1. Open Loop Systems

As noted in Section 3.1, open loop systems in Waterloo Region date back to the 1950's. These early systems obtained groundwater from the bedrock aquifers and discharged it to nearby streams or storm sewers. More recent open loop systems must obtain an ECA (Environment Compliance Approval) permit from the MECP to return the groundwater back to the same aquifer.

Table 1, on the following page, lists some of the known existing (and former) open loop geothermal systems in the Region. Going forward, the opportunities for open loop development in Waterloo Region can be determined with more certainty. The locations where open loop systems are not permitted (eg – the WHPA's close to municipal wells and local contaminated aquifers) are also well known.

5.2. Closed Loop Systems

Closed loop systems include mainly vertical boreholes, however horizontal loops are often installed on the larger rural properties. Unlike open loop systems, there is no effective way to document and map closed loop systems. The MECP does not require geothermal drilling contractors or horizontal loop installers to file installation records in the same manner as open loop water well records.

As noted in Section 4.2, closed loop borehole systems are prohibited from the Source Water Protection Areas in Waterloo Region. Table 2, as seen below, lists a few examples of large-scale closed loop systems that have been installed in Kitchener outside the WHPAs. These examples have been obtained from the designers or installers of the systems.

Table 1

Selected Open Loop Systems in Waterloo Region

Owner	Location	Year of Open Loop Well Installation	Well ID Number (from MECP database)	PTTW* Number	Maximum Well Capacity Permitted M m^3/day
Refrigeration Plant (owner not known)	Hwy 8 (former), Kitchener	1956	6500277	N/A	N/A
AirBoss of America Corp	Glasgow St., Kitchener	1968	6302870	6686-96MPCG	5.2 (2 wells)
Kuntz Electroplating Inc	Wilson Ave, Kitchener	1970 1985	6503310 6505758	5841-BS6M62	3.8 (3 wells)
Strudex Fibres Ltd.	Conestoga Rd, Waterloo	1972	6503659	N/A	2.0 (capacity of injection well)
Safety-Kleen Canada Inc	Woolwich St., Breslau	2013	7202296	3676-9QXQLU	0.5 (2 wells)
Columbia Village Inc (HUB)	Columbia St., Waterloo	2016 2017	A216950 (Tag) A213716 (Tag)	3248-APUS4N	3.7 (2 wells)
evolv 1	Wes Graham Way, Waterloo	2017	A216958 (Tag)	N/A	2.0 (1 well)

N/A – Information not available
*PTTW – Permit To Take Water

Table 2

Selected Closed Loop Borehole Systems in Waterloo Region

Location	Year of Installation	Estimated Number of Boreholes	Estimated Depth of Boreholes, m (ft)	Estimated Number of Aquifers Penetrated
Sunnyside Supportive Housing, 245 Franklin St. N, N, Kitchener	2009	36	91 (300)	Overburden – 1 Bedrock - 1
Victoria Common, 310 Louisa St., Kitchener	2017-2020	65	91 (300)	Overburden – 1 Bedrock - 1
Garment St. Condos, 120 Victoria St. S, Kitchener	2018	Unknown	Unknown depth in bedrock	Overburden – 1 Bedrock - 2
Weber Scott Pearl Development, 66 Weber St. E, Kitchener	2020	90	130 (420)	Overburden – 1 Bedrock - 2

6. The Combined Use of Aquifers for Geothermal Energy and Water Supply

As noted previously, most of Waterloo Region is underlain by major aquifers, both in the overburden and bedrock. This condition is unique to the Region and relatively rare in Ontario. The presence of multiple aquifers provides an opportunity to use them for both municipal supply and geothermal applications. The best quality aquifers are suitable for public water supplies and the mineralized bedrock aquifers are usually suitable for heating and cooling the building sector.

