GOVERNMENT OF THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENTAL CONSERVATION

ENVIRONMENTAL CONSERVATION DEPARTMENT

Environmental Impact Assessment Guidelines for the Mining Sector

TECHNICAL GUIDANCE

ENIVIRONMENTAL IMPACT ASSESSMENT OF MINING

October 2018

Draft Working Document

Prepared by Myanmar Mining EIA Guidelines Working Group with the technical assistance of ADB TA 8786-MYA: Environmental Safeguard Institutional Strengthening

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Disclaimer:

This working document was prepared by consultants working under ADB TA 8786 MYA and for WWF. It does not provide an exhaustive or definitive treatment of the issues and subject matter. The information on good practices contained herein is based on subjective assessment of current practices in environmental impact assessment. The working document's interpretations and contents do not necessarily reflect the views of the Government of the Republic of Union of Myanmar, ADB's Board of Governors, or WWF. The Government of the Republic of Union of Myanmar, the Asian Development Bank, or WWF do not guarantee the accuracy of the information included in this work and accepts no responsibility for any consequences of its use.

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Environmental Impact Assessment Guidance for the Mining Sector

Environmental impact assessment guidance for the mining sector includes:

- Mineral Exploration: Guidelines for Preparation of an Environmental Management Plan
- Mining: Guidelines for Environmental Impact Assessment
- Technical Guidance for Environmental Impact Assessment of Mining
- Guide for Review of Environmental Assessment Documentation
- Guide for Preparing an Environmental Compliance Certificate for a Mining Project
- Guide for Environmental Compliance Monitoring and Inspection

Proponents and their consultants should select guidance that is most relevant to the proposed project, either guidance for exploration, new mines, or existing mines. When conducting the assessment of impacts, the more detailed *Technical Guidance for Environmental Impact Assessment of Mining* should be used as a reference.

Environmental Reviewers including Environmental Conservation Department (ECD) staff, ECD consultants, and members of the Interdepartmental EIA Review Committee should refer to *Guide for Review of Mining Environmental Assessment Documentation*.

ECD staff responsible for preparing Environmental Compliance Certificates should refer to *Guide for Preparing an Environmental Compliance Certificate for a Mining Project.*

ECD staff responsible for compliance monitoring and environmental and social staff of mining companies should refer to *Guide for Environmental Compliance Monitoring and Inspection.*

TABLE of CONTENTS

I. INTRODUCTION 1

II. PROJECT DESCRIPTION 2

A. Introduction 2

1. Project Purpose and Need 3
2. Project Location. 3
3. Basic Facilities, Components, and Activities 3
4. Site Layout. 3
5. Mine Development 3
6. Overview of Operations 4
7. Mining Method 5
8. Ore Processing, Treatment, and Final Products 7
9. By-products, Stockpiles, Dumps, and Tailing Ponds 10
10. Haulage and Transportation Facilities 10
11. Mine Power Supply and Support Facilities 12
12. Offsite Ancillary Facilities 12
13. Water Management Facilities 12
14. Restoration and Closure Plan 14
15. Employment, Local Hiring, and Local Purchasing 14
16. Effluents Discharges 14
17. Emissions 15
18. Solid Waste Treatment and Disposal System 15
19. Hazardous Waste 15
20. Project Development and Implementation Schedule 15
21. Construction Material and Equipment Use 15
22. Water Use 15
23. Energy Use 15

III. ANALYSIS OF ALTERNATIVES 16

A. Method 16

1. Identification of Alternative Technologies 17
2. Screening of alternative technologies 17
3. Identification of Alternative Locations 18
4. Screening Alternative Locations 18
5. Assessment of Environmental and Social Impacts 18

6. Comparative Evaluation of Alternatives 18
7. Approach 19
IV. ENVIRONMENTAL MANAGEMENT PLANNING 20
A. Environmental Management Principles and Requirements 20
B. Environmental Management Requirements in Myanmar EIA Procedures (2015) 21
C. Institutional Arrangements 21
D. Preparing and Environmental Management Plan. 23
E. Mitigation Measures 23
F. Environmental and Social Management Subplans 24
G. Developing Emergency Response Procedures 25
H. Designing Environmental Quality Monitoring Programs 26
1. Environmental Monitoring in Environmental Impact Assessment 26
2. Monitoring for Compliance with Environmental Quality Standards or Guidelines 26
3. Design of Environmental Monitoring Programs 26
I. Community Engagement and Community Development 27
J. Supervision and Monitoring for ECC Compliance and EMP Implementation 27
K. Staffing Requirements 27
L. Capacity Development and Training Needs 28
M. Cost Estimate and Scheduling 28
V. ENVIRONMENTAL MANAGEMENT SYSTEMS 30
A. Introduction 30
B. Objectives 30
C. Key Components of an Environmental Management System 31
D. ISO Environmental Management Systems Standards. (ISO 14000) 32
E. Why is an EMS important? 33
F. EMS and EIA 33
VI. COMMUNITY ENGAGEMENT AND COMMUNITY DEVELOPMENT 35
A. Community Engagement 35
B. From Community Engagement to Community Development 37
C. Community Development- Letpadaung Copper Mine Example. 39
VII. ASSESSING THE SIGNIFICANCE OF IMPACTS 41
A. Environmental Impact Defined 41
B. Determining Significance 41
VIII. RISK ASSESSMENT 47

IX. CUMULATIVE IMPACT ASSESSMENT 49
X. BIODIVERSITY ASSESSMENT 51
A. Mining, Ecosystems and Biodiversity. 52
1. Impacts on Biodiversity 52
2. Mitigation Hierarchy 53
3. Mining and Protected Areas 54
B. Myanmar Key Biodiversity Areas 55
C. Biodiversity Assessment 58
1. Establishing the Significance of Ecological Impacts 59
2. Biodiversity Action Plan 60
XI. AIR QUALITY, NOISE, AND VIBRATION 62
A. Air Quality Impacts 62
B. Mitigation Measures 64
C. Noise 65
D. Vibration 66
XII. MINE SITE GOOD PRACTICES 67
A. Topsoil Management 67
1. Existing Topsoil Resources 67
2. Topsoil Stripping 67
3. Topsoil Stockpiling 69
4. Erosion Potential and Control 70
5. Topsoil Application Procedure 72
6. Review and Improvement Process 73
B. Hazardous Materials 73
1. What are Hazardous Materials? 73
2. Process and general-use hazardous materials 74
3. Hazardous Materials Management 76
4. Example Hazardous Materials Handling and Storage - Letpadaung Copper Mine 77
C. Personal Protective Equipment 80
1. Head Protection 81
2. Eye and Face Protection 81
3. Ear Protection 82
4. Arm and Hand Protection 83
5. Torso Protection 83
6. Foot and Leg Protection 83

7. Respiratory Protection 84
8. Other Protective Equipment 84
9. Thermal Stress 85
XIII. WATER MANAGEMENT, WASTE ROCK MANAGEMENT, AND EROSION PREVENTION AND CONTROL 86
A. Water Management 86
1. Preparing the Environmental Baseline 86
2. Assessing Potential Environmental, Economic, and Social Impacts 91
3. Designing mitigation measures 92
B. Mine Waste Rock 93
1. Types of Solid Mine Waste 93
2. Environmental Impacts of Mine Waste 94
3. Mine Waste Characterization 94
4. Management of Mine Waste Impacts 96
C. Erosion Prevention and Control 103
1. Land Disturbance Evaluation 103
2. Land Disturbance Management 104
3. Land Disturbance Control Measures 104
XIV. MINE CLOSURE PLAN 106
A. Mine Closure Objectives 106
B. Impacts to Be Considered During Mine Closure Planning 106
C. Steps in Mine Closure Plan Development 107
D. Management of Waste Following Mine Closure 109
E. Typical Closure Plan Outline 109

APPENDICES

Appendix 1. Policy, Legal and Institutional Framework for Environmental Impact Assessment
Appendix 2. Institutional Framework for Environmental Assessment and Management of Mines
Appendix 3. International Environmental Agreements

I. INTRODUCTION

1. To support the development of environmentally management practices of mining in Myanmar, a set of Guidelines has been developed. The Guidelines were developed under the direction of the Mining EIA Guidelines Working Group, an interdepartmental group established by the Minister of Natural Resource Management and Environmental Conservation.

2. This document, *Technical Guidance for Environmental Assessment of Mining* provides more detailed information that may be used by Project Proponents and their consultants to support preparation of EIAS, IEEs, and EMPs. It may also be used by Environmental Reviewers from the Environmental Conservation Department and the Inter-Ministerial EIA Review Committee to increase their understanding of the environmental impacts of mining and measures to mitigate impacts.

3. The document provides information on how to:

i. prepare project descriptions;
ii. conduct analysis of alternatives;
iii. conduct environmental management planning;
iv. establish environmental management systems;
v. conduct community engagement activities and develop community development plans;
vi. assessment the significance of impacts;
vii. conduct risk assessment;
viii. conduct cumulative impact assessment;
ix. conduct biodiversity assessment;
x. assess the impacts on air quality;
xi. assess the impacts of noise and vibration;
xii. design measures for mine site good practices for topsoil management, hazardous material management; and for providing workers with personal protective equipment;
xiii. design measures for water management, waste rock management, and erosion prevention and control; and
xiv. design and prepare mine closure plans.

4. **Cautionary Note.** The document presents examples of good practices based on the judgement of the authors. The document does not an exhaustive and definitive treatment of the good practices. Users of this document are strongly encouraged to seek other approaches and methods. Users are also encouraged to the consult the many references that are provided throughout the document.

II. PROJECT DESCRIPTION

A. Introduction

5. All environmental assessments require a detailed project description, which outlines the basic components and activities of the project. The project description should include a clear statement of the purpose and need with a justification of for the project. The project description should provide enough detail to support an accurate definition of the environmental and social risks associated with the project (Box 2.1). The description should cover all phases from site preparation through construction to operation to closure. The project description is to provide information on (i) mining method, (ii) processing system; (iii) waste rock: stockpiles, dumps, and tailings; (iv) transportation facilities; (v) water management; (vii) mine closure; and (viii) employment, local hiring, and local purchasing. The description should also provide details on amount and type of emissions to air, effluent discharges to water, and solid waste disposal.

Box 2.1. Basic Elements of a Project Description

- Project Justification and Need
- Project Location (including detailed map)
- Basic Components, Facilities, and Activities
- Site Layout Map or Schematic Diagram
- Construction
- Operations
- Ore Extraction
- Ore Processing
- Waste Rock: Stockpiles, Dumps, and Tailings
- Transportation Facilities
- Mining Support Facilities
- Offsite Ancillary Facilities
- Water Management
- Mine Closure
- Employment, Local Hiring, and Local Purchasing
- Amount and type of emissions to air, effluent discharges to water; amount of type solid waste disposal; and amount and type of hazardous waste
- Project Development and Implementation Schedule
- Construction Material and Equipment Use

1. Project Purpose and Need

6. The rationale for the project is to be provided. The following should be answered:

- Who needs the mined materials and for what purpose?
- Where is the mined material needed and what form must it take to meet the need?
- How much mined material is needed and when are different quantities and quality needed?
- What are the levels of uncertainty in the assessment of needs?

7. The purpose and need description should explain whether the proposed project is a new project, an expansion or a replacement/maintenance of an existing project, and whether and why the project might be phased in over time. It should clarify the use of the mined material - including whether it will be used locally, nationally, or exported to other countries.

2. Project Location.

8. The location of Project facilities and components is to be identified using maps, plans and diagrams. The general location and access should be presented on an overview map, which places the activity in its geographic context.

3. Basic Facilities, Components, and Activities

9. **Project Facilities and Components –** All projects facilities and components are to be described including the mine site, waste rock disposal sites, tailing ponds, water systems, wastewater systems, roads and other transportation systems, repair shops, warehouses and other support facilities. A simple summary table of information for each component should be prepared.

4. Site Layout.

10. The layout of the project site (including ground levels, buildings, other physical structures, underground works, storage facilities, water features, planting, access corridors, boundaries) is to be presented. The layout should show the various locations of the mining operation components such as the mine, processing sites/facilities, disposal sites, transportation, ancillary facilities, etc. This information should be presented in at an appropriate scale to show each component in relationship to the other components, and in relation to natural features such as topography, existing structures and communities, water bodies, wetlands, and flood plains

5. Mine Development

11. Mine development works include: access roads, civil, residential and industrial constructions, opening the deposit (i.e. in open cut mines), shaft sinking and tunneling (i.e., in underground mines), building of crushing plant, washing plant, mineral processing plants, leach pads, CIP plants, water reservoirs, sumps, power stations, transformers, tailing ponds, and tailing dump sites. Upon completion of physical construction of all infrastructures essential for production operation, the mine and the plants are commissioned for production operations.

