SKILLEDTRADES BC

PROGRAM OUTLINE

Geoexchange Driller

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GEOEXCHANGE DRILLER
PROGRAM OUTLINE

APPROVED BY INDUSTRY

[JUNE 2014]

Developed by
GeoExchange BC in association with the British Columbia Ground Water Association (BCGWA) and SkilledTradesBC

SKILLED TRADES BC

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Section 1

INTRODUCTION

Geoexchange Driller

Foreword

A Program Outline is an SkilledTradesBC Program Standards communication tool. It reflects the scope of knowledge and skills required to competently perform an occupation anywhere in BC.

All SkilledTradesBC assessment tools are designed to measure achievement of the competencies and learning tasks described by the Program Outline for an occupation.

The Program Outline informs industry, the public, employers and challengers of the occupation's requirements for certification, including:

- The program Credentialing Model
- General Areas of Competence (GACs) and specific competencies required by individuals to perform proficiently in this occupation
- Learning tasks and content that must be mastered in order for an individual to be deemed competent

SAFETY ADVISORY

Be advised that references to the WorkSafe BC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com). Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.

Acknowledgements

The Program Outline was prepared with the advice and direction of an industry Subject Matter Experts committee convened by GeoExchange BC in a coordinated effort with the British Columbia Ground Water Association (BCGWA). Members include:

- Mike Wei - Water Protection & Sustainability Branch, BC Ministry of Environment
- Lindsay Macfarlane - Water Protection & Sustainability Branch, BC Ministry of Environment

Industry Subject Matter Experts retained to assist in the development of Program Outline Content:

- Gord Horbay
- Jeff Quibell
- Ruben Arellano
- Scott Steward

Facilitators:

- Dan McFaull (North Pacific Training & Performance Inc.)
- Taruna Goel (North Pacific Training & Performance Inc.)
- Diane Evans – SkilledTradesBC

GeoExchange BC, in association with the British Columbia Ground Water Association (BCGWA) and SkilledTradesBC, would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Geoexchange Driller occupation.

How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

Section	Employers	Challengers
Program Credentialing Model	Understand the length and structure of the program	Understand challenger pathway to Certificate of Qualification
OAC	Understand the competencies that a challenger is expected to demonstrate in order to achieve certification	Understand the competencies they must demonstrate in order to challenge the program
TOS and Suggested Weighting for exam	Understand the relative weightings of various competencies of the occupation on which assessment is based	Understand the relative weightings of various competencies of the occupation on which assessment is based
Program Content	Identifies detailed program content and competencies	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels

Section 2

PROGRAM OVERVIEW

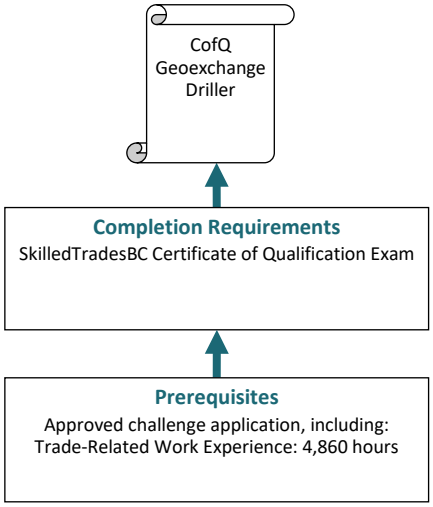
Geoexchange Driller

Program Credentialing Model

Challenge Pathway

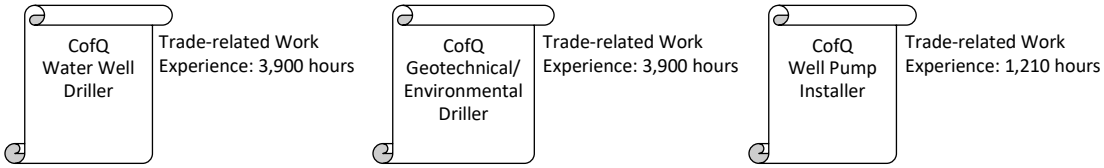
Geoexchange Driller

C of Q = Certificate of Qualification



CREDIT FOR PRIOR LEARNING

Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program



Occupational Analysis Chart

GEOEXCHANGE DRILLER

Occupation Description: A "Geoexchange Driller" refers to a person who sets up and operates mobile equipment used to drill *vertical closed-loop borehole heat exchangers* to provide a heat source/sink for geoexchange heating and cooling systems. These systems may be developed for residential, commercial, and industrial applications. They must have familiarity with the geological formations in the area they are working to enable selection of the most appropriate type of drilling technology. They must have knowledge related to borehole heat exchange principles and have an awareness of the advantages and drawbacks of different borehole completion designs. They must have knowledge of hydrogeological principles and be knowledgeable and skilled in practices important for protecting groundwater aquifers.