The most critical aspect of combining aquifer usage for both potable supplies and geothermal energy is the protection of the drinking water sources. Fortunately, the regional groundwater flow patterns generally migrate downward, from the fresh water sand and gravel aquifers to the poorer quality bedrock aquifers. The only upward groundwater flow occurs along the flanks of the Grand River and its tributaries.

With downward groundwater flow patterns dominating in the Region, the operation of open loop geothermal wells in the bedrock cannot cause any quality or thermal impacts to the shallower freshwater aquifers. In addition, the return of all geothermal supplies back to the deeper bedrock aquifers ensures that the regional groundwater discharge to the Grand River system will not be adversely affected.

Open loop geothermal wells are constructed to the same standards as municipal water supply wells. For example, the annulus around the well casings is pressure grouted with cement to protect the integrity of all overburden aquifers penetrated by the wells. In addition, the open loop well casings are constructed of stainless steel to prevent long-term corrosion and are seated and cemented 10 m into the bedrock. These well construction features make it feasible to utilize the aquifer systems in Waterloo Region for both water supply and geothermal heating and cooling

In rural areas of the Region, the combined use overburden aquifers for both drinking supply and geothermal systems is a common practice. The average flow required to heat and cool typical rural homes and farm buildings is seldom more than 1 L/s. For larger heating and cooling applications such as greenhouses, poultry barns, cold storage, etc., the deeper bedrock aquifers can be utilized.

7. Geothermal Action Plan and Policy Recommendations for Waterloo Region

The vast distribution of both overburden and bedrock aquifers in the Waterloo Region provides a unique carbon-free resource for heating and cooling the building sector. Open loop geothermal systems have the potential to drastically increase the Region's energy production capacity. The extensive reservoir of stored geothermal energy in the earth formations found throughout the rural areas can be tapped by closed loop boreholes.

In order to promote the development of geothermal energy in the Region we recommend the following Action Plan and Policy recommendations:

1) Resource Assessment – Mapping of the open loop geothermal resources in the Guelph and Gasport bedrock aquifers and mapping of the closed loop geothermal resources in the overburden deposits.

2) Enabling Framework – Support the development of effective policies and regulations to enable widespread adoption of closed loop geothermal systems outside the WHPAs and open loop geothermal systems outside all WHPA "Class B" areas. The policies should include:
   - a mechanism to track closed-loop systems in Waterloo Region;
   - development of rigorous inspection protocols to ensure the required borehole sealing measures are enforced;
   - educating energy developers and the building sector on aquifer mapping, local groundwater uses, groundwater terminology and Provincial regulations; and
   - removal of barriers for open-loop systems by incentivizing test wells for proposed geothermal installations.

3) Support the Geothermal Network – Provide a leadership role in supporting decarbonization strategies through the development of carbon-free geothermal energy.

8. Limitations

This report has been prepared for WR Community Energy and is intended for the sole and exclusive use by WR Community Energy.

The findings of this study are general in nature, and require confirmation with various field investigations.

This Study may not be relied on by any other person or entity without the express written consent of Beatty Geothermal Consulting.

Any use by a third party, or reliance on, or decisions to be made based on this report, is the responsibility of such third party.

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Part 2:

An addendum to Geothermal Energy Potential for Waterloo Region Building Sector

The report in Part 1 was prepared by Beattie Geothermal Consulting, a group of hydrogeologists specializing in geothermal system design. They are not, however, energy or greenhouse gas specialists. As such, WR Community Energy has prepared the following addendum to put additional light on the potential for open loop geoexchange in Waterloo Region. It includes several sections including:

Contents

Open Loop Thermal Heat Recovery, Cost, and GHG Savings Potential

"In the next few decades, the transition to global decarbonization will see a gradual reduction in the use of fossil fuel to heat buildings. As society transforms to a clean energy future, geothermal energy is poised to become the holy grail of heating and cooling. It is a constant source of carbon-free energy that is available in the ground beneath virtually every building site." Brian Beattie (Geothermal Energy Potential for Waterloo Region Building Sector, Section 2)

The following formula can be used to calculate the thermal energy from geothermal sources:

