Grades 9 to 12
Mining Engineering Technology

Manitoba Technical-Vocational
Curriculum Framework
of Outcomes

Manitoba

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Available in alternate formats upon request.

Contents

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Technical-Vocational Education Overview

In 2013, Manitoba Education released the document *Technical-Vocational Education Overview* (available online at www.edu.gov.mb.ca/k12/cur/teched/sy_tech_program.html) to provide the philosophical and pedagogical underpinnings for curriculum development and the teaching of courses in the Senior Years Technology Education Program.

This overview presents educators with the vision and goals of technical-vocational education (TVE) in Manitoba. Topics include the following:

- curriculum revitalization and renewal
- curriculum framework and implementation
- articulation
- assessment and reporting
- safety
- employability/essential skills and career development
- sustainable development

The TVE curriculum includes Grades 9 to 12 courses in a variety of areas, including mining engineering technology.

Mining Engineering Technology Overview

Introduction

Grades 9 to 12 Mining Engineering Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes identifies the goals, general learning outcomes (GLOs), and specific learning outcomes (SLOs) for nine mining engineering technology courses. This framework is intended for use in all Manitoba schools teaching Mining Engineering Technology as part of the Senior Years Technology Education Program.

Curriculum Description

Mining is one of the most important sectors in Manitoba's economy. Mining engineering technologists work in hard and soft rock mining and in both surface and underground operations here in Manitoba, across Canada, and around the world.

Mining Engineering Technology is an eight-credit high school technical-vocational program (with an additional optional credit in Grade 9) that provides students with the opportunity to learn about the mining industry. The program also teaches some of the knowledge, skills, and attitudes required to become a certified engineering technician. However, it is not a complete, certified mining engineering technology program.

Mining engineering technicians are part of an engineering team, involved in all aspects of mining from exploration, planning, development, and operation to mineral extraction and environmental control, surveying, ventilation, ground control, mine planning, and supervision. Mining engineering technicians need to be team players, good at problem solving, comfortable working with new technology, and committed to workplace safety. Mining companies regularly recruit graduates of mining engineering technology programs.

Teachers teaching these courses are encouraged to provide students with as many authentic experiences as possible by providing on-site, hands-on, field, and classroom experiences. Students will learn to apply scientific principles to basic mining engineering situations. They will build knowledge and skills in mine exploration, planning, design, blasting, processing, and ventilation. They will obtain a clear understanding of all aspects of a career in mining engineering technology and related vocations.

Students enrolled in the program will develop knowledge, skills, and attitudes in

- safety
- geology and geophysics
- computer applications in mining
- ground control
- mine hydrology
- environmental concerns pertaining to mining
- mine ventilation
- mining exploration and development
- ore processing and transportation
- project management
- surveying
- drafting

Career Opportunities in Mining

Students completing the Mining Engineering Technology program may receive advanced standing in a number of career paths that may or may not include apprenticeship programs or post-secondary education in university or college. Careers of interest to graduating students can include the following:

- mining engineering technology
- surveyors
- planners
- production supervisors
- assayers
- process operators
- metallurgical technicians
- exploration or mine geological technicians
- government mine inspectors
- mine tech (ventilation, ground control, environmental projects)
- sales and technical service representatives
- engineers

Delivery of the Mining Engineering Technology Subject Area

To receive a Senior Years Technical Education diploma, a student must complete eight departmentally developed courses from an approved technical-vocational cluster, together with 16 compulsory credits and six optional credits. The grade level in which the courses are offered is a local school-based decision, but it is highly recommended that the sequencing of credits follow the schedule set out at the end of this overview.

In most courses, the emphasis is on applied activities. For instructional purposes, the sequence of outcomes can vary based on the activities within the course. Teachers are advised to select the activities best suited to teach the outcomes, based on a variety of factors including access to resources or regional needs.

1. The curriculum is not sequential. In other words, outcomes might be taught in an order different from how they appear in the document.
2. In light of rapid changes in technology, teachers are encouraged to update their activities in order to meet the needs of students.

Trade Safety Awareness Manual

Apprenticeship Manitoba has developed a Trade Safety Awareness Unit, the purpose of which is to increase student awareness of trade safety in the workplace. All students, including those in high school, studying a designated trade must complete this seven-hour unit. The learning outcomes from the Trade Safety Awareness Unit have been incorporated into Goal 1 of this curriculum. For more information, and to access the Trade Safety Awareness Unit and its tests and other resources, please visit www.gov.mb.ca/tce/apprent/apprentice/trade_safety/. Though mining engineering technology is not a designated trade, the development team for this curriculum felt that students taking these courses would benefit greatly by completing the Trade Safety Awareness Unit.

The Trade Safety Awareness Unit's alphanumeric designations are located at the end of the framework learning outcomes. For example, the following SLO is found in Grade 10 Mining Engineering Technology: Explain the S.A.F.E. acronym. (TSA 6)

The (TSA 6) indicates that this outcome is taken from the Trade Safety Awareness Unit from Apprenticeship Manitoba.

Mining Engineering Technology (except for 9147) Goals, General Learning Outcomes (GLOs), and Specific Learning Outcomes (SLOs)

Grades 9 to 12 Mining Engineering Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes identifies specific learning outcomes (SLOs) for use in all Manitoba schools teaching Grades 9 to 12 Mining Engineering Technology as part of the Senior Years Technology Education Program. SLO statements define what students are expected to achieve by the end of a course.

It is essential for students to learn and to demonstrate safety practices and employability skills; therefore, some SLOs related to health and safety, as well as to employability skills, are repeated in several courses.

Please note that SLOs are not identified for the goals and GLOs that are not addressed in a given course.

Please note also that the goals and GLOs for *9147 Drafting for Mining Engineering 30S/30E/30M* are significantly different from the goals and GLOs for all other courses. Therefore, they are listed separately.

The learning outcomes for each course in the Mining Engineering Technology program (with the exception of 9147 Drafting for Mining Engineering 30S/30E/30M) were developed based on the following program goals and general learning outcomes:

Goal 1: Describe and apply appropriate **health and safety** practices.

GLO 1.1: Describe and apply appropriate **health and safety** practices.

GLO 1.2: Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**.

Goal 2: Demonstrate the identification, selection, use, and maintenance of **tools, equipment, materials, and consumables**.

GLO 2.1: Demonstrate the identification, selection, use, and maintenance of **tools, equipment, materials, and consumables**.

Goal 3: Demonstrate an understanding of the theories related to the **origins of the universe, solar system, and planet earth**.

GLO 3.1 Demonstrate an understanding of the theories related to origin of planet earth, particularly with respect to geology.

Goal 4: Demonstrate the ability to provide basic descriptions of the **layered structure of planet earth, the dynamic processes that affect it, and the evidence** that supports our current understanding.

GLO 4.1: Demonstrate the ability to provide basic descriptions of the **layered structure of the earth, the dynamic processes that affect it, and the evidence** that supports our current understanding.

Goal 5: Identify the environment that allows for the formation of **minerals** that are important to the mining sector, as well as the basic characteristics of those minerals.

GLO 5.1: Demonstrate a basic understanding of the formation of **minerals** and the ability to identify common minerals and their characteristics.

Goal 6: Demonstrate an understanding of the formation of **rocks** and how their formation is related to their characteristics and identification.

GLO 6.1: Demonstrate an understanding of the environment that allows for the formation of common **rocks**, and relate their characteristics to their identification.

Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting.

- **GLO 7.1:** Use various **surveying** techniques in land surveying.
- **GLO 7.2:** Use various surveying techniques in **hydrographic surveying.**
- **GLO 7.3:** Use various surveying techniques in **mine surveying.**

Goal 8: Demonstrate an understanding of **exploration, development,** and **production** of mineral resources from a position of environmental stewardship and sustainability.

- **GLO 8.1:** Demonstrate an understanding of common **exploration** techniques, with attention to the principles of **sustainable practices**.
- **GLO 8.2:** Demonstrate an understanding of mine **development** with an emphasis on **environmental responsibility**.
- **GLO 8.3:** Demonstrate an understanding of **mine production** and its place within the overall **life cycle** of a mine operation.

Goal 9: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**.

- **GLO 9.1:** Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**.

Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology.

- **GLO 10.1:** **Read, interpret, and communicate** information relevant to mining engineering technology.
- **GLO 10.2:** Apply the knowledge and skills from **mathematics** relevant to mining engineering technology.
- **GLO 10.3:** Apply the knowledge and skills from **the sciences** relevant to mining engineering technology.
- **GLO 10.4:** Apply the knowledge and skills from **information and communication technology (ICT)** relevant to mining engineering technology.
- **GLO 10.5:** Apply the knowledge and skills from **other subject areas** (physical education/health education) relevant to mining engineering technology.

Goal 11: Demonstrate an awareness of **sustainability principles** as they influence mining engineering technology.

- **GLO 11.1:** Describe the mining industry's **sustainability practices** and impact on the environment.
- **GLO 11.2:** Describe the impact of **human well-being as a sustainability priority** among those employed in the mining sector and the individuals and communities affected by mining practices.
- **GLO 11.3:** Describe **sustainable business practices** within the mining industry.

Goal 12: Demonstrate an awareness of the **ethical and legal standards** as they pertain to the mining industry.

GLO 12.1: Demonstrate an awareness of the **ethical and legal standards** that pertain to the mining industry.

Goal 13: Demonstrate fundamental **employability skills.**

GLO 13.1: Demonstrate **fundamental employability skills.**

GLO 13.2: Demonstrate an awareness of **cultural proficiency** and its importance in the workplace.

GLO 13.3: Demonstrate an understanding of the **business operation** of a mine complex.

GLO 13.4: Demonstrate **critical thinking skills.**

Goal 14: Demonstrate an understanding of the **mining industry**.

GLO 14.1: Demonstrate an understanding of the scope of the mining industry as it functions in Canada today in an international context.

GLO 14.2: Demonstrate an understanding of the **educational and career opportunities,** as well as **industry, professional, and trade associations**, related to mining engineering technology.

GLO 14.3: Demonstrate an understanding of **working conditions** in mining.

Goal 15: Demonstrate an awareness of the **evolution, technological progression, and emerging trends** in mining.