12. Initial construction schedule should be presented, for the various components of the mining operation including roads, repair shops, warehouses and other support facilities, power sources and transmission lines, water sources and conveyances, material handling systems,

processing facilities, and mine development. Quantitative and qualitative information on the degree of site clearing and vegetation removed from the site, plans for sequencing site clearing and resulting changes in plant cover and non-permeable surfaces for all phases.

6. Overview of Operations

13. The flowchart (Figure 2.1) shows the relationship between the five main stages of the mine operations phase. Stages shown in time-sequential order are mining, crushing, grinding, ore separation and concentrate dewatering. From the mining phase two outputs are waste rock to the waste rock pile and waste water from both mining and the waste rock pile. Water and reagents are added at the grinding and ore separation stages. Tailings are produced from the ore separation stage and go to the tailings management facility. Water is recycled between the grinding, ore separation and concentrate dewatering stages, and the tailings management facility. The final product is the ore concentrate, which goes to further processing.

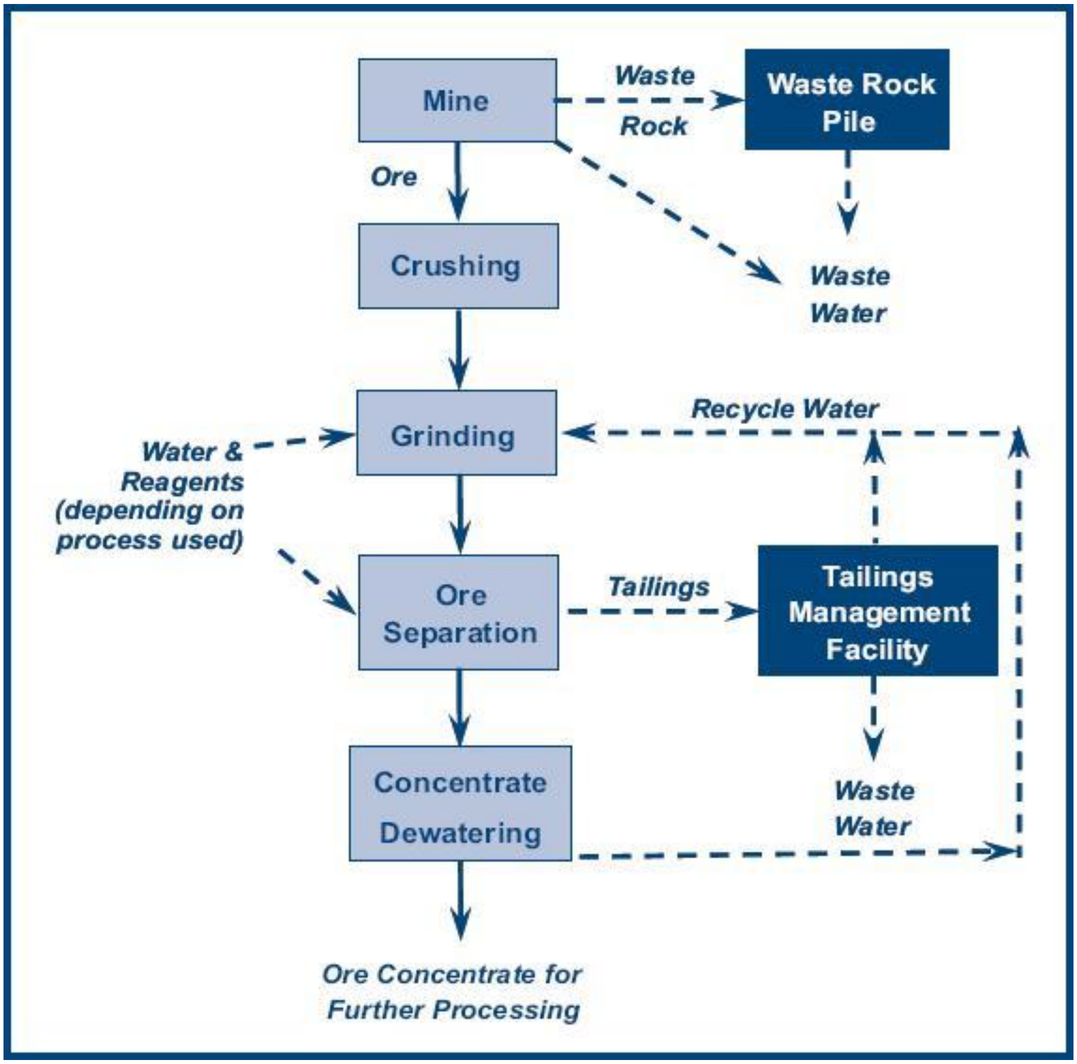

Figure 2.1. Typical Activities of the Mine Operations Phase.

Source: Environmental Code of Practices for Metal Mines. Environment Canada.
https://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=CBE3CD59-1&offset=1&toc=show

7. Mining Method

14. Ore extraction is done by the operation of the selected mining method which depends on the type of ore, use of selected equipment and amount of targeted production. The method for ore extraction is the be described**.** For metal mines, the extraction method may be surface or open-pit, underground, or in-situ. The mining method will be determined largely by the physical characteristics of the ore body and geology such as depth to the ore body, surface topography, geologic structure and location.

15. **Open Pit.** Table 2.1 summarizes the information needed for surface or open-pit design.

Table 2.1: Proposed Surface or Open-pit Mining Design

Component	Surface or Open-pit Mining
Mine Design	Benches (sizes by year) Slopes (stability, angles and lengths) Area and depth by year (table and map) Map showing mining sequence Typical pit cross-section (showing stripping/benching) Transport/access ramps and in-mine roads Pit backfilling sequences.

Source Volume I. EIA Technical Review Guideline: Non-MetalandMetalMining**,** Regional Document prepared under CAFTA DR Environmental Cooperation Program to Strengthen Environmental Impact Assessment (EIA) Review. Prepared by CAFTA DR and US Country EIA and Mining Experts. United States Environmental Protection Agency (U.S. EPA), Agency for International Development (U.S. AID), and/or the Central American Commission on Environment and Development (CCAD). May 2011

16. **Underground.** The information needed for underground mine is summarized in Table 2.2.

Table 2.2 Underground Mine Design Considerations.

Component	Underground Mining
Mine Design	• Detailed descriptions of method o Stoping o Cut and fill o Room and pillar o Block Caving • Location of the shafts (primary and secondary) • Map showing tunnel extensions by year • Roof support • Roof Stability Analysis • Subsidence Prediction Study

Source Volume I. EIA Technical Review Guideline: Non-Metal and Metal Mining, Regional Document prepared under CAFTA DR Environmental Cooperation Program to Strengthen Environmental Impact Assessment (EIA) Review. Prepared by CAFTA DR and US Country EIA and Mining Experts. United States Environmental Protection Agency (U.S. EPA), Agency for International Development (U.S. AID), and/or the Central American Commission on Environment and Development (CCAD). May 2011.

17. **In-situ mining**. In-situ mining entails pumping a chemical solution via a system of injection wells into intact rock to dissolve the metals from the ore body, and then pumping the pregnant solution out through a system of extraction wells. The product is then recovered through further processing. The process varies with the type of host rock and ore. In-situ mining can be used to extract water-soluble salts (using water), uranium (using acid or a carbonate such as sodium bicarbonate), and copper (using acid).

18. Information that should be included in design for in- situ mining is the same as for other mining methods, including clearing and grubbing, equipment rosters, onsite support facilities, power needs, operating needs and health and safety programs. Other design components, however, are unique to in-situ mining. These include injection and pumping rates, recovery and monitoring well locations and designs, chemical specifications, injection and recovery program.

19. **Placer Mining.** Placer mining is used when the metal is associated with sediment in a stream bed or floodplain. Bulldozers, dredges, or hydraulic jets of water (a process called 'hydraulic mining') are used to extract the ore. Placer mining is usually aimed at removing gold from stream sediments and floodplains. Because placer mining often occurs within a streambed, it is an environmentally-destructive type of mining, releasing large quantities of sediment that can impact surface water for several miles downstream of the placer mine.

20. Design consideration for placer mines include:

i. **Operational plan** – including areas to be dredged, operational hours, procedures to be used when woody debris and fallen trees are encountered, daily and weekly operating frequencies, average upstream dredge movement, and time necessary to dredge the entire area;
ii. **River or shoreline access** – including stream bank disturbance; erosion control; timing and extent of clearing, grubbing and other disturbance to the riparian vegetation; and temporary stream crossings (design and materials). Stream beds should not be used as transportation routes for construction equipment;
iii. **River diversions and flood control** – including instream berms; and
iv. **Sediment control plan** – Sediment should be prevented from entering the stream. Erosion and sediment controls should be designed according to the size and slope of disturbed or drainage areas to detain runoff and trap sediment and should be properly selected, installed, and maintained in accordance with good engineering practices. Erosion and sediment control measures should be place and functional before earth moving operations begin, and should be constructed and maintained throughout the construction period.

21. **Quarrying.** For extraction of construction materials, the most common methods are quarrying and dredging. The design for a quarry is much the same as for an open-pit mine but usually on a smaller scale. Basic design considerations should include:

i. Site preparation – top soil removal, runoff control, erosion and sediment control, etc.
ii. Haul and access road construction – grade control, runoff control, erosion and sediment control, and dust control.
iii. Blasting and excavation – pit design, erosion and sediment, dust, fumes and exhaust, and accidental spills; and

iv. Crushing and sizing – dust and noise control.

22. **Dredging.** When sand and gravel is excavated using dredging, the design considerations are similar to those for placer mining. In addition, off-loading and storage areas are needed. Often barges are used to transport the sand and gravel to a port – these port facilities need to be designed.

8. Ore Processing[1], Treatment, and Final Products

23. **Final Products**. Mines generally produce products in various types. Some mines produce raw ores to be sold to treatment plant operators, some produce mineral concentrates which are marketable grade, some produce pyro refined metals, and some produce refined metals, depending on their scale of investment and market demands. The type of ore and desired final products should be described somewhere in the Project description.

24. Once ore is extracted from a mine it is processed to recover the valuable minerals. Ore typically consists of small amounts of valuable minerals in close association with much larger amounts of waste minerals of no economic value (gangue). The valuable ore minerals are separated (liberated) from the gangue in milling operations to obtain higher quality metal. Major steps in ore processing include grinding and crushing, chemical/ physical separation and dewatering.

25. **Ore flowcharts**. Flow charts should show the path of the ore from removal through mining, crushing, grinding, ore separation and concentrate dewatering (see Figure 2.1 above). The flow charts should include the flow of waste material (i.e., waste rock, tailings, wastewater, and loadings of materials in wastewater). General information on the ore body, should be presented in this section, including:

i. Grade of ore by region within the ore body;
ii. Types and amount of ore that will be extracted and processed;
iii. Estimated amount of final product to be produced, by product type; and
iv. Estimated amount of waste rock and overburden to be disposed during different phases of the project.

26. **Grinding and Crushing.** Grinding and crushing of ore is undertaken to physically liberate valuable minerals prior to separation by physical and chemical processes. Crushing is done dry, and is used for coarse size reduction. Grinding is used to achieve finer size reduction. Grinding is conducted wet, and chemicals such as lime, soda ash, sodium cyanide, and Sulphur dioxide may be added in the grinding circuit in preparation for ore separation. Ore must be ground fine enough to liberate the ore minerals from the gangue, or subsequent separation methods will not be as effective.

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[1] Adapted from Source: Environmental Code of Practices for Metal Mines. Environment Canada. https://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=CBE3CD59-1&offset=1&toc=show

27. **Ore Separation**. Ore separation may be done using physical or chemical separation methods. The end product of ore separation is an ore concentrate. After separation, some ore concentrates are sent for further processing, such as smelting, to produce pure metal for sale. A by-product of ore separation is tailings, which are a mixture of water and finely ground rock from which most of the minerals of value have been removed. Tailings may still contain metal -bearing minerals, and the mixture may also contain residues of reagents used in ore processing.

28. **Physical Separation Processes**: Physical separation processes exploit differences in the physical properties or behavior of mineral particles, such as size, density and surface energy. The bulk of the mineral is not chemically altered, although chemical reagents may be used to help in the separation process.

29. **Gravity Separation**: Minerals can be separated on the basis of differences in density, particularly for iron ore and gold, as well as tungsten, tantalum and niobium. Gravity separation may also be used to pre-concentrate metallic minerals prior to further processing. Gravity separation tends to require the use of smaller amounts of process re- agents than some other ore separation methods.

30. **Magnetic Separation**: Minerals can be separated on the basis of differences in magnetic susceptibility. Magnetic separation has been used in Canada to separate iron ore from waste minerals, to remove magnetite (iron oxide) and pyrite (iron sulphide) from base metal ores prior to flotation, and to recover magnetite from copper concentrates. Like gravity separation, magnetic separation tends to require the use of smaller amounts of process reagents than some other ore separation methods.