Thermal Energy (kW_{th}) = Flow (m^3/h) x Specific Thermal Capacity (kWh/m^3 x °C) x Temperature difference (°C)

Example: *Flow = 100 m^3/hour (or 28 liters/second)*

Specific Thermal Capacity at 10°Celsius = 1.164 kWh/m^3 x

Temperature difference = 10 – 6 = 4 °Celsius (heating); 16-10 = 6 °C (cooling)

Heating Thermal Energy = 100 x 1.16 4x 4 = 465.6 kW_{th}

Cooling Thermal Energy = 100 x 1.16 4 x 6 = 698.4 kW_{th}

Assuming the above:

- 465.6 kW_{th} is enough to provide annual baseline heating and cooling for a building ~10,000 m^2.
- If used to displace Natural Gas baseload heating, it would save ~55 m^3 per hour and ~ 180,000 m^3 a year.
- This is the equivalent of saving 344 tonnes of greenhouse gas emissions / year
- With a carbon price of $170 / tonne, a geothermal system would save $58,000 / year
- For a building of 10,000m2, that's a savings of $58 / m^2.

Other Open Loop Geoexchange Cost Considerations:

In addition to energy considerations, the full cost of an geothermal system would require considerations such as:

1. Viable number of wells on a site (intake and injection wells should be 150m apart)
2. Pumping Cost (7kWh * lift) (the height required to pump the aquifer to the mechanical system)
3. Testing, Drilling, Construction (observation / Production wells ~$30k / well)
4. Mechanical Technologies (EER – assuming 22 & COP - assuming 3.5)
5. Maintenance / well (generally low but important to maximize life expectancy and reduce risks to municipal supply aquifers)

Regulatory Framework

Below are important policies relevant to geoexchange. This is not intended to be a comprehensive list of all relevant policies.

Ontario:

- Ontario Water Resources Act
    - Permit to Take Water (required for greater than 50m^3 of water / day)
- Ontario Environmental Protection Act
    - O. Reg. 98/12: GROUND SOURCE HEAT PUMPS

Region of Waterloo:

- Regional Official Plan: Geothermal energy systems are prohibited within the two-year time of travel of a municipal well.
- Construction of Geothermal Wells in Well Head Protection Areas (pg. 67)

Area Municipalities:

- Zoning By-Laws for Geothermal
    - Waterloo (pg. 131) – prohibiting geothermal wells west of Weber St.
    - Cambridge (pg. 263) – Geothermal prohibited until ROP amended to incorporate source protection plans from the Clean Water Act (2006)

CSA Standard for Geoexchange:

- Design and Installation of Earth Energy Systems for Commercial and Institutional Buildings

Policy Recommendations

In addition to the policy recommendations from the Beattie Report, WR Community energy makes the following policy recommendations:

1) Region of Waterloo amend the Regional Official Plan to incorporate clear guidance on areas suitable for open and closed loop geothermal systems and acknowledge linkages with policies and regulations related to source water protection Plans.
2) Cities update geothermal policies or regulations to reflect differences between open loop and closed loop geothermal technologies highlighted in maps below. (example City of Waterloo by-law mentioned above)

3) City Planners comment on open loop geoexchange opportunities for new developments over 5,000m2, on sites larger than 10,000m2, and that lay outside of the wellhead protection areas. Planners should be sure to consult with Regional staff to ensure the site is not contaminated and otherwise available for geoexchange
4) Set-up a working group to support safe widespread development of open loop geoexchange opportunities and consider financial incentives to de-risk open loop geoexchange opportunities.