GLO 15.1: Describe the **history, technological progression,** and **emerging trends** in mining.

9147 Drafting for Mining Engineering 30S/30E/30M Goals, GLOs, and SLOs

The **learning outcomes for 9147 Drafting for Mining Engineering 30S/30E/30M** were developed based on the following program goals and general learning outcomes:

Goal 1: Solve problems using the **design process**.

GLO 1.1: Define design problems.

GLO 1.2: Research and analyze verbal and numeric **information** for design solutions.

GLO 1.3: Synthesize information and ideas to create design solutions.

Goal 2: Communicate design solutions.

GLO 2.1: Prepare **computer models** of design solutions.

GLO 2.2: Prepare working and presentation drawings and documents.

Goal 3: Use appropriate **materials and processes** of building/manufacturing.

GLO 3.1: Describe **materials** used in design solutions.

GLO 3.2: Demonstrate an awareness of construction and manufacturing processes.

Goal 4: Present design solutions.

GLO 4.1: Plan and organize presentations of design solutions.

GLO 4.2: Use presentation production methods.

GLO 4.3: Present/defend design solutions.

Goal 5: Describe and apply the common **tools and equipment** used in design drafting.

- **GLO 5.1:** Describe and use **drawing and modelling tools and equipment**.
- **GLO 5.2:** Describe and use **hardware and equipment**.
- **GLO 5.3:** Describe and use **software**.

Goal 6: Describe and apply transferable **cross-curricular knowledge and skills** that relate to design drafting.

- **GLO 6.1:** Describe and apply **mathematical concepts** as they relate to design drafting.
- **GLO 6.2:** **Read, interpret, and communicate** information.

Goal 7: Demonstrate an awareness of **sustainability** as it pertains to design drafting.

- **GLO 7.1:** Identify **environmental sustainability factors** that influence drafting design solutions in the mining industry.
- **GLO 7.2:** Describe the impact of architectural/ engineering design on **human health and well-being**.
- **GLO 7.3:** Demonstrate an awareness of the **economic impact** of sustainable practices in design drafting solutions for mining engineering technology.

Goal 8: Understand the **evolution** of design drafting, including its **technological progression and emerging trends**.

- **GLO 8.1:** Describe the **evolution of design drafting, including its technological progression and emerging trends**.

Goal 9: Follow the **ethical and legal standards** in design drafting.

- **GLO 9.1:** Demonstrate an awareness of legal standards in design drafting.
- **GLO 9.2:** Describe the **ethical expectations** of designers.

Goal 10: Demonstrate an awareness of **health and safety** requirements.

- **GLO 10.1:** Demonstrate an awareness of **health and safety** requirements.

Goal 11: Demonstrate **employability skills** required in design drafting.

- **GLO 11.1:** Demonstrate fundamental **employability skills**.

Goal 12: Describe **post-secondary** and **career opportunities** in design drafting.

- **GLO 12.1:** Describe **post-secondary and career opportunities** related to design drafting.

Course Descriptions

9145 Introduction to Mining Engineering 15S/15E/15M 10S/10E/10M

In this optional course, students are introduced to the mining industry and the role of the mining engineering technician. Students explore the following topics:

- mine safety
- the origins of the universe, solar system, and planet earth
- the structure of planet earth
- formation and classification of rocks
- surveying
- staking mineral rights claims
- surface and underground mining methods
- fundamental employability skills

9146 Mining Engineering Technology 20S/20E/20M

This course is a broad, introductory overview of mining, the mining industry, and mining engineering technology. Students are introduced to

- mine safety
- the origins of the universe, solar system, and planet earth
- the structure of planet earth
- formation and classification of rocks
- surveying
- exploration
- mine development and production
- mining industry's sustainability practices
- human sustainability for workers in the mining industry
- sustainable business practices
- ethical and legal standards
- mine engineering as a profession
- mining as an industry

9147 Drafting for Mining Engineering 30S/30E/30M

Drafting for Mining Engineering is an entry-level design drafting course intended for students wishing to explore drafting as it pertains to mining engineering technology. Curriculum content focuses on an introduction to design drafting, with an emphasis on its use in mines, mining structures, and mining equipment. Topics include the following:

- freehand sketching
- principles of design
- drafting standards
- materials and processes
- computer modelling
- architectural/engineering basics

Because these two courses have similar outcomes, students can hold credits for either this course **or** 8435 Design Drafting Essentials 1 20S/20E/20M, which is part of the Design

Drafting Technical-Vocational Subject Area (available online at www.edu.gov.mb.ca/k12/cur/teched/sytep/design_drafting/index.html). Students **cannot** hold credit for both 8435 and 9147.

9148 Geological Engineering 30S/30E/30M

This course is an introduction to geology, covering the Big Bang to the formation of minerals. Curriculum content focuses on introducing students to the study of the planets, earthquakes, geologic maps, and plate tectonics. This course covers the three rock groups, their chemical makeup, and how they are formed and change over time. Basic identification of minerals and rocks is a large part of this course, with a focus on hands-on practice. Topics include the following:

- theories of the origin and formation of the universe, solar system, and planet earth
- the structure of planet earth
- continental drift and plate tectonics
- the field of mineralogy and the role of mineralogists in mining
- definition of minerals and how they are formed
- identification of minerals based on physical and chemical makeup
- definition and formation of rocks (igneous, metamorphic, sedimentary)
- identification of rocks based on physical and chemical makeup

9149 Surveying for Mining Engineering 30S/30E/30M

This course focuses on surveying as it pertains to mining. Curriculum content focuses on introducing students to the principles of accuracy and precision in measuring distance and levelling. The course provides students with exposure and hands-on experience with operating surveying tools. Basic math skills (specifically trigonometry) are required. Topics include the following:

- identification, selection, use, and maintenance of tools and equipment
- using basic surveying instruments including surveying tape, Brunton compass, transit, and total station
- measurement units and the importance of precision
- various types of surveys and plotting plans based on data collected
- mapping ore bodies
- the use of ICT as it relates to surveying

9152 Advanced Geological Engineering 40S/40E/40M

This course will expand the knowledge and skills students acquired in 9148 Geological Engineering. It introduces students to the geologic processes that affect the deposition of minerals and rocks such as earthquakes, volcanoes, running water, ice, wind, and mass movement. The curriculum focuses on the methods of determining geological time scale in the context of paleontology and the three geological eras, the principles of structural geology as they

relate to mining, and more detailed identification of minerals and rocks. Topics include the following:

- principles of earth structures and structural geology
- detection and prediction of volcanic activity
- function and use of a Brunton compass
- processes in the formation of fossils
- geologic setting, events, and life forms present during the three geological eras
- geological time scale
- energy resources within planet earth
- environmental issues surrounding harvesting and use of energy resources
- history of people's use and methods of harvesting mineral resources
- identification of minerals and rocks in a field setting

9153 Mineral Processing 40S/40E/40M

This course focuses on the processing of minerals. The curriculum focuses on the milling process, including crushers, ball and rod mills, flotation cells, and furnaces. Students require basic chemistry and math skills. Topics include the following:

- all processes from detection, accessing, mining, and processing ore
- chemical makeup of ores
- chemical processes involved in milling processes
- calculations to determine tonnage of milling products
- comparing and contrasting metallic and non-metallic ore flotation
- calculate products of flotation processes
- chemical processes in fire and electro-refining metallic ores

9154 Advanced Surveying for Mining Engineering 40S/40E/40M

Students will expand the knowledge and skills acquired in 9149 Surveying for Mining Engineering. It provides students with exposure and hands-on operation of an engineer's transit and total surveying station. The curriculum focuses on field studies of land, highway, hydrographic, and mine surveying. Topics include the following:

- building, property, and site layout
- route surveying
- role of mine surveying in the mining process
- theory related to the operation of EDM (electronic surveying) equipment
- performing and plotting surveys both on land and underground
- use of the geographic information and global positioning systems
- interpretation of topographic information from aerial photos
- preparing cross-section maps from topographical maps and constructing topographical maps from field data

9155 Applied Mining Engineering 40S/40E/40M

This course provides students with the opportunity to synthesize and apply all of the knowledge, skills, and values they have learned in previous courses. The curriculum introduces detailed processes in mining, including development of mineshafts, ore extraction and hauling, ore processing, and future trends in mining. Students will learn the basic concepts of structures and loads and how they apply to the physical aspects of the mining process. Environmental impact is an important aspect of this course as are ethical practices as they relate to the environment and First Nations concerns. Topics include the following:

- civil engineering as a profession
- a study of the use and handling of explosives
- importance and implication of proper ground support
- engineering properties of common rock types
- defining the location of shafts for mine development
- activities involved in mine haulage
- methods used in mine ventilation and dewatering
- the principles of ore processing
- theoretical future mining methods
- environmental concerns as applied to mines and the mining industry
- the physics of structures used in mining activities including mathematical analysis to solve problems

Curriculum Implementation Dates

During **voluntary implementation**, teachers have the option of teaching the entire new draft curriculum as soon as Manitoba Education and Training releases it on the Technology Education website at www.edu.gov.mb.ca/k12/cur/teched/sy_tech_program.html.