31. **Flotation Separation**: Flotation is used for the separation of a wide variety of minerals on the basis of differences in surface properties of minerals in contact with air and water. It is the dominant process for the recovery of base metal ores and is also used in uranium and gold processing operations. To separate minerals using flotation, fine air bubbles are introduced into a mixture of ground ore in water, known as a slurry. In this slurry, mineral particles collide with air bubbles, and minerals that favor contact with air attach to the air bubbles and float to the surface of the flotation cell. As air bubbles accumulate at the surface, a froth forms and eventually overflows as the flotation cell concentrate. Minerals that favor contact with water remain in the slurry and go to the flotation cell tailings. A number of chemical reagents are used to aid the process.

32. **Chemical Separation Processes**: Chemical separation processes involve the preferential leaching of one or more minerals, particularly for the recovery of gold, silver and uranium and in some cases copper.

33. **Leaching with Cyanide.** This is the dominant method for recovery of metallic gold or silver. A dilute solution of calcium or sodium cyanide is used to dissolve the metal. Following leaching, metals are recovered from the solution by absorption directly from the leach slurry onto activated carbon granules or by the addition of zinc dust to the solution which causes the precious metals to precipitate from the solution.

34. **Leaching with Sulphuric Acid:** Uranium ores are processed using sulphuric acid to dissolve the uranium. The uranium is then removed from the solution using ion exchange or

solvent extraction, which results in the adsorption of uranium on a resin or organic solvent. The uranium is then removed from the resin or solvent. In some cases, copper ores are also leached with sulphuric acid.

a. Ore Separation Facilities

35. The type of ore separation process (i.e., beneficiation[2]) is to be described for the processing stage. A schematic diagram of the beneficiation processes is to be prepared including means of transfer between processing steps and the details for ore, other inputs and waste flows through the processing facilities. For each type of processing and means of transfer, detailed designs should be presented including individual facility schematics (showing locations and sizes of component parts) and design and operational details. The design and operational details for each unit should include:

i. Volumes of ore to be treated per unit of time (e.g., tonnes per day),
ii. Volumes of waste (solid and liquid) to be generated per unit of time (e.g., tonnes per day),
iii. Chemical additives (types, volumes/time, recovery, etc.),
iv. Chemical composition of aqueous solutions,
v. Containment structures for processes using aqueous solutions,
vi. Water use requirements,
vii. Wastewater treatment facilities,
viii. Air emission controls,
ix. Health and safety,
x. Dust control plan (construction and operation).
xi. Leaching methods (i.e., tank or vat, dumps, and heaps). For dump and heap leaching operations, additional information is required for containment provisions including liner design, stability analysis of each structure, construction and design details of structures (dimensions, volume, slopes) by year, and conveyance of leaching solutions to and recovery of pregnant solutions from containments; and
xii. Amalgamation Processes.

b. Mineral Processing (Smelters)

36. Mineral processing may occur onsite and is specific to the metal being mined. For example, for copper processing, there may be smelters or solvent extraction and electro-winning (plants. Designs for the operating program, construction, waste stream analysis and basically the same type of information required for beneficiation facilities should be included in the design for these facilities. For smelters, the design should include controls for stack and fugitive air emissions.

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[2] Typical beneficiation includes one or a combination of the following processes: crushing; milling; washing; filtration; sorting; sizing; magnetic separation; pressure oxidation; flotation; leaching; gravity concentration; and agglomeration (pelletizing, sintering, briquetting, or nodulizing). (Source Volume I. EIA Technical Review Guideline: Non-Metal and Metal Mining, Regional Document prepared under CAFTA DR Environmental Cooperation Program to Strengthen Environmental Impact Assessment (EIA) Review. Prepared by CAFTA DR and US Country EIA and Mining Experts. United States Environmental Protection Agency (U.S. EPA), Agency for International Development (U.S. AID), and/or the Central American Commission on Environment and Development (CCAD). May 2011.

9. By-products, Stockpiles, Dumps, and Tailing Ponds

37. In the mineral production operations, it is quite common that there will be more than one single product. These by-products should be mentioned the project description.

38. Disturbed rock and earth from mines are major sources of dust, erosion, sedimentation and contamination. Acid rock drainage, associated with metal mining, is a major environmental issue. This section of the Project Description should include information describing ore stockpiles, dumps and piles, waste rock dumps, tailings (reagent residue) and any heap leach areas that are part of the mine design. The design details should include:

i. Location of all stockpiles, dumps, and tailings structures
ii. Clearing and grubbing, including disposal of debris
iii. Design of structures, including dump foundations and drainage structures, and justification for the design
iv. Transport ramps onto structures
v. Stability analysis of each structure
vi. Construction and design details of structure (dimensions, volume, slopes) by year
vii. Chemical and physical characterization of materials in tailings, dumps and piles
viii. Potential for pollution and contamination;
ix. Design to prevent pollution and contamination (water, air, and direct contact)

10. Haulage and Transportation Facilities

39. Onsite transport facilities should be addressed in this section, including onsite roads, trains, tram, conveyors, and waterways. If the mine requires new access routes, these should also be included in this section. This section should contain a map of transportation routes that will be constructed and maintained by the mining operation, indicating the type and size of each route as well as the timing of its construction.

a. Roads

40. There are several types of onsite roads used in mining: primary and secondary roads used for haul roads and mine and facility access and smaller roads used for accessing remote sites for monitoring. For each of these roads, the design should include maps and specific design information including:

i. Timing of construction;
ii. Road surface and shoulder width and barriers;
iii. Grade specifications;
iv. Construction methods including clearing and grubbing;
v. Construction materials (if waste rock will be used, include geochemical specifications it should meet, e.g., net neutralizing potential to acid generating potential should be at least 3:1);
vi. Stream crossings and associated designs;
vii. Sedimentation and erosion prevention structures and practices;
viii. Stabilization methods for cuts and fills; and

ix. Operations program with traffic volume, operating speeds and trip times.

41. Typical elevations should be provided for each type and situation of road displaying construction materials, levels of compaction and erosion and sedimentation features. This section should also include the following general information about the road system:

i. Dust control measures for construction and operation;
ii. Maintenance measures; and
iii. Roster for construction and maintenance equipment, specifying type and quantity by: size, motor size, and fuel requirements for each type of equipment.

c. Transportation by Rail

42. If a railroad is to be constructed, information will need to be provided concerning its construction and alignment, including a map of its location. Necessary design criteria include:

i. Timing of construction;
ii. Roadbed width;
iii. Roadbed construction method including clearing and grubbing;
iv. Roadbed materials;
v. Grade and maximum grade;
vi. Tightest curves;
vii. Track construction materials;
viii. Turnouts and sidings;
ix. Railroad communications and signaling;
x. Designs, including typical elevations of road crossings and stream crossings;
xi. Sedimentation and erosion prevention structures and practices;
xii. Stabilization methods for cuts and fills;
xiii. Maintenance;
xiv. Dust control measures during construction;
xv. Borrow pits;
xvi. Location and size (area and volume of material); and
xvii. Sedimentation and erosion controls.

43. An operations program should address traffic volume, operating speeds and trip times. The train itself should be described in terms of the type and number of cars and locomotives, the overall length, the average tons per car and per train, the number of trips per week it would be operated. If an existing railroad is to be used, improvements and changes to the existing operations will need to be indicated in terms of the aspects outlined in the above paragraphs.

d. Conveyors

44. Conveyors play an important role in mining for transporting materials. In-mine and in-pit conveyors should be addressed in the Mining Methods section. Some mines, however, use overland conveyors moving materials from the mine to the beneficiation facility or even to a load-out facility for transportation from the mine to its destination. Maps showing the locations of these

conveyors and complete design details, including source of energy for operation and dust control measures, should be included in this section. Where conveyors cross water bodies, conveyors should be covered to prevent water contamination.

e. Barges and Waterways

45. Ore may be shipped by barges which will require a complete description of design, construction, and operation of loading docks as well as rosters of boats used to move barges, specifying type and quantity by: size, motor size, and fuel requirements.

11. Mine Power Supply and Support Facilities

46. The mine power supply is an essential for the mine. In addition, mining operations will have many on-site ancillary structures such as office, domestic facilities, laboratories, shops, vehicle maintenance areas, warehouses, storage buildings, storage areas, power generation and transmission facilities, and fueling facilities. These may be located at the mine, processing facilities, and loading and unloading areas, or in a separate area. The mine may also have employee housing and support facilities (stores, restaurants, recreational facilities, etc.). Many of these facilities will require water systems, sewage treatment facilities and solid waste collection and disposal. Some of them, such as vehicle maintenance, storage areas, power generation, and fueling facilities, may generate hazardous wastes including solvents, lubricants, hydraulic fluids, anti-freeze, spent tires and wash water. Others, such as warehouses, storage buildings and fueling stations may store hazardous products (fuels, chemicals and explosives) that will require containment and emergency procedures.

47. A description of each type of facility including its location, design, and associated services (water, sewage, solid waste disposal, etc.). It should include a description of areas that will be temporarily disturbed during construction as well as those areas that will be occupied by the facilities.

12. Offsite Ancillary Facilities

48. The project and its geographic, ecological, social, and temporal context includes any offsite investments that may be required, for example:

i. Dedicated and shared pipelines;
ii. Access roads;
iii. Sources of power for the operation;
iv. Water supply;
v. Housing;
vi. Raw material and product storage facilities;
vii. Wastewater treatment;
viii. Waste management; and
ix. Storage of fuels and hazardous materials.

13. Water Management Facilities

49. This section should include information on design, construction and maintenance of appropriate water-control measures including stream relocations, collection ditches and

sedimentation ponds, diversions, culverts and activities that would minimize erosion and sedimentation. The design should address run-on, runoff and seepage.

a. Erosion Control Facilities

50. Basic information needed includes:

i. Location of all facilities;
ii. An analysis showing that the smallest amount of land as possible will be disturbed at one time;
iii. Methods to reduce runoff, run-on, sedimentation and erosion;
iv. Method of retaining sediment;
v. Method for diverting runoff from the disturbed areas;
vi. Method for diverting surface water, including storm water, around the disturbed area;
vii. Method for preventing seepage;
viii. Method for treating and maintaining roads for reducing runoff, erosion, and dust;
ix. All supporting designs, methodology and justification for methodology;
x. Methods for closure and restoration; and
xi. Monitoring and maintenance plans

f. Temporary Ponds and Permanent Impoundments

51. Basic information needed includes:

i. Number of each type of impoundment;
ii. Location, size and capacity of each structure;
iii. Material to be used, and its source;
iv. Use of each structure;
v. Design, design criteria and justification;
vi. drawings;
vii. Water discharge treatment facilities;
viii. Methods for closure and restoration; and
ix. Monitoring and maintenance programs

g. Culverts, Dikes and Diversions

52. Basic information needed includes:

i. Number of each type of structure;
ii. Location and size of each structure;
iii. Methodology for design;
iv. Typical construction: cuts, fills, materials and their sources, compaction;
v. Timing of construction;
vi. Typical elevations;
vii. Grades for diversions;
viii. Methods for closure and restoration; and
ix. Monitoring and maintenance programs.

h. Groundwater Management

53. Basic information needed includes:

i. Dewatering requirements – volume;
ii. Dewatering well locations, pumping requirements for each well, electricity requirements;
iii. staging of activities, and discharge pipeline design;
iv. Water chemistry and water treatment requirements;
v. Discharge location for dewater systems
vi. Methodology for design – groundwater model and projected drawdowns; and
vii. Monitoring and maintenance programs

14. Restoration and Closure Plan

54. The Project Description should include a restoration plan describing the size of the area to be restored and the plans and schedule for restoration. The restoration plan should include, but not be limited to, the following types of structures:

i. Pits and quarries;
ii. Waste rock dumps;
iii. Stockpiles;
iv. Tailings impoundments;
v. Heap leach pads;
vi. Solid waste disposal facilities;
vii. Facilities;
viii. Roads;
ix. Electrical structures; and
x. Water conveyance and treatment structures.

55. A comprehensive mine closure plan (see Chapter VII Mine Closure Plan) is to be included in the EIA or IEE document. This plan should include the restoration costs for each restoration activity and describe financial assurance for the project to ensure funds will be available to close and restore the site by a third party if the mine company cannot complete the job.

15. Employment, Local Hiring, and Local Purchasing

56. The Project Description should present information on the number and type of employees that will be hired by the mine, during all phases of mine life, and the level at which the mine will be relying upon local businesses to provide goods and services. This information is necessary for assessing the social benefits impacts of the proposed mine.

16. Effluents Discharges

57. This section should summarize all types and quantities of liquid effluents generated (including site drainage and run-off, process wastes, cooling water, treated effluents, sewage). Describing methods for collecting, storing, treating, transporting and disposing of effluents.

