

National Exams December 2018

**09-MMP-A6, Mining and the Environment**

3 hours duration

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.  
Any non-communicating calculator is permitted.
3. Any FIVE (5) of the six questions constitutes a complete exam paper. The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions do not require an answer in essay format. Clarity and organization of the answer are important. Keep answers concise. The use of point form is acceptable when stated in the question.

**Marking Scheme**

1. A= 5 marks; B=10 marks; C= 5 marks
2. A=9 marks; B= 11 marks
3. A= 8 marks; B= 5 marks; C=7 marks
4. A= 2 marks; B= 6 marks. C= 12 marks
5. A= 8 marks; B= 12 marks
6. A= 4 marks; B= 8 marks; C= 8 marks

**COVER PAGE**

**Question 1: Lifecycle Stages of Mining and Associated Environmental Impacts**

Mining is a global industry and is often located in remote and less-developed areas including many Indigenous lands and territories. Historically, mining has contributed to many issues in sustainable development, however, in recent decades, the industry has made significant advances in improving how companies manage their environmental and social impacts at all lifecycle stages of the mining operation.

- 5 marks      A. List the lifecycle stages of a mining operation. Bullet point is acceptable.
- 10 marks     B. Describe in detail five environmental or social impacts that the mining industry may influence. If social impacts are described they must be fundamentally related to the environment. Include in your answer mitigation measures that may be considered and comment on the relative environmental impacts of each. Comprehensive bullet point is acceptable. (Hint- think environmental matrices (soil, water, air, sediment) and associated impacts on them) (10 marks)
- 5 marks      C. List key stakeholders in a mining project, describe what “Aboriginal and Treaty Rights” may mean with respect to a mining project, highlight the importance of meaningful engagement and comment on the implications failing to do so may have on the success of a mining operation.

**Question 2: Mining Acts and Regulations**

- 9 marks      A. The following is a list of a few of the most important Canadian/ Ontario environmental Acts/Regulations related to mining and the environment.
- Canadian Environmental Protection Act
  - Canadian Environmental Assessment Act
  - Species at Risk Act
  - The Fisheries Act
- Choose three of the above Acts/Regulations, and for each:
- i) state the overall objective of the Act/Regulation and how the act relates to the protection of the environment (2 marks)
  - ii) include the most up to date citation year (0.5 marks)
  - iii) which government agency is the custodian (i.e. enforces) it (0.5 marks)

3 marks will be provided for each of the three Acts/Regulations.

11 marks

B. In Canada, the Metal and Diamond Mining Effluent Regulations fall under The Fisheries Act.

- i) What is the definition of “deleterious substance” and list two prescribed deleterious substances under the act (3 marks)
- ii) Authority to Deposit- the owner or operator of a mine may deposit, or permit the deposit of, an effluent that contains a deleterious substance in any water or place referred to in subsection 36(3) of the Act if a transitional authorization permits the deposit or if the following three conditions are met. Define the three conditions that must be met under the Authority to Deposit (3 marks)
- iii) Answer the following True/False Questions with respect to the Metal Mining Effluent Regulations (5 marks)

*1. The owner or operator of a mine may deposit waste rock or an effluent that contains any concentration of a deleterious substance if the disposal area is confined by anthropogenic or natural structures as long as it's not a natural body of water frequented by fish.*

*2. The owner or operator of a mine can combine effluent with water or any other effluent for the purpose of diluting the effluent before it is deposited*

*3. The owner or operator of a mine shall identify each final discharge point and submit in writing to the authorization officer... the following information i) location plans, ii) how the discharge point is designed and maintained and iii) the name of the receiving water body.*

*4. Once a month the owner or operator of a mine shall conduct acute lethality testing on a grab sample collected from each final discharge point.*

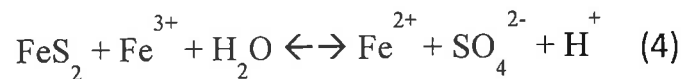
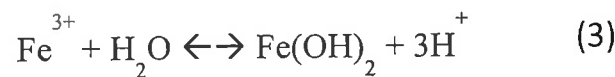
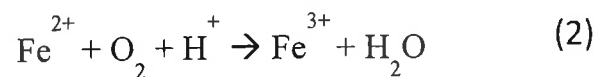
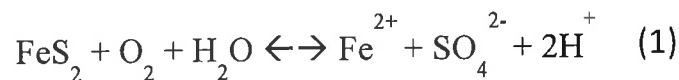
*5. The Environment Canada Biological Test Method: Reference Method for Determine Acute Lethality of Effluents to Daphnia magna (Reference Method EPS 1/RM/14) is required for each effluent sample collected for the acute lethality test.*

**Question 3: Mining Waste and Management- Waste Rock**

Mining operations produce a large amount of waste materials requiring management. There are different types of mining wastes which vary in their physical and chemical composition which ultimately determines the effective management strategy for each. One of the most common mining wastes requiring management are waste rock. The following series of questions relates to the environmental issues, challenges and management of waste rock.

