# Surface Mining
# NTQF Level -2

Based on December 2018, Version 1 OS and April.2021, V1 Curriculum

Module Title: Conducting Waste and tailing dump Reclaiming operation

LG Code: MIN SMN2 M13 LO (1-3) LG (50-52)

TTLM Code: MIN SMN2 TTLM 0421v1

April, 2021
Adama, Ethiopia,

# Table of Contents

| LG #50 | LO #1- Prepare for operations |
|---|---|

**Instruction sheet**

This learning guide is also developed to provide you the necessary information regarding the following content coverage and topics –

- Accessing, interpreting and applying compliance documentation
- Obtaining, interpreting and clarifying work requirements and shift details
- Accessing, interpreting and applying geological and survey data
- Carrying out worksite inspection
- Rectifying or reporting hazards or other notifiable conditions
- Accessing and applying safety information and procedures

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Access, interpret and apply compliance documentation
- Obtain, interpret and clarify work requirements and shift details
- Access, interpret and apply geological and survey data
- Carry out worksite inspection
- Rectify or report hazards or other notifiable conditions
- Access and apply safety information and procedures

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets ”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish from “Self-check 1 up to Self-check 6
5. Ask your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check).
6. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet
7. Submit your accomplished Self-check. This will form part of your training portfolio.

**Information Sheet 1- Accessing, interpreting and applying compliance documentation**

## 1. Introduction

**Compliance Documentation** means specific documents or information including records, reports, observations, and verbal responses to establish or confirm compliance with a regulatory requirement by a program or facility.

### 1.2 Legislative, organizational and site requirements and procedures

The Constitution of Ethiopia (1995) places the ownership of all natural resources (including minerals) in the State and People of Ethiopia. In Ethiopia like anywhere else in the World, Artisan and Small-scale Mining is subject the country's constitution, mining law, and mining regulations. The mining law determines which activities can be undertaken by an individual or a group of individuals forming an entity recognized by the law (association, cooperative, company etc). Typically, permission to undertake prospecting or mining activities is given in the form of a License.

- In Ethiopia, Artisan and Small-scale Mining is regulated by the following Proclamations and Regulations:
  - ✓ The Mining Operations Proclamation 678/2010 as amended by the Mining Operations (Amendment) Proclamation 816/2013
  - ✓ The Mining Proclamation 52/1993 as amended by the Mining Income Tax (Amendment) Proclamation 23/1996
  - ✓ The Mining Operations Council of Ministers Regulations 182/1994 as amended by the Mining Operations Council of Ministers (Amendment) Regulations 27/1998 and 124/2006
  - ✓ The Transaction of Precious Minerals Proclamation 651/2009.

**A License contains several key elements:**

- The particulars of the Licensee

- The geographical area it covers, usually defined by a map or by its coordinates
- A description of the activities permitted by the License
- A list of specific minerals
- A term (duration) which may be renewable or not
- Certain rights and duties of the Licensee

**The Main types of licenses are:**

a. The Artisanal Mining License
b. The Special Small-Scale Mining License
c. The Small-Scale Mining License
d. Large scale mining license

### a. Artisanal Mining License

**Scope**: Surface mining by Ethiopian individuals or cooperatives, non-mechanized (manual work).

**Term**: 2 years maximum, non-renewable

**Conditions**:

- Surface mining only. No underground mining except vertical shaft to 15 m depth max.
- Held by an Ethiopian individual or small / micro enterprise
- Extraction is done by manual work
- No hiring of workers
- No financial resources or competence required
- The license can be inherited
- Gold and silver must be sold to the National Bank of Ethiopia
- Royalty and Income Tax rates determined at Regional Government level

### b. Special Small-scale Mining License

**Scope**: Surface mining on gemstones and placer resources (gold, silver, platinum, tantalite) by Ethiopian individuals or micro enterprises, mechanized.

**Term**: Up to 10 years renewable 5 years

**Conditions**:

- Held by an Ethiopian individual or small / micro enterprise
- Extraction is mechanized
- Gemstones and placer resources (Au, Ag, Pt, Ta)
- Annual run-off-mine ore does not exceed:
  - 100,000 $m^3$ for precious and semiprecious minerals placer operations
  - 75,000 t for precious and semiprecious minerals primary operations
  - 80,000 $m^3$ for sand, gravel, clay etc
  - 10,000 $m^3$ for dimension stone such as marble and granite

- Applicant must have sufficient financial resources for mechanization
- Requires an Environmental Impact Assessment, and a Community Development Plan
- Up to 10 years renewable 5 years
- Gold and silver must be sold to National Bank of Ethiopia
- Royalty and Income Tax rates determined at Regional Government level

### c. Small-scale Mining License

**Scope**: Surface and underground mining within the annual run of mine limits of the Small-Scale Mining License (see below) by Ethiopian or foreign individuals or companies, mechanized.

**Term**: 10 years maximum, renewable for 5 years

**Conditions**:

- May be held by an Ethiopian of foreign individual or company
- Extraction is mechanized
- Annual run-off-mine ore does not exceed:
  - 100,000 $m^3$ for precious and semiprecious minerals placer operations
  - 75,000 t for precious and semiprecious minerals primary operations
  - 80,000 $m^3$ for sand, gravel, clay etc
  - 10,000 $m^3$ for dimension stone such as marble and granite
- Applicant must have sufficient financial resources for mechanization
- Requires an Environmental Impact Assessment, and a Community Development Plan
- Up to 10 years renewable 5 years
- Gold and silver must be sold to National Bank of Ethiopia
- Royalty and Income Tax rates determined at Regional Government level

**What is the process for grant of Artisan Mining License?**

The Department of Youths and Sports has the following role:

- Identify names of youths
  - Below 25 years old
  - Landless
  - Jobless
- Mobilize (office has a mobilization expert)
- Assist in formalization up to obtention of license
- Monitor and evaluate development
- Help to get loans from microfinance
- Formal training helps to obtain microfinance loans

The Department of Mining

- Prepares and issues the licenses
- Manages and inspects.

### 1.3 Requirements of health and safety legislation:

The benefits of rules and regulations in mining are that they protect employees and the company from suits.

The main provisions of these Regulations require employers:

- ✓ To provide: adequate lighting, heating, ventilation and workspace (and keep them in a clean condition);
- ✓ Staff facilities, including hospitals, toilets, washing facilities and refreshment; and. safe passageways, i.e. to prevent slipping and tripping hazards, If you are an employer or self-employed.
- ✓ Creating safe working environment.

- ✓ It is a legal requirement for every employer and self-employed person to make an assessment of the health and safety risks arising out of their work. The purpose of the assessment is to identify what needs to be done to control health and safety risks.
- ✓ Provide information, training, instruction and supervision - ensure staffs are aware of instructions provided by manufacturers and suppliers of equipment.
- ✓ Provide a safe place of employment.
- ✓ Provide a safe working environment.
- ✓ Provide a written safety policy/risk assessment.

| Self-check 1 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements of health and safety legislation?(3pts)
2. Mention the types of licenses.(3pts)
3. Define what a artisanal miners mean? (2)
4. Define what a Legal Requirement mean. (2pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 2- Obtaining, interpreting and clarifying work requirements and shift details**

## 2. Work instructions

Work Instructions are documents that clearly and precisely describe the correct way to perform certain tasks. When planning any work you must take into account your duty of care obligations and the policy and procedures of your workplace. You must make sure your conduct is safe and does not place others at risk.

Mining wastes is generated during the process of extraction, beneficiation and processing of Minerals. Extraction is the first phase that consists of the initial removal of ore from the earth. This is normally done by the process of blasting.

### 2.1. Work instruction for waste and tailing dump reclaiming

**The purpose of the job** The spatial distribution of the dump, slope of the surface, height of slope sediments, and strength of mixed materials, depth of slope water, and other factors all affect the stability of the dump slope.

**Hazard assessment:** The main disaster that affects dumps is landslides, and the key for preventing landslides is to control the slope stability of the dump.

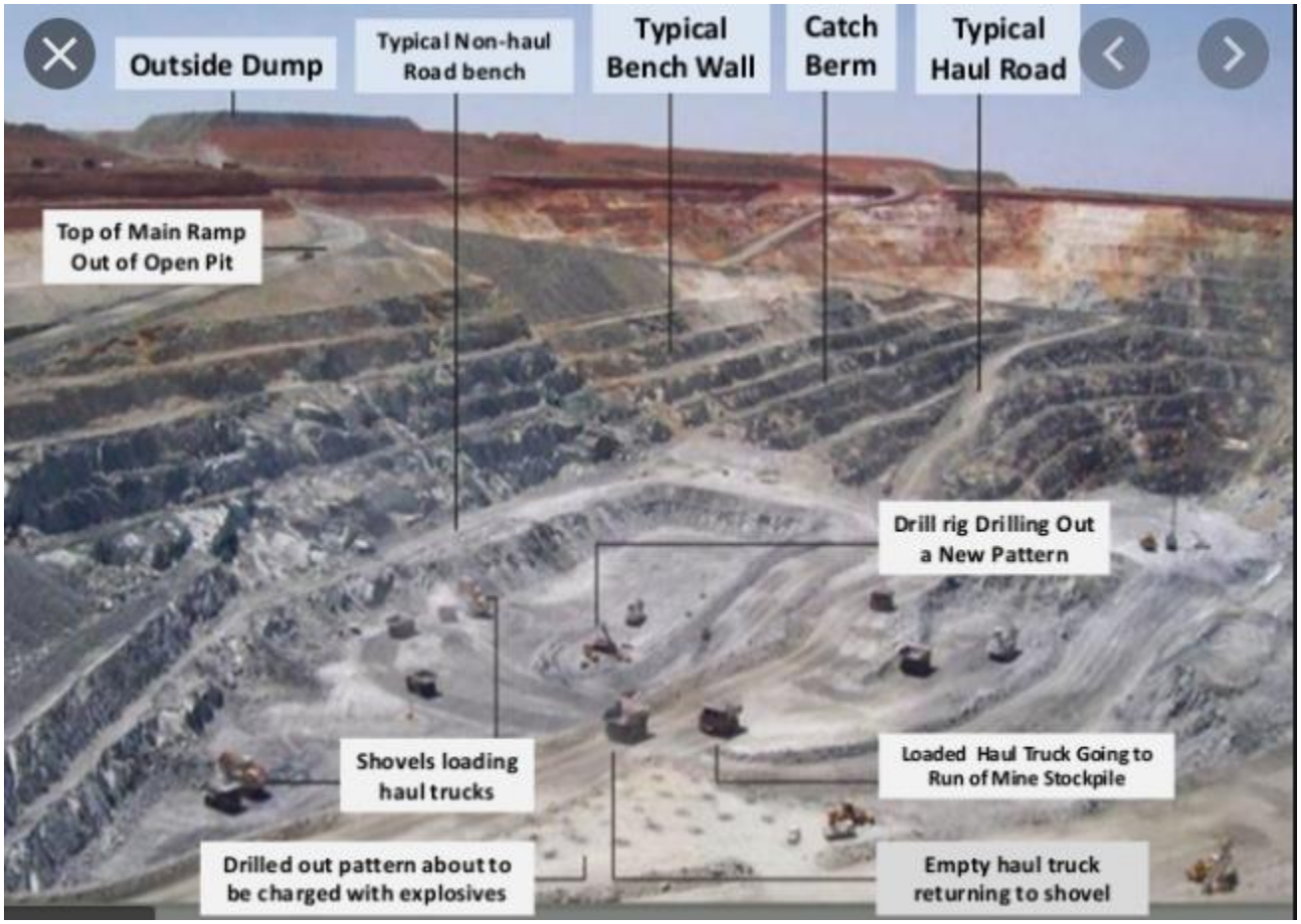
**Emergency requirements:** The person discovering an emergency is required to: Maintain the safety of themselves and others in the vicinity as a first priority, Evaluate the extent of the emergency, Take action to prevent further injury, Initiate emergency response at site level by making contacting with your immediate supervisor or the senior manager.

**PPE requirements:** List and use the types of Personal Protective Equipment that is required to be used whilst undertaking the task.

**Time frames:** Any work that is allocated to you or your team must be completed to the required standard and within the required time frame.

Legislation includes specific requirements for tailings management such as:

- A detailed plan,
- A design that complies with good engineering practice,
- Environmental management plan.
- Mine waste dump control
- Construction under the supervision of a professional engineer,
- Stability against any static and dynamic loading,




The operations performed on a mine site to exploit and utilize an ore deposit by:

- Access to the ore deposit (clearance, and galleries producing barren waste) Management of mining, quarrying, and ore-processing waste
- in situ ore extraction and selection,

- Ore-processing. The aim was to identify typical systems accounting for the main techniques of mining and processing mineral substances
- The topographic, geological and hydro geological situation, as well as the geometry and morphology of the ore deposit, determine the mining method used for its exploitation,
- The chemical composition and mineralogy of the ore deposit determine to a large extent the processing,
- The reserves and economic conditions determine the production rate.