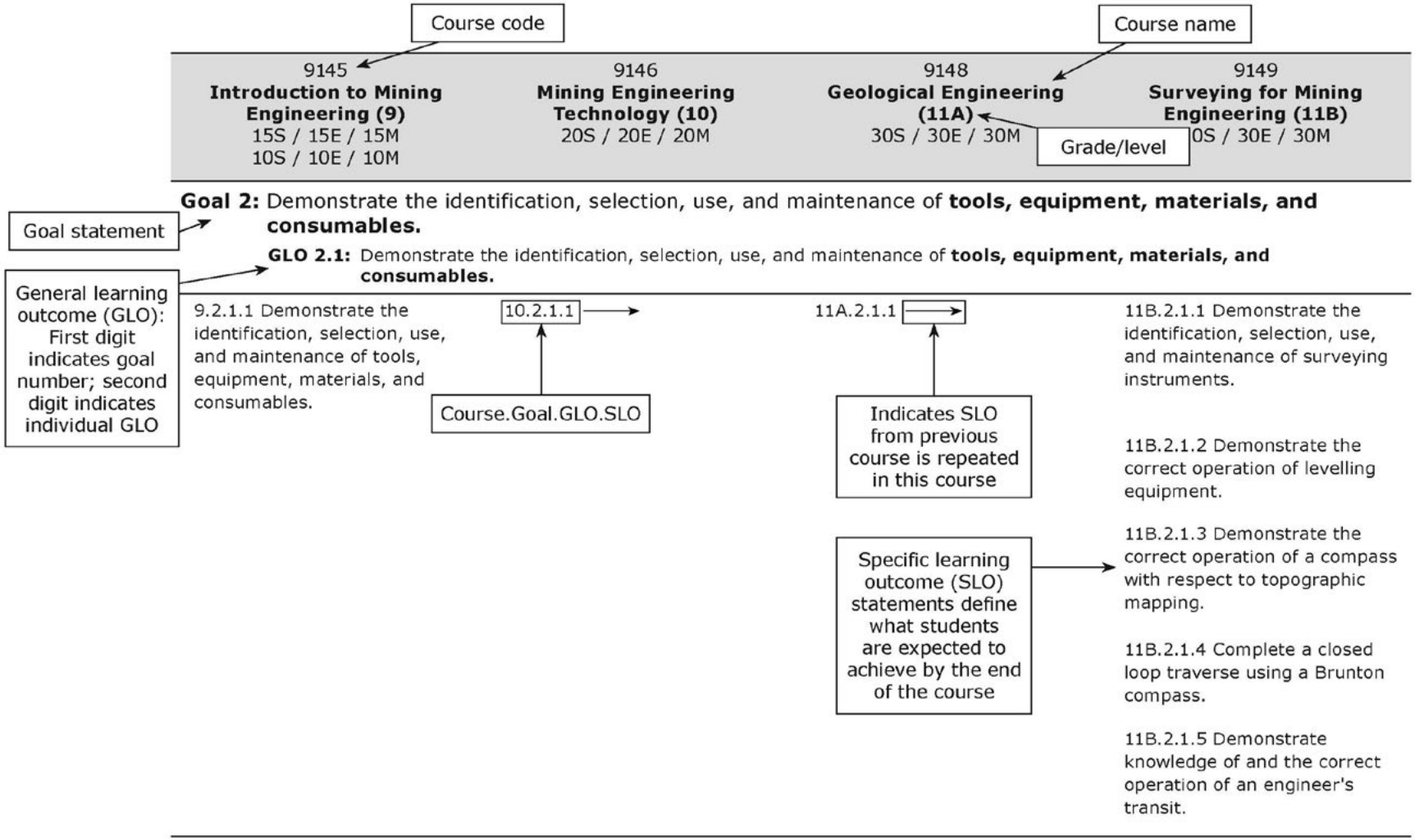
They also have the option of teaching the courses from the previous curriculum. Teachers who implement courses before system-wide implementation need to ensure that students who are already taking courses from the previous curriculum achieve all SLOs with a minimum of redundancy.

Voluntary implementation of all courses began in the fall of 2015 and will continue until their respective system-wide implementation dates.

Date	System-Wide Implementation
Fall 2016	Grade 9 (optional)
Fall 2017	Grade 10
Fall 2018	Grade 11
Fall 2019	Grade 12

Under **system-wide implementation**, all teachers in Manitoba teach the new curriculum and use the new course codes. Teachers will no longer be able to use the previous course codes. Course codes are found in the *Subject Table Handbook: Technology Education* at www.edu.gov.mb.ca/k12/docs/policy/sthte/index.html.

Guide to Reading Mining Engineering Technology Goals and Learning Outcomes



GRADES 9 TO 11
MINING ENGINEERING TECHNOLOGY

General and Specific Learning Outcomes by Goal

Grades 9 to 11 Mining Engineering Technology: General and Specific Learning Outcomes by Goal

Because **9147 Drafting for Mining Engineering 30S/30E/30M** contains different goals and GLOs from the other courses, it is in its own section of this document.

9145 **Introduction to Mining Engineering (9)** 15S / 15E / 15M 10S / 10E / 10M	9146 **Mining Engineering Technology (10)** 20S / 20E / 20M	9148 **Geological Engineering (11A)** 30S / 30E / 30M	9149 **Surveying for Mining Engineering (11B)** 30S / 30E / 30M
Goal 1: Describe and apply appropriate **health and safety** practices.			
GLO 1.1: Describe and apply appropriate **health and safety** practices.			
9.1.1.1 Demonstrate an understanding of hazards in the mining industry.	10.1.1.1 →	11A.1.1.1 →	11B.1.1.1 →
9.1.1.2 Discuss and demonstrate safe work practices.	10.1.1.2 →	11A.1.1.2 →	11B.1.1.2 →
9.1.1.3 Demonstrate an understanding of air quality hazards.	10.1.1.3 →	11A.1.1.3 →	11B.1.1.3 →
9.1.1.4 Discuss and demonstrate safe work practices related to air quality.	10.1.1.4 →	11A.1.1.4 →	11B.1.1.4 →
9.1.1.5 Create and maintain a safe and organized work environment.	10.1.1.5 →	11A.1.1.5 →	11B.1.1.5 →

9145 **Introduction to Mining Engineering (9)** 15S / 15E / 15M 10S / 10E / 10M	9146 **Mining Engineering Technology (10)** 20S / 20E / 20M	9148 **Geological Engineering (11A)** 30S / 30E / 30M	9149 **Surveying for Mining Engineering (11B)** 30S / 30E / 30M
Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)*			
GLO 1.1: Describe and apply appropriate **health and safety** practices. *(continued)*			
9.1.1.6 Discuss procedures for reporting hazards.	10.1.1.6 →	11A.1.1.6 →	11B.1.1.6 →
	10.1.1.7 Demonstrate knowledge of first aid/CPR.		11B.1.1.7 Discuss and demonstrate health and safety practices related to surveying.
GLO 1.2: Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**.			
	10.1.2.1 Explain the importance of trade safety and health in reducing injuries and fatalities to young employees in Manitoba. (TSA 1) 10.1.2.2 Describe the rights and responsibilities of employees, employers, and supervisors under the *Workplace Safety and Health Act*. (TSA 2) 10.1.2.3 Describe the steps to use in the Right to Refuse process. (TSA 3)		

9145 **Introduction to Mining Engineering (9)** 15S / 15E / 15M 10S / 10E / 10M	9146 **Mining Engineering Technology (10)** 20S / 20E / 20M	9148 **Geological Engineering (11A)** 30S / 30E / 30M	9149 **Surveying for Mining Engineering (11B)** 30S / 30E / 30M
Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)* **GLO 1.2:** Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**. *(continued)*			
	10.1.2.4 Explain how and where to find information on workplace safety and health. (TSA 4) 10.1.2.5 Demonstrate how to handle a potentially dangerous work situation. (TSA 5) 10.1.2.6 Explain the S.A.F.E. acronym. (TSA 6) 10.1.2.7 Define workplace safety and health hazards. (TSA 7) 10.1.2.8 Give examples of trade-specific workplace safety and health hazards. (TSA 8) 10.1.2.9 Give examples of five types of safety and health hazards. (TSA 9) 10.1.2.10 Define workplace safety and health risk. (TSA 10)		

9145 **Introduction to Mining Engineering (9)** 15S / 15E / 15M 10S / 10E / 10M	9146 **Mining Engineering Technology (10)** 20S / 20E / 20M	9148 **Geological Engineering (11A)** 30S / 30E / 30M	9149 **Surveying for Mining Engineering (11B)** 30S / 30E / 30M
Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)* **GLO 1.2:** Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**. *(continued)*			
	10.1.2.11 Give examples of trade-specific workplace safety and health risks. (TSA 11) 10.1.2.12 Explain the principles of hazard recognition and control as they apply to the specific trade. (TSA 12) 10.1.2.13 Explain the Workplace Hazardous Material Information System (WHMIS). (TSA 13) 10.1.2.14 Match the WHMIS hazardous materials symbols and their meanings. (TSA 14) 10.1.2.15 Describe the importance of the Material Safety Data Sheets (MSDS). (TSA 15) 10.1.2.16 Describe the importance of using personal protective equipment (PPE). (TSA 16)		

9145 **Introduction to Mining Engineering (9)** 15S / 15E / 15M 10S / 10E / 10M	9146 **Mining Engineering Technology (10)** 20S / 20E / 20M	9148 **Geological Engineering (11A)** 30S / 30E / 30M	9149 **Surveying for Mining Engineering (11B)** 30S / 30E / 30M
Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)* **GLO 1.2:** Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**. *(continued)*			
	10.1.2.17 Demonstrate proper selection and use of a variety of PPE and fall protection systems. (TSA 17) 10.1.2.18 Outline the safety principles for working on and around electrical equipment. (TSA 18) 10.1.2.19 Outline workplace fire safety principles. (TSA 19) 10.1.2.20 Identify the hazards in confined spaces and the preparation needed to work in a confined space. (TSA 20)		

9145 **Introduction to Mining Engineering (9)** 15S / 15E / 15M 10S / 10E / 10M	9146 **Mining Engineering Technology (10)** 20S / 20E / 20M	9148 **Geological Engineering (11A)** 30S / 30E / 30M	9149 **Surveying for Mining Engineering (11B)** 30S / 30E / 30M
Goal 2: Demonstrate the identification, selection, use, and maintenance of **tools, equipment, materials, and consumables.** **GLO 2.1:** Demonstrate the identification, selection, use, and maintenance of **tools, equipment, materials, and consumables.**			
9.2.1.1 Demonstrate the identification, selection, use, and maintenance of tools, equipment, materials, and consumables.	10.2.1.1 →	11A.2.1.1 →	11B.2.1.1 Demonstrate the identification, selection, use, and maintenance of surveying instruments. 11B.2.1.2 Demonstrate the correct operation of levelling equipment. 11B.2.1.3 Demonstrate the correct operation of a compass with respect to topographic mapping. 11B.2.1.4 Complete a closed loop traverse using a Brunton compass. 11B.2.1.5 Demonstrate knowledge of and the correct operation of an engineer's transit.