Industry Overview and Professional Work Practices **A**	Describe the scope of the trade in BC. A1	Describe the BC Certification System. A2	Describe professional work practices. A3		
Workplace Safety **B**	Describe common safety hazards associated with the trade. B1	Use safety equipment and procedures when dealing with hazards. B2	Use the WHMIS System to practice safe care and control of hazardous products. B3	Recognize and describe hazards to the environment associated with the trade. B4	Recognize and comply with WorkSafeBC Regulations. B5	Recognize and comply with BC Water Act and the BC Groundwater Protection Regulations. B6
	Work safely on drilling sites B7	Recognize and comply with road and traffic regulations. B8	State the safety considerations when dealing with gas encounters, utility clearances and sources of contamination. B9			
Drilling Methods **C**	Describe the different types of drilling methods applicable to the trade. C1	Use drilling methods as applicable to the trade. C2				

Geology **D**	Identify various rock types and the processes that form them. D1	Describe various soil types found in BC. D2	Use proper terminology to describe rock formations as it applies to the trade. D3	
Ground Water **E**	Describe the Hydrologic Cycle (Water Cycle). E1	Use proper terminology to describe ground water formations. E2	Describe different sources of water. E3	
Artesian Water Flow Prevention **F**	Describe the characteristics of artesian water flow. F1	Recognize and prepare for the likelihood of encountering artesian water flow. F2	Identify the potential hazards associated with artesian water flow. F3	Describe the measures to contain/close artesian water flow. F4
Maps and Other Information Sources **G**	Read and interpret maps that pertain to geology, hydrogeology and location. G1	Read and interpret BC Water Resources Atlas online GIS resource. G2	Seek information from the property owner. G3	

Vertical Closed Loop Borehole Heat Exchanger Construction and Installation **H**	Explain the principles of borehole heat exchanger performance. H1	Identify the different types of closed loop geoexchange boreholes. H2	Use specific methods for vertical closed loop geoexchange borehole construction. H3	Use specific methods for vertical closed loop geoexchange borehole pipe installation. H4	Describe the purpose of sealing, grouting and cementing boreholes. H5	Use different types and application of grout for vertical closed loop geoexchange borehole grouting. H6

Hydraulic Systems **I**	Explain the principles of operation and components of different types of hydraulic systems applicable to the trade. I1	Explain the importance of maintenance schedules and required system servicing. I2

Suggested Weighting for Exam

GEOEXCHANGE DRILLER

		Weighting %
Line A	**Industry Overview and Professional Work Practices**	**5%**
A1	Describe the scope of the trade in BC.	
A2	Describe the BC Certification System.	
A3	Describe professional work practices.	
Line B	**Workplace Safety**	**17%**
B1	Describe common safety hazards associated with the trade.	
B2	Use safety equipment and procedures when dealing with hazards.	
B3	Use the WHMIS System to practice safe care and control of hazardous products.	
B4	Recognize and describe hazards to the environment associated with the trade.	
B5	Recognize and comply with WorkSafeBC Regulations.	
B6	Recognize and comply with the BC Water Act and the BC Groundwater Protection Regulations.	
B7	Work safely on drilling sites.	
B8	Recognize and comply with road and traffic regulations.	
B9	State the safety considerations when dealing with gas encounters, utility clearances and sources of contamination.	
Line C	**Drilling Methods**	**9%**
C1	Describe the different types of drilling methods applicable to the trade.	
C2	Use drilling methods as applicable to the trade.	
Line D	**Geology**	**10%**
D1	Identify various rock types and the processes that form them.	
D2	Describe various soil types found in BC.	
D3	Use proper terminology to describe rock formations as it applies to the trade.	
Line E	**Ground Water**	**10%**
E1	Describe the Hydrologic Cycle (Water Cycle).	
E2	Use proper terminology to describe ground water formations.	
E3	Describe different sources of water.	
Line F	**Artesian Water Flow Prevention**	**15%**
F1	Describe the characteristics of artesian water flow.	
F2	Recognize and prepare for the likelihood of encountering artesian water flow.	
F3	Identify the potential hazards associated with artesian water flow.	
F4	Describe the measures to contain/close artesian water flow.	