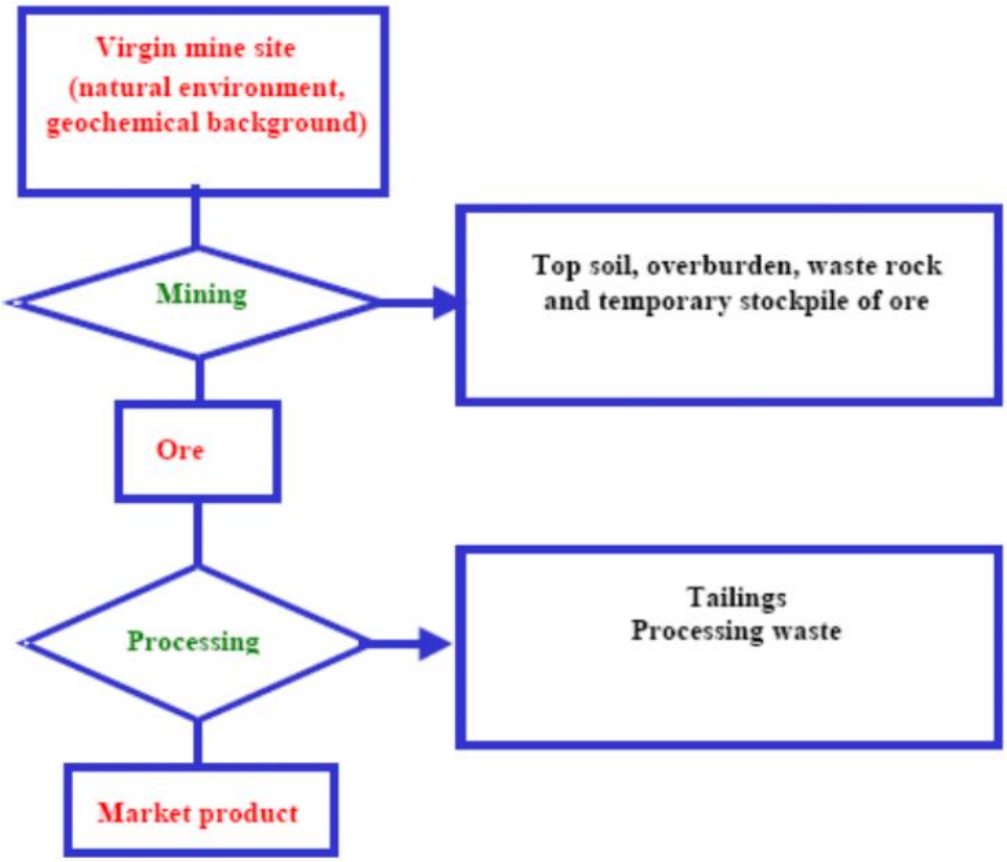



**Figure 1** – Mining waste types (Source P. Charbonnier, 2001, pp. 7)

| Self-Check – 2 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the Requirements of Mine waste dump?(3pts)
2. Define what mean a waste dump. (4pts)
3. Write work instruction for waste and tailing dump reclaiming? (3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 3- Accessing, interpreting and applying geological and survey data**

### 3.1. Geological Controls on Waste Disposal Site Selection:

Geological field mapping is the process of selecting an area of interest and identifying all the geological aspects of that area with the purpose of preparing a detailed geological report which must include a map. Good geological mapping should be executed in three phases; planning, data collection and reporting.

- Factors which determine suitability of tip sites from a geological/hydro geological Standpoint are:-
  - ✓ **Bedrock Litho logy** - rock type, grain size characteristics, texture, homogeneity, bedding characteristics, etc.
  - ✓ **Hydrological Properties** - of both bedrock and drift, ie. porosity, permeability, hydraulic conductivity, attenuation potential etc.
  - ✓ **Geological Structure** - attitude of bedding, folding, faulting, jointing, including discontinuities on all scales.
  - ✓ **Hydrogeology** - groundwater levels, distribution of aquifers and aquicludes, Ground water flow patterns etc.
  - ✓ **Surface Runoff Patterns** - size and discharge of streams running through the site -controlled by the topography of the site
  - ✓ **Topography** - inclination of sloping sites, shelter from wind, visual impact

**Some Terminologies in Structural Geology**

- **Fault**: is a type of fractures or breaks in rocks on which displacement/dislocation of the blocks have occurred.
- **Fold**: is a structure produced when an originally planar surface is bent or curved as a result of deformation.

**Anticline folds**: up arched fold in w/c the two limbs diverge away from each other. The oldest rock is found at the core.

**Syncline folds**: down-arched fold in w/c the two limbs converge towards each other. The youngest rock is found at the core.

- **Joint**: is a crack or fracture on which there has been no visible shear displacement or no visible displacement.
- **Discontinuity**: is mechanical defect, flaw, or plane of weakness in a rock mass.
- **Dike, vein,**

### 3.2 Survey data:-

Mining surveyors are a type of surveyor or mapping scientist that use all the tools, technologies and methods at the disposal of the discipline to record details for mines.

**OBJECTIVES OF SURVEY**

- Collect and record data of points on the surface of the earth
- Compute areas and volumes
- Prepare plans and maps
- Lay out engineering works using survey data
- Check the accuracy of laid out works
- number and location of disposal sites
- volume and composition of waste accepted
- quantities of waste coming to the sites and the types of vehicles delivering waste and the activities that have generated the waste
- consent information where applicable
- Site operator and operation details
- Current gate fees/disposal charges, and
- Classification of sites.

Figure 1:- Surveying

- The skill set required for a Mining Surveyor includes:
  - ✓ Possess a technical degree in surveying
  - ✓ Ability to work within a team and efficiently independently as required by the job
  - ✓ Capacity to take direction and report to a supervisor
  - ✓ Perform work in extreme weather and environmental conditions; work sites often have steep slopes and rugged terrain
  - ✓ Possess strong technical, oral and written communication skills
  - ✓ Produce detailed mappings and mathematical measurements for multiple aspects of mining operations
  - ✓ Adherence to safe work practices and wear personal protective equipment as required

- ✓ Perform surveying functions and produce maps of underground mines
- ✓ Locate utility lines and permanent structures through surveying
- ✓ Maintain and regularly calibrate surveying instruments and equipment
- ✓ Design emergency maps for the mine and measure ventilation throughout the mine.

| Self-Check – 3 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the difference between fault and fold??(3pts)
2. What is surveying? (3pts)
3. Define what mean geology? (4pts)

***Note:*** **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 4- Carrying out worksite inspection**

### 4.1 Work site consideration:

One of the greatest environmental problems caused by the mining and refinement of strategic elements, this becomes a problem when mines and refineries that do not adhere to regulations regarding proper waste disposal. This can result in soil and water contamination by substances such as heavy metals and radioactive materials. This affects the ecosystem around the waste disposal site; and, if the contaminants get into the water table, it can affect areas beyond the site.

#### 4.1.1 Work Site investigation

Work Site investigation is done for obtaining information about surface and subsurface conditions at the site of proposed construction.

- Information about surface & subsurface features is essential for the design of structures and planning construction techniques.
- It also includes in-situ testing of soils.
- To determine bearing capacity of the soil
- To determine the maximum probable and differential settlement
- To predict lateral earth pressure against retaining walls and abutments
- To select suitable mining techniques
- To predict and solve potential foundation problems
- To ascertain the suitability of soil as construction material
- To investigate the safety of existing structures and suggest the remedial measures.
- Relevant information is obtained by drilling, taking soil samples, determining the index and engineering properties of soils.
- In-situ tests are conducted to determine the properties of soil at its natural conditions

**Site investigation may include activities such as:**

- Review of data such as the geology of the site, volume and types of wastes disposed, reports, studies, historical records concerning the dumpsite (operations, unusual events such as fires, dumping of hazardous wastes, etc.)
- Review of available maps (map of the dumpsite and its surroundings, topographical, geological, and hydro geological, etc.)
- Interview with those directly involved with the operation of the dumpsite, waste pickers, and residents near site
- Inventory of existing settlements, structures, surface water bodies, water wells, etc.
- Identification of existing land uses around the area and points of leachate seepage and ponding within and beyond the disposal facility
- Conduct of topographic survey of the dumpsite, extending some distance from its boundaries

Conduct of geotechnical investigation to determine stability of slopes

- ✓ Identification of sources of soil or other cover material for the site
- ✓ Determination of depths of the dumped wastes
- ✓ Determination of gas leakage within and on the areas surrounding the dumpsite
- ✓ Conduct of leachate and gas sampling (if practical)
- ✓ Conduct of water quality sampling of surface waters, water wells, groundwater

**Generally, the purpose site investigation is to**:

- Assess the suitability of a site for the proposed structure
- Evaluate the impact of construction on existing site conditions and existing site conditions on proposed construction
- Anticipate what can be expected during construction

- Develop criteria for design and construction based on site specific physical parameters.

**Criteria for upgrading dump sites**

- Characteristics of the dumps, such as the depth and characteristics of solid waste and degree of compaction that took place, variability of wastes within the site, the size of the dumps as defined by the total amount of solid waste disposed of and the areal extent of the dumps
- Environmental and health impacts of the existing dumps and definition of current contamination
- Potential for “mining” decomposed organic materials (compost) from the existing dumps
- Occupational health of landfill scavengers and scope for assimilating these scavengers into the onsite activities during the up gradation of dumps
- Number of people and especially any sensitive populations that could be influenced by the release of pollutants from the landfill and the duration of exposure

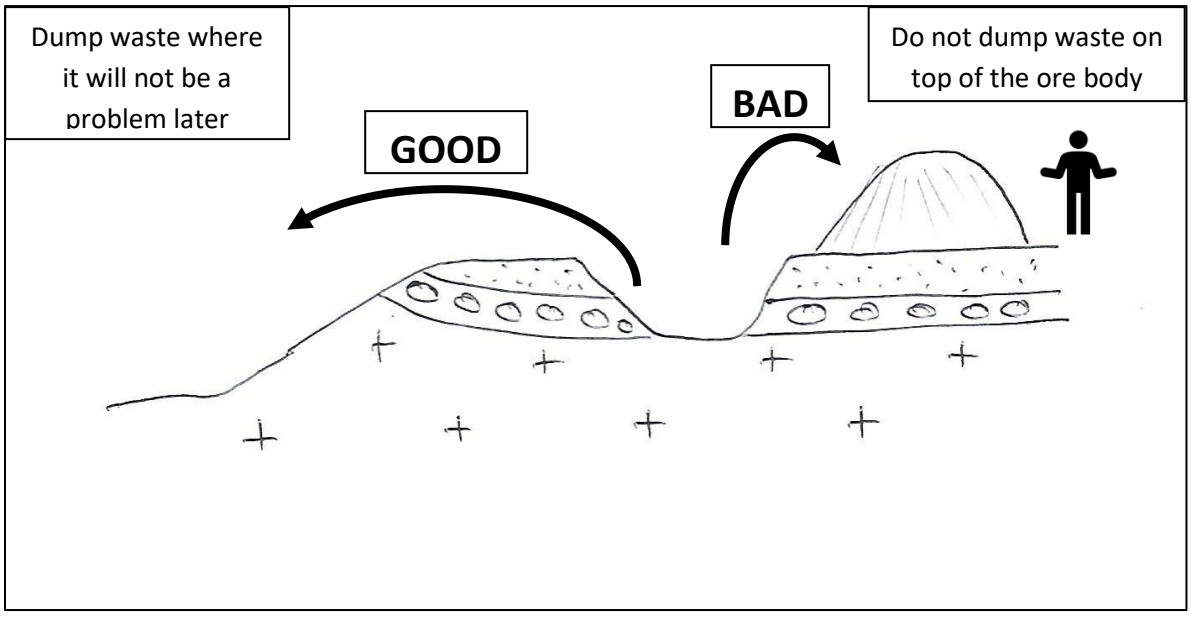



**Fig**: before to start dumping overburden (waste), think and plan. What is the best location so that the waste does not become a problem later? In which direction is the mining likely to go?

| Self-Check – 4 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the consideration of work site investigation? (3pts)
2. What are the procedures in surface mining? (2pts)
3. How to prevent wall collapse?(2pts)
4. Mention the elements of site investigation? (3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 5- Rectifying or reporting hazards or other notifiable conditions**

### 5.1 Introduction:-

A mining hazard is a source of danger or potential danger, caused by the working of minerals, which has the potential to cause harm to life or damage to a mine, infrastructure, utilities, land, or the environment. Mining has always been among the most hazardous of occupations, and with the increasing demand for coal and minerals safety in mines assumes even greater importance.