- 8 marks
- A) General:
- Define waste rock (1 mark)
  - Differentiate the two types of contaminant testing for waste rock to determine leaching potential (2 marks)
  - Describe Top-Down and Bottom-Up Storage for Waste Rock (2 marks)
  - Waste rock piles may contain sulfide materials. State one common sulfide mineral (1 marks)
- If sulphide minerals are present in any of the rocks, there is the potential for acid mine drainage.***
- Differentiate "Acid Mine Drainage" and "Acid Rock Drainage" (1 mark)
  - Acid Mine Drainage is an example of what kind of chemical reaction? Very briefly explain the flow of electrons in this type of reaction (1 mark)

- 5 marks
- B) Explain what is occurring in each of the four chemical equations related to acid mine drainage. For equation 4, balance the chemical equation (5 marks)



- 7 marks
- C) Describe the negative effects that acid mine drainage may have on the environment. Two effects in bullet point form is sufficient (2 marks)
- D) Describe three methods to prevent/treat acid mine drainage. Comment on if it is an active or passive approach. (3 marks)

- E) Comment on how acid mine drainage treatment or prevention may be unique or influenced due to Canada's northern environment. Two bullet points is sufficient (2 marks)

**Question 4: Mining Waste and Management- Tailings**

Mining operations produce a large amount of waste materials requiring management. There are different types of mining wastes which vary in their physical and chemical composition which ultimately determines the effective management strategy for each. One of the most common mining wastes requiring management are waste rock. The following series of questions relates to the environmental issues, challenges and management of mine tailings.

- 2 marks      A) General:
- i)      What are mine tailings? Approximately what percentage of tailings by weight are solids (range is acceptable) (1 mark)
  - ii)      True or False?- Tailings water may be basic, acidic or saline (1 mark)
- 6 marks      B) Tailings Storage/ Disposal Practices:
- i)      List and describe briefly four common tailings storage/disposal practices. (4 marks)
  - ii)      Site selection is the most important aspect in affecting the tailings storage facility design. Different sites have different site-specific characteristics and considerations are required in determining a suitable location. Consider you were responsible for proposing a tailings disposal facility, list four site-specific considerations you would make with respect to the environment when choosing the best tailings disposal for your particular mine. Bullet points are sufficient (2 marks)
- 12 marks      C) Tailings Impoundment Construction (12 marks):
- There are three common methods of raised embankment design and construction: downstream; upstream; and, centerline. Populate the following table and provide a cross-sectional sketch of each method showing embankment construction progression, beach location, pond location, and any other relevant features.

<b>Deliverable</b>	<b>Upstream</b>	<b>Downstream</b>	<b>Centerline</b>
<b>Description/Details</b> (1 mark each, 3 total)			
<b>Advantage</b> (0.5 marks each, 1.5 total)			
<b>Disadvantage</b> (0.5 marks each, 1.5 total)			
<b>Sketch</b> (2 marks each, 6 total)			

**Question 5- Contaminants of Concern and Mine Water**

8 marks

## A) Contaminants of Concern:

What are the primary environmental and human health concerns associated with the following and state their source with respect to mining. (8 marks)

- i) Acid Rock Drainage
- ii) Mercury (be sure to mention both organic and inorganic)

Discussion should be 3-4 sentences for each substance and include a discussion of contaminant toxicity, transport and fate mechanisms. Be sure to specifically comment on their source from the mining industry or any other key links to mining and mining's impact on the environment.

12 marks

## B) Mine Water Treatment:

Water leaving a mine site must not pose risk to human or ecological receptors. In order to comply with regulations and ensure that the quality of water leaving mine sites is not adversely affecting water users downstream, mining companies develop water management plans to minimize the potential for water contamination, and to prevent the release of contaminated water into the environment.

Various control techniques can be used to reduce the potential for water contamination and minimize the volume of water requiring treatment. These techniques include five common technologies

- i) List three common mine water control technologies and state their objective/ mode of effective action (6 marks) (hint, the question asks for water **control** technologies, think about how you would control where and how water moves at a mine site).
- ii) Describe and differentiate active and passive water treatment options. Discuss energy inputs, maintenance and disposal costs, if monitoring is required, and provide an example of each. (6 marks) (hint- answer can be relative. Think general differences between active or passive treatment strategies)

**Question 6 Mine Closure and Reclamation Plans**

A Mine Closure and Reclamation Plan is a document, prepared by the mine proponent, that contains and describes all of the studies and plans related to closure and reclamation of the mine site and all of the related mine facilities.

- 4 marks      A) General
- i) Define- progressive reclamation (1 mark)
  - ii) Global objectives are overarching objectives that will apply to all mine sites, regardless of the mine type or location. Global objectives take into consideration the **physical stability, chemical stability, and future use and aesthetics** at the site after closure. Provide a short comment on each of the three global objectives. What are their intentions? Answers should be limited to 1 sentence each (3 marks)
- 8 marks      B) Revegetation
- i) What is/are the primary objectives of revegetation of a mine site with respect to human and environmental health and safety (2 marks).
  - ii) Consider you are developing a mine closure and reclamation plan. List two assumptions, key considerations or actions you would make with respect to revegetation during both the 1. Pre-Mining Planning Stage and 2. During Progressive and Post-Closure Stages. Would sampling or monitoring be required and why? (5 marks)
  - iii) Would there be any special considerations for Canada's Northern environment? (1 mark)
- 8 marks      C) Open Pit Mining
- i) What is/are the primary objectives reclamation of open pit mines with respect to human and environmental health and safety (2 marks)
  - ii) Consider you are developing a mine closure and reclamation plan. List two assumptions, key considerations or actions you would make with respect to open pit mining during both the 1. Pre-Mining Planning Stage and 2. During Progressive and Post-Closure Stages. Would sampling or monitoring be required and why? (5 marks)
  - iii) Would there be any special considerations for Canada's Northern environment? (1 mark)