Part 3:

Geothermal Maps for Waterloo Region

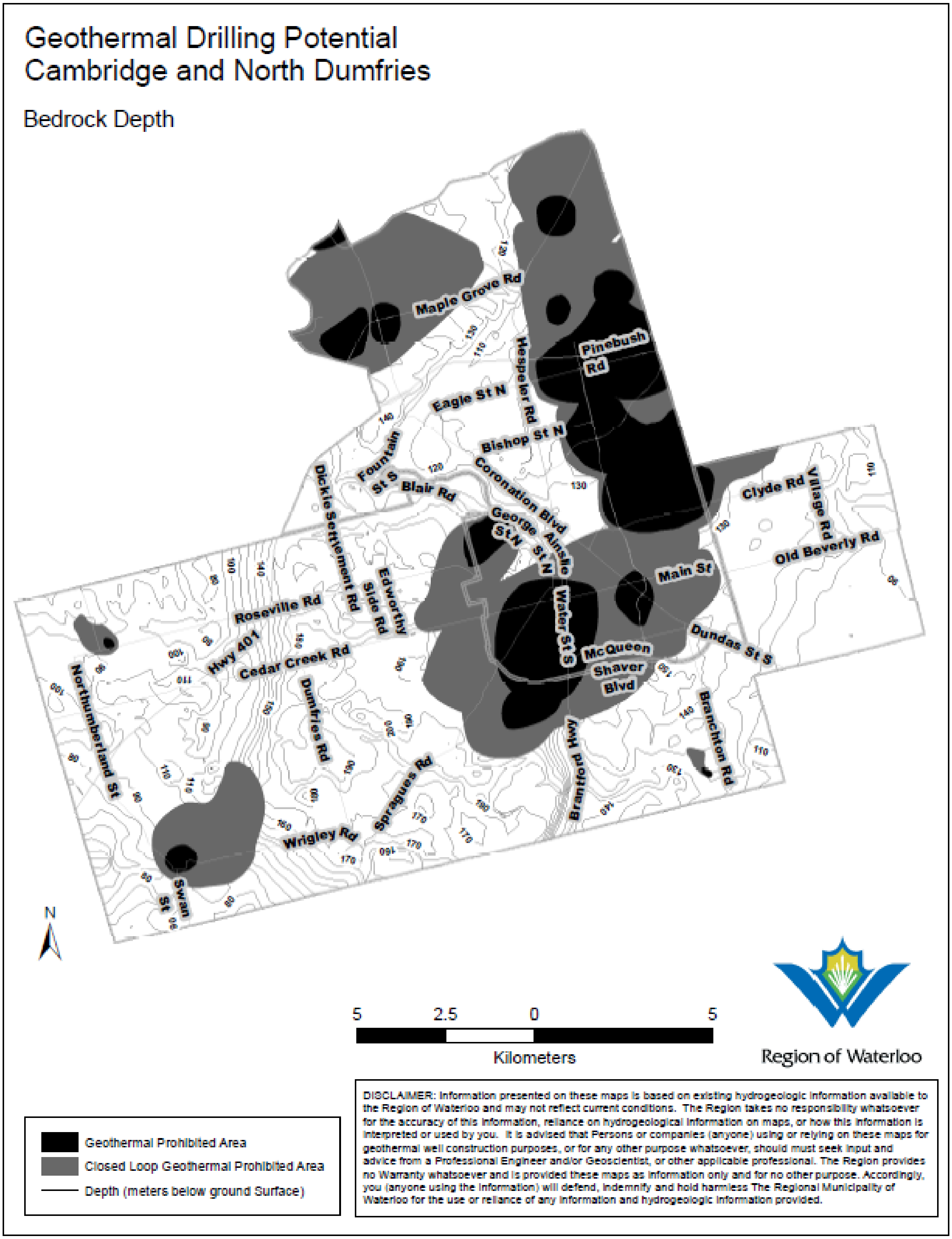
The following maps are divided by municipal areas.

At bedrock depth, aquifer flow rates can change from one meter to the next and consequently are not mapped here. Flow rates are usually between five to 30 liters / second.