### 5.2 Mining Hazards:

Mining adversely affects the environment by inducing loss of biodiversity, soil erosion, and contamination of surface water, groundwater, and soil. Mining can also trigger the formation of sinkholes. Most rock extraction sites, including mine sites and building construction sites, require a plan to assess, and mitigate if present, the risk of acid mine drainage (AMD). AMD is typically the major environmental concern where sulfide minerals are present in the excavated material and AMD prediction and remediation is based on internationally-accepted acid-base accounting (ABA) tests of representative field samples.

**The main risks when doing surface mining are**:

- Wall collapse
- Rock fall

A **wall collapse** is when the side of the mine falls into the mine and buries people and equipment.

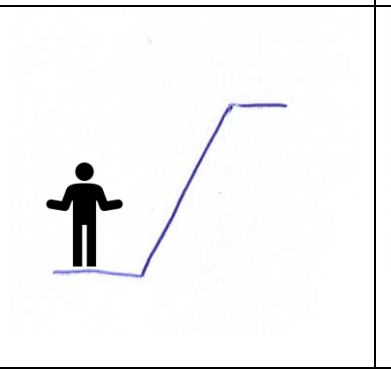
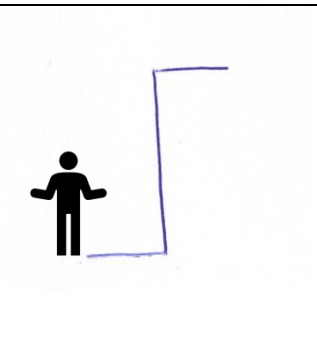
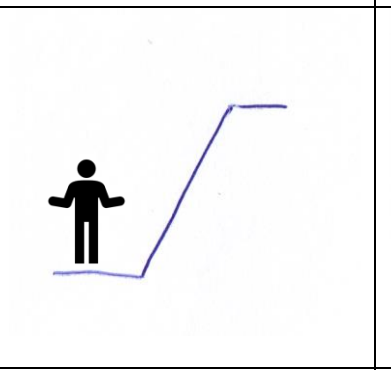
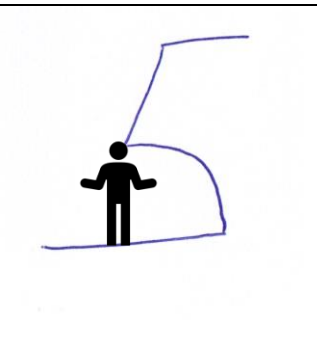
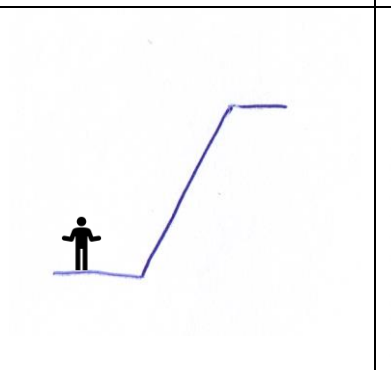
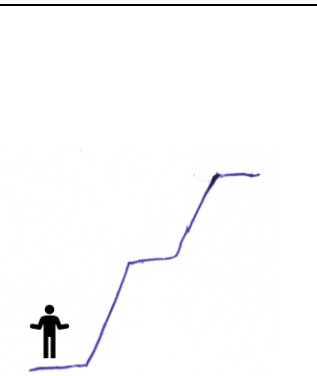
A **rock fall** is when a rock detaches itself from the wall of the mine and falls on someone.

**How to avoid wall collapse?**

A wall collapse is more likely to happen when:

- The pit wall is made of sand, soil, or weathered rock
- It has rained heavily and there is a lot of water in the ground

**To prevent wall collapse:**

| What to do? | RIGHT | WRONG |
|---|---|---|
| • Maintain a **low pit wall angle** |  |  |
| • **Do not under-cave** the pit wall |  |  |
| • Make benches when the pit is deep |  |  |

**To anticipate wall collapse:**

**Take the time to observe** the pit walls and surroundings **from different angles.**

Are there any new cracks visible, or have existing cracks evolved? Have rocks fallen from the pit wall?

**How to avoid rock fall?**

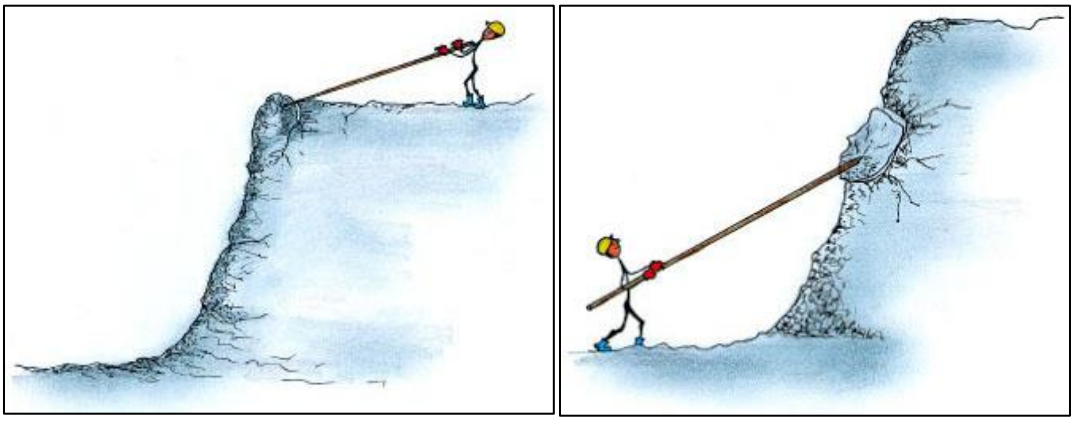
- Maintain a low pit angle
- Do not under-cave the pit wall
- Do not place waste on the edge of the pit
- Take the time to OBSERVE and ACT to remove lose rocks on pit wall (scaling)

**Scaling**

Scaling (removing lose rocks on an open pit wall or underground) is the most important skill any miner must know.

Underground, use a metal tool to “sound” the roof and wall of the galleries and detect any loose rock.

- “Ting !!!” -> the rock is hard and secure
- “Duhhh !!!” -> the rock is loose and might fall



*Scaling in an open pit.*

*Use a scaling bar long enough to ensure the rocks cannot fall on you or on other people.*

**Mining Hazards May include**

- spontaneous combustion
- wet weather operations
- electrical start-up and shutdown
- belt systems fires
- electrical fires

- working with other equipment
- tailing failure
- sliding waste dump
- Land slide:
- Fall


Fig: The danger of tailings dam

| Self-Check – 5 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least five mining hazard.(4pts)
2. Define what toppling failure mean.(3pts)
3. How can you manage the mine site from pollution?(3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

## Information Sheet 6- Accessing and applying safety information and procedures

### 6.1 safety information and procedures:

Mine safety refers to the management of operations and events within the mining industry, for protecting miners by minimizing hazards, risks and accidents.

**MSHA** (mine safety and health administration) works to prevent fatalities, illness, and injury from mining and secure safe and healthful work places. Mine Safety and Health Enforcement is responsible for performing activities including:

- Creating safe working environment.
- Issuing citations and orders for any observed violations.
- Issuing a withdrawal order, removing equipment from service, and/or withdrawing miners in cases of imminent danger.
- Conducting health sampling of respirable dust and noise exposure at mines, as well as monitoring toxic materials and harmful physical agents.
- Investigating fatal and serious nonfatal accidents.
- Investigating complaints of hazardous conditions reported by miners.
- Investigating criminal violations.
- Examining complaints of discrimination reported by miners.
- Conducting safety and health conferences with mine operators on violations.
- Approving required roof control, ventilation, emergency response, and training plans.
- Reviewing mine operators' mining plans and education and training programs for miners
- Directing various mine safety and health assistance programs.
- Training and certifying instructors.
- Developing improved safety and health standard


Fig 1: Mine safety signs.

### 6.2.1 Environmental Management of sites:

Measures to minimize acid drainage and pollution from water containing dissolved metals, salts and process chemicals, are as follows:

- Minimize percolation to subsoil and groundwater, by low permeability of the substrate and low permeable cover,
- Minimize seepage through the impoundment wall,
- Collect seepage by a collection and treatment system,
- Minimize influx of surface runoff by trenching and by-passing the tailings depository,
- Maximize circulation of process water,
- Minimize infiltration of water into the tailings dam.

| Self-Check – 6 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the mine safety signs. (4pts)
2. Define what mine safety mean. (3pts)
3. What is the importance of Environmental Management of sites? (3pts)

***Note:*** **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

| LG #51 | LO #2- Operate plant and equipment |
|---|---|

**Instruction sheet**

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Coordinating work activities
- Understanding mining methods
- Carrying out pre-start, start-up, park-up and shutdown procedures
- environmental requirements and constraints related to reclaim operations
- Monitoring systems and alarms requirements
- Loading, sampling and dispatching specified materials
- waste dump management processes
- Recognizing hazardous and emergency situations
- Completing work in accordance with the agreed plan

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

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5. Ask your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check).
6. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

## Information Sheet 1- Coordinating work activities

### 1. Introduction

During coordinating work activities communication with other personnel is very important for sharing information and ideas between the management of organization and employees and vice versa

**Mine and quarrying processes and related waste pathways activities are:**

- Exploration - Geophysics
- Exploration - Drilling
- Geology - Analytical and Mineralogical Assessment
- Economic Feasibility Assessment
- Ore body Modeling
- Mine Planning and Metallurgical Test work

**Construction**

- Mine
  - ✓ Shaft-sinking & tunnel/stope development (U/G)
  - ✓ Adit & tunnel/stope development (mountain-top)
  - ✓ Top soil removal, key-cut, haul road development (Open-Pit)
- Plant
  - ✓ Site Preparation, Foundations, Construction of buildings
  - ✓ Procurement and Installation of Equipment
- Waste and Tailing Disposal
  - ✓ Site Selection and Preparation
  - ✓ Construction of Initial Coffer Dam for tailing disposal

**Operation**

- Mine
  - ✓ Blast, Load, Haul, Dump

- ✓ Transport (hoist, convey, truck, rail), Stockpile
- ✓ Safely Store Waste (on site or in-mine)

- Mill
  - ✓ Crush, Grind (comminution)
  - ✓ Physical Separation (maybe chemical) (beneficiation)
  - ✓ Thicken and Filter (dewater)
  - ✓ Safely Store Tailing
- Waste Disposal
  - ✓ Dump
  - ✓ Contour, Spread top soil
  - ✓ Hydro-seed and plan for final drainage
- Tailing Disposal
  - ✓ Plan for Lifts as Tailing Dam builds
  - ✓ Control Water Levels
  - ✓ Recover water for recycle
  - ✓ Revegetate dam walls

Processing –

- Extract values, reject waste
- Conversion of mined ore into usable product
- More expensive/challenging with lower grade ores
- Numerous processing methods


Fig 2: component of mine

**Mine plan consideration**:

- Equipment selection
- Waste disposal site selection
- Skilled Mining experts(Geology, Mining, processing, other related management departments)
- Location of mine plant, tailing dam,
- Water supply, power supply,
- Environmental management plan
- Resources estimation, life of mine

- Mining method selection
- Magazine explosive storage
- Facility consideration
- Infrastructures

| Self-Check – 1 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the Mine plan consideration .(4pts)
2. List down the Mine waste hierarchy.(3pts)
3. Define what operations manual mean. (3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 2- Understanding mining methods**

## 2.1 Mining's role in Sustainable Development

- Creator of New Wealth
    - ✓ Jobs, taxes and economic growth
    - ✓ Foundation for eliminating poverty
    - ✓ Make a profit -- Shareholder return
    - ✓ Enhanced standard of living
- Providing Mineral-based Products to Meet Society's Basic Material and Energy Needs and Demands
- Building blocks of economic growth Advances in Civilization
    - ✓ All successful societies have encouraged, and will continue to encourage, mining
    - ✓ Metallurgical and technological advances have defined advances in civilization
- Mitigation of Society's Impact on the Environment
    - ✓ Mineral products make environmental protection technology possible
    - ✓ Modern mines are designed and built for closure
    - ✓ Use Recyclable mineral products
- Efficient use of resources – energy, water, land and minerals

**What determines the type of mining?**

- Underground vs. Surface Mining vs. Solution
    - ✓ Depth of below surface
    - ✓ Size of the ore body
    - ✓ Shape of the ore body
    - ✓ Grade
    - ✓ Type of Ore

**Surface mining methods allow**

- higher degree of worker safety
- greater flexibility in extraction
- Lower development and maintainace costs
- High productivity