		Weighting %
Line G	**Maps and Other Information Sources**	**9%**
G1	Read and interpret maps that pertain to geology, hydrogeology and location.	
G2	Read and interpret BC Water Atlas online GIS resource.	
G3	Seek information from the property owner.	
Line H	**Vertical Closed Loop Borehole Heat Exchanger Construction and Installation**	**20%**
H 1	Explain the principles of borehole heat exchanger performance.	
H 2	Identify the different types of closed loop geoexchange boreholes.	
H 3	Use specific methods for vertical closed loop geoexchange borehole construction.	
H 4	Use specific methods for vertical closed loop geoexchange borehole pipe installation.	
H 5	Describe the purpose of sealing, grouting and cementing boreholes.	
H 6	Use different types and application of grout for vertical closed loop geoexchange borehole grouting.	
Line I	**Hydraulic Systems**	**5%**
I1	Explain the principles of operation and components of different types of hydraulic systems applicable to the trade.	
I2	Explain the importance of maintenance schedules and required system servicing.	
	Total Percentage for Geoexchange Driller	**100%**

Section 3

PROGRAM CONTENT

Geoexchange Driller

Line (GAC): A INDUSTRY OVERVIEW AND PROFESSIONAL WORK PRACTICES

Competency: A1 Describe the scope of the trade in BC.

Objectives

To be competent in this area, the individual must be able to:

- Describe the scope of the trade as it applies to BC.
- Identify industry associations and whom they represent.

LEARNING TASKS	CONTENT
1. Describe the scope of the trade	• Role and responsibilities of a geoexchange driller
2. Identify industry associations	• British Columbia Ground Water Association (BCGWA)

Line (GAC): A INDUSTRY OVERVIEW AND PROFESSIONAL WORK PRACTICES

Competency: A2 Describe the BC Certification System.

Objectives

To be competent in this area, the individual must be able to state the certification process for the trade in BC.

LEARNING TASKS	CONTENT
1. Describe the requirements for certification	• Skills and qualities • Specific job knowledge • Work experience
2. Describe the challenge pathway and certification	• Certification process • Role of British Columbia Ground Water Association (BCGWA)
3. Describe registration process with the Government	• Registration process • Role of BC Government

Line (GAC): A INDUSTRY OVERVIEW AND PROFESSIONAL WORK PRACTICES

Competency: A3 Describe professional work practices.

Objectives

To be competent in this area, the individual must be able to:

- Recognize the need for record keeping.
- State the need for various records and reports and to whom they are distributed.

LEARNING TASKS	CONTENT

1. Recognize the need for record keeping	• Day sheets
	  ○ Drilling information
	  ○ Business information
	  ○ Borehole closure information

2. State the need for various records and reports for regulated borehole construction	• For the customer • For the Engineer-of-Record. • For the driller or company file
3. Understand environmental obligations in contracts	• What should be included in a contract (from the perspective of regulations) for example, regarding suspected sources of contamination, or if artesian groundwater conditions are encountered. • Verbal contract • Written contract

4. Follow professional standards and industry best practices for closing a borehole	• For permanent abandonment of boreholes, follow:
	  ○ Professional standards
	  ○ Industry best practices

Line (GAC): B WORKPLACE SAFETY

Competency: B1 Describe common safety hazards associated with the trade.

Objectives

To be competent in this area, the individual must be able to describe the types of personal hazards associated with the work assigned to a geoexchange driller.

LEARNING TASKS

1. Describe common personal safety hazards

CONTENT

- Electrical tools and systems hazards
- Lifting and hoisting equipment – fall, crane and overhead hazards, working from heights (e.g. up on the mast)
- Confined space hazards
- Hazards related to compressed gases
- Hazards related to welding
- Hazards related to tripping on pipes lines and debris
- Mud/soft ground hazards
- Pinch hazards
- Trench and excavation hazards
- Hazards when handling HDPE loop pipe and pressure-testing of HDPE loop pipe etc.

Line (GAC): B WORKPLACE SAFETY

Competency: B2 Use safety equipment and procedures when dealing with hazards.