17. Emissions

58. This section should summarize the types and quantities of gaseous and particulate emissions (including process emissions, fugitive emissions, emissions from combustion of fossil fuels, emissions from traffic, dust from materials handling, odors). It should describe the methods for collecting, treating and finally discharging these emissions. Identifying the locations for discharge of emissions and the characteristics of the discharges (e.g. height of stack, velocity and temperature of release).

18. Solid Waste Treatment and Disposal System

59. This section should summarize the types and quantities of solid waste generated (including construction or demolition wastes, surplus spoil, process wastes, by-products, surplus or reject products, hazardous wastes, household or commercial wastes, agricultural or forestry wastes, site clean-up wastes, mining wastes, decommissioning wastes). It should describe the methods for collecting, storing, treating, transporting and disposing. It should identify locations for final disposal of all solid wastes.

19. Hazardous Waste

60. This section should summarize the types and quantities of hazardous materials used, stored, handled or produced. It should the methods for collecting, storing, treating, transporting and disposing of hazardous wastes. It should identify the locations for final disposal of all hazardous wastes.

20. Project Development and Implementation Schedule

61. **Main Project Activities and Schedule –** The main activities for construction, operation, and closure of the mine are to be presented. The schedule for implementation, detailing estimated length of time and start and finish dates for construction, operation and mine closure is needed.

21. Construction Material and Equipment Use

62. **Construction materials.** The amounts of basic construction materials (i.e., sand, gravel, rock, and cement are to be estimated. Sources are to be identified. If borrow pits or quarries are to be new established, the size and location are to be shown on a map.

63. **Equipment Use.** A complete list of mining equipment is to be prepared.

22. Water Use

64. The amount of water used is to be estimated (daily, monthly, and annual estimates). The sources of the water are to be identified. The sustainability of the sources is to verified.

23. Energy Use

65. The amount of fuel needed is to be estimated (daily, monthly, and annual estimates). The sources of the fuel are to be identified. The amount of electricity needed is to be estimated (daily, monthly, and annual estimates). The sources of the electricity are to be identified. As indicated in section 11 above, the power transmission and distribution facilities needed for the mine described and located on a map.

III. ANALYSIS OF ALTERNATIVES

66. The EIA Procedure (2015) requires an analysis of project alternatives for all EIA Type projects to determine the best method of achieving project objectives while minimizing environmental and social impacts. This analysis is an important element of the environmental assessment process as it brings environmental and social considerations into early decision making (at the stage of feasibility study), providing the main opportunity to avoid and, if avoidance is not possible, minimize adverse environmental impacts and risks. A serious analysis of alternatives can also reduce the project cost, assist in gaining greater public support for the project, and improve the likelihood of project approval. If this opportunity is foregone, the best that can be achieved in most instances is damage limitation by applying impact mitigation measures during project implementation.

67. **No – Project Alternative**. The analysis of alternatives includes the “no project” alternative. This will generally indicate (i) the beneficial outcome and net contribution to development that would be foregone without the project, and (ii) main adverse impacts that would be avoided without the project. It should consider alternative land uses (i.e., other than mining).

68. **Alternative Technologies.** Reasonable technically and economically feasible project options that would reduce potential adverse environmental and socioeconomic impacts such as alternative designs, technology, site design and facility design options for the project location including proposals by stakeholders, for modifications or new project options posing lower impact. Consideration should be given to:

i. alternative mining methods (i.e., underground versus open-pit versus heap leaching);
ii. alternative ore processing methods and facilities; and
iii. alternative size of the mine and sequencing of the mine development and operation

69. **Alternative Locations**. Due to the fixed location of mineral ore bodies, there may not be readily identifiable alternative locations for mineral extraction. However, an alternative analysis of proposed mining projects should nevertheless consider:

i. alternative sites for alternative sites for mining facilities (waste rock dumps; processing facilities; and tailing ponds);
ii. alternative alignments for roads, rail lines or pipelines within the mine site;
iii. alternative sites of storage of materials (including hazardous materials); and
iv. and alternative modes and routes for transportation access to the mine site.

A. Method

70. A simple method for conducting the analysis of alternatives at the Project EIA Level is outlined in Figure 3.1 below. The starting point is the Project Proposal which contain a preliminary project description. Early in the project design process it is desirable to (i) identify and screen the technologies that might be used; and (ii) identify and screen alternative locations. The project technology – location alternatives should undergo a preliminary assessment of the environmental and social impacts. Alternative designs, mitigation measures, operational measures, and implementation plans and schedules are to be included in the options. The completed impact assessment is to be included in the overall comparative evaluation of alternatives.

71. The comparative of evaluation of alternatives is to be based on based on economic, technical, as well as the environmental and social factors.

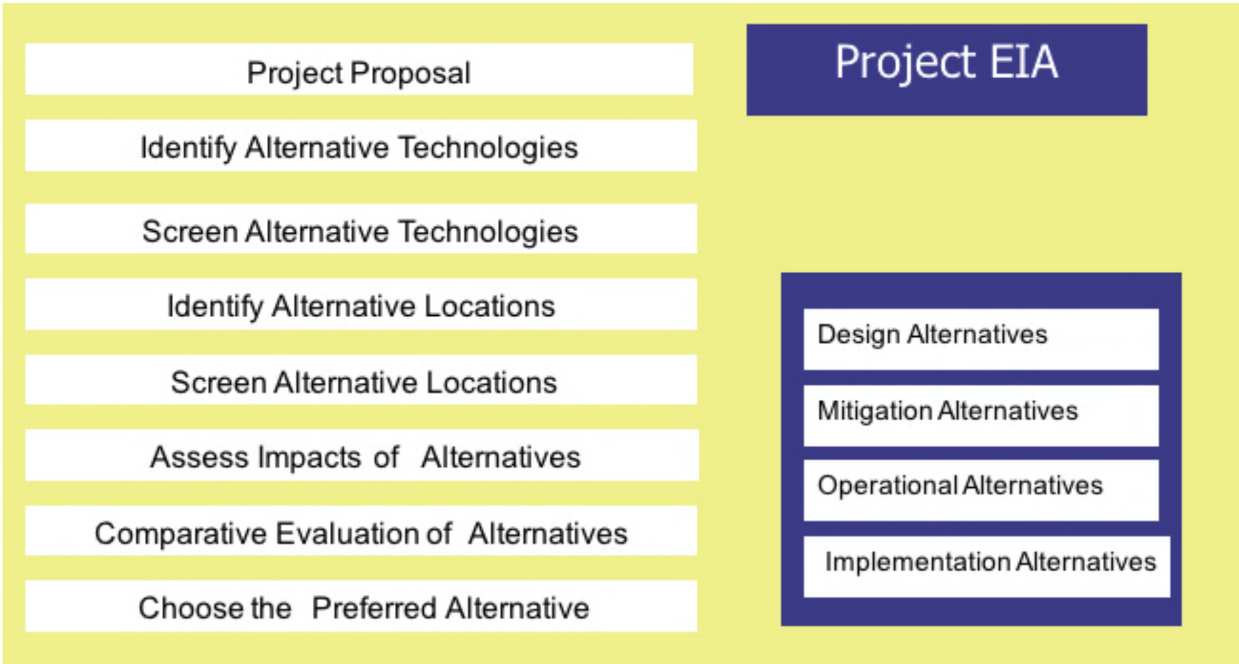


Figure 3.1. Overview of the steps in conducting an analysis of alternatives.

1. Identification of Alternative Technologies

72. An alternative analysis of proposed mining projects should consider:

i. alternative mining methods (i.e., underground versus open-pit versus heap leaching);
ii. alternative ore processing methods and facilities; and
iii. alternative size of the mine and sequencing of the mine development and operation.

73. Having defined a range of technologies or strategies, "resource requirements" should be determined for each alternative. This includes energy types and quantities, water, land areas, associated infrastructure, staffing, raw materials/fuel, solid waste and effluent disposal and other requirements plus associated costs. All phases of the project should be considered—site preparation, construction, operation and, if applicable, decommissioning or closure.

2. Screening of alternative technologies

74. This helps to limit the efforts and costs associated with data collection and processing. Screening should be based on factors such as ability of the technology to meet the project objectives, availability of resource requirements (at a macro level), suitability in a particular situation, and the broad environmental and economic acceptability. The lead-times associated with bringing projects on-line are also important in determining the suitability of alternatives. The screening process should define a realistic range of alternatives for further consideration. At this

stage, a consultation exercise involving key stakeholders should take place in order to seek consensus on the short-listed technologies.

3. Identification of Alternative Locations

75. It may be appropriate to identify alternative locations for the mine or selected components of the project. However, in many instances, the location of mine is determined as the ore body is fixed. However, this still leaves scope for analysis of alternative sites for alternative sites for mining facilities (waste rock dumps; processing facilities; and tailing ponds); alternative alignments for roads, rail lines or pipelines. alternative sites for mining facilities alternative sites of storage of materials (including hazardous materials); and alternative modes and routes for transportation access to the mine. Identification of suitable alternative locations should take into consideration the resource requirements identified for the short-listed technologies.

4. Screening Alternative Locations

76. Screening of alternative locations includes the ability to meet project objectives, resource requirements for short-listed technologies, and broad environmental planning and economic considerations. For example, reasons for rejection of alternative locations could include conflict with existing planning policies or settlements, encroachment into conservation areas or habitat of endangered species, disturbance of archaeologically important sites, opportunity cost of inundating high quality agricultural land, seismic hazard, and risks to groundwater.

77. Significant social concerns, such as involuntary resettlement, often form the basis for rejection of locations. During the initial screening of alternative locations, the concerns of the wider public may be represented by government agencies, institutions, community organizations or NGOs.

5. Assessment of Environmental and Social Impacts

78. The project technology – location alternatives should undergo a preliminary assessment of the environmental and social impacts. Alternative designs, mitigation measures, operational measures, and implementation plans and schedules are to be included in the options The completed impact assessment is to be included in the overall comparative evaluation of alternatives.

6. Comparative Evaluation of Alternatives

79. The comparative of evaluation of alternatives is to be based on based on economic, technical, as well as the environmental and social factors. The objective of comparative analysis is to sharply define the benefits and adverse impacts of alternatives to provide a clear basis for choosing between alternatives. The key challenge to EA practitioners in comparative assessment is to show distinctions objectively, and as simply as possible. A simple comparative evaluation method should be used. A simple set of indicators for the economic, technical, social, and environmental factors should be chosen. Evaluation criteria should be adopted. A table or matrix should be prepared summarizing qualitative or quantitative information for each option in terms of the indicators and evaluation criteria.

7. Approach

80. In most instances, it is ideal for the analysis of alternatives to be conducted by a multidisciplinary team that combines environmental, social, technical and economic/financial expertise so that these different factors are adequately considered to a similar level and weighed against each other/traded off to select the best option.

81. The analysis of alternatives may be undertaken prior to the consultation. Nevertheless, it is important to consider the views of interested parties when choosing both the selection criteria and alternatives to be assessed, as support for or opposition to an alternative may be a key determinant of whether it is feasible or not. In addition, local knowledge can provide valuable insights on local conditions that can assist in site selection. Conversely, not presenting the proposed alternative and the criteria used in the selection process can create community resistance.

82. An overriding “no go” criteria may also be incorporated in the selection process if a significant and unacceptable environmental or social impact is identified to warrant curtailing further consideration of the alternative (e.g. significant conversion or degradation of a critical habitat on a project site). This prevents an unacceptable alternative from being preferred based on the net sum of its merits against all selection criteria

IV. ENVIRONMENTAL MANAGEMENT PLANNING

A. Environmental Management Principles and Requirements

83. **Principle Avoid, Minimize, Restore, or Offset Impacts, and Enhance Positive Impacts.** Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and enhance positive impacts by means of environmental planning and management. Key considerations include mitigation of potential adverse impacts to the level of no significant harm to third parties, and the polluter pays principle. For example,

- Avoid - e.g., environmentally sensitive areas, populated areas, schools, hospitals
- Minimize – e.g., pollution – air emissions, effluent discharges, solid and hazardous waste management, control erosion, flood protection
- Restore and Rehabilitate
- Offset – e.g., create new habitat or undertake conservation measures; provide new facilities to compensate for lost property, access, or opportunity
- Enhance – e.g., provide additional resources to enhance a projects positive benefits

84. **Principle. Prepare an Environmental Management Plan.** The objective is to be achieved through preparation of an environmental management plan (EMP) that addresses the potential impacts and risks identified by the environmental assessment. The EMP will include the proposed summary of potential environmental impacts, mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, public consultation and grievance redress mechanisms, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.

85. **Principle. Implement the Environmental Management Plan and Monitor its Effectiveness**. Under this principle, the mitigation measures and monitoring programs are to be implemented. Supervision and compliance monitoring is to be undertake to assess the effectiveness of EMP. Monitoring results are to be documented and disclosed.