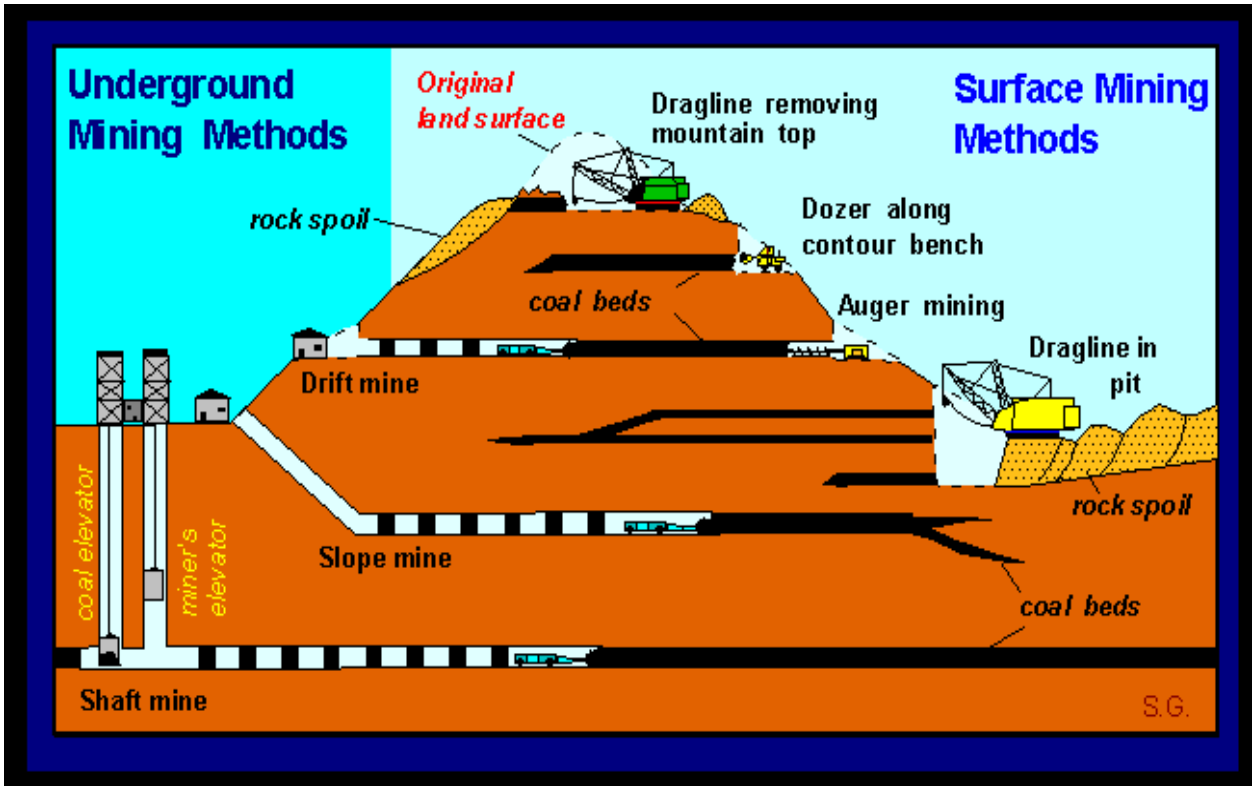


Fig 1: Mining methods

1. **Surface Mining**

Surface mining is the predominant exploitation procedure worldwide, producing in the United States about 85% of all minerals, excluding petroleum and natural gas. most of these are mined by open pit or open cast methods.

Two types of methods may be used in surface mining: mechanical extraction and aqueous extraction.

1. **Mechanical extraction method:**

The mechanical extraction involves mechanical processes to obtain minerals from the earth. There are four mechanical extraction methods

a. **Open pit**- e.g. Base and precious metals
   - Used for steeply dipping beds/veins or massive irregular body
   - Overburden and waste rocks are removed from the area
   - Some crushing overburden or waste rock may be required for handling or bunding
   - Produce several times as much waste as underground mines
   - The shape is formed by series of benches or terraces
   - May reach several thousand feet below the surafce
   - Restoration can be very expensive if it involves backfilling
   - Overburden and waste rock are often used during operation and closure of mine.

SR is the mass of In open pit mining, mechanical extraction method, a thick deposit is generally mined in benches or steps, although thin deposits may require only a single bench or face.

Strip ratio applies to an open pit mine, is the mass of waste to be mined to obtain one unit mass of ore.

**Strip ratio =$\frac{\text{waste}}{\text{Ore}}$**

Fig 2: open pit mine

b. **Open cast mining** is usually employed to exploit a near-surface deposit or one that has a low stripping ratio. It often necessitates a large capital investment but generally results in high productivity, low operating cost, and good safety conditions. Open cast mining
    - Lateral extraction and hence most suitable for shallow deposits
    - A strip of overburden is first removed to expose the underlying deposit
    - Deposits are then taken out following which another strip is prepared, with overburden being placed preceding strip

**c. Quarrying**, The term quarrying, of course, is very loosely applied to any of the surface mining operations but it should be confined to a surface mining method to mine out the dimensional stones such as slate, marble, granite etc. Quarrying is a highly specialized small-scale method, slow and the costliest of all mining methods. Only square set stopping method is as much expensive as quarrying.

**d**. **Auger mining**. Auger mining is a surface mining technique used to recover additional coal from a seam located behind a highwall produced either by stripping or open-pit mining. Augering is employed to recover coal from the highwall at the pit limit. This method is also specialized but involves low costs.

## 2. The aqueous extraction methods

Depend on water or another liquid (e.g., dilute sulfuric acid, weak cyanide solution, or ammonium carbonate) to extract the mineral. The deposits are sometimes located near the surface datum but covered by an aqueous body such as a lake, tank, river, or even by seawater. Mining of such deposits is also a part of surface mining practices. These are known as aqueous extraction methods.

The aqueous extraction methods must be provided with the access to water or an aqueous mixture during mining and processing. They recover the valuable mineral by jetting, slurrying, melting or dissolving.

- **Placer mining** is used to exploit loosely consolidated deposits like common sand and gravel or gravels containing gold, tin, diamonds, platinum, titanium, or coal. Placer mining Placer mining is used to mine mineral deposits that are not consolidated (combined/joined), such as sand, gravel or alluvium in which a valuable heavy mineral exists freely. It is an ancient method of using water to excavate, transport, concentrate, and recover heavy minerals from alluvial or placer deposits. Valuable heavy minerals such as diamonds, native gold, native platinum, and titanium can be found in placer form.

1. **Hydraulic king utilizes** a high-pressure stream of water that is directed against the mineral deposit (normally but not always a placer), undercutting it, and causing its removal by the erosive actions of the water.

2. **Dredging** performed from floating vessels, accomplishes the extraction of the minerals mechanically or hydraulically.


3. **Sluicing box**:

A sluice box is a channel equipped with a carpet. The gold-bearing material mixed with water flows over the surface of the sluice box and the gold stays trapped in the carpet. A sluice box allows processing more material than a pan. A long time ago, the carpet used to be made of animal skin. There are different designs and sizes of sluice boxes but they all follow the same principles.

It is possible to process:

- Mixtures of mud and sand from secondary deposits (soil, river sediments)
- Quartz ore (primary) that has been milled into a powder using a ball mill

**Sluice box types**

| American design | Kenyan / Tanzanian design |
|---|---|
|  |  |
| • Made of metal<br>• Carpet is held by a grill<br>• No sieve box | • Made of wood, or wood and metal<br>• Carpet made of blanket or coffee bags<br>• Easy to make<br>• Larger<br>• Has a sieve to help mix material with water and to remove stones |

**How to set the sluice box**

The sluice box must be set so that:

- The angle of the sluice box is about 12 to 15 degrees (it can be adjusted to achieve the desired water flow speed)
- The height of the sieve must be comfortable for the operator to add water and material.
- The sluice box must be placed near a source of water and the source of the gold-bearing material (pit, or mill if the material comes from a mill)
- The flow of water on the sluice box must be uniform (not on one side)
- The sluice box can be set on wooden legs, or on bags filled with soil, or using the terrain.

- **Solution mining:**

Solution mining Includes both borehole mining, such as the methods used to extract sodium chloride or sulfur, and leaching, either through drillholes or in dumps or heaps on the surface. Placer and solution mining are among the most economical of all mining methods but can only be applied to limited categories of mineral deposits. Solution mining employing surface or in situ techniques is used for deposits of minerals that can be excavated by dissolution as well as by melting, leaching, or slurring. The two methods are similar. Surface leaching employs heap or dump leaching of mineral values; copper, gold, and uranium are the examples. In situ mining uses water to dissolve, melt or slurry the minerals. The Barren solution is introduced down one set of wells and the loaded solution returns to the surface through concentric or another set of wells. This mining method is mainly used with sulphur, evaporate, or water-soluble minerals. In situ leaching utilizes chemical or bacteriological reagents, usually mixed

with water to selectively dissolve the valuable minerals. Drill holes are used to inject and recover the solution

| Self –Check-2 | Written Test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. How to set the sluice box? (4pts)
2. Define what quarry mean. (3pts)
3. What is the difference between open pit and open cast mining? (3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 3- Carrying out pre-start, start-up, park-up and shutdown procedures**

### 3.1 Pre-start planning:

Excavation and disposal operations require detailed planning and management. The complexity of the planning and design stage clearly depends on the scale and nature of the operation.

| Unit operation | Operational requirement | Support |
|---|---|---|
| Pre-operational period | • Environmental impact assessment | • Base-line monitoring<br>• Community consultation |
| Site preparation | • Site services (power/water/drainage)<br>• Site access/internal access/working platforms<br>• Temporary storage/recycling/materials treatment areas<br>• Disposal area (use below)<br>• Site security<br>• Wheel and vehicle washing<br>• Weigh bridge<br>• Haul roads<br>• Railway sidings | • Environmental protection measures (whole area, operational areas)<br>• Monitoring (equipments/support facilities)<br>• Health and safety requirement/emergency support area) |
| Excavation | • Depth and extent of excavation<br>• Means of controlling depth and extent of excavation (physical stability nature of strata degree of contamination)<br>• Size zoning/phasing (horizontally) vertically/ over time)<br>• Volumes, types and variability of material to be excavation | • Environmental protection (air/water protection measures, vehicle decontamination, temporary cover over excavation)<br>• Monitoring (QC an arising/recycled material/effluent, in support of health and environmental protection, in respect of residual contamination for partial excavation) |
| Excavation (Contd.) | • Rate of excavation (material flows)<br>• Number, types and variability of material to be handled<br>• Segregation, separation and dewatering needs<br>• Material flows<br>• Numbers and types of vehicles or other transport means<br>• Plant and equipment needs | • Health and safety (equipment/procedures)<br>• Record-keeping procedure |

Fig: Planning for excavation and disposal**:**

## 3.2 Dump site Reclamation Process

Dumpsite Reclamation or Mining is the process of excavating from operating or closed solid waste landfills, and sorting the unearthed materials for recycling, processing, or for other dispositions

Technically, dumpsite mining employs the method of open cast mining for sorting out the mixed material from the landfill according to their size by using a screening machine. The oversized materials are prescreened by another sorting machine which separates the larger objects like tyres and rocks from cardboards and other smaller unearthed materials.

### Unit operations

Unit operations related to surface mining may include most of the following activities.

- ✓ Site Preparation (cutting timber)
- ✓ Cleaning & Grubbing
- ✓ Top soil removal
- ✓ Transport top soil to storage or to direct replacement
- ✓ Prepare drilling bench
- ✓ Drilling
- ✓ Charging and blasting or ripping with dozer ripper
- ✓ Loading
- ✓ Transport of ore, eg., to process plant and waste to “waste rock dump”
- ✓ Reclamation that may involve loading, transport, leveling, profiling, etc.

### 3.2.1 Top soil Removal:

In mining, **overburden** refers to all unprofitable material that needs to be excavated to access an ore deposit, including topsoil and overburden. Overburden refers to the consolidated material underlying the topsoil and generally overlying the ore body. **Topsoil** refers to the layer of unconsolidated material at the surface that is suitable for sustaining plant growth. Because of the unconsolidated nature of topsoil, it often requires different excavation techniques. Depending on climate, topography, and

bedrock geology, topsoil can vary from anywhere between centimeters and tens of meters thick.

• As topsoil is generally free digging, scrapers, bulldozers, front-end loaders, and small hydraulic excavators are the most common equipment used in topsoil stripping. Bulldozers can be used for pushing material onto piles for further excavation by front-end loaders or hydraulic Excavators. Alternatively, Graders are mostly used for precision applications such as haul road construction

### 2.2.2 Objectives of Dumpsite mining

• Conservation of landfill space.

• Reduction in landfill area.

• Elimination of potential contamination source.

• Rehabilitation of dump sites.

• Energy recovery from recovered wastes.

• Reuse of recovered materials.