Objectives

To be competent in this area, the individual must be able to identify and use safety equipment and procedures when dealing with hazards associated with being a geoexchange driller.

LEARNING TASKS	CONTENT

1. Identify and use safety equipment	• PPE
	  ○ Personal apparel
	  ○ Hand protection
	  ○ Leg and foot protection
	  ○ Headgear
	  ○ Eye protection
	  ○ Ear protection
	  ○ Lung protection
	• Use, inspect, maintain and store PPE

2. Identify and use safety procedures	• Use safety procedures guided by regulations that govern the drilling and construction of regulated boreholes.

Line (GAC): B WORKPLACE SAFETY

Competency: B3 Use the WHMIS System to practice safe care and control of hazardous products.

Objectives

To be competent in this area, the individual must be able to:

- Describe the purpose of the Workplace Hazardous Materials Information System (WHMIS).
- Explain the contents of Material Safety Data Sheets (MSDS).
- Use the WHMIS System.

LEARNING TASKS	CONTENT
1. State the purpose of WHMIS	• Appropriate labelling to ensure protection of workers • Recognition of rights
2. Describe the key elements of WHMIS	• Material Safety Data Sheets (MSDS). • Labelling of containers for hazardous materials
3. Describe the information disclosed in MSDS	• Hazardous ingredients • Preparation information • Product information • Physical data • Fire or explosion • Reactivity data • Toxicology properties • Preventive measures • First-aid measures
4. Identify symbols found on WHMIS labels and describe their meaning	• Compressed gases • Flammable and combustible materials • Oxidizing materials • Poisonous and infectious materials • Corrosive materials • Dangerously reactive materials
5 Use the WHMIS system	• Use, storage and disposal of hazardous materials

Line (GAC): B WORKPLACE SAFETY

Competency: B4 Recognize and describe hazards to the environment associated with the trade.

Objectives

To be competent in this area, the individual must be able to recognize and describe hazards to the environment associated with the trade.

LEARNING TASKS

1. Describe the hazards to the environment

CONTENT

- Contamination of ground water
  - Contaminants entering groundwater from surface along geoexchange boreholes
  - Contaminants migrating from one aquifer zone to another along geoexchange boreholes
- Depletion of aquifers from groundwater migrating along geoexchange boreholes
- Uncontrolled artesian flow
  - Environmental and property hazards
  - Aquifer depletion
- Hydraulic leaks and spills
- Inappropriate waste disposal
- Improper borehole drilling and construction procedures
- Infrastructure degradation (from unmanaged artesian flow perhaps)

Line (GAC): B WORKPLACE SAFETY

Competency: B5 Recognize and comply with WorkSafeBC Regulations.

Objectives

To be competent in this area, the individual must be able to recognize and comply with WorkSafeBC Regulations.

LEARNING TASKS	CONTENT
1. Interpret and comply with WorkSafeBC regulations as applicable to the trade	• Regulations • Standards • Guidelines

Line (GAC): B WORKPLACE SAFETY

Competency: B6 Recognize and comply with the BC Water Act and the BC Groundwater Protection Regulations.

Objectives

To be competent in this area, the individual must be able to recognize and comply with the BC Water Act and the BC Groundwater Protection Regulations.

LEARNING TASKS	CONTENT
1. Interpret and comply with the BC Water Act and the BC Groundwater Protection Regulations	• Regulations • Standards • Guidelines

Line (GAC): B WORKPLACE SAFETY

Competency: B7 Work safely on drilling sites.

Objectives

To be competent in this area, the individual must be able to work safely on drilling sites.

LEARNING TASKS

1. Work safely on the drilling sites

CONTENT

- Identify safety hazards related to the work site such as uneven terrain, traffic, energized overhead and underground lines etc.
- Follow safety procedures and regulations on the worksite
- Identify the importance of safety tailgate meetings
- Reporting and communication requirements:
  - Construction Manager (CM) site safety requirements
  - When to contact owner or CM
  - When to contact overseeing engineer
  - Other reasons for communication etc.

Line (GAC): B WORKPLACE SAFETY

Competency: B8 Recognize and comply with road and traffic regulations

Objectives

To be competent in this area, the individual must be able to recognize and comply with road and traffic regulations.