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Goal 3: Demonstrate an understanding of the theories related to the **origins of the universe, solar system, and planet earth.** **GLO 3.1:** Demonstrate an understanding of the theories related to the origins of planet earth, particularly with respect to geology.			
9.3.1.1 Demonstrate an awareness of the theories related to the origins of the universe, solar system, and planet earth.	10.3.1.1 Demonstrate an awareness of the theories related to the origins of the universe, solar system, and planet earth.	11A.3.1.1 Demonstrate an awareness of geology and the geosciences. 11A.3.1.2 Outline the main tenets of the Big Bang theory of the origin of the universe, and describe the available evidence that supports the theory (e.g., cosmic microwave background radiation). 11A.3.1.3 Demonstrate an understanding of the formation and life cycle of the sun, and relate this to the origin of the solar system.	

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Goal 4: Demonstrate the ability to provide basic descriptions of the **layered structure of planet earth, the dynamic processes that affect it, and the evidence** that supports our current understanding.			
GLO 4.1: Demonstrate the ability to provide basic descriptions of the **layered structure of the earth, the dynamic processes that affect it, and the evidence** that supports our current understanding.			
9.4.1.1 Illustrate by use of a diagram an understanding of the structure of planet earth.	10.4.1.1 Illustrate by use of a diagram an understanding of the structure of planet earth.	11A.4.1.1 Illustrate by use of a diagram an understanding of the structure of planet earth. 11A.4.1.2 Describe Alfred Wegener's main ideas in the early 20th century regarding continental drift, and then show evidence that supported the theory. 11A.4.1.3 Outline the major objections to continental drift theory by its opponents. 11A.4.1.4 Describe how the recent theory of plate tectonics explains continental drift. 11A.4.1.5 Describe with examples how plate tectonics explains phenomena such as earthquakes, volcanic activity, and the origin of mineral deposits.	

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Goal 5: Identify the environment that allows for the formation of **minerals** that are important to the mining sector, as well as the basic characteristics of those minerals.			
GLO 5.1: Demonstrate a basic understanding of the formation of **minerals**, and the ability to identify common minerals and their characteristics.			
		11A.5.1.1 Demonstrate an awareness of the formation of minerals.	
Goal 6: Demonstrate an understanding of the formation of **rocks** and how their formation is related to their characteristics and identification.			
GLO 6.1: Demonstrate an understanding of the environment that allows for the formation of common **rocks**, and relate their characteristics to their identification.			
9.6.1.1 Describe in basic terms the formation of igneous, metamorphic, and sedimentary rocks.	10.6.1.1 →	11A.6.1.1 Describe in a general way the formation of igneous rocks (both extrusive and intrusive), and demonstrate the ability to identify them in a field setting.	
9.6.1.2 Identify some igneous, metamorphic, and sedimentary rocks.	10.6.1.2 →	11A.6.1.2 Describe the formation of sedimentary rocks, and demonstrate the ability to identify them in a field setting. 11A.6.1.3 Identify common sedimentary rocks using physical and chemical properties.	

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Goal 6: Demonstrate an understanding of the formation of **rocks** and how their formation is related to their characteristics and identification. *(continued)* **GLO 6.1:** Demonstrate an understanding of the environment that allows for the formation of common **rocks**, and relate their characteristics to their identification. *(continued)*			
		11A.6.1.4 Describe the formation of metamorphic rocks, and demonstrate the ability to identify them in a field setting. 11A.6.1.5 Identify metamorphic rocks using physical and chemical properties. 11A.6.1.6 Identify common igneous rocks using physical and chemical properties, and demonstrate the ability to identify them in a field setting. 11A.6.1.7 Identify igneous rocks using physical and chemical properties.	

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting.			
GLO 7.1: Use various **surveying** techniques in land surveying.			
9.7.1.1 Demonstrate an awareness of surveying.	10.7.1.1 Demonstrate understanding of surveying.		11B.7.1.1 Describe the relationship between drafting and surveying.
9.7.1.2 Discuss the role of surveying in mining.	10.7.1.2 Discuss the role of surveying in mining engineering technology.		11B.7.1.2 Demonstrate an understanding of field procedures to determine and establish distance.
9.7.1.3 Measure, using the Pythagorean theorem, a large right-angle shape.	10.7.1.3 →		11B.7.1.3 Perform simple surveying operations using the tape alone.
9.7.1.4 Use a grid system to produce a contour plan of a given area.	10.7.1.4 →		11B.7.1.4 Demonstrate methods to avoid obstructions when chaining, using random lines, offsets, and triangles. 11B.7.1.5 Conduct and illustrate a pole and chain, and offset surveys. 11B.7.1.6 Conduct and illustrate a closed differential levelling survey.

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting. *(continued)* **GLO 7.1:** Use various **surveying** techniques in land surveying. *(continued)*			
			11B.7.1.7 Recognize the errors in levelling and how to manage them. 11B.7.1.8 Conduct a differential levelling survey in a tunnel. 11B.7.1.9 Use a grid system to produce a contour plan of a given area. 11B.7.1.10 Stake out a required contour line. 11B.7.1.11 Demonstrate knowledge of the principles and purposes of compass surveying. 11B.7.1.12 Demonstrate the procedures for computing survey traverse networks. 11B.7.1.13 Compute the bearings of survey traverse lines from angular observations.

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting. *(continued)*			
GLO 7.1: Use various **surveying** techniques in land surveying. *(continued)*			
			11B.7.1.14 Compute the angle to set off a known baseline to establish a required bearing. 11B.7.1.15 Compute an open traverse direct from field notes. 11B.7.1.16 Conduct a closed loop traverse.
GLO 7.2: Use various surveying techniques in **hydrographic surveying**.			
GLO 7.3: Use various surveying techniques in **mine surveying**.			
Goal 8: Demonstrate an understanding of **exploration, development,** and **production** of mineral resources from a position of environmental stewardship and sustainability.			
GLO 8.1: Demonstrate an understanding of common **exploration** techniques, with attention to the principles of **sustainable practices**.			
9.8.1.1 Demonstrate an awareness of mineral exploration.	10.8.1.1 Describe the exploration process with particular emphasis on impacts in sensitive natural areas.		

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Goal 8: Demonstrate an understanding of **exploration, development,** and **production** of mineral resources from a position of environmental stewardship and sustainability. *(continued)*			
GLO 8.1: Demonstrate an understanding of common **exploration** techniques, with attention to the principles of **sustainable practices**. *(continued)*			
9.8.1.2 Demonstrate an awareness of staking mining claims.	10.8.1.2 Explain the importance and demonstrate the use of geological maps in the exploration for economic minerals. 10.8.1.3 Demonstrate the ability to stake a mining claim. 10.8.1.4 Describe the methods and purposes for sampling an ore body. 10.8.1.5 Calculate the assay value of cores and sludges, as well as the tonnage in an ore-body sampled by drill holes, and estimate total deposit value.		
GLO 8.2: Demonstrate an understanding of mine **development** with an emphasis on **environmental responsibility**.			
9.8.2.1 Describe the various surface and underground mining methods.	10.8.2.1 ⟶ 10.8.2.2 Demonstrate an understanding of a mine layout.		

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Goal 8: Demonstrate an understanding of **exploration, development,** and **production** of mineral resources from a position of environmental stewardship and sustainability. *(continued)*			
GLO 8.2: Demonstrate an understanding of mine **development** with an emphasis on **environmental responsibility**. *(continued)*			
	10.8.2.3 Describe methods of mine development. 10.8.2.4 Describe major mining systems and the engineering implications for each.		
GLO 8.3: Demonstrate an understanding of **mine production** and its place within the overall **life cycle** of a mine operation.			
	10.8.3.1 Describe current methods of mine production, and assess their level of environmental responsibility (include a particular emphasis on reclamation planning).		
Goal 9: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**.			
GLO 9.1: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore.**			
		11A.9.1.1 Demonstrate an understanding of the processes used in accessing, recovering, transporting, and processing ore.	

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Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology.			
GLO 10.1: Read, interpret, and communicate information relevant to mining engineering technology.			
	10.10.1.1 Read, interpret, and communicate information.	11A.10.1.1 →	11B.10.1.1 Read, interpret, and communicate information found on drafting instruments.
GLO 10.2: Apply the knowledge and skills from **mathematics** relevant to mining engineering technology.			
	10.10.2.1 Demonstrate proficiency in the **mathematics** required in mining engineering technology.	11A.10.2.1 Demonstrate an understanding of using and calculating angles.	11B.10.2.1 Demonstrate an understanding of measurement units and the importance of precision in surveying.
		11A.10.2.2 Demonstrate proficiency in the use of fractions, decimals, ratios, percentages, and the conversion of metric (SI), standard or imperial measures.	11B.10.2.2 Demonstrate an understanding of the mathematics required in surveying.
			11B.10.2.3 Demonstrate proficiency in trigonometric functions.

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Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology. *(continued)*			
GLO 10.3: Apply the knowledge and skills from **the sciences** relevant to mining engineering technology.			
		11A.10.3.1 Demonstrate an understanding of geologic time scales.	11B.10.3.1 Demonstrate an understanding of expansion and contraction of materials when subjected to temperature change.
		11A.10.3.2 Demonstrate an understanding of basic chemistry as it pertains to the composition and structure of rocks and minerals.	
GLO 10.4: Apply the knowledge and skills from **information and communication technology** (ICT) relevant to mining engineering technology.			
	10.10.4.1 Demonstrate an awareness of the use of ICT in mining engineering technology.		11B.10.4.1 Demonstrate the use of ICT to conduct surveys and plot plans.

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Goal 11: Demonstrate an awareness of **sustainability principles** as they influence mining engineering technology.			
GLO 11.1: Describe the mining industry's **sustainability practices** and impact on the environment.			
9.11.1.1 Demonstrate an awareness of the mining industry's sustainability practices and impact on the environment.	10.11.1.1 Discuss the mining industry's sustainability practices and impact on the environment (with particular emphasis on reclamation planning).		
GLO 11.2: Describe the impact of **human well-being as a sustainability priority** among those employed in the mining sector and the individuals and communities affected by mining practices.			
	10.11.2.1 Describe human well-being from the position of sustainability practices. 10.11.2.2 Describe ergonomically appropriate procedures to avoid injury. 10.11.2.3 Discuss risk factors for hearing loss. 10.11.2.4 Discuss procedures to minimize hearing loss.	11A.11.2.1 Discuss long-term health hazards related to field geology.	11B.11.2.1 Discuss long-term health hazards related to field surveying.