• Reduction in waste management costs.

• Redevelopment of landfill sites.

Fig 1: Waste Rock Pile

| Self-Check – 3 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the Unit operations of mining .(4pts)
2. Define what overburden mean.(3pts)
3. What is the Objectives of Dump site mining?(3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 4- environmental requirements and constraints related to reclaim operations**

## 4.1 Introduction

The general environmental impacts associated with mineral extraction refer to the effects of processing chemicals on the environment and to a lesser extent, on air pollution and noise pollution during mechanical extraction processes. Other forms of air pollution can also occur during metallurgical processes where heavy metals and other toxic elements are introduced into the atmosphere.

## 4.2 Environmental, Health, and Safety Requirement:

**1. Biodiversity/Flora/Fauna/Ecosystem:** To maintain representation, diversity, viability and ecological function at the species, population and community level.

**2. Water resources** To maintain the hydrological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including ecosystem maintenance, are protected.

**3. Landforms** Mining will not result in appreciable land degradation or the contamination or pollution of the land.

**4. Mine closure** Mines are closed in a manner to make them (physically) safe to humans and animals, (geo-technically) stable, (geo-chemically) non-polluting/ non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State.

Fig1: Gold ore processing within the river using sluice box

**Management of impacts on air**

- Particulate matter (dust) may be reduced by methods such as
  - cleaner smelting technologies
  - removing stockpiles from nearby residential areas
  - establishing greenbelts between mines and residential communities
  - dampening roads
  - covering concentrate storage facilities
  - continuous monitoring of dust and weather conditions

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## Impacts on Water

- One impact of mining is to bring to the surface large quantities of minerals that are unstable in the weathering environment.
- In particular, sulphide minerals in waste rock and tailings react to form **sulphuric acid ($H_2SO_4$).**
- The resulting acidic runoff can be devastating to the surrounding ecosystem.
- Runoff from mines may also have enhanced levels of metals such as **arsenic, copper, lead, iron, cadmium and nickel**.

**Acid mine drainage** (**AMD**),

Acid Mine Drainage (AMD) refers to the outflow of acidic water from (usually) abandoned metal mines or coal mines.

In many localities the liquid that drains from coal stocks, coal handling facilities, coal washeries, and even coal waste tips can be highly acidic

After being exposed to air and water, oxidation of metal sulfides (often pyrite) occur within the surrounding rock and overburden generates acidity


***Recommendations for environmental management***

- Sufficient distance from vulnerable natural areas (including forests, historical sites, water resources etc.)
- Environmental management system to ensure environmental responsibility
- Wastes of hazardous products should be treated properly
- Measure for reduction of discharges to the air
- Location of discharge outlets for waste water, and of chimneys to ensure dispersal of discharge substances
- Plan of operation which considers short and long-term pollution.
- Tailing ponds of adequate dimensions to withstand natural disasters
- Rehabilitation measures upon closure - sinking fund account
- Geology of the area taken into account to prevent cave-ins or landslides Safety zones around open pit mining facilities
- Water consumption to be in accordance with existing water use in the area Utilise environmentally friendly technology

| Self-Check – 4 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the Recommendations for environmental management. (4pts)
2. Define what Acid mine drainage mean.(3pts)
3. What is the importance of Environmental Management of sites?(3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 5- Monitoring systems and alarms requirements**

### 5.1 Introduction:-

Alarms used to alert vehicle drivers and workers on foot to dangerous situations must stand out from the normal working environment

### 5.2 Design Considerations for Alarm System:-

The sensing zone installed on the back of a haul truck. Alarms used to alert vehicle drivers and workers on foot to dangerous situations must stand out from the normal working environment. Ambient noise levels, lighting, and placement of alarm devices should be carefully considered. Creative alarming devices such as a tugging seat belt, vibrating steering wheels, and pager-type vibrating devices may be helpful. False (nuisance) alarms could cause workers to ignore the alarms over time. Maintenance and testing should be done regularly to ensure confidence in the safety system. It is applicable for explosive storage, office building, etc. Alarm signal transmit an display on the screen of the computer through alarm software. It is suitable for the miners on duty center. The alarm center monitors the state of the host and the zones through the internal network. It can also be applied to centralized management of chain super markets, franchise stores.

Design should consider:

- Alarm types,
- Nuisance alarms,
- Environmental effects,
- Safety assessments,
- Fail-safe operation,
- Electrical interference,
- Operating range,
- Sensor orientation,
- Activation latencies,
- Vehicles speeds,

- Worker exposures,
- Multiple device activation,
- Explosives ignition hazards, and
- Intrinsic safety issues.

### 5.3 Purpose of common Site and Workplace Alarms

- To prevent or minimize physical and economic loss.
- Used in workplaces to give an audible or visual warning about a problem or condition.
- Reversing vehicle alarm is used to warn site users that a vehicle is reversing and the driver may have restricted vision.
- Flashing or rotating light on an item of plant is used to warn site users that the plant is operating and the operator may be concentrating on the job in hand and may not be aware of persons in the vicinity
- Smoke detector is used for the early detection of fire through identifying smoke in the area
- Evacuation air horn alarm is a distinctive sound used to cut through ambient noise and warn site users to assemble at the evacuation point

| Self-Check -5 | Written Test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the requirements of Monitoring systems and alarms in mine area?
2. Define what mean a Alarm.
3. What is the Purpose of common Site and Workplace Alarms?

***Note:*** **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 6- Loading, sampling and dispatching specified materials**

## 6.1 Sampling and dispatching specified materials:

**Sampling considerations:** The siting of sampling points at strategic locations is of major importance.

The following considerations are applicable:

- Samples should be taken from boreholes only when they breathe out and when it can be ensured that the borehole is leak free.
- Samples should be taken up the gradient from a fire near the roof because hot gases rise.
- Samples should be taken in by a ventilation door to avoid leakage.
- All sampling points should be clearly shown on maps of schematics of the mine ventilation system.

Taking gas samples underground or from surface boreholes for analysis at another location is difficult and error prone.

The sample in the bag or container must truly represent the atmosphere at the sampling point.

**Dispatching** refers to the activity to assign the next job to be processed from a set of jobs awaiting service. An essential difference between dispatching and planning is that dispatching makes decisions for immediate actions, but planning makes decisions for future activities. Depending on the dispatching policy, a production system can be either classified as a pull or push system.

The main functions of dispatching are to determine the priority, to set the best order, to make instructions, and to control the process. The Material to be dispatched is available in the Stock.

### 6.1.1 Sampling and weighing the ore:

Sampling is defined as taking a small portion of a whole mass that accurately represents the whole mass. Since this site is primarily concerned with mining and

mining issues. Ideally, weighing and sampling should be carried out before the material is subject to losses in the mill.

| Self-Check – 6 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is sampling? (4pts)
2. Define what dispatching mean.(3pts)
3. What is the importance of RQD?(3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 7- waste dump management processes**

### 7.1 Introduction:

Mine wastes are a broad group of waste materials resulting from the extraction of metals and non-metals. The wastes include solid, as well as liquid waste, and can be inert or can contain hazardous constituents. In general, mine waste consists of high volume, low toxicity wastes.

### 7. 2 Dump design

Geotechnical properties of dump and base ground material properties are one of the important input for slope stability investigations. Cohesion (c), internal friction angle ( ), and unit volume weight ( ) are geotechnical parameters used in limit equilibrium analyses of slope stability. Mainly two distinct material are defined. The first one is the dump material while the other one is called as base ground. The steeper a pit wall is, the more likely it is to collapse. This can not only hurt or kill people, but it will also stop or delay production. Wall collapse must be avoided. This is done by choosing a pit slope angle which will be stable (which will not collapse).

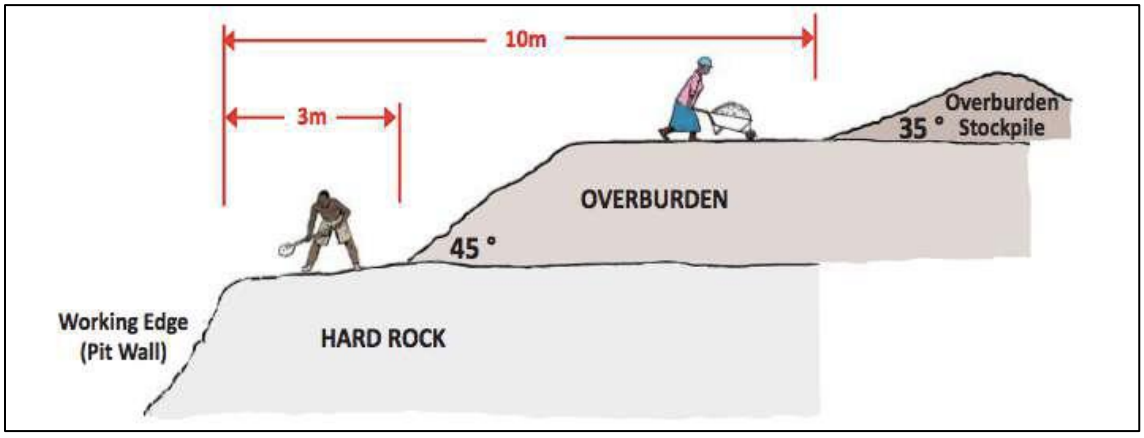
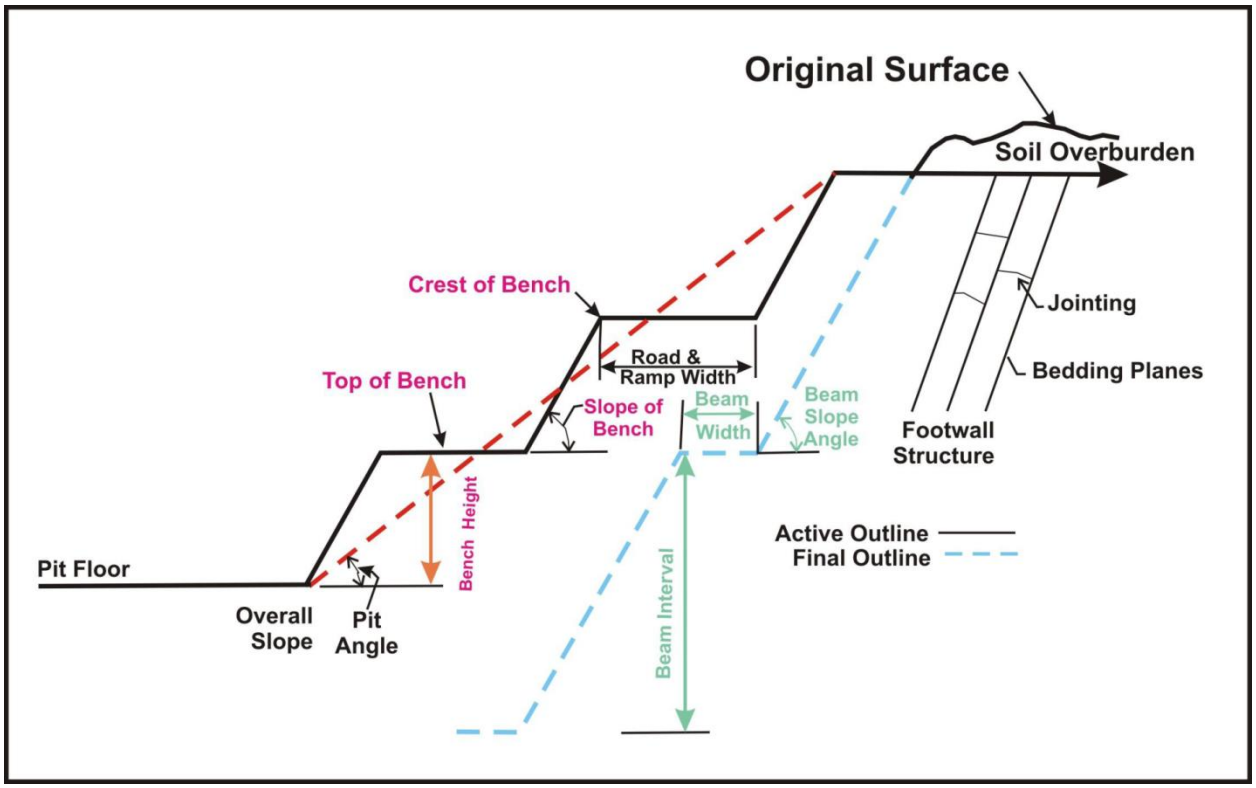
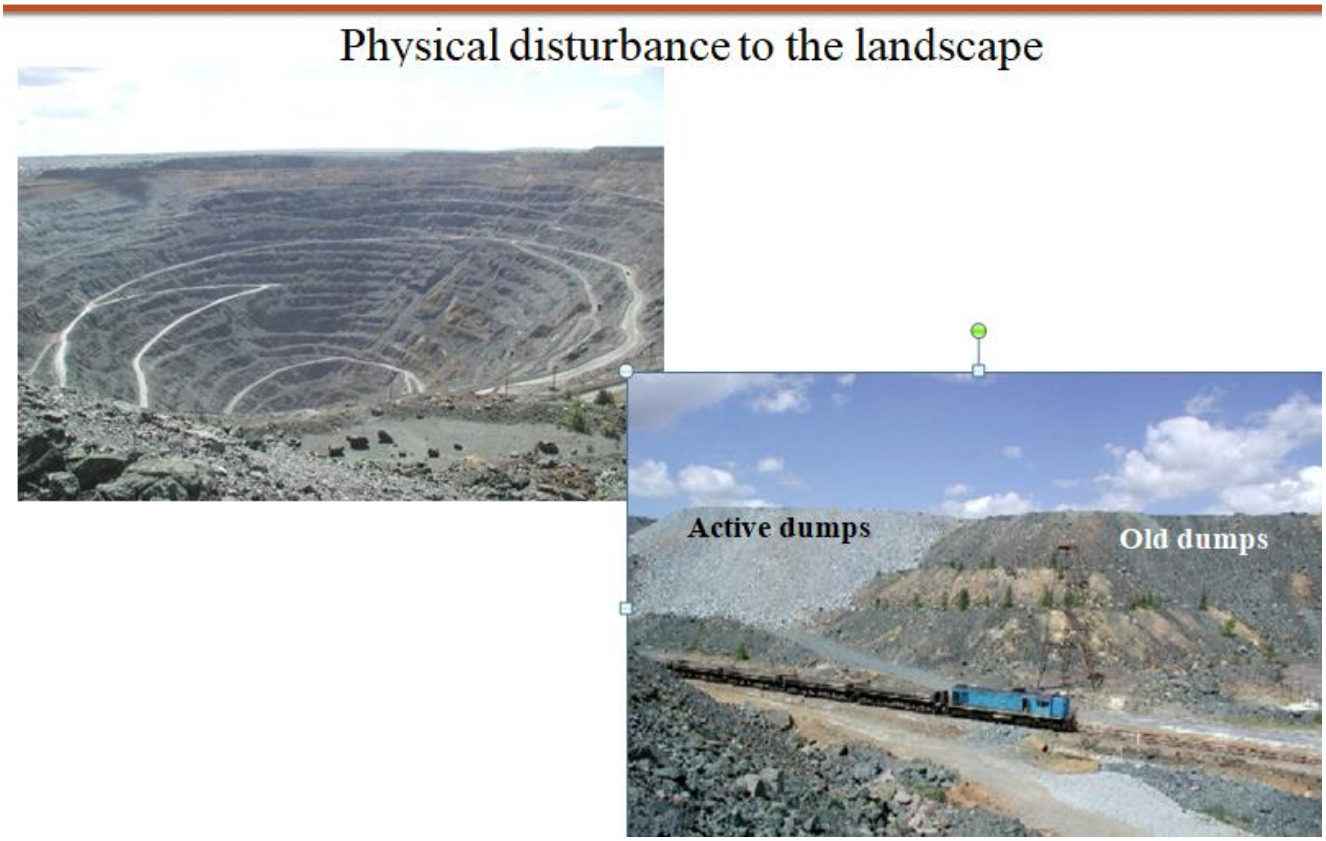