86. Implementation requires:

- establishment environmental management offices and staffing
- establishment and operation of project grievance redress mechanisms
- implementation of mitigation measures
- implementation of environmental monitoring programs
- supervision and compliance monitoring
- safeguard monitoring reporting and disclosure

B. Environmental Management Requirements in Myanmar EIA Procedures (2015)

87. Under the EIA Procedure (2015), Chapter VII, the Proponent must prepare an environmental management plan as part of the EIA Report. Some projects, that have resettlement impacts, will also require a Resettlement Action Plan. Environmental management plans are required for all mining projects that are subject to the EIA Procedure (2015).

C. Institutional Arrangements

88. Effective environmental management, requires (i) an environmental management plan (EMP); (ii) well trained environmental professionals; and (iii) sufficient financial resources. Institutional arrangements identify the people needed to implement the EMP. It the environmental staffing positions and the project specific responsibilities of Environmental Staff.

89. **Environmental and Social Management Systems**. Some organizations have a well-defined corporate environmental and social management system, which includes (i) an environmental and social policy; (ii) qualified environmental and social staff including a senior officer, who has overall responsibility for environmental and social affairs; (iii) environmental management procedures; and (iv) reporting mechanisms for reporting on environmental management performance. However, many do not. In these cases, the ESMS must established at the Mine Level.

90. Figure 4.1 below shows an example of the institutional arrangements needed for the environmental management of a mine. It covers both construction, operation, and mine closure.

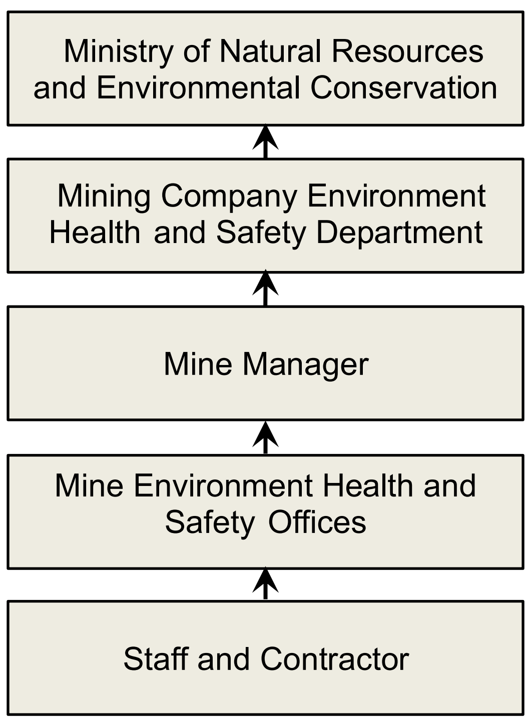


Figure 4.1 Institutional Arrangement for Environmental Management of the Mine

92. **Construction Contractor**. The Construction Contractor will be responsible for:

i. implementation of the environmental management plan mitigation measures during construction; and

ii. frequent monitoring and reporting of environmental management plan implementation during construction

93. **Mine Site Environmental Health and Safety Office (Mine EHS**). The Mine EHS will be responsible for

i. supervision and monitoring of and reporting on implementation of the EMP on behalf of Mine Manager;

ii. supervision of third party environmental monitoring contractors;

iii. assist Mine Manager in preparing of the environmental safeguard monitoring reports; and

iv. assist Mine Manager in organization of training and capacity development.

94. **Mine Manager.** The Mine Manger will have overall responsibility for:

i. ensuring implementation of all mitigation measures;
ii. ensuring implementation of all monitoring programs;
iii. supervision and monitoring of the implementation of the environmental management plan;
iv. establishment and operation of the Grievance Redress Mechanism;
v. meeting all the conditions of the Environmental Compliance Certificate; and
vi. preparation of draft semi-annual environmental monitoring reports.

95. **Corporate Environmental Health and Safety Unit (Corporate EHS**). The Corporate EHS will:

i. provide quality assurance during environmental impact assessment and review;

ii. provide quality assurance for environmental management of construction and operation and closure;

iii. provide training and capacity development for Mine Manager and Mine EHS staff, and Contractor environmental staff;

iv. finalize environmental monitoring reports for mines;

v. submission of environmental monitoring reports to Ministry of Natural Resources and Environmental Conservation.

96. **Ministry of Natural Resources and Environmental Conservation** (MONREC). MONREC is responsible for:

i. review of the periodic environmental safeguard monitoring reports submitted by DOH to ensure that adverse impacts and risks are mitigated as planned;

ii. as necessary, conduct monitoring and inspection of projects to determine compliance with all environmental and social requirements;

iii. as necessary, impose penalties and /or require Project Proponent to undertaken corrective action; and

iv. where Projects are not in compliance or not likely to comply with its environmental and social requirements, take appropriate enforcement actions including: (i) suspension of project operation; and (ii) employing third parties to correct non-compliance.

D. Preparing and Environmental Management Plan.

97. For mining projects, the recommended contents for an environmental management plan is shown in Box 4.1.

Box 4.1. Basic Elements of an Environmental Management Plan:

- Institutional arrangements for implementation of the EMP
  - Responsibilities
  - Monitoring and Reporting
- A summary potential environmental and social impacts
- Mitigation measures
- Environmental and Social Management Subplans
- Emergency response plans
- Environmental quality monitoring requirements
- Community Engagement and Community Development
- Grievance Redress Mechanism
- Capacity development and training programs
- Implementation schedule; and
- Cost estimate

E. Mitigation Measures

98. **Mitigation Hierarchy.** Mitigation measures should be designed to avoid and minimize environmental impacts. Where impacts are unavoidable, measures should be taken to restore or rehabilitate affected environmental components. In case, where restoration and rehabilitation is not possible or impractical, impacts should be offset through programs to enhance other lands or water bodies and/or facilities to offset biodiversity impacts; and to provide facilities or compensation to offset social and economic impacts. (see Box 4.2).

Box 4.2. Mitigation Hierarchy for Mining Projects

Avoid

Mine site selection

Transportation corridor alignments

Mine layout for facilities

Minimize

Pollution and waste

Minimize land take and disturbance

Minimize use of borrow pits for construction materials (i.e., sand and gravel)

Minimize use of water

Minimize use of energy

Restore and Rehabilitate

Exploration drilling sites

Rehabilitation of disturbed areas (e.g., borrow pits; stream crossings)

Restoration of mining areas after mining closure

Replanting of vegetation and trees

Restocking of fish and wildlife

Offset

For conservation purposes - provide land or water bodies and/or facilities to offset biodiversity impacts

Provide facilities or compensation to offset social and economic impacts

Enhance

Community Development Programs to provide additional resources to enhance a projects positive social and economic benefits.

F. Environmental and Social Management Subplans

99. Environmental and Social Management and Sub-Plans are to be prepared for each Project phase (pre-construction, construction, operation, decommissioning, closure and post-closure)[3]. The Management and Monitoring Sub-Plans shall address and satisfy all relevant environmental and social management and monitoring issues such as but not limited to noise, vibrations, waste, hazardous waste, wastewater and storm water, air quality, odor, chemicals, water quality, erosion and sedimentation, biodiversity, occupational and community health and safety, cultural heritage, employment and training, and emergency response.

[3] EIA Procedure (2015), Article 63. Section 8.5.

G. Developing Emergency Response Procedures

100. Emergency response procedures and systems are those procedures for handling sudden or unexpected emergency situations. The objective is to be prepared to:

i. Prevent fatalities and injuries to workers
ii. Reduce damage to buildings, stock, and equipment
iii. Protect the environment and people in the community
iv. Accelerate the resumption of normal operations

101. Development emergency response plans should include the following:

i. hazard identification/assessment;
ii. emergency resources;
iii. communication systems;
iv. administration of the plan;
v. emergency response procedures;
vi. communication of the procedures; and
vii. debriefing and post-traumatic stress procedure.

102. **Hazards**. Emergencies arise from accidents or other trigger events associated with technological and natural hazards. Examples of technological hazards are:

i. Fire.
ii. Explosion.
iii. Building collapse.
iv. Major structural failure.
v. Spills of flammable liquids.
vi. Accidental release of toxic substances.
vii. Deliberate release of hazardous biological agents, or toxic chemicals.
viii. Other terrorist activities.
ix. Exposure to ionizing radiation.
x. Loss of electrical power.
xi. Loss of water supply.
xii. Loss of communications.

103. Areas where flammables, explosives, or chemicals are used or stored should be considered as the most likely place for a technological hazard emergency to occur.

104. The risk from natural hazards include:

i. Floods.
ii. Earthquakes.
iii. Tornadoes.
iv. Other severe wind storms.
v. Snow or ice storms.
vi. Severe extremes in temperature (cold or hot).
vii. Pandemic diseases like influenza.

105. The possibility of one event triggering others must be considered. An explosion may start a fire and cause structural failure while an earthquake might initiate many of the technological events listed above.

H. Designing Environmental Quality Monitoring Programs

1. Environmental Monitoring in Environmental Impact Assessment

106. Environmental monitoring programs provide the necessary information to:

i. check that environmental quality guidelines are being met:
ii. verify the actual environmental impacts; and
iii. determine the effectiveness of measures to mitigate adverse environmental impacts

107. Feedback from environmental monitoring programs may be used to determine whether corrective action is needed to further mitigate impacts or to address unforeseen environment problems.

2. Monitoring for Compliance with Environmental Quality Standards or Guidelines

108. Monitoring for compliance with environmental quality standards or guidelines is a commonly practiced form of environmental monitoring. The purpose of compliance monitoring is to ensure that the quality or quantity of an environmental component is not altered by a human activity beyond a specified standard or guideline level. An example of compliance monitoring is a sampling program conducted by either industry or government to ensure that concentrations of a contaminant do not exceed a specified level either in the effluent or in the receiving waters. Implicit in compliance monitoring is the assumption that if the parameter being monitored is within acceptable limits, then the effects will be within acceptable limits.

3. Design of Environmental Monitoring Programs

109. Here "environmental monitoring" is defined as the systematic collection, analysis, and evaluation of environmental data to determine the actual impacts. The basic design includes:

i. formulation of the environmental monitoring objectives;
ii. choice environmental indicators to monitor (e.g., air quality, water quality);
iii. choosing the sampling sites (i.e., specific locations);
iv. determining the sampling period (e.g., days, months, years)
v. determining the sampling frequency (e.g., hourly, daily, weekly, seasonally)
vi. design the sampling protocols
vii. sampling
viii. analysis of sampling data, which may include laboratory analysis; and
ix. interpretation of results.

110. Designing environmental monitoring programs to determine actual impacts; ensure compliance with EMP requirements and corporate commitments; determine the effectiveness of mitigation measures; and identify unanticipated impacts.

I. Community Engagement and Community Development

111. Community engagement is a critically important requirement throughout the EIA process (and life of mine). In most countries giving interested and affected people the opportunity to comment on a mining proposal is a legal requirement. Successful community engagement and community development is important and no mining project should be allowed to proceed without having included extensive communty engagement in the process. For detailed description of community engagement and community development, see section VI.

J. Supervision and Monitoring for ECC Compliance and EMP Implementation

112. Designing supervision and monitoring mechanisms including responsibilities and reporting have been described above (section IV.C).

113. **Reporting Requirements**. Monitoring of the environmental management plan will have weekly reporting be the Contractor; and monthly reporting by the Company EHS Unit. The EHS Unit will prepare environmental monitoring reports and Mining Company will submit the reports to ECD (see Table 4.1).

Table 4.1 Monitoring Reporting Requirements.

Responsibility	Reporting Requirement	Reporting to
Construction Contractor	Weekly inspection and monitoring reports	Mine Manager
Mine Environment, Health, and Safety Unit	Monthly inspection and monitoring reports	Mine Manager
	Draft of semi-annual environmental monitoring reports	Mine Manager
Mine Manager	Submission of draft semi-annual environmental monitoring reports	Corporate EHS
Corporate Environment, Health, and Safety Unit	Finalization and submission semi-annual environmental monitoring reports	MONREC

K. Staffing Requirements

114. Environmental staff are needed by the (i) Construction Contractor, (ii) Corporate EHS Unit, and (iii) Mine EHS Unit. It is Proponent’s responsibility to ensure that qualified and trained staff are hired (see Table 4.2).

115. Independent Third Party Environmental Monitoring Contractors need to retained to conduct ambient environmental quality monitoring of air quality, water quality and noise.

Table 4.2. Indicative Staffing and Outside Consultant Needs

Staff	Position	Level of Effort
Contractor	Environmental Safeguards Officer	Full time during construction
Corporate Environment, Health, and Safety Unit	Environmental Engineer	Full time
	Environmental Safeguard Specialist	Full time
Mining EHS Staff	Mining Engineer	Intermittent
	Environmental Safeguard Specialist	Full time
Outside Consultants	Environmental Management Training	Lump Sum Contract
	Independent Third Party Environmental Quality Monitoring Contractors	To be estimated based on proposed environmental monitoring programs.