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Goal 11: Demonstrate an awareness of **sustainability principles** as they influence mining engineering technology. *(continued)* **GLO 11.3:** Describe **sustainable business practices** within the mining industry.			
	10.11.3.1 Define, using examples or a case study, and discuss the concept of sustainable business practices.	11A.11.3.1 Discuss, using examples or a case study, business practices that promote the long-term viability of mines and mining complexes.	11B.11.3.1 Discuss, using a case study, the economic and social effects of mine closure on a community.
Goal 12: Demonstrate an awareness of the **ethical and legal standards** as they pertain to the mining industry. **GLO 12.1:** Demonstrate an awareness of the **ethical and legal standards** that pertain to the mining industry.			
	10.12.1.1 Explain the filing of exploration programs for staking mineral rights. 10.12.1.2 Describe the details of regulations that govern mines and mining.	11A.12.1.1 Discuss ethical considerations in the mining industry. 11A.12.1.2 Discuss the consequences of unethical behaviour.	11B.12.1.1 Discuss the ethical requirements related to surveying.

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Goal 13: Demonstrate fundamental **employability skills**. **GLO 13.1:** Demonstrate **fundamental employability skills**.			
9.13.1.1 Demonstrate regular and punctual attendance.	10.13.1.1 →	11A.13.1.1 →	11B.13.1.1 →
9.13.1.2 Demonstrate the ability to communicate respectfully and effectively with teachers, supervisors, co-workers, and students.	10.13.1.2 →	11A.13.1.2 →	11B.13.1.2 →
9.13.1.3 Demonstrate accountability by taking responsibility for their actions.	10.13.1.3 →	11A.13.1.3 →	11B.13.1.3 →
9.13.1.4 Demonstrate adaptability, initiative, and effort.	10.13.1.4 →	11A.13.1.4 →	11B.13.1.4 →
9.13.1.5 Demonstrate teamwork skills.	10.13.1.5 →	11A.13.1.5 →	11B.13.1.5 →
9.13.1.6 Demonstrate the ability to stay on task and effectively use time in class and work environments.	10.13.1.6 →	11A.13.1.6 →	11B.13.1.6 →
9.13.1.7 Demonstrate the responsible use of wireless communication devices.	10.13.1.7 →	11A.13.1.7 →	11B.13.1.7 →

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Goal 13: Demonstrate fundamental **employability skills**. *(continued)*			
GLO 13.2: Demonstrate an awareness of **cultural proficiency** and its importance in the workplace.			
GLO 13.3: Demonstrate an understanding of the **business operation** of a mine complex.			
	10.13.3.1 Discuss the requirements for mining complexes to generate profits in order to continue operating.		11B.13.3.1 Discuss the requirements for businesses to function efficiently in order to continue operating.
GLO 13.4: Demonstrate **critical thinking skills**.			
	10.13.4.1 Discuss the need for critical thinking.	11A.13.4.1 Analyze and synthesize information in order to identify rocks and minerals.	11B.13.4.1 Discuss the need for critical thinking skills required to conduct surveys and plot plans.
	10.13.4.2 Discuss the need for problem-solving skills.		11B.13.4.2 Discuss strategies that can be used to solve problems encountered while conducting surveys and plotting plans.

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Goal 14: Demonstrate an understanding of the **mining industry**.			
GLO 14.1: Demonstrate an understanding of the scope of the mining industry as it functions in Canada today in an international context.			
	10.14.1.1 Demonstrate an understanding of the scope of mining engineering technology.	11A.14.1.1 Describe the mining industry in Canada, with an emphasis on Manitoba. 11A.14.1.2 Discuss the place of mining in the Canadian economy.	
GLO 14.2: Demonstrate an understanding of the **educational and career opportunities,** as well as **industry, professional, and trade associations,** related to mining engineering technology.			
9.14.2.1 Demonstrate an awareness of the scope of careers and post-secondary opportunities in mining.	10.14.2.1 Demonstrate an understanding of the scope of careers in the mining industry.	11A.14.2.1 Describe the professions related to geology. 11A.14.2.2 Discuss the level of physical fitness required by field geologists.	11B.14.2.1 Discuss the level of physical fitness required by field surveyors.
GLO 14.3: Demonstrate an understanding of **working conditions** in mining.			
	10.14.3.1 Describe working conditions related to different occupations in the mining industry.	11A.14.3.1 Describe working conditions related to geology.	11B.14.3.1 Describe working conditions related to surveying.

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Goal 15: Demonstrate an awareness of the **evolution, technological progression,** and **emerging trends** in mining. **GLO 15.1:** Describe the **history, technological progression**, and **emerging trends** in mining.			
	10.15.1.1 Describe the historical development of mining.	11A.15.1.1 Describe the history, technological progression, and emerging trends in geological engineering technology.	11B.15.1.1 Describe the history, technological progression, and emerging trends in mining engineering technology surveying.

9147 Drafting for Mining Engineering (11) 30S/30E/30M

Course Description

Drafting for Mining Engineering is an entry-level drafting course that is intended for students wishing to explore drafting as it pertains to mining engineering technology. Curriculum content focuses on an introduction to design drafting, with an emphasis on its use in mines, mining structures, and mining equipment. Topics include the following:

- freehand sketching
- principles of design
- drafting standards
- materials and processes
- computer modelling
- architectural/engineering basics

The course includes an introduction to safety, employability skills, career development, sustainability, and new and emerging technologies in design drafting.

Cross-curricular learning outcomes, which include those in design drafting math, science, and the interpretation of technical documents, are to be integrated into the course.

For instructional purposes, the sequence of learning outcomes and the learning outcomes included in each unit of study can vary based on the projects within the course.

Because these two courses have similar outcomes, students can hold credits for either this course **or** 8435 Design Drafting Essentials 1 20S/20E/20M, which is part of the Design Drafting Technical-Vocational Subject Area (see www.edu.gov.mb.ca/k12/cur/teched/sytep/design_drafting/index.html). Students **cannot** hold credit for both 8435 and 9147.

Goal 1: Solve problems using the **design process**.

GLO 1.1: Define design problems.

SLO 1.1.1 Identify a structured model to solve basic problems.

SLO 1.1.2 Identify drafting design problems in mining engineering technology.

SLO 1.1.3 Use a structured model to solve architectural/engineering problems in mining engineering technology.

GLO 1.2: Research and analyze verbal and numeric **information** for design solutions.

SLO 1.2.1 Demonstrate an awareness of architectural design principles (e.g., work triangle, mining structures, circulation) in mining engineering technology.

SLO 1.2.2 Demonstrate an awareness of engineering design principles (e.g., physical properties, fits, mechanical principles) in mining engineering technology.

SLO 1.2.3 Identify factors (e.g., materials, cost, manufacturing processes) that influence design in mining engineering technology.

SLO 1.2.4 Discuss sustainability as it relates to design (e.g., materials used, social impact) in mining engineering technology.

SLO 1.2.5 Discuss universal design in mining engineering technology.

SLO 1.2.6 Demonstrate an awareness of aesthetic principles.

SLO 1.2.7 Identify common research methods used in design.

SLO 1.2.8 Follow architectural design principles (e.g., work triangle, circulation) for design solutions in mining engineering technology.

SLO 1.2.9 Follow engineering design principles (e.g., physical properties, fits, mechanical principles) in mining engineering technology.

SLO 1.2.10 Research information to solve design problems in mining engineering technology.

SLO 1.2.11 Include sustainable concepts in designs.

SLO 1.2.12 Include universal design in solutions.

SLO 1.2.13 Identify possible solutions for design problems in mining engineering technology.

GLO 1.3: Synthesize information and ideas to create design solutions.

SLO 1.3.1 Identify influences that can have an impact on the decision-making process for design solutions.

SLO 1.3.2 Identify techniques used for 2-D and isometric sketching.

SLO 1.3.3 Select design solutions based on provided criteria and related research.

SLO 1.3.4 Create freehand sketches to solve architectural and engineering design problems.

Goal 2: Communicate design solutions.

GLO 2.1: Prepare **computer models** of design solutions.

SLO 2.1.1 Identify the function of computer models (e.g., visualization, model to working drawing, assembly).

SLO 2.1.2 Define basic geometric construction principles (e.g., linear, angular, perpendicular, parallel, tangential).

SLO 2.1.3 Identify basic architectural components typically found in mines and mining structures.

SLO 2.1.4 Identify basic engineering features of parts (e.g., fillets, chamfers, holes).

SLO 2.1.5 Create basic architectural and engineering models of design solutions.

GLO 2.2: Prepare working and presentation drawings and documents.

SLO 2.2.1 Identify the differences between working and presentation drawings.

Layout

SLO 2.2.2 Identify components (e.g., title blocks, border, sheet sizes, sheet layout, architectural scales) of an architectural drawing.

SLO 2.2.3 Identify the components (e.g., title block information, border with zones, view arrangements, engineering scale) of an engineering drawing.

SLO 2.2.4 Identify architectural symbols (e.g., walls, doors, windows, built-ins, fixtures, stairs) for floor plans.

SLO 2.2.5 Identify basic engineering symbols (e.g., fillets, chamfers, holes) for orthographic projection drawings.

Line Work

SLO 2.2.6 Identify basic architectural line types (e.g., object, hidden, centre, construction, extension, dimension lines) and their intended uses (e.g., walls, doors, windows, built-ins, fixtures, stairs).

SLO 2.2.7 Identify basic engineering line types (e.g., object, hidden, centre, construction, extension, dimension, leader lines) and their intended uses (e.g., fillets, chamfers, holes).

GLO 2.2: Prepare working and presentation drawings and documents. *(continued)*

Dimensioning and Annotating

SLO 2.2.8 Identify dimensioning standards.