Fig 1 Ideal (safe) design of an open pit wall

General consideration

- Overall Slope Angle
- Slope Angle
- Slope Height (m)
- Slope Width (m)
- Maximum Elevation (m)
- Total Damp Volume (million m3 )
- Site selection for mine waste dump
- Environmental considertion






**In dump designing, costs may be governed by any or all of the following factors**:

- **Geometry**: Usually designed to handle a total capacity throughout the life-of-mine. Over-dimensioning can cause underutilization of valuable areas. Under dimensioning can result in the increase of the total haulage distances.
- **Operating costs**: Costs resulting from fuel, energy, maintenance and labour of the haul trucks.
- **Haulage distances**: Minimizing the total haulage distance while meeting the required capacity by strategic placing of the ramps, exits, entrances and dumping

sequence.

- **Stability control**: It will define the angle of repose and the nature of the underlying material. Maintaining the stability of the dump may require relocation of weathered rock or material blending, especially if water is present.
- If it is a dump leach, a leaching cycle time will define the mining delivery rate and dumping schedule. Ideally, deliveries rate from the mine should match the leaching cycle times of the dump. Otherwise, there is a risk of short cycling and losing on mineral recoveries.
- Acquisition of the land permit for dumping purposes as specified by law.
- Environmental factors: costs of implementing and maintaining effective systems to reduce and eliminate loses and contamination.

Fig 1: mine's waste rock and tailings management plans.

| Self-Check – 7 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What it the difference between slope angle and over slope angle.(4pts)
2. Define what pit slope mean.(3pts)
3. List down the Dump design considerations?(3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

## 8.1 Emergency

An emergency is any unforeseen event which has the potential to:

1. Cause death or injury to employees, customers or members of the general public

2. Disrupt or shut down business operations

3. Physically damage equipment and/or the environment

**Emergency management**

Emergency management is the process of:

1. Planning and preparing for an emergency

2. Organizing a response to an emergency

3. Recovering from an emergency

**Uses emergency response plan are:**

1. Preservation of life is always the first and most important goal of emergency response.

2. An objective of any plan is the protection of the health and safety of employees, emergency responders and the general public.

3. Emergency plans are required by legislation

4. In the event of a disaster it would be difficult to prove “due diligence” without proof of the prior existence of an emergency response plan and the equipment and training required.

5. An emergency response plan is intended to control losses to people, equipment, materials and environment.

6. Having an emergency response plan and procedures can reduce a company's exposure to civil or criminal liability in the event of an incident and may reduce insurance premiums.

Nine Steps to developing an Emergency Response Plan

1. Establish a planning team
2. Evaluate current plans, procedures and incident or drill records
3. Identify hazards, estimate probability and assess potential impact on people, property and business.
4. Identify emergency resources
5. Review codes and regulations

Some emergency situations may be caused or complicated by failing to follow the dictates of one or more codes of practice. Legislation is in place to direct companies on procedures to follow and notification to be given in case of an emergency

6. Develop training programs.

Everyone who works for the company requires some type of training. Even contractors and visitors may require some emergency response training and orientation.

7. Develop a communication strategy.

Effective communication is essential to report emergencies to first response support teams, employees, neighboring businesses and residences, the community, news media and other interested parties such as employees' families and company customers. Even a temporary communication disruption can have a serious effect on the response process.

8. Write the plan.

Every component of every emergency response plan requires the approval of some level of management. Plan development will proceed more smoothly and with fewer

revisions if the approvals process and deadlines are established and understood beforehand.

9. Implement the plan.

There are several aspects to plan implementation:

Management can indicate its “buy-in” to the plan by adding a launch

- covering letter signed and dated by the most senior manager for the site or operation The employee introduction to the emergency plan may take place through
- safety meetings, orientation meetings or specific training programs Emergency preparedness information from the plan may be distributed or
- promoted through posters, bulletin board showings and employee newsletters Supervisors should make a habit of asking employees what they would do if
- a fire (explosion, hurricane, etc) occurred. Plan implementation should include a launch with police, fire, medical and
- other support service

### 8.2. Hazard occurred during waste and tailing dump reclaiming

- **Sliding waste dump** leads to pollution of the surrounding environment. Toxins or hazardous material infiltrating soil and drink water threaten the health of local residents.
- **Tailing failure**: the materials lefts over after the process of separating the desired product from an ore. They often consist of fine particles suspended in water which have the potential to damage the environment by releasing toxic metal causing erosion and sinkholes, and contaminating soil and waters.
- spontaneous combustion
- wet weather operations
- belt systems fires
- electrical fires
- working with other equipment

Fig .waste dump

| Self-Check – 8 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the impacts of mine development. (4pts)
2. Define what mine emergency.(3pts)
3. How to develop an Emergency Response Plan?3pts)

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

## 9.1 Site preparation and clearing

If a mine site is located in a remote, undeveloped area, the project proponent may need to begin by clearing land for the construction of staging areas that would house project personnel and equipment. Even before any land is mined, activities associated with site preparation and clearing can have significant environmental impacts, especially if they are within or adjacent to ecologically sensitive areas. The EIA must assess, separately, the impacts associated with site preparation and clearing.

### Active mining

Once a mining company has constructed access roads and prepared staging areas that would house project personnel and equipment, mining may commence. All types of active mining share a common aspect: the extraction and concentration (or beneficiation) of a metal from the earth. Proposed mining projects differ considerably in the proposed method for extracting and concentrating the metallic ore.

## 9.2 Site selection factors

- Regulatory and social factors
- Mining factors
- Terrain and geology factors
- Environmental factors
- Geotechnical factors
- Fill material quality factors
- Closure factors

### Mining factors

Mining-specific factors that should be considered in the site selection process include:

- ✓ Proximity
- ✓ Access

- ✓ Mining method
- ✓ Haul road grades
- ✓ Equipment options
- ✓ Capacity
- ✓ Alternative uses
- ✓ Mineral potential.

**Terrain and geology factors**

The terrain and geology category includes factors related to the overall geography and engineering geology of the site, including:

- ➢ Topography
- ➢ Geomorphology
- ➢ Natural hazards
- ➢ Bedrock geology
- ➢ Surficial geology
- ➢ Glaciology.

**Environmental factors**

The key environmental factors that are important to consider in the site selection process include:

- ■ Climate
- ■ Vegetation
- ■ Hydrology
- ■ Hydrogeology
- ■ Water quality
- ■ Dust
- ■ Habitat.

## Geotechnical factors

Geotechnical factors include those aspects of the site that may impact the competency and stability of the waste dump or stockpile foundation:

- Foundation slope
- foundation shape
- overburden type
- overburden thickness
- bedrock competency
- Ground water conditions.

| Self-Check – 9 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write down the Site preparation and clearing procedures.(4pts)
2. What Active mining mean .(3pts)
3. Mention some of the Mining factors3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

| LG #52 | LO #3- Carry out operator maintenance |
|---|---|

## Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Manufacturer's service manual and organizational guidelines
- Carrying out plant and equipment inspections
- Carrying out routine operational servicing, maintenance and housekeeping
- Inspecting structures and components visually
- Processing, reporting and filing maintenance records

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Manufacturer's service manual and organizational guidelines
- Carry out plant and equipment inspections
- Carry out routine operational servicing, maintenance and housekeeping
- Inspect structures and components visually
- Process, report and filing maintenance records

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish from “Self-check 1 up to Self-check 6.
5. Ask your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check).
6. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation

Sheet.

7. Submit your accomplished Self-check. This will form part of your training portfolio.

**Information Sheet 1- Manufacturer's service manual and organizational guidelines**

### 1.1Introduction:-

The main purpose design waste dump area for an open pit mine based on slope stability principles as per the design works of open pit bench and overall slope angle. Therefore, geotechnical properties of dump material as well as ground must be primarily determined. Hydrogeology as well as seismicity which have important effect on the stability should be also part of stability works.

### 1.2 Organization management

Organization management is a multi-disciplinary field that focuses on managing all aspects of an organization's operations. "The typical organization consists of the integration of many different functions; the two most obvious functions are to provide the product or service and to sell the product or service. Operations management focuses on the function of providing the product or service. Operations managers apply ideas and technologies to increase productivity and reduce costs, improve flexibility to meet rapidly changing customer needs, enhance product quality, and improve customer service.

### 1.3 Manufacturer's service manual:

Open-pit mines create a significant amount of waste. The four main operations in a mine that contribute to this load: drilling, blasting, loading and hauling. Waste rock is hauled to a waste dump. Waste dumps can be piled at the surface of the active pit, or in previously mined pits. Leftover waste from processing the ore is called tailings, and is generally in the form of slurry. This is pumped to a tailings dam or settling pond, where the water is reused or evaporated. Tailings dams can be toxic due to the presence of un extracted sulfide minerals, some forms of toxic minerals in the gangue, and often cyanide which is used to treat gold ore via the cyanide leach process. If proper environmental protections are not in place, this toxicity can harm the surrounding environment.

**The basic geometric elements of the internal dump as**:

- Height of dump,
- Number of bench,
- Minimum width of the bench in more benches dumps,
- Working angle of bench, - completed angle of bench,
- completed angle in one benches dump and
- Points of dumping.

The selection and definition of basic geometric elements of the internal dump is a function of:

- Configuration of the ground,
- Geotechnical characteristics of the base,
- planned total mass of waste for dumping,
- planned annual capacity of waste for dumping,
- Stability of slopes of the dumping and carrying of the base,
- Technical capabilities of available equipment, the methodology and mode of dumping (mining trucks and bulldozers).