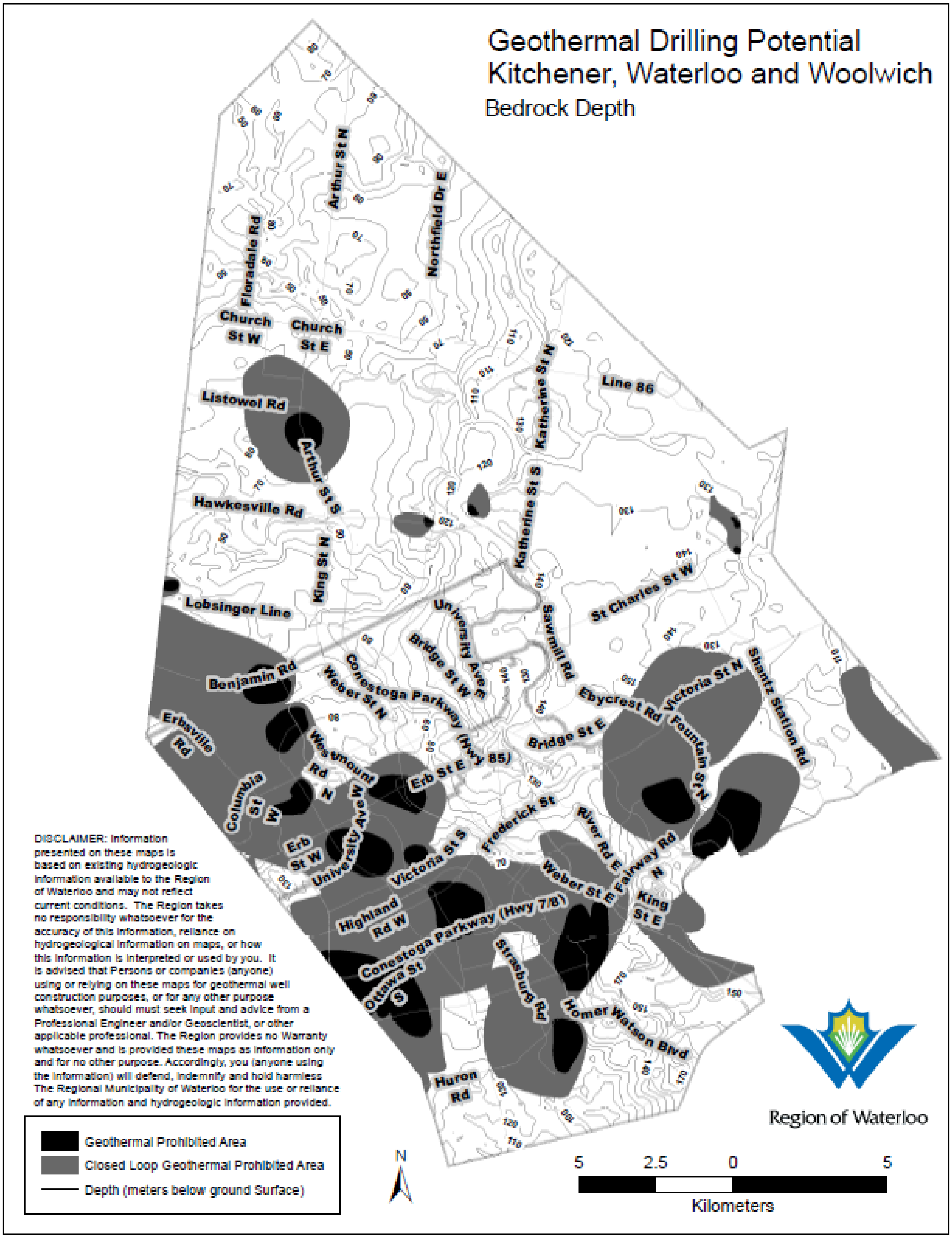
The maps show wellhead protection areas and their impact on different vertical geothermal types. Open loop geoexchange is less restricted than closed loop systems.

Overburden level geothermal maps (including flow rates) are available by request.