LEARNING TASKS	CONTENT
1. Recognize and comply with the BC Highway Traffic Act	• Regulations • Standards • Guidelines
2. Recognize and comply with municipal regulations that apply to the trade	• Road and traffic regulations • Other regulations such as: ○ Air quality
3. Recognize and comply with federal regulations that apply to the trade	• Road and traffic regulations

Line (GAC): B WORKPLACE SAFETY

Competency: B9 State the safety considerations when dealing with gas encounters, utility clearances and sources of contamination.

Objectives

To be competent in this area, the individual must be able to state the safety considerations when dealing gas encounters, utility clearances and sources of contamination.

LEARNING TASKS

1. State the safety considerations when dealing with gas encounters, utility clearances and sources of contamination

CONTENT

- Gas encounters and hazardous vapours such as:
  - Methane
  - Hydrogen Sulphide
  - Natural gas
- Underground and overhead utility clearances (locating utility services)
- Known or suspected sources of contamination
- Importance of safety when:
  - Testing the atmosphere
  - Venting the work area
- Ignition hazards (reducing)
- Safe egress

Line (GAC): C DRILLING METHODS

Competency: C1 Describe the different types of drilling methods applicable to the trade.

Objectives

To be competent in this area, the individual must be able to describe the different types of drilling methods applicable to the trade.

LEARNING TASKS	CONTENT
1. Describe High Air Volume Drilling system	• Terminology, application and environmental impact
2. Describe Mud Rotary drilling method	• Terminology, application and environmental impact
3. Describe Air Rotary drilling method	• Terminology, application and environmental impact
4. Describe Dual Rotary drilling method	• Terminology, application and environmental impact
5. Describe Air Hammer drilling method	• Terminology, application and environmental impact
6. Describe Vibra-Sonic drilling method	• Terminology, application and environmental impact
7. Describe Auger and Boring drilling method	• Terminology, application and environmental impact
8. Describe HDD drilling method	• Terminology, application and environmental impact

Line (GAC): C DRILLING METHODS

Competency: C2 Use drilling methods as applicable to the trade.

Objectives

To be competent in this area, the individual must be able to use drilling methods as applicable to the trade.

LEARNING TASKS	CONTENT
1. Use High Air Volume Drilling system	• Operational safety requirements of compressed air systems

2. Use Mud Rotary drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids
	• Principles of operation
	• Procedures

3. Use Air Rotary drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids/compressed air
	• Principles of operation
	• Procedures

4. Use Dual Rotary drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids
	• Principles of operation
	• Procedures

5. Use Air Hammer drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids/compressed air
	• Principles of operation
	• Procedures

6. Use Vibra-Sonic drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids
	• Principles of operation
	• Procedures

7. Use Auger and Boring drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids
	• Principles of operation
	• Procedures

LEARNING TASKS	CONTENT

8. Use HDD drilling method	• Components
	  ○ Drill bits
	  ○ Drilling fluids
	• Principles of operation
	• Procedures

Line (GAC): D GEOLOGY

Competency: D1 Identify various rock types and the processes that form them.

Objectives

To be competent in this area, the individual must be able to identify various rock types and the processes that form them.

LEARNING TASKS	CONTENT
1. Identify various rock types	• Igneous • Metamorphic • Sedimentary
2. Identify the processes that form various rock types	• Erosion • Volcanic • Ice • Heat • Pressure
3. Describe hydraulic properties of rocks	• Porosity • Permeability • Hydraulic properties • Types of aquifers • Transmissivity • Storativity • Hydraulic gradient

Line (GAC): D GEOLOGY

Competency: D2 Describe various soil types found in BC.

Objectives

To be competent in this area, the individual must be able to describe various soil types found in BC.

LEARNING TASKS	CONTENT
1. Identify various soil types and their characteristics	• Fluvial • Alluvial • Loams • Glacial (till and outwash) • Saturated and unsaturated • Unique BC soils with coarse gravels, cobbles and boulders and colluviums deposits which can be very challenging to drill

Line (GAC): D GEOLOGY

Competency: D3 Use proper terminology to describe rock formations as it applies to the trade.

Objectives

To be competent in this area, the individual must be able to use proper terminology to describe rock formations as it applies to the trade.

LEARNING TASKS	CONTENT
1. Use proper terminology to describe rock formations as it applies to the trade	• Sedimentary, igneous, metamorphic • Hardness (drilling resistance) • Competency (fractured or not) • Fractures (water saturated or not)

Line (GAC): E GROUND WATER

Competency: E1 Describe the Hydrologic Cycle (Water Cycle).