**Mine Equipment's and Machinery selection considerations:**

- Material characteristics of the mine
- Loading equipment
- Haul route requirements
- Maneuvering space
- Dumping conditions
- Capacity
- The distance from the pit exit to the mine plant,
- The distance from the pit exit to the waste disposal area.
- Life of mine.
- General site condition aspects  Altitude  temperature range  Rainfall  type of terrain  power availability  site accessibility  skilled labor availability  convenience to manufacturers support facility

**Generally there are three primary considerations**:

**Productivity**: We must be able to produce enough ore to satisfy requirements.

**Cost**: We want to keep purchasing and operating costs as low as possible.

**Compatibility**: The trucks and loaders must be able to work together. Not all trucks and loaders are compatible!

Grader, front end loader,
Grader and ripper, truck,
Conveyor, hydraulic shovel,
Scraper, drilling rig,
Dumper, sin truck, water spray machine

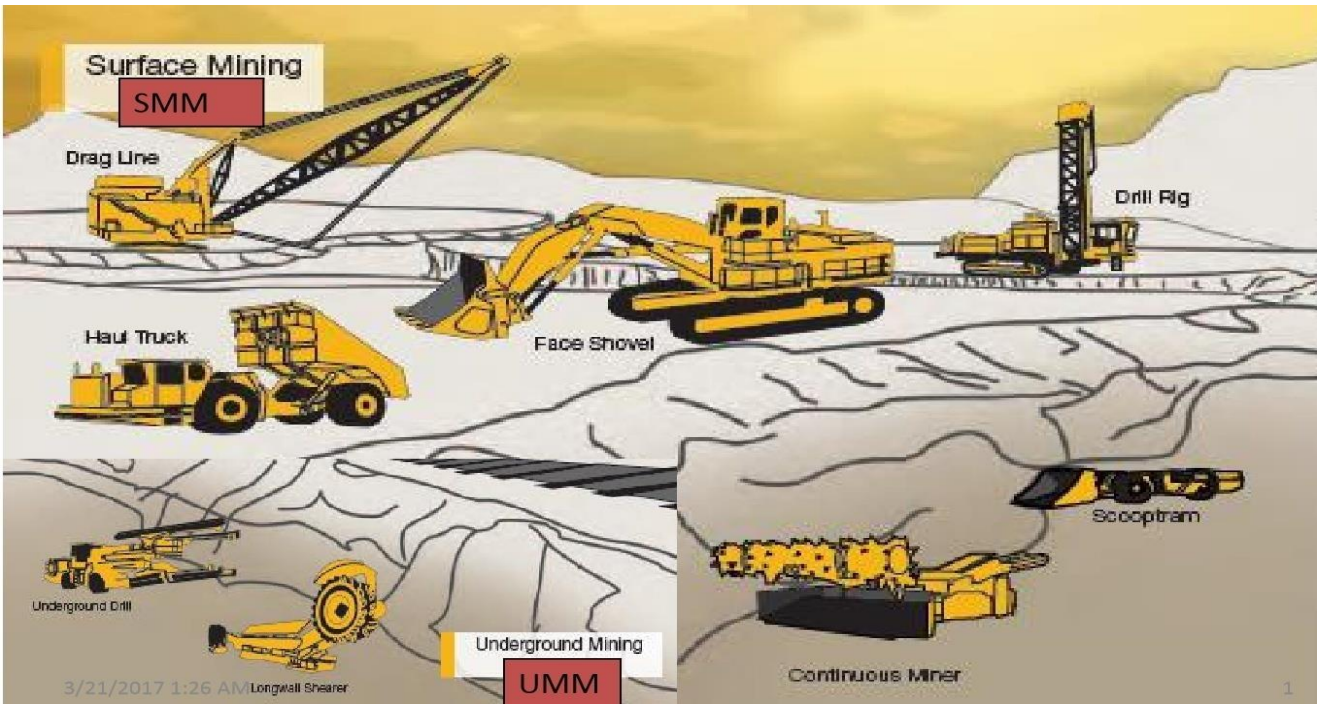



Fig 1 : mine equipment and machinery

| Self-Check – 1 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the Mine Equipment's and Machinery. (4pts)
2. List down The basic geometric elements of the internal dump.(3pts)
3. What are considerations for mine Equipment's and Machinery selection? (3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 2- Carrying out plant and equipment inspections**

## 2.1 Introduction

**GEOLOGY – MINING – PROCESSING**

All 3 aspects must be favorable to make a deposit economically viable

**Geology**: Find it. Is it big enough to be economic? (Conduct a geological survey and estimate the ore reserves, their quality and tenor).

**Mining:** Dig it. Is it economically recoverable from the ground? (Mine the ore and bring it to the surface of the earth).

**Processing**: Extract it. Is it economically separable from the host rock? ( beneficiate the ore to higher tenor. Thus beneficiated ore, if it is metallic ore, is smelted and the metal is extracted which is further utilized for the production of alloys).

### 2.1 Mine plant:

While the mineral processing industry was in its early years of development, most mineral processing plants adopted low-level tailings management mode due to the limited economic level and ore beneficiation technology, which not only increased the amount of tailings discharge, but also caused mine resources waste. Nowadays, with the gradual exhaustion of mine resources, and the development of mineral processing technology, the issue of tailings reprocessing technology becomes more and more outstanding. Tailings reprocessing technology means higher demands on mining enterprise, especially in tailings test, technological innovation, energy-saving and capital investment. For the majority of mining companies, they can't afford these huge capital investment and strict technical requirements.

**Processing –**

- Extract values, reject waste
- Conversion of mined ore into usable product
- More expensive/challenging with lower grade ores
- Numerous processing methods

1. **Comminution**: Reduction of particle size starts at mine with blasting

The following are some of the objectives of comminution:

- Reduction of large lumps into small pieces.
- Production of solids of desired size range.
- Liberation of valuable minerals from gangue minerals.
- Preparation of feed material for different beneficiation operations.
- Increasing the surface area for chemical reaction.
- Convenience in handling and transportation

- Two basic types of equipment used:
  - Crushing – breakage by compression
  - Grinding – breakage by abrasion and impact

| Self-Check – 2 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the objectives of comminution.(4pts)
2. Define what a Comminution mean.(3pts)
3. **What is the difference between crushing and grinding**?(3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 3- Carrying out routine operational servicing, maintenance and housekeeping**

### 3.1 Equipment maintenance

Tools and equipment must be maintained if they are to be operated in a safe and effective manner.

- Elements of good maintenance requirements include:
  - ✓ Inspection of the tools and equipment at must occur checkout or start-up of the job.
  - ✓ Inspection of tools and equipment must also occur at check in or at completion of the job.
  - ✓ Routine maintenance as per the manufacturer's requirements should be carried out.
- **Important of maintenance of equipment**
  - ✓ It assures optimal working conditions
  - ✓ Conserves the life span of the equipment
  - ✓ A planned preventive maintenance may cause small hindrance for production, but that is nothing compared to actual downtime caused by a breakdown.

**Benefits of Proper Storage of Tools and Equipment:**

- Tools and parts are kept in good condition and are easy to find
- Costs are reduced
- Productivity is increased because time is not lost looking for tools, parts and equipment
- Workshop staffs develop a sense of responsibility and pride in their work .How?
  - ✓ Workshop staff identify tools, parts and equipment
  - ✓ Work shop staffs develop a system.

### 3.2 Housekeeping tasks:-

Maintaining a clean and tidy site with well organized operations, equipment and stores is an important part of a good housekeeping program.

- Poor housekeeping at a drilling operation, including the camp, can lead to injuries, fires and damage to health.
- Performing emergency evacuation; and practicing good housekeeping in the workplace according to environmental plan, government legislation, company standards and manufacturer specifications.
- Performing emergency shutdown; working around mobile equipment; working around rotating, stationary and portable equipment; working from tower/elevated work platform; lifting and carrying materials and/or supplies manually; locking out and tagging mobile and fixed equipment.
- Maintain good housekeeping practices, store sampling supplies, coolers, tools, and equipment orderly and out of the main traffic area to avoid unnecessary slip, trip, and fall hazards.
- Good housekeeping is a proactive approach to keeping the job-site clean which in-turn reduces accidents and injuries. A clean work environment adds to drilling speed and efficiency. Customers like it when you keep and leave a work-site clean because it shows professionalism. Together, good housekeeping improves working conditions and safety practices. Every crewmember should inspect the work site upon his arrival to assure that equipment is in safe condition and the job site is in proper order. Return the job site to proper order prior to proceeding with work. Housekeeping means cleaning-up, which is an ongoing part of drilling, rather than an occasional activity.

| Self-Check – 3 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down some of the Benefits of Proper Storage of Tools and Equipment.(4pts)
2. Define what a house keeping mean. (4pts)
3. Write down the procedures of Equipment maintenance.(2pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

### 4.1 Tailing Disposal

Tailings are the residue of the milling process used to extract metals of interest from mined ores or to clean coal. During this process, ores are milled and finely ground, and then treated in a flotation and/or hydrometallurgical plant. The extracted metal represents a small percentage of the whole ore mass and so, the vast majority of the mined material ends up as finely-ground slurry.

Tailings contain all other constituents of the ore except for the majority of the extracted metal. These consist of heavy metals and other substances at concentration levels that can be toxic to bio-diversity in the environment. Moreover, tailings contain the chemicals added during the milling process, although these levels and types are generally not of major concern. After milling, these contaminants are better available for dispersion into the environment than in the original ore because of their finer particle size and higher surface area. Furthermore, the mechanical stability of the tailings mass is poor because its small grain size and high water content.

Fig 1: Tailing dam

### 4.1.1 Tailing impoundments

Most mill tailings produced worldwide are dumped in large surface impoundments ("Tailing dams"). In other cases, tailings are processed for use as backfill in undergrounds mine workings. The embankments of these large impoundments are typically constructed as earth-fill dams. Although water-retention dams are suitable for use, their cost is too high. Unlike water-retention dams, tailings dams usually are not initially constructed to completion but rather, are raised sequentially as the impoundment fills.

The tailings dam shall be constructed to hold a total volume of 150 thousand cubic meter of solid residue and the dam has to be protected from run of water during rainy season.

Fig 1: Tailing dam at Ezana gold mining

**Requirements for site selection, construction, operation and monitoring of tailings dams**

These requirements include:

- An environmental impact study,

- Compliance with laws governing the preservation of historical or cultural heritage,
- Assurance that there will be no percolation of toxic leachates to the nearest aquifer or surface water body
- Approved plans for surface and groundwater monitoring,
- Detailed characterisation of the underlying geological structure and the mechanical properties of rock formations and soil deposits,
- Land surveys of the site to delineate elevations and features such as roadways and pipelines,
- Monitoring instruments for dams

**Properties of Tailings**

Tailing Types: copper, gold, iron ore, bauxite, oil sands, massive sulphide, phosphate, laterite nickel

- ✓ Geotechnical Properties: settling and consolidation behavior, permeability, gradation, plasticity,
- ✓ Geochemistry: ARD potential, neutral leaching
- ✓ Process Modifications: water (thickening, paste, dewatered); geochemistry (sulphide floatation)

- Function of Tailings Impoundments
  - ✓ Safe storage of tailings solids & process water
  - ✓ Sedimentation & clarification of water for reclaim to process plant
  - ✓ Store & attenuate floods at mine site
  - ✓ Mitigate Acid Rock Drainage(ARD)

**Important Attributes of a Tailings Site**

1. **Small catchment area**
   - Enables safe management of storm water
   - Reasonably sized diversion systems
   - Improves water balance & treatment requirements
2. **Good foundations**
   - Dense and low permeability soils and bedrock preferred
   - Enhances dam stability and reduces seepage losses

### 3. Lack of geo hazards

- Absence of slope instabilities, avalanche chutes, debris flows and steep & unstable terrain
- Improves security and performance of diversions, tailings pipelines & workers

### 4. Topography and Location

- Wide valleys preferred over steep incised valleys
- Lower dam heights
- Improved ability to manage water

**Tailings and risk**

- Tailings storage facilities must meet operator and public health and safety, community, and environmental protection objectives.
- These objectives can only be met if tailings storage facilities are designed, operated, closed and rehabilitated to a level of risk that is acceptable to stakeholders for the full operating life of the facility and beyond.
- Management strategies need to be risk-based and account for the viewpoints and expectations of the communities in which companies operate.

The principal tailings-related risks to people and the environment can be characterised for the operational and closure phases.

