Part 1 – Site Suitability Guidelines

(Alternate title: 'Assessing Site Suitability and Ground Coupling Options')

Part one in the set of four Professional Guidelines for Geoexchange Systems in British Columbia

Second Edition

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GeoExchange BC – in pursuit of performance

Dear Reader,

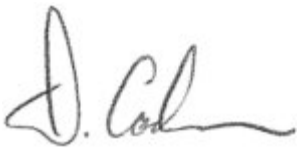
GeoExchange BC is a not for profit provincial industry association in British Columbia dedicated to the education, promotion and responsible design and installation of low temperature ground source (geoexchange) energy systems. Our mission and vision is to promote information sharing between industry professionals and other stakeholders associated with the geoexchange industry, as well as to maximize the energy performance of geoexchange systems to realize their full financial, environmental, and social benefits.

Geoexchange BC has published this document as one of a series of guidelines to educate key players on the requirements of a successful geoexchange project. These guidelines also help establish a strong standard of practice for the industry going forward. Each guideline covers a separate topic and is focused on commercial-scale applications within BC, although many of the concepts are applicable to smaller projects and other regions. The guidelines are for use by developers, owners, coordinating professionals, construction managers, engineers, installers and commissioning teams. The primary goal of these guidelines is to assist a project team in delivering a cost-effective geoexchange system that will provide reliable operation and energy savings throughout the life of the system.

A supplemental User Guide has also been developed to facilitate access to all the detailed information contained within the guideline documents. The User Guide summarises the key content of each guideline, provides a flowchart and checklist format for guidance and record-keeping, and identifies topics within the guideline relevant to each key player on the project team.

We hope and expect that these guidelines will be of great service to you, to your industry peers, and consequently to all British Columbians alike.

Best regards,



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Site Suitability Guidelines

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1.0 INTRODUCTION

1.1 Professional Guidelines Series

With the rapid growth of the geoexchange industry in British Columbia, there is a widespread need for a set of professional guidelines for the rational, suitable and appropriate application of geoexchange technology. Such guidelines will promote appropriate and responsible designs, leading to successful, sustainable systems that will, in turn, meet owner's requirements and improve the reputation of the industry.

This document is one in a series called Professional Guidelines for Geoexchange Systems in British Columbia, made up of four parts:

- Part 1 – Assessing Site Suitability and Ground Coupling Options (this document);
- Part 2 – Design;
- Part 3 – Commissioning and Troubleshooting; and
- Part 4 – Procurement.

The full series covers the life cycle of a geoexchange project, from the initial concept through site evaluation, ground coupling selection, procurement, system design and commissioning.

The guidelines are intended as a resource for building owners, architects, project managers and construction co-ordinators to fully understand the steps involved in design, construction, commissioning and procurement of geoexchange systems. They are also a useful reference for industry professionals, engineers and contractors involved in the design and construction of geoexchange systems.

This series of guidelines is geographically focused on British Columbia, which has a very diverse range of geologic settings, topography, soil types, climatic conditions and site conditions. This series is also framed for provincial and federal regulatory regimes that apply to this province. However, the fundamental concepts presented here may also be applied in other parts of Canada and the general staged methodology could be applied anywhere.

1.2 Purpose and Scope of this Guideline

The purpose of this Guideline is to provide a rational framework to assist owners, developers and industry professionals in making decisions on how best to apply geoexchange technology, from the initial concept to the start of design. This Guideline is presented as a model of recommended practice for evaluating the suitability of a site and highlighting which ground source options best fit site characteristics. This Guideline establishes a general standard for site selection and pre-design work for geoexchange projects in BC. The decision-support methodology described here is based on engineering practice and will be most applicable to commercial, institutional or larger residential systems. Nevertheless, the concept of objectively characterizing a site and letting its

features govern the appropriate selection of ground coupling should be applied to any geoexchange application.