Objectives

To be competent in this area, the individual must be able to describe the Hydrologic Cycle (Water Cycle).

LEARNING TASKS

1. Describe the Hydrologic Cycle (Water Cycle)

CONTENT

- Terminology
  - Importance of precipitation
  - Infiltration
  - Transpiration
  - Evaporation
- The affect of weather and water movement on the water cycle

Line (GAC): E GROUND WATER

Competency: E2 Use proper terminology to describe ground water formations.

Objectives

To be competent in this area, the individual must be able to use proper terminology to describe ground water formations.

LEARNING TASKS

1. Use proper terminology to describe ground water formations

CONTENT

- Aquifer (saturated zone)
- Aquitard and aquiclude (confining beds)
- Porosity
- Occurrence and movement of ground water

Line (GAC): E GROUND WATER

Competency: E3 Describe different sources of water.

Objectives

To be competent in this area, the individual must be able to describe different sources of water.

LEARNING TASKS

1. Describe different sources of water

CONTENT

- Surface water
- Effects of surface water on the water table
- Ground water
  - Differences between 'artesian' and 'flowing artesian'
  - How to detect in the field, reporting in logs, and implications for later drilling from a lower elevation (i.e. in an excavation)
- GUDI (Ground Water Under the Direct Influence of Surface Water)

Line (GAC): F ARTESIAN WATER FLOW PREVENTION

Competency: F1 Describe the characteristics of artesian water flow.

Objectives

To be competent in this area, the individual must be able to describe the characteristics of artesian water flow.

LEARNING TASKS	CONTENT

1. Describe the characteristics of artesian water flow	• Occurrence (where are artesian conditions most likely to occur)
	• Pressures
	• Flows
	  ○ high head low flow
	  ○ low head high flow

Line (GAC): F ARTESIAN WATER FLOW PREVENTION

Competency: F2 Recognize and prepare for the likelihood of encountering artesian water flow.

Objectives

To be competent in this area, the individual must be able to recognize and prepare for the likelihood of encountering artesian water flow.

LEARNING TASKS

1. Recognize and prepare for the likelihood of encountering artesian water flow

CONTENT

- Perform a database review
  - BC Water Atlas online GIS System
- Do a site assessment
- Use a test hole (designed and installed)
- Use appropriate protocols such as cemented surface casing where likelihood of artesian flow is high
- Use appropriate sealing methods and to allow for artesian head to be contained
- Identify the limitations and capabilities in dealing with artesian water flow
- Develop and continuously maintain an Artesian Preparedness Plan

Line (GAC): F ARTESIAN WATER FLOW PREVENTION

Competency: F3 Identify the potential hazards associated with artesian water flow.

Objectives

To be competent in this area, the individual must be able to identify the potential hazards associated with artesian water flow.

LEARNING TASKS

1. Identify the potential hazards associated with artesian water flow

CONTENT

- Environmental risks
  - Contamination of surface water
  - Impact on the habitat of aquatic species
- Aquifer depletion
- Subsurface voids
- Flooding of the borehole site
- Property damage including slope failure and soil erosion
- Liabilities
- Personal hazards

Line (GAC): F ARTESIAN WATER FLOW PREVENTION

Competency: F4 Describe the measures to contain/close artesian water flow.

Objectives

To be competent in this area, the individual must be able to describe the measures to contain/close artesian water flow.

LEARNING TASKS

1. Describe the measures to contain/close artesian water flow

CONTENT

- Identify if flow control is practical or required
- Gather information for control strategy
- Flow is contained when:
  - It is conveyed through the production casing
  - It does not pose a risk to property, environmental damage or public safety
  - It can be indefinitely stopped without leakage
- Flow control by permanently sealing with grouts
- Determine the best material/method to stop flow:
  - Concrete-based grout
  - Bentonite mixtures
  - Barite weighting material
  - Chemical-based products (seldom used)
  - Considerations related to the quality of water used to create mixture *(the need for treating water)*
- Substantial flow may require capping and pressure grouting hole
- Extreme circumstance, BH loop may have to be abandoned to control flow
- Document all measurements, observations and procedures done to stop flow

Line (GAC): G MAPS AND OTHER INFORMATION SOURCES

Competency: G1 Read and interpret maps that pertain to geology, hydrogeology and location.