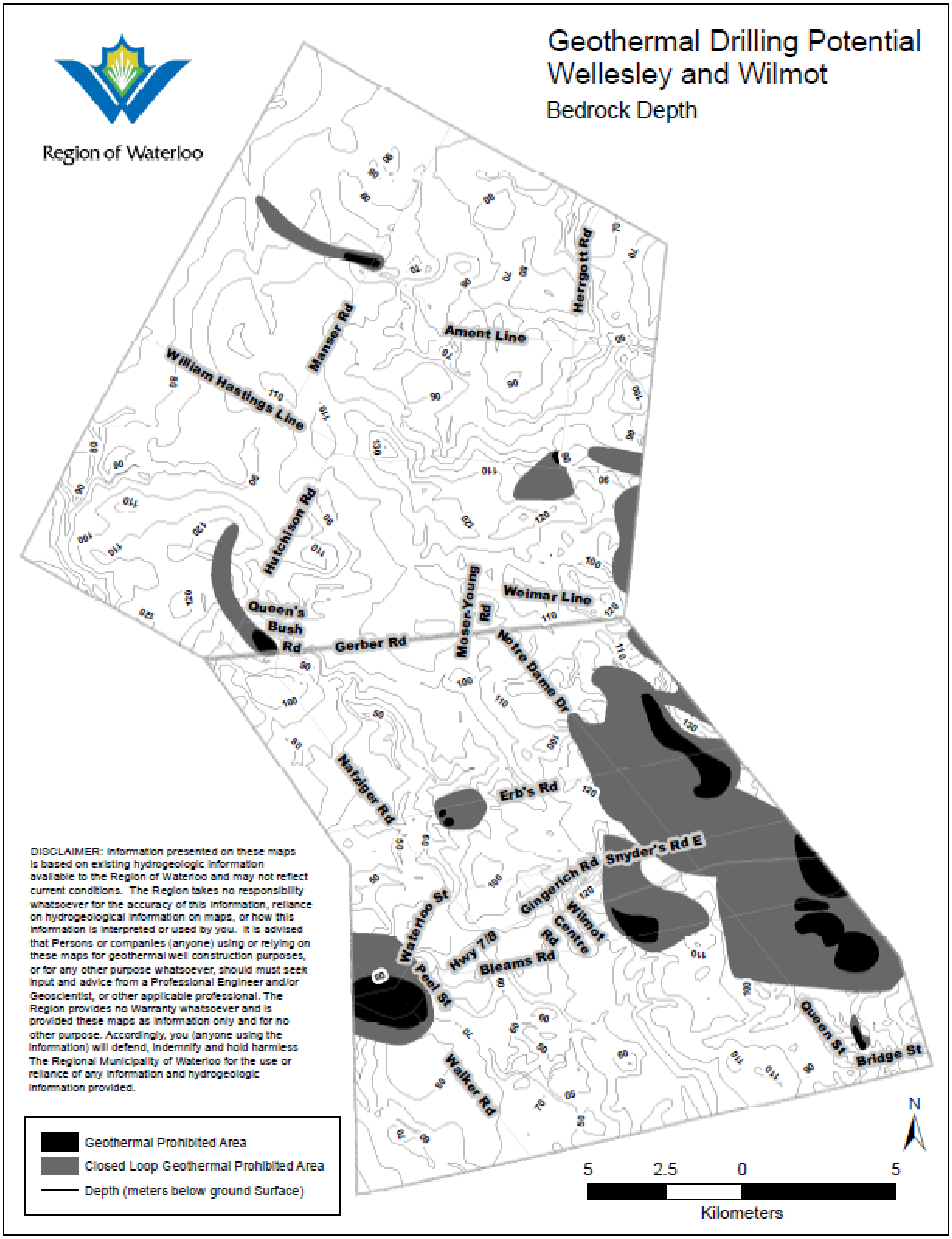
Map 1. Geothermal Drilling Potential Cambridge and North Dumfries: Bedrock Depth