L. Capacity Development and Training Needs

116. Proponent needs to provide capacity development and/or training programs to ensure that all staff and contactors (i) fully understand the environmental management plan; (ii) understand their responsibilities; and (iii) are capable to undertake their responsibilities. If the Proponent, does not have environmental and social management staff, the Proponent needs to hire a qualified contractor to conduct necessary training and capacity development programs.

M. Cost Estimate and Scheduling

117. Environmental management costs need to be carefully estimated. Costs are to be included in the overall Project Budget (see example – Table 4.3). Costs include:

i. Cost of all mitigation measures;
ii. Cost of all rehabilitation measures;
iii. Cost of all environmental monitoring programs;
iv. Costs of environmental staff of the contractor, exploration team, and proponent; and
v. Costs of all training programs

118. **Scheduling**. Implementation of the mitigation and rehabilitation measures and the environmental monitoring requirements need to be planned to coincide with the project schedule. Environmental staff mobilization and training programs needs be included in the schedule. Environmental Monitoring reports on implementation of the EMP need to be scheduled as well.

119. **Scheduling Guidelines**. Environmental staff should be in place prior to the start of the Project. Environmental staff of the contractor should be trained prior to the start of work. Implementation of the environmental mitigation measures needs precede or coincide with relevant exploration activities. Rehabilitation programs should begin as soon as possible after the completion of an exploration activity.

Environmental quality monitoring programs should be scheduled taking into account the exploration program scheduling and seasonal characteristics.

Table 4.3. Proforma Cost Environmental Management Plan Cost Estimate

Item	Cost	Comment
Mitigation Measures		
Measure 1		
Measure 2		
Measure 3		
Rehabilitation Measures		
Measure 1		
Measure 2		
Measure 3		
Environmental Monitoring Programs		Normally contracted out to qualified environmental monitoring agencies. However, the cost must be estimated.
Program 1		
Program 2		
Program 3		
Public Consultation and Grievance Redress Mechanism		
Environmental Staff		
Contractor		e.g., x person months and cost
Corporate EHS Staff		e.g., x person months and cost
Mine EHS Staff		e.g., x person months and cost
Capacity Development Programs		
Vehicles and Equipment		If necessary
Subtotal		
Contingency (10% of subtotal cost)		
TOTAL COSTS		To be included in the project costs.

V. ENVIRONMENTAL MANAGEMENT SYSTEMS

A. Introduction

120. An important requirement of a government's review of an EIA for a proposed mining project will be to evaluate the commitment and credentials of the prospective mining company that is seeking to invest in a new mining venture in Myanmar. A good indicator of whether a company will pose unacceptable environmental and social risks or alternatively will manage its impacts responsibly will be if they have an effective Environmental Management System (EMS) in place.

121. By reviewing the company's EMS government officials can assess issues such as the approach that a company will take in addressing its environmental and social challenges, the extent of a company's commitment and readiness to integrate environmental responsibility into the culture of the company, the way it will conduct its business and how it will engage with its stakeholders. This will help government officials to reduce the risks posed by mining companies who do not take their environmental and social responsibilities seriously.

122. Most international financial institutions require a mining company to have an EMS in place when they consider their proposals for funding. For example, the European Bank for Reconstruction and Development (EBRD) states that: "Clients are required to establish and maintain an EMS appropriate to the nature and scale of the project and commensurate with the level of its environmental and social impacts and issues (it faces) …. The objective of such a management system is to integrate the implementation of environmental and social requirements into a streamlined and coordinated process and to embed them in the main operational activities of the client's assessment of impacts and issues."

B. Objectives

123. The purpose of this section is to provide a profile of what constitutes good practice in designing, developing and implementing an EMS in the mining sector. Understanding the requirements of an EMS will help government officials to efficiently and effectively assess the likelihood that a company wishing to invest in Myanmar will do so in an environmentally and socially responsible way.

What is an Environmental Management System (EMS)?

124. An EMS is one of the most effective tools to manage risk and achieve good environmental performance in an organization. It is a continuous, methodical and systematic approach to environmental management and helps them identify, manage, monitor and control their environmental and social impacts in a structured way.

125. An EMS enhances management controls, adding environmental dimensions to other more traditional production oriented tasks and integrates environmental management into routine activities and long-term planning across the entire company. In essence, an EMS requires establishing targets and objectives and standards and monitoring and reviewing progress towards these as part of a commitment to managing the impact that the company's activities have on the environment.

126. It will be initiated and supported by senior management but encourages every level of the organization to focus on common environmental commitments. It not only enhances clear communications within the company but also between the company and its stakeholders. It is a continuous process of looking for opportunities to reduce negative impacts on the environment and improve the environmental benefits of the company's activities – in the spirit of continuous improvement.

127. An EMS uses Quality Assurance principles to monitor a company's environmental performance towards goals and objectives. The process followed draws on the established business management process of "plan, do, check, and act," – the logical sequence of planning, implementing, reviewing and reacting to outcomes in a structured way.

PLAN: Plan ahead for change. Analyze and predict the results.
DO: Execute the plan, taking small steps in controlled circumstances.
CHECK: Check and study the results.
ACT: Take action to standardize or improve the process.

128. An EMS must be capable of being adapted to changing circumstances as new needs are identified. It therefore follows that regular internal reviews of applicability of procedures, staff skills, allocation of resources and the adequacy of reporting systems will be required. These should be complemented by periodic audits with external third-party verification.

C. Key Components of an Environmental Management System

129. An EMS involves the development and implementation of appropriate policies, plans, procedures and programs to anticipate, monitor and manage environmental and social risks and the development of strategies to minimize negative impacts and maximize positive outcomes. It will also include attention to emergency preparedness and response plans.

130. The most important components of an effective EMS in the mining sector include:

i. Senior Management Commitment.
ii. Responsibility, Accountability, and Reporting structures.
iii. A Corporate Environmental Policy (or policies) and a Strategy to operationalize Policy
iv. A Corporate Environmental Management Plan (including Objectives, Targets and Key Performance Indicators).
v. Risk and Environmental Impact Assessment Procedures for new or significant changes to Investments/Projects.
vi. Site and Project Specific Environmental Management Plans
vi. Specific Environmental Management Plans, e.g., including:
    - Biodiversity Action Plan,
    - Mine Closure Plan.
    - Pollution Prevention and Control Plan (containing emission, effluent standards, monitoring and measurement systems),
    - Cyanide Management Plan (for gold or silver mining),
    - Acid Rock Drainage Management Plan,
    - Community Engagement and Development Plans
    - Emergency Awareness and Preparedness Procedures

vii. Documentation and Records. (e.g., Published policy, monitoring and inspection records (of effluents and emissions etc.), allocated responsibilities, Issue specific management plan records, emergency procedures, registers of complaints and responses, staff training records, chemicals manifests, international certification – such as the cyanide code certification for gold and silver mines - lists of pertinent regulations, environmental impact reports, commitments register, audit protocols and records etc.). These are often written up in an Environmental Manual and in a form, that can be shared/ referenced/ updated publicly and with regulators.

viii. Training, awareness and competency frameworks and capacity development programs provided to staff – with more detailed, technical training for personnel needing specific skills to perform their duties.

ix. Environmental Performance Review and Auditing Procedures (of internal policies and systems and external legal standards and compliance requirements). Audits identify existing or potential problems and gauge the efficacy of current environmental management measures to manage negative impacts and determine any corrections needed.

D. ISO Environmental Management Systems Standards. (ISO 14000)

131. Certification to an internationally recognized EMS system provides investors, government authorities, communities as well as other stakeholders with assurances that the company is taking its environmental responsibilities seriously and has a system in place to manage them.

132. Formal International Standards for EMS have existed since 1996. The most widely recognized EMS standard is the Organization for International Standardization's series of Environmental Management Systems Standards (better known as ISO 14000)[4]. This is now the principle international certification scheme and reference for Environmental Management Systems. Its latest update was in 2015.

133. The standard provides good practice approaches to improving environmental performance and maps out a framework that can to be followed to set up and maintain an EMS.

134. The 14000:2015 standards of most relevance to Mining Investments include:

- ISO 14001 - Implementation Handbook
- ISO 14004 - General Guidelines on Principles, Systems and Supporting Techniques.
- ISO 14015 - Environmental Assessment of Sites and Organizations.
- ISO 14031 - Environmental Performance Evaluation
- 1S0 14040 - Life Cycle Assessment.
- ISO 14063 - Environmental Communication
- ISO 14064 - Greenhouse Gases.
- ISO 19011 - Guidelines for Auditing Management Systems

[4] The webpage for the ISO 14001 Environmental Management Systems Standard can be found at: https://www.iso.org/iso-14001-environmental-management.html

E. Why is an EMS important?

135. While there is no guarantee that having an EMS in place will automatically lead to responsible environmental performance, the chances are considerably better that it will than if it does not. If a company has no comprehensive, systematic approach to managing its impacts environmental management requirements may be inadvertently over looked, performance standards will be unclear, legal compliance will be more difficult, communications will be poor, responsibilities will be confused, progress in implementing targets will be slow and the company will be less resilient to changing circumstances or prepared to handle emergencies.

136. Ad hoc, haphazard and reactive responses to individual environmental challenges and responsibilities will be inefficient, confusing and costly. A pro-active and structured approach can be monitored, periodically audited and is amenable to progress and effectiveness reporting.

137. An effective EMS helps a company to better manage risks, take advantage of opportunities, have better control over operations and costs, enhance their social and environmental performance and reputation and may lead to improved financial performance.

138. An EMS will provide assurances to company management, employees as well as external stakeholders that environmental impacts are being measured and managed, that compliance obligations and environmental targets are being met and thus will enhance environmental performance.

139. The internal, comprehensive monitoring and auditing requirements inherent in an EMS will assist under resourced government departments to fulfil their own monitoring requirements.

F. EMS and EIA

140. Having the procedures in place (and the capacity and resources) to undertake an EIA of any new mining project, significant change or other investment (such as a merger or acquisition) is an inherent component of good practice EMS.

141. Establishing the existence of and assessing the quality of a company’s EMS is a good starting point for government officials to carry out an EIA review (see Box 5.1 for checklist questions). It will provide assurances that any conditions that are agreed during the project approval process will progress into an Environmental Management Plan and be effectively implemented in practice throughout the life of a mine. If a company does not have an EMS, the government should request this as a condition prior to EIA approval and issuing a mining permit.

Box 5. 1 Assessing the Quality of a Company’s Environmental Management System

Checklist Questions:

Has the company a reputation as a leader or a laggard in environmental performance? Has it got a history of poor good or poor performance or litigation and community conflicts for environmental problems in earlier projects?

Has an Environmental Management System been put in place and is it signed off at senior level in the company?

Does it include an Environmental Policy that indicates the company’s values on matters such as environmental protection and enhancement and the principles top which it will adhere?

Are the company’s strategic objectives in sustainable development and social responsibility aligned and compatible with those of the government of Myanmar and its international commitments?

Does the company’s corporate governance structure indicate accountability and responsibility for the effective implementation of an Environmental Management System indicated?

Does the company have appropriately qualified specialist staff in place to monitor and manage specific EMS issues?

Does the company limit its focus to legal compliance, or does it aspire to achieve standards beyond legal compliance?

Are procedures in place to manage identified risks?

Does the company have established environmental reporting practices?

Has the company established good relations with all the communities that are impacted, either directly or indirectly by their activities?

Does the company have a constructive dialogue with NGOs and experts in specific subjects?

Does the company have good labor relations?

Does the company management have an Emergency Preparedness Plan in place to safeguard against any accidents?

Does the company have a knowledge of international initiatives and standards?

VI. COMMUNITY ENGAGEMENT AND COMMUNITY DEVELOPMENT

A. Community Engagement

142. Community engagement is a critically important requirement throughout the EIA process (and life of mine). In most countries giving interested and affected people the opportunity to comment on a mining proposal is a legal requirement. Successful community engagement is important and no mining project should be allowed to proceed without having included extensive communty engagement in the process.

143. Community engagement builds on local knowledge and utilises participatory processes to analyse the concerns of interested and affected parties. It will help with baseline data collection and the identify the issues communities consider to be significant. It involves stakeholders in the assessment of impacts, the analysis of alternatives, and monitoring of the planned intervention. It will consider impacts of the project on issues such as aesthetics (landscape analysis); archaeological resources, cultural heritage (both tangible and non-tangible); community values; demographics; economic and fiscal regimes; gender; health; indigenous rights; leisure and tourism; politics (human rights, governance, democratisation etc.); poverty; access to and ownership of resources; livelihoods, social and human capital and other impacts.

Defining 'Communities'.