This Guideline is not an official standard method, but refers to standard methods and other reference documents where useful. This document is intended to be a practical resource for owners, geoexchange designers, engineers and contractors, municipal engineers and planners, provincial regulators and the public. The supporting information in the appendices relates to British Columbia, but the general concepts of site appraisal and ground coupling selection can be applied just about anywhere. Special considerations for cold climate applications are also included.

1.3 How to Use this Guideline

This Guideline is subdivided into the following sections:

1. Introduction
2. Engineering Approach for Geoexchange Development
3. Geological and Hydrogeological Considerations
4. Other Site Considerations and Constraints
5. Methodology for Site Suitability Assessment and Options Analysis
6. Regulatory and Environmental Considerations
7. Summary and Conclusions
8. References

Appendices include geoexchange source information (for BC and North America), geologic source information for BC, regulatory source information pertaining to BC, and reference tables for the Options Decision Analysis process.

Sections 1 through 4 provide background and context to the methodology. Here you will find basic concepts of why an engineering approach is not only critical to ensuring life cycle performance, but also provides good value for geoexchange applications. Fundamentals of geology and hydrogeology relating to geoexchange systems are presented, with references to many useful information sources and links pertinent to BC.

Section 5 presents the core methodology, based on a flowchart. This methodology steps down from owner concept to pre-design work through three stages of Geoexchange Suitability Assessment (Stage 1, 2 and 3 GSA), with milestone options to jump directly to design if warranted. This is the core of this Guideline. An example Table of Contents for a Stage 1 GSA is appended. This will assist owners in specifying an appropriate scope for properly assessing site suitability and ground coupling options, and guide those carrying out such work in effectively organizing their results. In addition, a concise synopsis of the whole methodology is presented as a useful document that could be attached to requests for proposals for geoexchange assessment work.

Section 6 provides information on the potential environmental effects of geoexchange systems and the regulatory controls in place within BC. Many useful information sources and pertinent links are also provided in Appendix C.

Although the reader can learn the core methodology by reading only Section 5, we strongly recommend that you read the entire Guideline to obtain a balanced, objective and thoughtful approach for assessing site suitability and ground coupling options.

1.4 Previous Work on Site Suitability Assessment

There are a number of previous studies relating to site characterization for geoexchange purposes. Kavanaugh and Rafferty (1997) described site characterization steps for obtaining design parameters for various ground coupling options for commercial and institutional systems. This remains a useful, pragmatic reference document for predesign studies (as well as geoexchange design). Bridger and Allen (2005) described aquifer characterization methods for physical, hydraulic, thermal and hydrochemical properties useful for aquifer thermal energy storage, and included references to a number of other characterization and design studies. In the Canadian Standards Association (CSA) Standard C448 (series 13), site characterization steps and scope are prescribed for various field investigations (e.g., number of test boreholes per site, testing requirements, etc.). C448 should be viewed as the minimum requirement for good practice; often there will be a need for additional effort driven by complex geology, large site size or critical system design requirements (e.g., for integrated or hybrid geoexchange systems). Significant contributions for specific field testing methods have been published by the American Society for Heating, Refrigeration and Air-conditioning Engineers (ASHRAE), such as detailed procedures for field tests of ground thermal properties (Kavanaugh, 2000). Further references to specific methodologies are included in the text below.

Site characterization studies or methods essentially address the question "could a site be used for geoexchange purposes?" and identify site characteristics useful for design input parameters. However, the site suitability methodology presented here goes beyond this to address the question "should a site be considered for geoexchange and if so which ground coupling is most appropriate?" This question incorporates technical site characterization parameters, as well as cost, schedule, logistical, regulatory and constructability factors, into an owner decision-making process. We are not aware of any other guideline that follows this comprehensive, owner-focused decision support approach.

2.0 ENGINEERING APPROACH FOR GEOEXCHANGE DEVELOPMENT

2.1 Drivers for Professional Guidelines

The main drivers for developing and using this Guideline are listed below:

1. Selecting the best system for the site conditions;