Objectives

To be competent in this area, the individual must be able to read and interpret maps that pertain to geology, hydrogeology and location.

LEARNING TASKS

1. Read and interpret maps that pertain to geology, hydrogeology and location

CONTENT

- Symbols and terminology
- Contours and topography
- Scales and measurements
- Lines and colors
- Slopes and gradients
- Spatial relationship
- Configuration of the land surface
- Other standard information available on maps

Line (GAC): G MAPS AND OTHER INFORMATION SOURCES

Competency: G2 Read and interpret BC Water Resources Atlas online GIS resource.

Objectives

To be competent in this area, the individual must be able to read and interpret BC Water Resources Atlas online GIS resource.

LEARNING TASKS	CONTENT
1. Describe the purpose of BC Water Resources Atlas	• Online GIS resource • Soil and bedrock related data • Groundwater information (including artesian information) • Query functionality • Available on Ministry of Environment website

2. Read and interpret BC Water Resources Atlas online GIS resource	• Interpret information about:
	  ○ Aquifer characteristics
	  ○ Aquifer classification
	  ○ Drinking water systems
	  ○ Water quantity and quality monitoring sites
	  ○ Water wells
	  ○ Lithologic logs for water wells
	  ○ Geology

Line (GAC): G MAPS AND OTHER INFORMATION SOURCES

Competency: G3 Seek information from the property owner.

Objectives

To be competent in this area, the individual must be able to seek information from the property owner.

LEARNING TASKS

1. Seek information from the property owner

CONTENT

- Information about the site and possible sources of contamination
- Available local borehole/well construction reports
- Information about the surrounding area for example, any history of flowing artesian wells in the area
- Location of existing underground and overhead services

Line (GAC): H VERTICAL CLOSED LOOP BOREHOLE HEAT EXCHANGER CONSTRUCTION AND INSTALLATION

Competency: H1 Explain the principles of borehole heat exchanger performance.

Objectives

To be competent in this area, the individual must be able to explain the principles of borehole heat exchanger performance.

LEARNING TASKS

1. Explain the principles of borehole heat exchanger performance

CONTENT

- Factors that affect the borehole performance:
  - Site setting
  - Geoexchange system configuration
  - Piping system balancing
- Role of grout in heat exchange
- Loop pipe size
- Multiple heat exchange loops in each borehole
- Bore resistivity
- Formation thermal conductivity

Line (GAC): H VERTICAL CLOSED LOOP BOREHOLE HEAT EXCHANGER CONSTRUCTION AND INSTALLATION

Competency: H2 Identify the different types of closed loop geoexchange boreholes.

Objectives

To be competent in this area, the individual must be able to identify the different types of closed loop geoexchange boreholes.

LEARNING TASKS

1. Identify the different types of closed loop geoexchange boreholes

CONTENT

- High-density polyethylene (HDPE) pipe
- Crosslinked Polyethylene (PEX) pipe
- Multiple loop boreholes
  - Advantages and disadvantages
- Direct Exchange (DX) using soft copper tubing

Line (GAC): H VERTICAL CLOSED LOOP BOREHOLE HEAT EXCHANGER CONSTRUCTION AND INSTALLATION

Competency: H3 Use specific methods for vertical closed loop geoexchange borehole construction.

Objectives

To be competent in this area, the individual must be able to use specific methods for vertical closed loop geoexchange borehole construction.

LEARNING TASKS

1. Use specific methods for vertical closed loop geoexchange borehole construction

CONTENT

- Consider the following factors:
  - Borehole/well construction requirements as per the Water Act
  - Equipment requirements
- Select drilling method based on geology and other site considerations
- Borehole wall stability
  - Casing systems
  - Mud systems
  - Specialized systems

Line (GAC): H VERTICAL CLOSED LOOP BOREHOLE HEAT EXCHANGER CONSTRUCTION AND INSTALLATION

Competency: H4 Use specific methods for vertical closed loop geoexchange borehole pipe installation.

Objectives

To be competent in this area, the individual must be able to use specific methods for vertical closed loop geoexchange borehole pipe installation.