SLO 2.2.9 Identify the purpose of notes and annotations (e.g., about materials, processes, finishes) in architectural and engineering drawings.

Layout

SLO 2.2.10 Use the components (e.g., title blocks, border, sheet sizes, sheet layout, architectural scales) of an architectural drawing.

SLO 2.2.11 Use the components (e.g., title block information, border with zones, view arrangements, engineering scale) of an engineering drawing.

SLO 2.2.12 Create floor plans using architectural symbols (e.g., walls, doors, windows, built-ins, fixtures, stairs).

SLO 2.2.13 Create orthographic projection drawings using basic engineering symbols.

SLO 2.2.14 Apply basic geometric construction principles (e.g., linear, angular, perpendicular, parallel, tangential).

Line Work

SLO 2.2.15 Select and use basic line types for architectural and engineering applications.

Dimensioning and Annotating

SLO 2.2.16 Apply placement, styles, and rules of dimensioning following dimensioning standards.

SLO 2.2.17 Apply the placement, style, size of text, and leaders for notes and abbreviations following standards.

Goal 3: Use appropriate **materials and processes** of building/manufacturing.

GLO 3.1: Describe **materials** used in design solutions.

SLO 3.1.1 Describe the materials used in design solutions for typical mining engineering applications.

SLO 3.1.2 List materials used in design solutions for typical mining engineering applications.

SLO 3.1.3 Include materials notes in drawings.

GLO 3.2: Demonstrate an awareness of construction and manufacturing processes.

SLO 3.2.1 Demonstrate an awareness of construction and manufacturing processes as they pertain to design drafting for mining engineering.

Goal 4: Present design solutions.

GLO 4.1: Plan and organize presentations of design solutions.

SLO 4.1.1 Identify presentation methods (e.g., design briefs, sketches, drawings).

SLO 4.1.2 Identify the rationale for presentations in the design process.

SLO 4.1.3 Demonstrate presentation methods (e.g., oral, written, graphic, 3-D model).

GLO 4.2: Use presentation production methods.

SLO 4.2.1 Identify the elements (e.g., rationale, functionality, research) of a design brief.

SLO 4.2.2 Identify the function of 3-D models as presentation methods.

SLO 4.2.3 Create design briefs to support design solutions.

SLO 4.2.4 Create shaded 3-D computer models.

SLO 4.2.5 Create physical models.

GLO 4.3: Present/defend design solutions.

SLO 4.3.1 Identify elements (e.g., clarity, conciseness) of effective verbal communication.

SLO 4.3.2 Demonstrate an awareness of competitions related to design drafting.

SLO 4.3.3 Present design solutions to an audience (e.g., peer, teacher).

Goal 5: Describe and apply the common **tools and equipment** used in design drafting.

GLO 5.1: Describe and use **drawing and modelling tools and equipment**.

SLO 5.1.1 Demonstrate the use of sketching tools and media.

SLO 5.1.2 Demonstrate the use of physical modelling tools (e.g., scissors, knives, saws).

SLO 5.1.3 Demonstrate the use of measuring devices (e.g., rulers; tape measures; engineering, architectural, and metric scales; calipers).

SLO 5.1.4 Demonstrate the use of sketching tools and media.

SLO 5.1.5 Demonstrate the use of basic physical modelling tools (e.g., scissors, knives, saws, tape measures, calipers).

GLO 5.2: Describe and use **hardware and equipment**.

SLO 5.2.1 Operate common computer hardware (e.g., three-button mouse, printers, monitors).

GLO 5.3: Describe and use **software**.

SLO 5.3.1 Demonstrate the use of industry-standard architectural and engineering CADD software.

SLO 5.3.2 Manage and organize project files.

Goal 6: Describe and apply transferable **cross-curricular knowledge and skills** that relate to design drafting.

GLO 6.1: Describe and apply **mathematical concepts** as they relate to design drafting.

SLO 6.1.1 Demonstrate the understanding and application of metric and imperial/standard systems of measurement.

SLO 6.1.2 Add, subtract, multiply, and divide fractions, decimals, feet, and inches.

SLO 6.1.3 Demonstrate the understanding and application of symbols related to imperial measurement (e.g., 2'-3").

SLO 6.1.4 Demonstrate the understanding and application of equivalent forms of fractions (e.g., " = ", lowest common denominator).

SLO 6.1.5 Identify standard drafting scales (e.g., relationship between ratios and fractions).

SLO 6.1.6 Relate the Cartesian coordinate system to CADD.

SLO 6.1.7 Use ratios for scale drawing.

SLO 6.1.8 Extract architectural and engineering data using measuring devices (e.g., rulers, tape measures, scales, calipers).

SLO 6.1.9 Calculate the length and area of buildings and individual rooms.

SLO 6.1.10 Calculate distance, area, and volume.

GLO 6.2: Read, interpret, and communicate information.

SLO 6.2.1 Read, interpret, and communicate information as it pertains to design drafting for mining engineering.

Goal 7: Demonstrate an awareness of **sustainability** as it pertains to design drafting.

GLO 7.1: Identify **environmental sustainability factors** that influence drafting design solutions in the mining industry.

SLO 7.1.1 Identify environmental sustainability factors that influence drafting design solutions in the mining industry.

GLO 7.2: Describe the impact of architectural/engineering design on **human health and well-being**.

SLO 7.2.1 Describe the impact of architectural/engineering design on **human health and well-being.**

GLO 7.3: Demonstrate an awareness of the **economic impact** of sustainable practices in design drafting solutions for mining engineering technology.

SLO 7.3.1 Demonstrate an awareness of the economic impact of sustainable practices in design drafting solutions for mining engineering technology.

Goal 8: Understand the **evolution** of design drafting, including its **technological progression and emerging trends**.

GLO 8.1: Describe the **evolution** of design drafting, including its **technological progression** and **emerging trends**.

SLO 8.1.1 Demonstrate an appreciation of traditional design drafting tools, equipment, materials, and drawings.

SLO 8.1.2 Demonstrate an appreciation of the impact of developing trends and emerging technologies on design drafting.

Goal 9: Follow the **ethical and legal standards** in design drafting.

GLO 9.1: Demonstrate an awareness of legal standards in design drafting.

SLO 9.1.1 Demonstrate an understanding of building codes and their purpose.

SLO 9.1.2 Demonstrate an awareness of the fact that drawings are legal and contractual.

GLO 9.2: Describe the **ethical expectations** of designers.

SLO 9.2.1 Define ethics and their application.

SLO 9.2.2 Demonstrate an awareness of the ethical responsibilities of producing accurate design drafting documents.

Goal 10: Demonstrate an awareness of **health and safety** requirements.

GLO 10.1: Demonstrate an awareness of **health and safety** requirements.

SLO 10.1.1 Demonstrate an awareness of **health and safety** requirements.

Goal 11: Demonstrate **employability skills** required in design drafting.

GLO 11.1: Demonstrate fundamental **employability skills**.

SLO 11.1.1 Demonstrate regular and punctual attendance.

SLO 11.1.2 Demonstrate the ability to communicate respectfully and effectively with teachers, supervisors, co-workers, and students.

SLO 11.1.3 Demonstrate accountability by taking responsibility for their actions.

SLO 11.1.4 Demonstrate adaptability, initiative, and effort.

SLO 11.1.5 Demonstrate teamwork skills.

SLO 11.1.6 Demonstrate the ability to stay on task and effectively use time in class and work environments.

SLO 11.1.7 Demonstrate the responsible use of wireless communication devices.

Goal 12: Describe **post-secondary** and **career opportunities** in design drafting.

GLO 12.1: Describe **post-secondary** and **career opportunities** related to design drafting.

SLO 12.1.1 Identify secondary and post-secondary educational opportunities in design drafting.

SLO 12.1.2 Identify careers related to design drafting.

SLO 12.1.3 Collect samples for a design drafting portfolio.

GRADE 12
MINING ENGINEERING TECHNOLOGY

General and Specific Learning Outcomes by Goal

Grade 12 Mining Engineering Technology: General and Specific Learning Outcomes by Goal

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Goal 1: Describe and apply appropriate **health and safety** practices.			
GLO 1.1: Describe and apply appropriate **health and safety** practices.			
12A.1.1.1 Demonstrate an understanding of hazards found in the mining industry.	12B.1.1.1 →	12C.1.1.1 →	12D.1.1.1 →
12A.1.1.2 Discuss and demonstrate safe work practices.	12B.1.1.2 →	12C.1.1.2 →	12D.1.1.2 →
12A.1.1.3 Demonstrate an understanding of air quality hazards.	12B.1.1.3 →	12C.1.1.3 →	12D.1.1.3 →
12A.1.1.4 Discuss and demonstrate safe work practices related to air quality.	12B.1.1.4 →	12C.1.1.4 →	12D.1.1.4 →
12A.1.1.5 Create and maintain a safe and organized work environment.	12B.1.1.5 →	12C.1.1.5 →	12D.1.1.5 →
12A.1.1.6 Discuss procedures for reporting hazards.	12B.1.1.6 →	12C.1.1.6 →	12D.1.1.6 →

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Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)*			
GLO 1.1: Describe and apply appropriate **health and safety** practices. *(continued)*			
			12D.1.1.7 Explain the factors included in and the importance of mine maintenance. 12D.1.1.8 Demonstrate an understanding of the importance of mine rescue teams and their training.
GLO 1.2: Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**.			
12A.1.2.1 Explain the importance of trade safety and health in reducing injuries and fatalities to young employees in Manitoba. (TSA 1) 12A.1.2.2 Describe the rights and responsibilities of employees, employers, and supervisors under the *Workplace Safety and Health Act*. (TSA 2) 12A.1.2.3 Describe the steps to use in the Right to Refuse process. (TSA 3)			

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Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)* **GLO 1.2:** Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**. *(continued)*			
12A.1.2.4 Explain how and where to find information on workplace safety and health. (TSA 4) 12A.1.2.5 Demonstrate how to handle a potentially dangerous work situation. (TSA 5) 12A.1.2.6 Explain the S.A.F.E. acronym. (TSA 6) 12A.1.2.7 Define workplace safety and health hazards. (TSA 7) 12A.1.2.8 Give examples of trade-specific workplace safety and health hazards. (TSA 8) 12A.1.2.9 Give examples of five types of safety and health hazards. (TSA 9) 12A.1.2.10 Define workplace safety and health risk. (TSA 10)			