144. The first challenge is to identify who to engage with. Communities' around mines are not homogeneous they can be very diverse and express a great variety of opinions, interests, values and priorities. Initially an it is necessary to undertake a *stakeholder analysis* to 'map' the extent and the diversity of the community likely to be impacted in some way or other by the mine - and thus with an interest in engaging in the EIA process. The *stakeholder analysis* should lead to a *stakeholder engagement plan* that will be followed The range of stakeholders that may be interested and /or affected by the mine need to be identified and the best means of communicating with them determined.

145. ***Meaningful and Effective*** Meaningful participation will ensure communities have the opportunity to *influence and impact* decisions about a mining proposal during the EIA process and also throughout the whole mine life cycle. In community relations the opportunity to engage in the process may be as important as outcomes achieved. Conversely, not to involve communities in mining project EIAs will likely lead to misunderstandings, frustrations and ultimately conflicts and costly delays.

146. ***Inclusiveness*:** The community engagement process must be inclusive. An EIA process must ensure that all members of a community (and other interested and affected people) have the opportunity to engage and influence material decision making not only in the planning stage but also throughout the life of a mine. This should include marginalised and vulnerable people in communities who may have to be targetted to ensure that they have a voice. Community dynamics must be understood to prevent or mitigate community conflicts that might occur when a sector feels left out. Cooperation, convergence and consensus need to be promoted.

147. The community profile must also ensure that participants in a dialogue are genuine representatives of a community. Some engagement processes have been criticised by communities for paying too much attention to the views of 'self- appointed' guardians of the

communities' interests – views that may be contrary to the desires of the community themselves. The representative legitimacy and mandate of those involved in the EIA process must be established. *Sufficient* definition of 'interested and affected communities' will be achieved when the full range of individuals and groups who represent the complete spectrum of a community and its expectations have been identified and effectively engaged.

148. ***Timing:*** Community engagement should not only take place when problems have arisen. Timing is critically important for meaningful community engagement in an EIA process. Although it is an on -going and iterative process, it must take place when it is still possible for the community to influence and impact decisions. It is *not* simply needed to 'tick a box' and gain approval from the community for decisions the mine and/ or government have already agreed and taken.

149. ***Transparency***. Meaningful community engagement requires full and transparent information disclosure by the project proponent on all material matters that will affect communities and their livelihoods. The community must be given access to as much information as they need to reach an informed judgement – within the bounds of commercial sensitivity. The mining company is responsible for providing this information in the EIA process. Relevant information about the nature of the project must be disclosed and disseminated in a way that is timely, understandable, culturally acceptable and accessible – preferably in local languages if appropriate.

150. **Two-way Dialogue**. Community engagement must not be limited to the mining company simply *providing information*. This is necessary and important, but it does not constitute *meaningful* participation. Meaningful participation requires stakeholder interaction, responses to questions and two way dialogue on issues of concern to communities. Fully understanding the risks and opportunities posed by the mine proposal will allow all interested and affected people to conclude if they are prepared to give it a 'social license to operate' or not. There is ongoing debate about what exactly is meant by a 'social licence to operate'. In simple terms, it is defined as a project proponent obtaining and maintaining broad community support and acceptance of the project. To reinforce trust community members must have easy access to government and mine officials to raise any concerns and have any questions about the project answered.

151. **Developing Community Capacity.** A community will likely lack information about a project and its potential consequences. There is often little understanding in communities of the information that they can demand of governments or the mining company. Although communities will have detailed knowledge about the area, and this information will be valuable for the EIA process, the mining company will have much more information on the technical aspects of mining and what impacts this is potentially going to have. They will have access to more expertise (including legal) than the community. Government should try and redress this imbalance and discussions should be facilitated. Community development must include contributing to communities so that they are better able to engage in the EIA process. To achieve this, communities need to have the capacity to engage and articulate their development aspirations and concerns about a mining proposal in a meaningful way.

152. A summary of community engagement requirements is provided in Box 6.1.

Box 6.1 Summary: Community Engagement Requirements:

- Stakeholder analysis
- Engagement Strategy development
- Engagement strategy implementation
- Disclosure and dissemination of information
- Consultation and participation
- Grievance mechanisms
- Joint environmental monitoring and on-going reporting to impacted communities.

B. From Community Engagement to Community Development

153. Community Development is a deeper process than engagement or participation. It is designed to increase the capacity of communities to engage in dialogue and decision-making and have greater control over their lives and livelihoods. This calls for long-term, multi stakeholder partnerships to process a mine's social and economic contribution to the community. Community Engagement and Development are distinct but overlapping processes. Engagement can be undertaken without necessarily including a commitment to development. Development, on the other hand, means that a company must undertake to contribute to the social, economic and institutional development of the communities in which they operate

154. Neighbouring communities near mines must gain development benefits from a mining investment. he benefits accruing to local communities from mining must be maximized in a sustainable way and the negative impacts must be either avoided or minimized.

155. Formal Community Development Agreements (CDAs) are a response to changing societal/ community expectations that mining companies must not only operate *responsibly* but must also contribute to long term *development* outcomes of the communities (and countries) in which they invest. There are no universally accepted definitions, standards, structures, content to be included or procedures to be followed for the design and implementation of CDAs. They even go by a variety of names/labels.[5] Consequently the nature of CDAs varies considerably. However key principles can be identified (Box 6.2).

156. This is going beyond simply improving the social and economic circumstances around a mine. It involves helping communities to develop the capacity to address their development priorities and improve their quality of life and livelihoods themselves while helping to break the

[5] Community Development Initiatives, Voluntary Agreements, Indigenous Land Use Agreements, Partnering or Partnership Agreements, Community Contracts, Shared Responsibilities Agreements, Community Joint Venture Agreements, Empowerment Agreements, Exploration Agreements (Canada), Impact Benefit Agreements (Canada), Social Trust Funds (Peru), Investment Agreements (Mongolia), Benefits Sharing Agreements (Chile). (World Bank, 2011)

dependency that may develop on a mine that will, in time, close. To achieve this CDA's formalize the relationships between communities, governments and mining companies.

Box 6.2 Key Principles of Community Development Agreements. (CDAs).

- In the absence of any universally accepted prescriptions several principles can be identified that help clarify the requirements of CDAs:
- CDAs are formal, negotiated and published agreements (that are likely to be a legal contract) established between communities, governments and mine management – (although bilateral arrangements between communities and companies are also common)
- Key governance arrangements for managing relationships are required (e.g. they are 'roundtables' and no one interest group should have more influence than the other.)
- The goals of CDAs are developed through a facilitated, negotiated, 'fair' and equitable process.
- Communities should not just be recipients of assistance but must be active partners shaping and developing the CDA.
- The content of CDAs should address agreed broad development outcomes (i.e. not just compensation issues or mitigation of negative impacts).
- All parties will have shared responsibilities and mutual obligations in implementing the CDA and ensuring the success of the outcomes.
- CDAs must be developed in an inclusive and transparent way - with care to ensure that marginalized and vulnerable groups, or those with occasional/ seasonal interests in the community, are not overlooked.
- Institutional and individual capacity assessment of all participants should form the basis for ensuring that all stakeholders have the capacity/resources to engage effectively. Capacity development must be provided where necessary.
- All stakeholders must have access to adequate resources. (Possibly a Trust Fund)
- Although CDAs must be well structured, they must also be flexible enough to adjust to changing circumstances. An exit strategy is important.
- There must be monitoring, and evaluation procedures and quality controls agreed for community development initiatives to measure the impact/efficacy of partnerships. (Rather than just measuring delivery of activities and outputs).
- Exit strategies must be developed to ensure continuity.

Source: (Based on "Good Practice Note Community Development Agreements" 2011 that can be found in

157. **Grievance mechanisms.** No matter how much effort goes into trying to achieve consensus, complaints and conflicts will still arise during the EIA process and the eventual operation of the mine if approved. Sometimes opinions differ about the principle of mining *per se* – and common ground seems to be unattainable. In such circumstances 'agreeing to disagree' may the only solution.

158. Where resolution may be possible, effective procedures for dealing with complaints, disputes and grievances are important. Many of a community's concerns and complaints about a mining company's EIA process and eventual environmental and social performance can be addressed and resolved through grievance mechanisms. During the EIA process the reponsible government officials should work with the project proponenets to make sure there are open communication channems to respond to concerns and questions. The measure of an effective grievance mechanism adopted by a company might not necessarily be the absence of complaints

or disagreements between communities and company, but rather the availability of a process of respectful and constructive dialogue between them about complaints. These may be formal grievance processes, such as arbitration and mediation involving a third party or it may be simply positioning a ‘complaints box’ within a community (that is regularly reviewed and responded to). Companies should make sure that they have appropriate processes in place because without such opportunities to have issues resolved they may escalate into costly, long term conflicts.

C. Community Development- Letpadaung Copper Mine Example.

159. The mining company operating the Letpdaung Copper Mine has a community development program that has four main elements: (i) education; (ii) infrastructure improvement; (iii) health care and (iv) social welfare[6]. The company helps communities to improve eduction system through constructing and repairing school buildings and provide grants to students to obtain better educaiton. The company improves infrastructure through repairing road, making draining improvements, and providing water supply and electrical supply. The company provide treatment for patients for local communities throuhgh a mobile clinic and raises awareness and knowledge through seminars on infectious diseases. The company’s social welfare assistance targets the elderly and women. The company has been implementing a Small and Medium Enterprise (SME) support program. Thirteen different SME’s have been formed generating employment in the local communities.

[6] Myanmar Wanbao Mining Copper Ltd. MWMCL CSR Report 2016 – 2017.

Further References and Support

General

- The United Nations Economic Commission for Europe (UNECE) (1998): Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.
- International Finance Corporation (2007**)** “Stakeholder Engagement- A Good Practice Handbook for Companies Doing Business in Emerging Markets” Washington DC, USA
- Department of Resources, Energy and Tourism, Australian Government (2009); “Community Engagement and Development”. Canberra, Australia.
- ICMM/IFC “‘Community Development Toolkit” up-dated 2012,

Effective Participation.

- Sherry R Arnstein. (1969**):** "A Ladder of Citizen Participation,**"** JAIP, Vol. 35, No. 4, July 1969, pp. 216-22
- **The International Association for Public Participation(IAP2) (2007):** “ IAP2 A Public Participation Spectrum” (http://www.iap2.org/)

Community Development Agreements

- World Bank (2010) (Prepared by ERM): “Mining Community Development Agreements – Practical Experiences and Field Studies.” Washington DC, USA
- World Bank (2010) (Prepared by James Otto): “Community Development Agreement Model Regulations and Example Guidelines”. Washington DC, USA

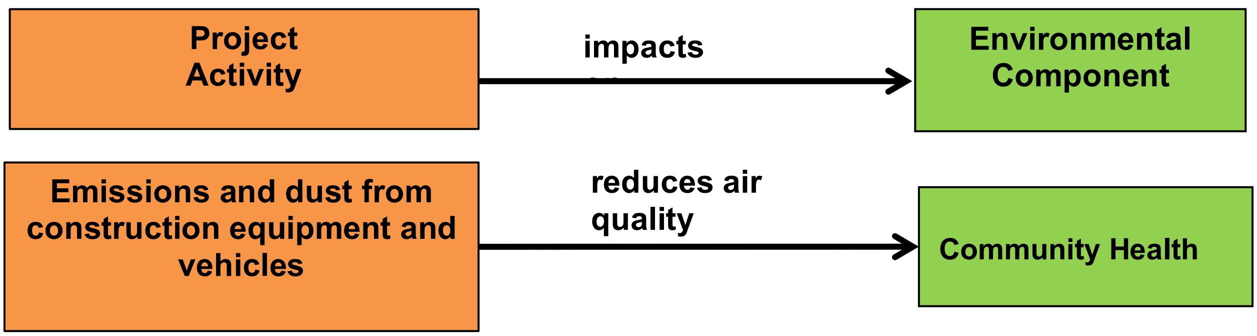
University of Dundee/World Bank Group (2011) “EI Sourcebook; Good Practice Note Community Development Agreements” - contributed by University of Queensland, Australia. **(www.eisourcebook.org)**

VII. ASSESSING THE SIGNIFICANCE OF IMPACTS

A. Environmental Impact Defined

1. An impact is any change in an environmental and social component brought about by a project activity.

2. One simple example of a common environmental impact of many projects is “emissions and dust from construction equipment and vehicles will reduce air quality and affect community health”. Note that the statement of impact has three parts “the project activity” causing “the impact” on an “environmental or social component”. In this case the activity is “emissions from construction equipment and vehicles”. The impact is “reduces air quality”. The environmental component is “community health”. See Figure below.



