

## National Exams May 2015

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. FIVE (5) questions constitute a complete exam paper.  
Questions 1 and 2 are MANDATORY.  
THREE questions must be selected from the OPTIONAL questions 3 to 6.  
Only Questions 1 and 2 and the first three other questions as they appear in the answer book will be marked.
4. Each question is of equal value (20 marks). Marks are allocated as indicated.
5. For most questions full sentence OR bullet point responses can be used. In either case clarity and organization of the answer are important.

**1. Risk Assessment and Management Principles (MANDATORY)**

- 4 marks 1. Tailings dam failures can have catastrophic results on the environment, communities, corporate finances and social perceptions of mining.

Identify two leading causes of modern tailings dam failures (e.g. post 2000).

- 16 marks 2. Describe industrial best practice with respect to tailings dam safety inspections and reporting practices. You should identify the key activities involved in dam safety inspections and the reporting requirements. Your discussion should reference industrial best practice and the minimum regulatory requirements of the province or territory in which you practice or are writing this exam. You may also wish to reference the Canadian Dam Association's *Dam Safety Guidelines*, the Mining Association of Canada's suite of publications relating to tailings facility management, or other relevant, recognised guidelines.

**2. Acid rock drainage-Characterization and formation (MANDATORY)**

- 7 marks a) Briefly describe either the humidity cell test OR column test approach to geochemical characterization of material with respect to acid rock drainage potential.

Your answer should include a description of the test method, identification of how the results of the method are used, and identification of the advantages or limitations of the method. The answer should take approximately 6 to 8 sentences.

- 7 marks b) Describe the sulphide oxidation process. Include the 3 chemical reactions involved in the oxidation of pyrite to form acid rock drainage.

- 6 marks c) Acid-base accounting is one method used in determining the potential for acid rock drainage production. The neutralizing potential ratio (NPR) is one of the indicators used in assessing the acid generating potential of an ore body.

- How is the neutralizing potential ratio calculated? (2 marks)
- Complete the following table by identifying the ARD potential and interpretation for screening value (4 marks). You may reproduce the table in your answer booklet.

Potential for ARD	Initial Screening Criteria	Interpretation
	NPR <1	
	1 < NPR < 2	
	NPR > 2	

### 3. Basic terms and knowledge (OPTIONAL)

True/False. Answer each of the five questions below with a “true” or “false” in your answer booklet and provide a one to two sentence explanation of your answer. No marks will be awarded if an explanation is not provided.

- /2 each  
10 marks total
- Subaqueous tailings disposal to fresh water lakes is allowable in Canada.
  - Mineral and mining rights fall under federal jurisdiction.
  - Federal environmental approval is required for most mining projects in Canada.
  - Mine sites in Canada are not allowed to discharge effluent to the environment.
  - Progressive reclamation is a requirement under the Mining Act, or equivalent legislation, in your Province.

Define ONLY FIVE of the following terms. One to two sentences should be sufficient for each term. You may define any five terms, but only the first five definitions provided in the answer booklet will be marked.

Define FIVE of:

- /2 each  
10 marks total
- Consequence (from a risk management perspective)
  - Plasticity index
  - Atterberg limits
  - Standard Proctor Compaction Test
  - Darcy’s Law
  - Hazard
  - Probable maximum flood

#### **4. Regulatory issues and management best practices (OPTIONAL)**

20 marks total

4 marks each

Discuss the role of FIVE of the following in the regulation or management of mine waste materials and mine closure.

Your discussion should include the activities governed by the legislation/regulations or addressed by the voluntary guidelines, the responsibilities assigned to the mine operator, including engineering staff, and the powers held by the government, where applicable.

Discussion of each item should take four to eight sentences.