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Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)*			
GLO 1.2: Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**. *(continued)*			
12A.1.2.11 Give examples of trade-specific workplace safety and health risks. (TSA 11)			
12A.1.2.12 Explain the principles of hazard recognition and control as they apply to the specific trade. (TSA 12)			
12A.1.2.13 Explain the Workplace Hazardous Material Information System (WHMIS). (TSA 13)			
12A.1.2.14 Match the WHMIS hazardous materials symbols with their meanings. (TSA 14)			
12A.1.2.15 Describe the importance of the Material Safety Data Sheets (MSDS). (TSA 15)			
12A.1.2.16 Describe the importance of using personal protective equipment (PPE). (TSA 16)			

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Goal 1: Describe and apply appropriate **health and safety** practices. *(continued)* **GLO 1.2:** Demonstrate an awareness of safety as it pertains to the **Trade Safety Awareness Manual**. *(continued)*			
12A.1.2.17 Demonstrate proper selection and use of a variety of PPE and fall protection systems. (TSA 17) 12A.1.2.18 Outline the safety principles for working on and around electrical equipment. (TSA 18) 12A.1.2.19 Outline workplace fire safety principles. (TSA 19) 12A.1.2.20 Identify the hazards in confined spaces and the preparation needed to work in a confined space. (TSA 20)			

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Goal 2: Demonstrate the identification, selection, use, and maintenance of **tools, equipment, materials, and consumables.** **GLO 2.1:** Demonstrate the identification, selection, use, and maintenance of **tools, equipment, materials, and consumables.**			
12A.2.1.1 Demonstrate the identification, selection, use, and maintenance of tools, equipment, materials, and consumables.	12B.2.1.1 →	12C.2.1.1 → 12C.2.1.2 Demonstrate an understanding of the theory of operation of EDM equipment. 12C.2.1.3 Perform assigned field surveys using a GPS system.	12D.2.1.1 →
Goal 3: Demonstrate an understanding of the theories related to the **origins of the universe, solar system, and planet earth.** **GLO 3.1:** Demonstrate an understanding of the theories related to the origins of planet earth, particularly with respect to geology.			
12A.3.1.1 Demonstrate an understanding of the development of the geologic time scale, with particular reference to comparing and contrasting relative and absolute dating techniques.			

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Goal 3: Demonstrate an understanding of the theories related to the **origins of the universe, solar system, and planet earth.** *(continued)* **GLO 3.1:** Demonstrate an understanding of the theories related to the origins of planet earth, particularly with respect to geology. *(continued)*			
12A.3.1.2 Describe, in a general way, the geologic setting, events, and life forms present during the Paleozoic, Mesozoic, and Cenozoic eras. 12A.3.1.3 Demonstrate an understanding of the various processes in the formation of fossils and how certain index fossils are important to the exploration for economic resource deposits.			
Goal 4: Demonstrate the ability to provide basic descriptions of the **layered structure of planet earth, the dynamic processes that affect it, and the evidence** that supports our current understanding. **GLO 4.1:** Demonstrate the ability to provide basic descriptions of the **layered structure of planet earth, the dynamic processes that affect it, and the evidence** that supports our current understanding.			
12A.4.1.1 Describe the processes in the formation of volcanoes and earthquakes and their impact on our planet. 12A.4.1.2 Describe types of mass movement, how it occurs, and its impact on the environment.			

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Goal 4: Demonstrate the ability to provide basic descriptions of the **layered structure of planet earth, the dynamic processes that affect it, and the evidence** that supports our current understanding. *(continued)*			
GLO 4.1: Demonstrate the ability to provide basic descriptions of the **layered structure of planet earth, the dynamic processes that affect it, and the evidence** that supports our current understanding. *(continued)*			
12A.4.1.3 Demonstrate an understanding of the basic principles of structural geology (e.g., folds, faults, horst/ graben, anticline/syncline, and strike/dip). 12A.4.1.4 Demonstrate an understanding of the various hydrological processes that affect the formation of geological structures. 12A.4.1.5 Demonstrate an understanding of the formation and action of glaciers and their impact on geological structures. 12A.4.1.6 Demonstrate the use of a Brunton compass (or similar) to determine the strike and dip of sedimentary structures in an outcrop.			

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Goal 5: Identify the environment that allows for the formation of **minerals** that are important to the mining sector, as well as the basic characteristics of those minerals. **GLO 5.1:** Demonstrate a basic understanding of the formation of **minerals** and the ability to identify common minerals and their characteristics.			
12A.5.1.1 Identify, in a field setting, minerals based on physical and chemical properties, and on mode of occurrence.			
Goal 6: Demonstrate an understanding of the formation of **rocks** and how their formation is related to their characteristics and identification. **GLO 6.1:** Demonstrate an understanding of the environment that allows for the formation of common **rocks**, and relate their characteristics to their identification.			
12A.6.1.1 Identify common igneous rocks using physical and chemical properties in a field setting. 12A.6.1.2 Identify common sedimentary rocks using physical and chemical properties in a field setting. 12A.6.1.3 Identify common metamorphic rocks using physical and chemical properties in a field setting.			

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting.			
GLO 7.1: Use various **surveying** techniques in land surveying.			
		12C.7.1.1 Demonstrate an understanding of land surveying. 12C.7.1.2 Complete a property description. 12C.7.1.3 Perform building and site layout. 12C.7.1.4 Demonstrate an understanding of route surveying. 12C.7.1.5 Demonstrate the ability to lay out a curve by deflection angles. 12C.7.1.6 Prepare a route cross-section.	
GLO 7.2: Use various surveying techniques in **hydrographic surveying**.			
		12C.7.2.1 Demonstrate an understanding of hydrographic surveys and their function.	

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting. *(continued)*			
GLO 7.2: Use various surveying techniques in **hydrographic surveying**. *(continued)*			
		12C.7.2.2 Demonstrate an understanding of flood stages and the resulting stream changes.	
GLO 7.3: Use various surveying techniques in **mine surveying**.			
		12C.7.3.1 Demonstrate an understanding of the role of mine surveying. 12C.7.3.2 Explain mine surveying operations. 12C.7.3.3 Demonstrate an understanding of how to establish control points and benchmarks. 12C.7.3.4 Draw and update plans from toping operations. 12C.7.3.5 Perform and plot a closed loop survey using electronic methods. 12C.7.3.6 Perform and plot a closed loop survey involving triangulation.	

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting. *(continued)* **GLO 7.3:** Use various surveying techniques in **mine surveying**. *(continued)*			
		12C.7.3.7 Perform and plot an open survey in a trilateration system. 12C.7.3.8 Locate points by intersection and resection. 12C.7.3.9 Perform a re-survey to establish existing points. 12C.7.3.10 Demonstrate an understanding of the function of Geographic Information Systems (GIS). 12C.7.3.11 Demonstrate an understanding of the role of the Global Positioning System (GPS) in current surveying techniques. 12C.7.3.12 Demonstrate an understanding of the acquisition, processing, and use of aerial photographs.	

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Goal 7: Use various **surveying** techniques to describe and map potential ore bodies in a field setting. *(continued)* **GLO 7.3:** Use various surveying techniques in **mine surveying**. *(continued)*			
		12C.7.3.13 Demonstrate the ability to interpret topographic information from aerial photos using stereoscopy. 12C.7.3.14 Demonstrate an understanding of the function of topographic mapping. 12C.7.3.15 Prepare cross-section maps from topographical maps. 12C.7.3.16 Construct a topographical map from field data.	
Goal 8: Demonstrate an understanding of **exploration, development,** and **production** of mineral resources from a position of environmental stewardship and sustainability. **GLO 8.1:** Demonstrate an understanding of common **exploration** techniques, with attention to the principles of **sustainable practices**.			
12A.8.1.1 Describe the various methods by which mining engineers find and identify mineral deposits.			

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Goal 8: Demonstrate an understanding of **exploration, development,** and **production** of mineral resources from a position of environmental stewardship and sustainability. *(continued)*			
GLO 8.2: Demonstrate an understanding of mine **development** with an emphasis on **environmental responsibility**.			
12A.8.2.1 Describe the various types of and methods for recovery of energy resources from earth.			12D.8.2.1 Describe the methods of mine development.
12A.8.2.3 Describe the various methods by which humans access mineral deposits.			12D.8.2.2 Describe the importance and implications of proper ground support. 12D.8.2.3 Describe the engineering properties of common rock types and how this affects decisions on mining methods.
GLO 8.3: Demonstrate an understanding of **mine production** and its place within the overall **life cycle** of a mine operation.			
12A.8.3.1 Describe the various methods by which humans harvest mineral deposits.			12D.8.3.1 Describe the methods of mine production. 12D.8.3.2 Describe the principles defining methods used in mine ventilation. 12D.8.3.3 Describe the principles of dewatering.

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Goal 9: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**. **GLO 9.1:** Demonstrate an understanding of the processes used in **accessing, recovering, transporting and processing ore.**			
	12B.9.1.1 Operationally define mineral processing, and describe the principal branches of mineral processing. 12B.9.1.2 Describe, by way of example, the process of obtaining concentrate from ore and the separation of tailings. 12B.9.1.3 Define relevant terms in milling, and make the necessary tonnage calculations of mill products. 12B.9.1.4 Describe the various steps in the proper sequences that take place in a typical milling plant. 12B.9.1.5 Describe in detail the entire comminution process.		12D.9.1.1 Demonstrate an understanding of the geologic characteristics determining the location and types of shafts for a mine development. 12D.9.1.2 Demonstrate an understanding of the different types of activities involved in mine haulage.

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Goal 9: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**. *(continued)*

GLO 9.1: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore.** *(continued)*

	12B.9.1.6 Describe grinding circuit and circulate load calculations. 12B.9.1.7 Define and explain the purpose and importance of sampling and the usefulness of representative sampling. 12B.9.1.8 Demonstrate an understanding of the flotation process through simple diagrams of flotation cells and flotation circuits. 12B.9.1.9 Name and describe the function of reagents used in the flotation process. 12B.9.1.10 Describe different concentrates obtained from a typical Cu-Ni sulfide ore.		

