Part 2 – Design Guidelines

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

Third Edition

Published by: GeoExchange BC
admin@geoexchangebc.com
www.geoexchangebc.com

GeoExchange BC – in pursuit of performance

Dear Reader,

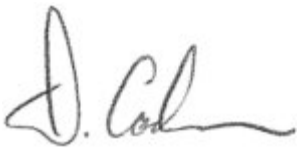
GeoExchange BC is a not for profit provincial industry association in British Columbia dedicated to the education, promotion and responsible design and installation of low temperature ground source (geoexchange) energy systems. Our mission and vision is to promote information sharing between industry 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,



David Cookson, B.Eng., MBA
Project Director, GeoExchange BC

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Acknowledgements

Design Guidelines

Third Edition contributors

Date: March 2014
Revised by: Associated Engineering (B.C.) Ltd.
Rachel Bolongaro, P.Eng. | Ruben Arellano, P.Eng., LEED AP
Contact: Rachel Bolongaro, P.Eng., 604-293-1411, bolongaror@ae.ca

Second Edition contributors

Date: May 2007
Revised by: EBA Engineering Consultants Ltd. (now Tetra Tech EBA)
H. Scott Schillereff, Ph.D., P.Geo., | Jeff Quibell, P.Eng. | Katherine Johnston, EIT
Contact: Don Williams, P.Eng., 250-862-4832, dwilliams@eba.ca
Support: Thanks to Lyn Ross, Chair of the Board (2007) for his efforts in securing core funding for the project, and to the Board of Directors of Geoexchange BC. Thanks also to Vladimir Mikler, P.Eng., Cobalt Engineering for his review of the revised edition.

First Edition authors

Date: 2004
Produced by: Hemmera Energy (now Hemmera)
Jeff Quibell, P.Eng.
VEL Engineering (now Integral Group)
Vladimir Mikler, M.Sc., P.Eng.,

First Edition Funding partners

Special thanks: BC Hydro, Metro Vancouver (previously GVRD), and the Canadian GeoExchange Coalition

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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;
- Part 2 – Design; (this document)
- 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 revised version accompanies "Part 1- Assessing Site Suitability and Ground Coupling Options". Both of the documents emphasize important regional considerations for geoexchange applications and identify design strategies for addressing challenges related to climate and ground conditions that are characteristic of BC.

This document is not intended to constitute a stand-alone comprehensive guide for the design and implementation of geoexchange systems. Rather, it should be used in conjunction with Commercial Earth Energy Systems: A Buyer's Guide, (Natural Resources Canada, 2002) and other appropriate resources as identified in this document.

Furthermore, this guideline elaborates on topics that are generally described in NRCan's Commercial Buyer's Guide such as:

- The role of geoexchange technology in the context of sustainable energy efficient building design in British Columbia.
- The challenges and opportunities presented by the wide variability of climate and geology in British Columbia and the need to be diligent in accounting for these factors in geoexchange design.
- Introduction to the range of ground-coupling opportunities that inherently result from varied geography with an emphasis to avoid template-style designs that frequently don't take full advantage of the natural potential of the setting.
- Introduction to the thermodynamic response relationship between the ground coupling and the load and how the understanding and appreciation of this relationship is critical for designing efficient, sustainable, and cost-effective geoexchange systems.
- Other relevant topics based on actual experience in British Columbia.
- Jurisdictional requirements in British Columbia.

This guideline focuses on closed loop geoexchange applications, in light of the dominance of this type of ground coupling application currently in BC. For other types of ground heat exchangers (e.g., open loop groundwater-based, surface water or waste heat applications), the same level of effort given to design of ground coupling should be applied to the design the well field, surface water intake, or waste heat coupling system. For any ground coupling option, an understanding of site suitability (as described in Part 1 of this series) is valuable for an appropriate and responsible design.

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. Geoexchange Energy Systems in the Context of Sustainable Building Design
3. Geoexchange – an Integration of Three Systems

4. Factors Affecting Successful Geoexchange Applications
5. Regional Considerations Unique to British Columbia
6. Suitable Geoexchange Applications
7. Building System Configurations
8. Types of Ground Heat Exchangers
9. Thermodynamic Response Relationship between the GHX and Building System
10. Geoexchange System Design
11. Ground Heat Exchanger Design
12. Quality Assurance/ Quality Control
13. Regulatory Considerations
14. Common Causes of Geoexchange System Shortfalls
15. Performance Targets
16. References

Appendices include a glossary of terms, an example of a Ground Heat Exchanger Design Specification Table of Contents, and geoexchange source information.

Sections 1 through 9 provide background and context for appropriate and responsible design. Here you will find concepts of why an engineering approach provides value for geoexchange applications, along with the principal factors that affect design.

Sections 10 and 11 present the core concepts of geoexchange system design, including the sequence for proper design, required information, designing for large or small systems and the effects of unbalanced loads.

Sections 12 through 15 relate to quality, regulatory issues, common difficulties and performance and monitoring targets that can be identified at the design stage.

Although the reader can view the core design guidance in Sections 10 and 11, we strongly recommend that you read the entire Guideline to obtain a balanced, objective and thoughtful approach for good geoexchange design.

2.0 GEOEXCHANGE ENERGY SYSTEMS IN THE CONTEXT OF SUSTAINABLE BUILDING DESIGN

The objective of sustainable building design is to minimize the negative environmental impacts of a building. The most significant environmental impact of a building is usually due to ongoing energy consumption. Focus on the energy efficiency of a building and the mechanical system should be the top priority of any sustainable building design.

To obtain a truly energy efficient building, the design focus should be first placed on achieving synergies between the passive components of the building and the surrounding environment. Factors such as shape, orientation, envelope, and thermal mass must be designed to complement the local climate. Only then can the design focus shift to the