Select AT LEAST TWO of:

##### **Federal Legislation and Regulations**

- Canadian Environmental Assessment Act
- National Pollutant Release Inventory (under the *Canadian Environmental Protection Act, 1999*)
- Metal Mining Effluent Regulations (MMER) (under the *Fisheries Act*)

Select NO MORE THAN THREE of:

##### **Industry Associations and Voluntary Guidelines**

- Canadian Dam Association – Dam Safety Guidelines
- Mining Association of Canada – Towards Sustainable Mining Tailings Working Group
- International Cyanide Management Code for the Gold Mining Industry
- International Council on Mining and Metals
- International Network for Acid Prevention-Global Acid Rock Drainage Guide

### 5. Acid rock drainage-Neutralization and treatment (OPTIONAL)

- a) Provide a detailed description of the conventional active treatment of ARD impacted mine water using a water treatment plant.

9 marks

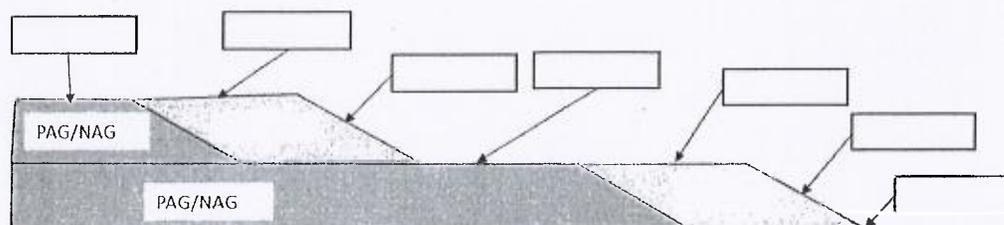
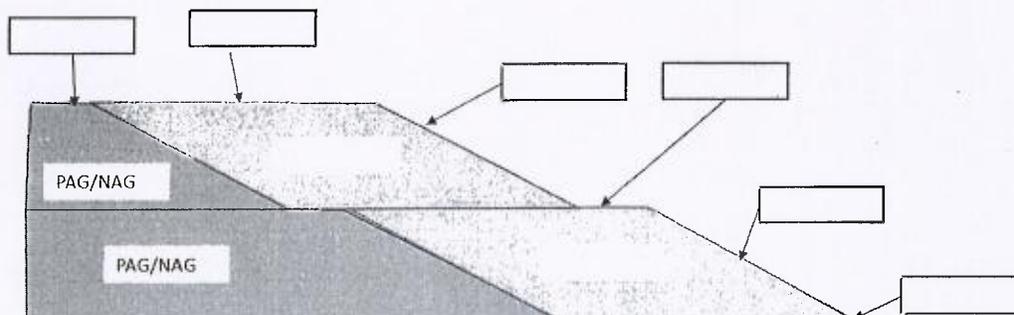
Your description should include an overview of the method, including the relevant chemical reactions involved, a discussion of the benefits and disadvantages of the method, and an indication of the relative cost and effectiveness of the method.

Discussion should take approximately eight to ten sentences.

- b) The figures below represent a generic sample waste rock encapsulation strategy. Identify the location of potentially acid generating materials (PAG), potentially acid neutralizing or non-acid generating materials (NAG), and the dump cover requirements by populating the empty boxes.

6marks

A copy of this figure is included at the end of the exam paper for mark-up and submission with your exam booklet.



- c) LIST five active or passive methods used in the prevention of ARD not discussed in a) or b) above.

5 marks

**6. Effluents and emissions (OPTIONAL)**

12 marks

a) What are the primary environmental health concerns associated with the following substances:

- Polycyclic aromatic hydrocarbons
- Mercury
- Lead
- Cyanide

Discussion should take three to five sentences each and include typical air and waterborne transmission mechanisms, human health effects and identification of the minerals most commonly associated with the substance.

8 marks

b) Excluding water spraying, discuss one method of dust control used for open pit haul roads and one method used for active waste dumps or active tailings impoundments. For each method discuss the advantages or benefits of the method as well as any drawbacks. Four to six sentences should be sufficient for each method.

Question 5