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Goal 9: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**. *(continued)*

GLO 9.1: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore.** *(continued)*

	12B.9.1.11 Explain the specifications for different concentrates that are to be obtained from lead-zinc-copper (Pb-Zn-Cu) ore. 12B.9.1.12 Describe the differences between metallic and non-metallic ore flotation. 12B.9.1.13 Describe different types of gold ores common to Canadian situations and the processes that are applied to extract them. 12B.9.1.14 Describe in detail a typical pyrometallurgical process including the chemical reactions involved. 12B.9.1.15 Describe the steps involved in the hydrometallurgical process of leaching uranium ore(s).		

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Goal 9: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore**. *(continued)*			
GLO 9.1: Demonstrate an understanding of the processes used in **accessing, recovering, transporting, and processing ore.** *(continued)*			
	12B.9.1.16 Describe how fire-refining and electro-refining are carried out. 12B.9.1.17 Explain how vapo-metallurgy is carried out, including the principal chemical reactions involved.		
Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology.			
GLO 10.1: Read, interpret, and communicate information relevant to mining engineering technology.			
12A.10.1.1 Read, interpret, and communicate information relevant to mining engineering technology.	12B.10.1.1 →	12C.10.1.1 →	12D.10.1.1 →

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Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology. *(continued)* **GLO 10.2:** Apply the knowledge and skills from **mathematics** relevant to mining engineering technology.			
	12B.10.2.1 Define relevant terms in milling, and make calculations necessary in calculating tonnages of mill products.	12C.10.2.1 Perform volume calculations in secured and unsecured areas.	12D.10.2.1 Demonstrate an understanding of structural loads, and apply mathematical resolution to simple problems associated with load.
	12B.10.2.2 Calculate the mineral processing costs from data given with and without mineral dressing operation.	12C.10.2.2 Calculate areas of cross-sections and volumes of earthwork.	12D.10.2.2 Explain stress and strain qualitatively, and apply mathematical analysis only to solve basic problems involved in load distribution.
	12B.10.2.3 Calculate various products in the flotation process.		12D.10.2.3 Demonstrate a working knowledge of the function of beams and columns, as well as the forces that are applied to them, and apply mathematical methods to solve problems associated with them.

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Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology. *(continued)* **GLO 10.3:** Apply the knowledge and skills from **the sciences** relevant to mining engineering technology.			
	12B.10.3.1 Name important ore minerals (restricted to two-element complex ionic compounds) and write chemical formulas for them (e.g., $Fe_2(SO_4)_3$).		12D.10.3.1 Define and describe qualitatively moment and structural equilibrium.
	12B.10.3.2 Name the physical properties of minerals that are helpful in mineral separation.		12D.10.3.2 Describe the elements and apply methods of coplanar force resolution. 12D.10.3.3 Explain qualitatively the purpose of free body diagrams (FBD), and draw a FBD with labelled force vectors. 12D.10.3.4 Describe couples and the form and function of supports. 12D.10.3.5 Perform analyses of members. 12D.10.3.6 Describe the historical context leading to the use of trusses in construction, and analyze different types of trusses.

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Goal 10: Describe and demonstrate the transferable **cross-curricular** knowledge and skills relevant to mining engineering technology. *(continued)*			
GLO 10.4: Apply the knowledge and skills from **information and communication technology** (ICT) relevant to mining engineering technology.			
Goal 11: Demonstrate an awareness of **sustainability principles** as they influence mining engineering technology.			
GLO 11.1: Describe the mining industry's **sustainability practices** and impact on the environment.			
12A.11.1.1 Discuss negative issues with the harvesting, transportation, and use of various energy resources.			12D.11.1.1 Describe the potential of future mining methods that are grounded in the principles of sustainability and feature "cradle-to-grave" visioning. 12D.11.1.2 Discuss the importance of environmental concerns as applied to mines and the mining industry.
GLO 11.2: Describe the impact of **human well-being as a sustainability priority** among those employed in the mining sector and the individuals and communities affected by mining practices.			
			12D.11.2.1 Discuss, using a case study, the economic and social effects of mine closure on a community.

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Goal 11: Demonstrate an awareness of **sustainability principles** as they influence mining engineering technology. *(continued)* **GLO 11.3:** Describe **sustainable business practices** within the mining industry.			
12A.11.3.1 Define and discuss the concept of sustainable business practices.			12D.11.3.1 Discuss, using examples or a case study, business practices that promote the long-term viability of mines and mining complexes.
Goal 12: Demonstrate an awareness of the **ethical and legal standards** as they pertain to the mining industry. **GLO 12.1:** Demonstrate an awareness of the **ethical and legal standards** that pertain to the mining industry.			
			12D.12.1.1 Demonstrate an awareness of the ethical and legal standards as they pertain to the mining industry.
Goal 13: Demonstrate fundamental **employability skills**. **GLO 13.1:** Demonstrate **fundamental employability skills**.			
12A.13.1.1 Demonstrate regular and punctual attendance.	12B.13.1.1 →	12C.13.1.1 →	12D.13.1.1 →
12A.13.1.2 Demonstrate the ability to communicate respectfully and effectively with teachers, supervisors, co-workers, and students.	12B.13.1.2 →	12C.13.1.2 →	12D.13.1.2 →

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Goal 13: Demonstrate fundamental **employability skills**. *(continued)* **GLO 13.1:** Demonstrate **fundamental employability skills**. *(continued)*			
12A.13.1.3 Demonstrate accountability by taking responsibility for their actions.	12B.13.1.3 →	12C.13.1.3 →	12D.13.1.3 →
12A.13.1.4 Demonstrate adaptability, initiative, and effort.	12B.13.1.4 →	12C.13.1.4 →	12D.13.1.4 →
12A.13.1.5 Demonstrate teamwork skills.	12B.13.1.5 →	12C.13.1.5 →	12D.13.1.5 →
12A.13.1.6 Demonstrate the ability to stay on task and effectively use time in class and work environments.	12B.13.1.6 →	12C.13.1.6 →	12D.13.1.6 →
12A.13.1.7 Demonstrate the responsible use of wireless communication devices.	12B.13.1.7 →	12C.13.1.7 →	12D.13.1.7 →
GLO 13.2: Demonstrate an awareness of **cultural proficiency** and its importance in the workplace.			
	12B.13.2.1 Demonstrate an awareness of culture.	12C.13.2.1 Discuss different ways of knowing found within cultures, including the view that rocks can be animate.	12D.13.2.1 Discuss the diversity of cultures in society.

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Goal 13: Demonstrate fundamental **employability skills**. *(continued)*			
GLO 13.2: Demonstrate an awareness of **cultural proficiency** and its importance in the workplace. *(continued)*			
		12C.13.2.2 Discuss how people's culture affects their values and behaviour.	12D.13.2.2 Demonstrate an understanding of the importance of consultation with local cultures in all aspects of the mining process.
GLO 13.3: Demonstrate an understanding of the **business operation** of a mine complex.			
			12D.13.3.3 Demonstrate an understanding of the business operation of a mine complex.
GLO 13.4: Demonstrate **critical thinking skills**.			
12A.13.4.1 Discuss the need for critical thinking.	12B.13.4.1 →	12C.13.4.1 →	12D.13.4.1 →
12A.13.4.2 Discuss the need for problem-solving skills.	12B.13.4.2 →	12C.13.4.2 →	12D.13.4.2 →
Goal 14: Demonstrate an understanding of the **mining industry**.			
GLO 14.1: Demonstrate an understanding of the scope of the mining industry as it functions in Canada today in an international context.			
12A.14.1.1 Demonstrate an understanding of the mining industry as it pertains to geology.		12C.14.1.1 Demonstrate an understanding of the mining industry as it pertains to surveying.	12D.14.1.1 Demonstrate an understanding of the mining industry as it pertains to the field of mining engineering.

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Goal 14: Demonstrate an understanding of the **mining industry**. *(continued)*			
GLO 14.2: Demonstrate an understanding of the **educational and career opportunities,** as well as **industry, professional, and trade associations,** related to mining engineering technology.			
12A.14.2.1 Describe geological engineering as a profession.	12B.14.2.1 Describe chemical engineering as a profession.	12C.14.2.1 Describe surveying as a profession.	12D.14.2.1 Describe mining engineering as a profession. 12D.14.2.2 Describe civil engineering as a profession. 12D.14.2.3 Demonstrate an understanding of educational and career opportunities involving mining engineering technology in Canada.
GLO 14.3: Demonstrate an understanding of **working conditions** in mining.			
12A.14.3.1 Demonstrate an understanding of the physical demands involved in field geology.	12B.14.3.1 Demonstrate an understanding of the physical demands and possible dangers involved in process engineering.	12C.14.3.1 Demonstrate an understanding of the physical demands involved in surveying.	12D.14.3.1 Demonstrate an understanding of the physical demands and possible dangers involved in mining engineering.

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Goal 15: Demonstrate an awareness of the **evolution, technological progression,** and **emerging trends** in mining.			
GLO 15.1: Describe the **history, technological progression**, and **emerging trends** in mining.			
	12B.15.1.1 Describe the history, technological progression, and emerging trends in mining process engineering.	12C.15.1.1 Describe the history, technological progression, and emerging trends in surveying in mining contexts.	12D.15.1.1 Describe the history, technological progression, and emerging trends in mining.

BIBLIOGRAPHY

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Human Resources and Skills Development Canada. *National Occupational Classification 2011*. Ottawa, ON: Human Resources and Skills Development Canada, 2011. Available online at http://www5.hrsdc.gc.ca/NOC (date accessed 06/1/2016)

Mining Industry Human Resources Council. *Explore for More*. Kanata, ON: Government of Canada, 2016. Available online at www.acareerinmining.ca/ (date accessed 06/1/2016)

Marshak, Stephen. *Earth: Portrait of a Planet, 4th edition*. New York, NY: W.W. Norton & Co., 2012.

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