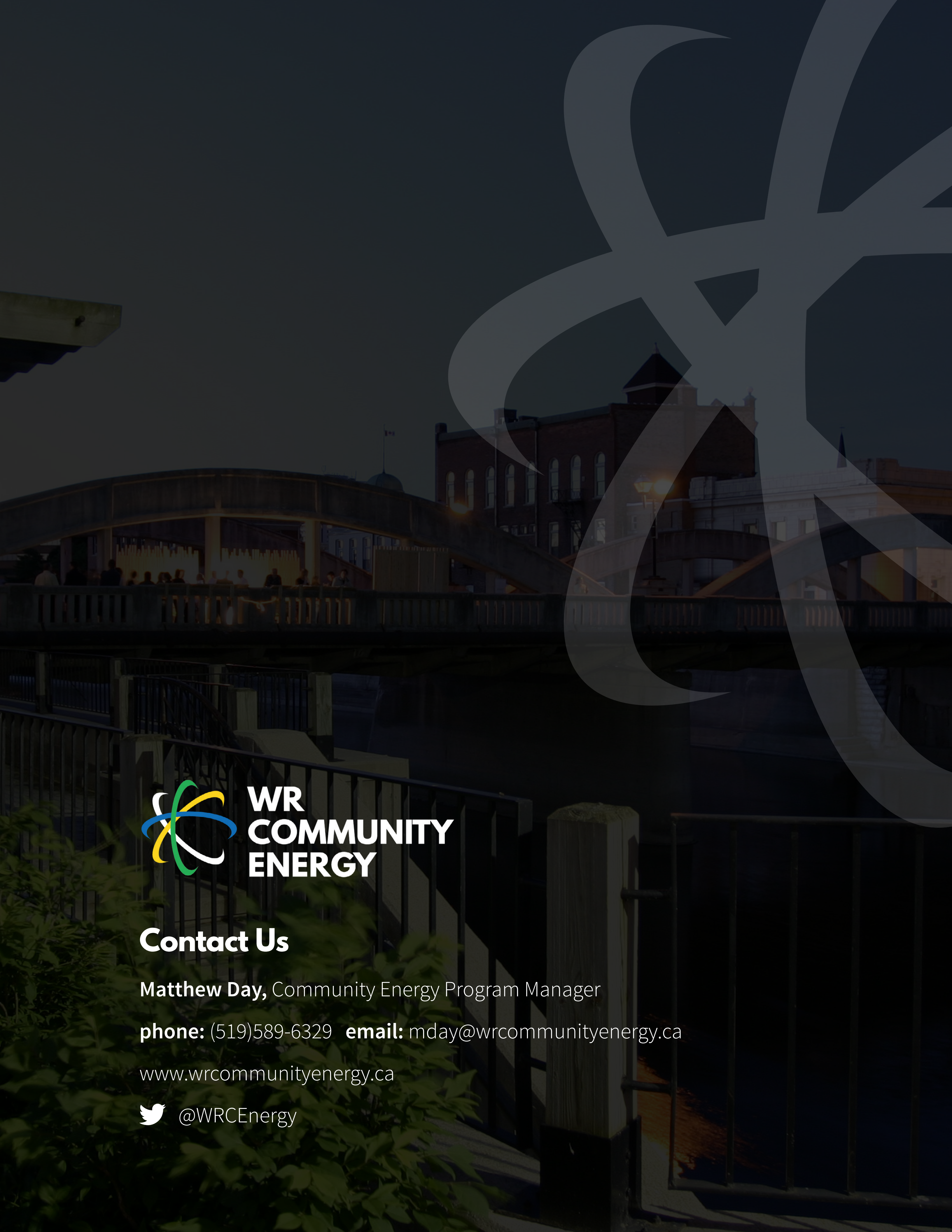


Map 2. Geothermal Drilling Potential Kitchener, Waterloo, and Woolwich: Bedrock Depth



Map 3. Geothermal Drilling Potential Wellesley and Wilmot: Bedrock Depth





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