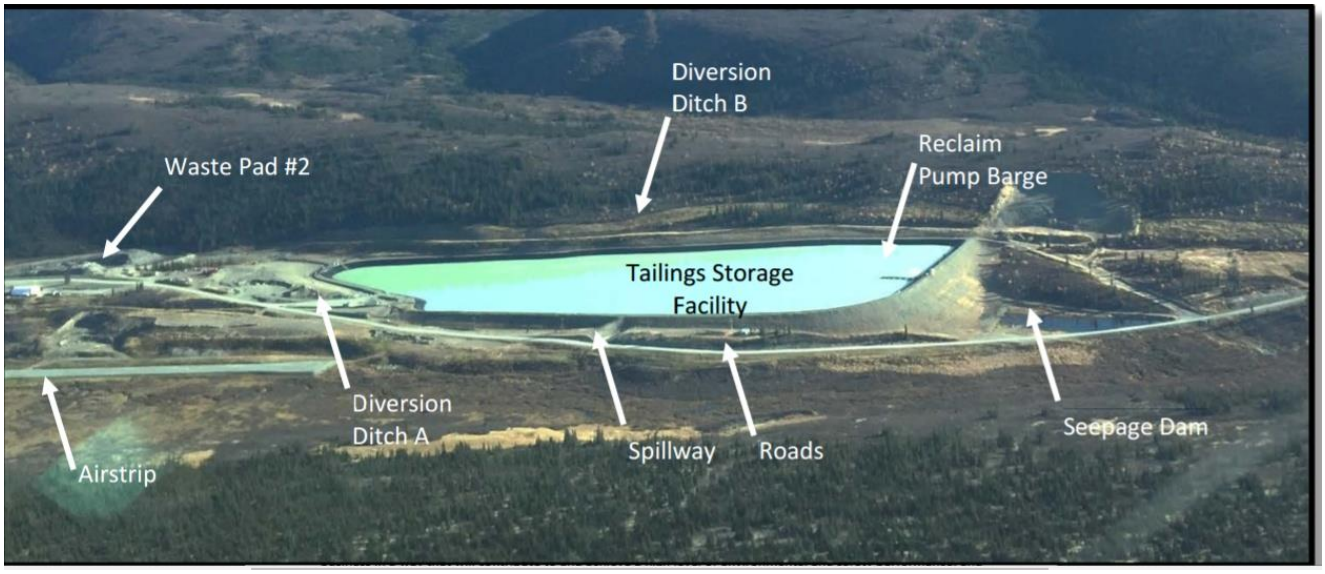



**Fig 2 : Tailing storage facility lay out**


Fig 3 : Industrial Complex Layout

| Self-Check – 4 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the Important Attributes of a Tailings Site.(4pts)
2. Define what pit slope mean.(3pts)
3. **What is the** Requirements for Tailing site selection, 3pts)

***Note:*** **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Information Sheet 5- Processing, reporting and filing maintenance records**

## 1.1 INTRODUCTION

In order to obtain the metals and other minerals needed for industrial processes, fertilizers, homes, cars, and other consumer products, large quantities of rock are mined, crushed, pulverized, and processed to recover metal and other mineral values. A fine grind is often necessary to release metals and minerals, so the mining industry produces enormous quantities of fine rock particles, in sizes ranging from sand-sized down to as low as a few microns. These fine-grained wastes are known as "tailings."

Figure 3 shows single and multiple cross-valley impoundment configurations.

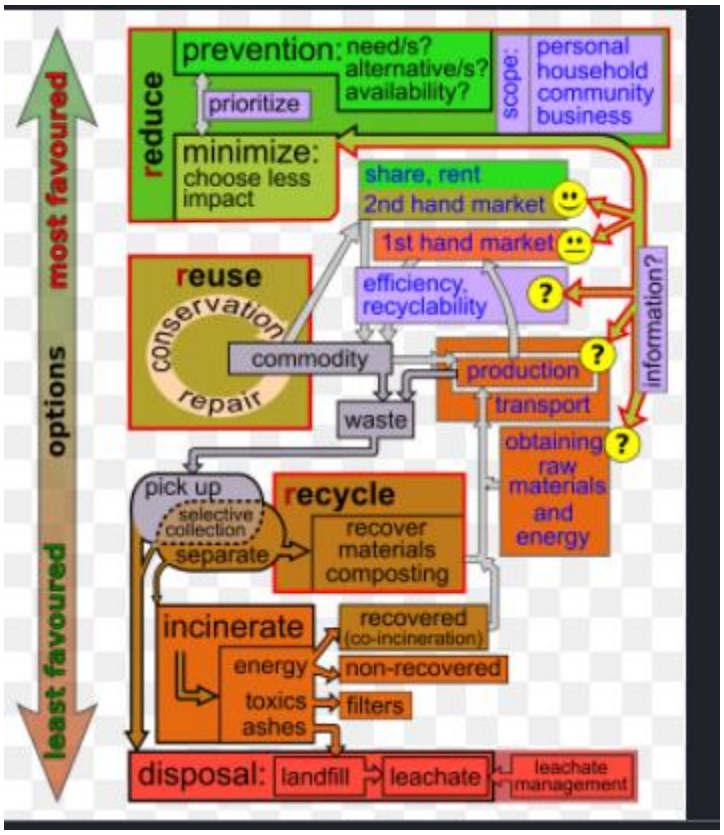



**Fig 1 : waste minimization**

### 1.2 Primary ore processing:

The objective of processing primary gold ore (quartz ore) is to separate the gold from the rest of the rock (quartz).

**Liberation** is the action of breaking the ore into pieces or grinding it into a powder so that the particle size of the ore is small enough that:

- all particles of milled ore are either quartz or gold
- no (or as few as possible) particles are mixed with both quartz and gold.

Liberation is very important in processing gold ore.

If liberation is not done properly (particles at the end of milling consist of gold mixed with quartz), the concentration process will not work and gold will be lost.

### Concentration

Once the milling is done and the gold has been liberated (freed), concentration is the action of separating the gold particles from the quartz particles.

**Crushing** is the action of breaking large pieces of quartz ore into smaller pieces.

The objective of crushing is to reduce the size of the quartz ore pieces so that they can be processed into a mill. Typically, the pieces of quartz ore should be about 15 mm in size.

During crushing, some dust is produced, and some gold is freed. It is important to recover all sizes of material produced by crushing as all will contain gold.

However, crushing alone is not sufficient to free all the gold contained in the ore. Milling is necessary.

Crushing can be done:

- Manually, by breaking the ore by hand using a hammer and an anvil (usually a slab of stone).
- Using a mechanized jaw crusher

### 1.3 Closure objectives

- containing/encapsulating the tailings to prevent their escape to the environment
- minimizing seepage of contaminated water from the tailings storage facility to surface and ground waters
- providing a stabilized surface cover to prevent erosion from the tailings storage facility
- Designing the final landform to minimise post-closure maintenance.

**Factors to consider during Closure**

- ore type and geochemistry, which will dictate the potential for the tailings to contaminate, taking into account the variable nature of the ore crushing, grinding, and the process and process chemicals used for ore extraction process water quality tailings disposal technique
- operating the tailings storage facility in preparation for closure, for example depositing benign tailings or discharging centrally to create a water shedding surface
- environment and climate in which the tailings storage facility is located
- post-closure land use
- closure cost estimation
- long-term landform stability, including geotechnical and erosional stability
- managing surface runoff and ponding, and the need for a closure spillway
- long-term seepage to the environment of potentially contaminated tailings water
- potential for dust generation both before and after rehabilitation
- the need for, desired function and selection of cover systems
- surface treatment and vegetation of the top of the tailings storage facility
- Profiling, surface treatment and vegetation of outer batter slopes.

**ENVIRONMENTAL MONITORING AFTER CLOSURE**

- Monitoring is carried out for physical stability, chemical stability, and for environmental impact. The purpose of post-closure monitoring is
- to evaluate the success of closure activities,

- to map out the actual environmental impact and the resulting changes in the environmental conditions in the impact area of a project

### 6.1 Mining waste management:

- The level and risk of contamination by contaminant from the facility is related to the characteristics deposited waste.
- In assessing the potential for loss-of-lives and serious danger to human health, the following factors should be considered :
  - The size and properties of the facility
  - The quantity and quality of the waste in the facility
  - The topography, including damping features such as, e.g., lakes
  - The travel time of the flood-wave to areas where people stay
  - The propagation velocity of the flood-wave
  - The water or slurry level
  - The rising rate of water or slurry levels

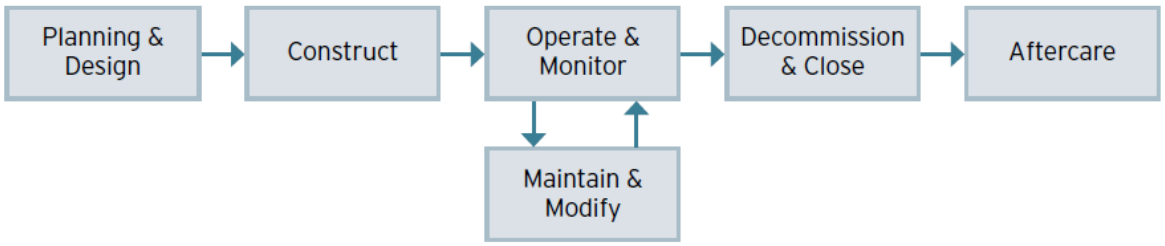



Fig 2 : Planning and design

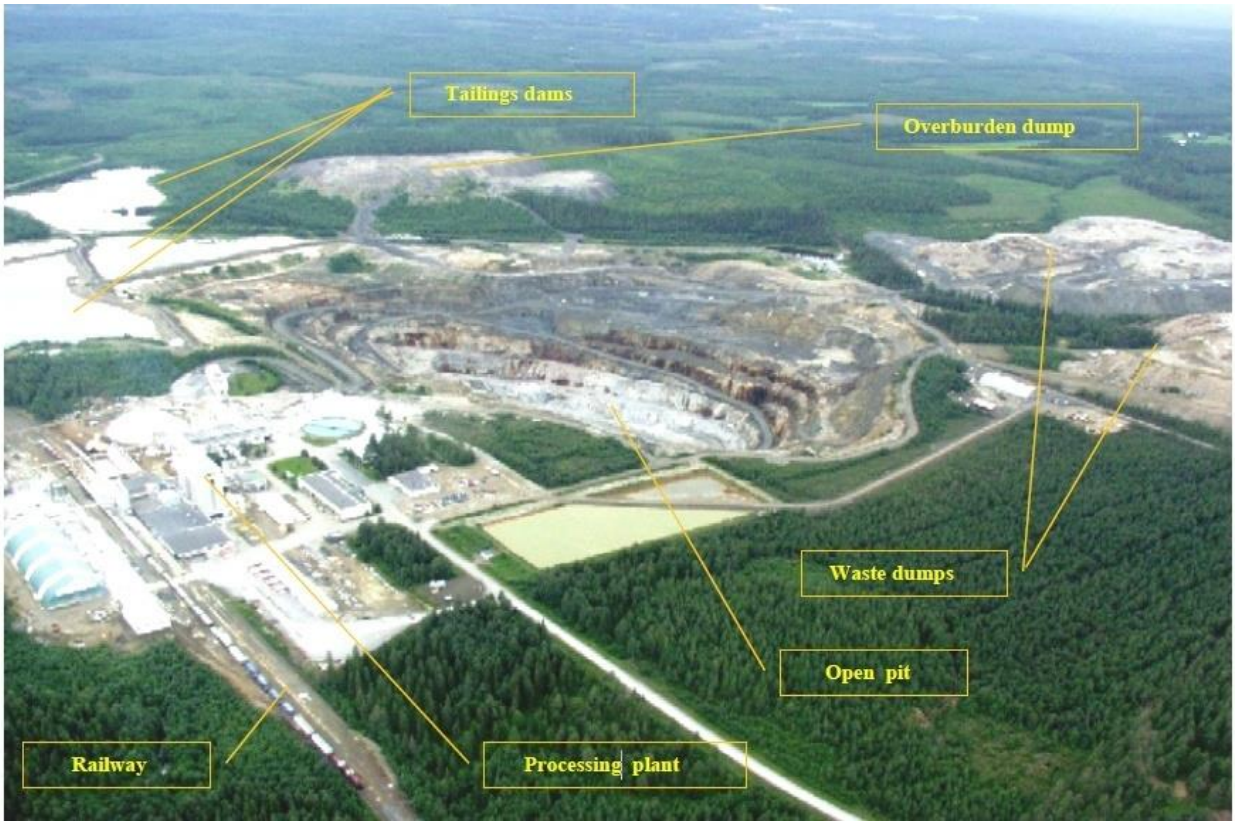



Fig 3: Main Surface Components of a Mine Site.

| Self-Check – 5 | Written test |
|---|---|

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define what Liberation mean.(3pts)
2. **What is the** objective of Closure?(3pts)
3. How to manage mine waste ?

***Note:*** **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

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**The trainers who developed the learning guide**

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