LEARNING TASKS	CONTENT
1. Use specific methods for vertical closed loop geoexchange borehole pipe installation	• Maintain borehole stability to accommodate loop pipe insertion • Maintain borehole stability to accommodate tremie-line insertion • Pressure testing previous to the installation • Loop integrity testing post installation
2. Use specific methods for vertical closed loop geoexchange borehole and piping integrity	• Installation of casing during the installation of borehole to protect the borehole from collapsing • Isolation of different aquifers to prevent contamination • Installation of a cathodic protection system to protect the integrity of the copper piping for DX systems • Pressure and flow testing of closed loop geoexchange boreholes post installation • Repair of leaks or if leak is inaccessible, isolate that loop tube and plug it • If grout seal is compromised, re-grout to original level

Line (GAC): H VERTICAL CLOSED LOOP BOREHOLE HEAT EXCHANGER CONSTRUCTION AND INSTALLATION

Competency: H5 Describe the purpose of sealing, grouting and cementing boreholes.

Objectives

To be competent in this area, the individual must be able to describe the purpose of sealing, grouting and cementing boreholes.

LEARNING TASKS

1. Describe the purpose of sealing, grouting and cementing boreholes

CONTENT

- Prevent migration of water and/or contaminants along the borehole to avoid:
  - Contaminants entering groundwater from surface sources
  - Mixing of poor quality aquifer zones with good quality zones
  - Changes in groundwater flow patterns which can cause unwanted effects (such as aquifer depletion, high water tables, flooding, slope instability, etc.)
- Prevent contamination
- Protect the water bearing formation
- Seal off a formation that is suspected of contamination or produces poor quality water

Line (GAC): H VERTICAL CLOSED LOOP BOREHOLE HEAT EXCHANGER CONSTRUCTION AND INSTALLATION

Competency: H6 Use different types and application of grout for vertical closed loop geoexchange borehole grouting.

Objectives

To be competent in this area, the individual must be able to use different types and application of grout for vertical closed loop geoexchange borehole grouting.

LEARNING TASKS

1. Use different types and application of grout for closed loop geoexchange borehole grouting

CONTENT

- Types of grout depending on geological conditions:
  - Bentonite-based
  - Thermally-enhanced bentonite based
  - Cement-based
- Other sealants for special conditions
- Applications
  - Pressure grouting from bottom to top using tremie pipe
- Mixing and placement
  - Use of grout additives
  - Silica sand for enhanced thermal properties
- Heat transfer fluid types
- Grout subsidence after placement and the need for careful top up of grout after initial placement

Line (GAC): I HYDRAULIC SYSTEMS

Competency: I1 Explain the principles of operation and components of different types of hydraulic systems applicable to the trade.

Objectives

To be competent in this area, the individual must be able to explain the principles of operation of different types of hydraulic systems applicable to the trade.

LEARNING TASKS	CONTENT

1. Explain the principles of operation of different types of hydraulic systems applicable to the trade	• Hydraulic
	  ○ Schematic/layout
	  ○ Principles of operation
	• Electric over hydraulic
	  ○ Schematic/layout
	  ○ Principles of operation
	• Different PSI pressures
	  ○ Principles of operation

2. Describe the functions of the basic components of hydraulic systems	• Schematic diagrams and symbols for hydraulic components • Types of hydraulic fittings (JIC, Metric DIN, BSPP) • Hydraulic hoses • Hydraulic hose clamps • Hydraulic oil • Pumps • Motors • Cylinders • Valves • Plumbing/fixtures/hoses • Reservoirs • Filters • Heat exchangers • Clutches and brakes (hydraulic) • Electric controls • Fuels • Accumulator

Line (GAC): I HYDRAULIC SYSTEMS

Competency: I2 Explain the importance of maintenance schedules and required system servicing.

Objectives

To be competent in this area, the individual must be able to explain the importance of maintenance schedules and required system servicing.

LEARNING TASKS

1. Explain the importance of maintenance schedules and required system servicing

CONTENT

- Need for maintenance
- Required system servicing such as changing filters and fluids
- Exhaust smoke type and implications
- Daily inspection of cooling systems, coolant quality, fan belt condition, alternator and battery condition etc.
- Daily/weekly hose wear checks and cleaning
- Annual inspection by pulling the pumps to check splines etc. and oil change

Reference Materials

For reference material and resources please contact BC Ground Water Association.

Telephone:	604-530-8934	Fax:	604-530-8934
Toll Free (within BC):	1-855-530-8934	Email:	secretary@bcgwa.org
Website:	www.bcgwa.org		