B. Determining Significance

3. Determination of the significance of the anticipated impacts is a key component of the environmental process. Many experts consider the following as significant adverse impacts:

i. loss of rare or endangered species;
ii. reductions in species diversity;
iii. loss of critical natural habitat;
iv. transformation of natural landscapes;
v. impacts on human health;
vi. reductions in the capacity of renewable resources to meet the needs of present and future generations;
vii. loss of current use of lands and resources for traditional purposes by indigenous peoples;
viii. foreclosure of future resource use or production; and
ix. contributions to global effects (e.g., ozone depletion, climate change).

4. **Suggested Criteria.** While expert judgement is used in the assessment of significance, there are criteria that can be used. The suggested criteria for evaluating a project’s environmental are listed impacts are listed below (Table 7.1). The significance of adverse impacts depends on the importance (environmental, economic, or social) of the component, geographic extent of the impact, duration and frequency of the impact, irreversibility of the impact, and magnitude of the change in the component. The application of these criteria is subjective and will require justification in the environmental assessment documentation.

Table 7.1. Suggested Criteria of Evaluating the Significance of Impacts.

Criteria	Definition	Attribute
Importance	The value that is attached to a specific environmental component in its current condition.	Low High: • Human health • Subsistence Agriculture • Subsistence Fisheries • Non-timber forest products • Protected area or species • Global or national importance • Commercially Valuable • Culturally Important
Spatial Extent	The geographic area of the impact	Site Local Regional International
Duration	The time scale for activity	Temporary Short-term Long-term Permanent
Frequency	The rate at which activity occurs or is repeated over a particular period of time.	Intermittent Seasonal Constant
Risk	The probability that the impact will occur	Unlikely Likely
Reversibility (Resilience)	The ability of the environmental components to recover their value after an impact has occurred	Irreversible Short term recovery Long term recovery
Magnitude of Change	The amount of change in environmental component	Small Medium Large

5. **Assigning Significance.** One simple approach (see Box 7.1) to is assess each potential impact as

i. No Impact;
ii. Significant Impact;
iii. Insignificant Impact; and
iv. Unknown Impact.

Box 7.1. Simplified Approach to Assessing Impact Significance

The potential impacts of the project (that is, each combination of project activity and environmental component) can be classified into one of five possible categories:

No Impact: The potential impact of project activity will be assessed as NO IMPACT if the project activity is physically removed in space or time from the environmental parameter.

Significant impact: An impact is said to be SIGNIFICANT if the activity has potential to affect an environmental or social component; and if the

i. importance of environmental or social component is – high (see Table 7.1); or
ii. spatial extent of the impact is - regional, national, or international; or
iii. time scale of the impact is - long term or permanent; or
iv. magnitude of the change in the environmental or component is – medium or large; or
v. impact is irreversible or the recovery of the component will take a long period of time.

Insignificant Impact: If an impact occurs but does not meet the criteria for significance it is assigned the category INSIGNIFICANT.

Unknown Impact. The potential impact of a project activity will be assessed as being UNKNOWN if:

i. the nature and location of the project activity is uncertain;
ii. the occurrence of the environmental component within the study area is uncertain;
iii. the time scale of the effect is unknown;
iv. the spatial scale over which the effect may occur is unknown; or
v. the magnitude of the effect cannot be predicted.

6. A simple template (see Template 7.1 below) can be used to structure the assessment.

7. Table 7.2 provides an example the overall assessment for the potential impact of "emissions and dust from construction equipment and vehicles will reduce air quality and affect human health." It is an example only – in another situation – the assessment may be very different depending on the actual activities and environmental components.

Template 7.1. Summary of Assessment

Impact	**Description:**			
Criteria	**Qualitative Assessment**			
Component Importance	Low		High	
	Rationale:			
Spatial Extent	Site	Local	Regional	National/ International
	Rationale:			
Duration	Temporary	Short Term	Long Term	Permanent
	Rationale:			
Frequency	Intermittent	Seasonal	Constant	
	Rationale:			
Risk	Unlikely	Likely	Certain	
	Rationale:			
Reversibility/ Recovery Time	Irreversible	Short Term Recovery	Long Term Recovery	
	Rationale:			
Magnitude of the Change	Small	Medium	Large	
	Rationale:			
Impact Significance	No Impact	Insignificant Impact	Significant Impact	Unknown
	Rationale:			

Table 7.2. Illustrative example of the use to the assessment template.

Impact	**Description:** missions and dust from construction vehicles will reduce air quality and affect community health".			
Criteria	**Qualitative Assessment**			
Component Importance	Low		High	
	Rationale: Particulates emissions and dust have been proven to have adverse impacts on human health			
Spatial Extent	Site	Local	Regional	National/ International
	Rationale: Emissions and dust will occur primarily at the mine site and access roads to the mine site.			
Duration	Temporary	Short Term	Long Term	Permanent
	Rationale: Impacts will be temporary associated with the construction phase.			
Frequency	Intermittent	Seasonal	Constant	
	Rationale: People in affected communities will only be exposed when equipment and vehicle are operating near communities.			
Risk	Unlikely	Likely	Certain	
	Rationale: The risk is likely is for some communities; and certain for others depending on the distance to the source (i.e., equipment and vehicles).			
Reversibility/ Recovery Time	Irreversible	Short Term Recovery	Long Term Recovery	
	Rationale: The impacts are reversible. In most cases, people will recover in a short time after the exposure to dust and emissions stops.			
Magnitude (size) of the Change	Small	Medium	Large	
	Rationale: The change is expected to be small as only few communities will be exposed to dust and emissions.			

<table>
<tr><td rowspan="2">Impact Significance</td><td>No Impact</td><td>Insignificant Impact</td><td>Significant Impact</td><td>Unknown Impact</td></tr>
<tr><td colspan="4">Rationale: Insignificant Impact. Impacts are expected to be small limited to the site, temporary, intermittent, and reversible with a short recovery time.

Standard mitigation measures for dust control on roads and construction sites and emission control on vehicles and equipment are required.</td></tr>
</table>

8. **Using Environmental Standards.** Environmental standards are necessary to provide a scale against which the environmental changes (positive or negative) associated with a project may be measured. The environmental assessment process is more objective where the assessment of the significance of impacts may be defined by comparing the expected changes in environmental components with the desired environmental quality standards. The effectiveness of the EIA process in protecting the environment is, of course, highly dependent on the degree of environmental protection offered by the standard.

9. *Ambient environmental standards* generally define the prescribed limits to which levels of environmental resources may be permitted to fall, or the upper limits to which pollutants may be allowed to reach in the environment. Ambient standards may define the degree of environmental quality which must be maintained in an environmental resource to support its continued beneficial human use. While often set to protect human health, ambient standards may also be set to ensure long-term sustainability of an environmental resource.

VIII. RISK ASSESSMENT

160. Risk assessment is the analysis and mitigation of risks of natural disasters and major industrial mining accidents with respect to consequences for the Project and resulting environmental and social impacts. The risk assessment of the EIA report should deal with risks posed by natural hazards and mining industrial hazards associated with each Project phase[7].

161. **Natural Hazards and Disaster Risk**. Typical natural hazards in Myanmar include floods, storms and cyclones, droughts, landslides, earthquakes, and UXO[8].

162. **Mining Industrial Hazards.** Typical mining industrial hazards are:

i. Dam failures;
ii. Landslide and slope failures;
iii. Fire;
iv. Explosions;
v. Chemical spills, leakages, and other unintended release of chemicals or radioactive materials;
vi. Electrical failures, equipment malfunctioning; and
vii. Mechanical and structural failures and equipment malfunction.

163. **Risk Assessment Approach.** The following approach is recommended:

i. Identification of types of natural hazards and disasters based on historical records and analysis of likely hazardous geologic and atmospheric events;
ii. Consideration of future climate change scenarios and implications for frequency and consequences of natural hazards;
iii. Estimation of spatial patterns, frequency, duration and intensity of the natural hazards
iv. Identify types of industrial hazards based on an analysis of the Project design and layout, use and handling of hazardous materials combined with case studies, and literature and media search;
v. Analyze cause and effect events that might lead to industrial hazards, and the probability of occurrence;
vi. Analyze the severity of industrial hazards including spatial patterns, frequency, duration and intensity of the hazards;
vii. Assess the extent and probability of damages, taking into account the planned Project location, layout and design of components, exposure routes and media in the surrounding environment, location of local communities and VEC, and aggravating factors;
viii. Calculate overall risk and compare with acceptable levels; and
ix. Identify needed risk mitigation measures.

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[7] General Technical EIA Guidelines (2017).

[8] UXOs are not a natural hazard but this hazard is included here as it is a hazard not related to the design and operations of a Project

164. The analysis should represent the range of potential impacts of potential accidents and destructive natural events, including those from likely scenarios as well as those from low-probability, high-consequence scenarios. The analysis of risk should be considered in the design of all structures as well as in the development of spill and catastrophic failure contingency plans. The analysis of risk should be considered in the design control technologies, tailings ponds, waste rock dumps stockpiles, processing plants, emission controls, and closure activities.

165. **Emergency Response Plans.** Emergency Response Plans are to be designed to deal with accidental spills, dam failures, fires, explosions, cyclones, unforeseen weather events, earthquakes, volcanic eruptions and other events. Emergency response plans are to include:

i. emergency resources (e.g., fire-fighting equipment; spill clean-up equipment; first aid supplies; medical clinics; emergency vehicles)
ii. communication systems;
iii. administration of the plan;
iv. emergency response procedures (e.g., emergency notification, evacuation, fire suppression, spill clean-up; medical support);
v. communication of the procedures;
vi. emergency preparedness training; and
vii. debriefing and post-traumatic stress procedure.

IX. CUMULATIVE IMPACT ASSESSMENT

166. Under the EIA Procedure (2015), a cumulative impact assesment [may be or is] required as part of the environmental impact assessent. The decision on whether a cumulative impact assessment should be made at the scoping phase. The decision will depend on whether the Project is likely to contribute significantly to cumulative impacts and/or whether cumulative impacts originating from other developments are likely to significantly affect the Project.

167. Cumulative impacts need to be assessed in mining;

i. when series of mining developments occur within an area will impact the same VECs (perhaps common water bodies or watercourses, wildlife populations, community health, community loss of access to assets, or multiple land takes); or

ii. when a large mining project requires major infrastructure investments (e.g., power transmission lines, major roads needed to provide to access the site, new towns), to support mining operations.

168. Currently, there is no single method or approach to cumulative impact assessment recommended for use in Myanmar. However, it is important is that during the process of identifying environmental and social impacts and risks project Proponent's recognize that: (i) recognize that their activities may contribute to cumulative impacts on valued environmental and social components on which other existing or future developments may also have detrimental effects, and (ii) mitigation measures be designed to avoid and/or minimize these impacts to the greatest extent possible[9].

169. **Cumulative Impact Defined**. Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity ("developments") when added to other existing, planned, and/or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities[10].

170. **Value Environmental and Social Component.** For a cumulative impact assessment to be effective in supporting good overall environmental and social risk management, its scope must be focused. Good practice is to limit the assessment and management strategies on the most important environmental and social components.

171. Valued Environmental and Social Components[11] (VECs) are those environmental and social attributes that are considered to be important in assessing risks. They may be:

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[9] Good Practice Handbook on Cumulative Impact Assessment and Management. International Finance Corporation. 2011.

[10] Good Practice Handbook on Cumulative Impact Assessment and Management. International Finance Corporation. 2011

[11] Good Practice Handbook on Cumulative Impact Assessment and Management. International Finance Corporation. 2011.

i. physical features, habitats, wildlife populations (e.g., biodiversity),
ii. ecosystem services,
iii. natural processes (e.g., water and nutrient cycles, microclimate),
iv. social conditions (e.g., health, economics), or
v. cultural aspects (e.g., traditional spiritual ceremonies).

172. **Recommended Approach**. It is recommended that the cumulative impact assessment follow the general approach outlined in the *Good Practice Handbook on Cumulative Impact Assessment and Management* prepared by International Finance Corporation (2013). This approach has six basic steps:

i. Step 1. Assess the potential impacts and risks of a proposed development over time, in the context of potential effects from other developments and natural environmental and social external drivers on a chosen Valued Environmental and Social Component (VEC).
ii. Step 2. Verify that the proposed development's cumulative social and environmental impacts and risks will not exceed a threshold[12] that could compromise the sustainability or viability of selected VECs.
iii. Step 3. Confirm that the proposed development's value and feasibility are not limited by cumulative social and environmental impacts.
iv. Step 4. Support the development of governance structures for making decisions and managing cumulative impacts at the appropriate geographic scale (e.g., air shed, river catchment, town, regional landscape).
v. Step 5. Ensure that the concerns of affected communities about the cumulative impacts of a proposed development are identified, documented, and addressed.
vi. Step 6. Manage potential risks.

[12] The viability or sustainability of VECs, whether ecological, biological, or related to human communities, is their capacity to endure (i.e., for the ecosystem, community, or population to remain diverse and productive over time). This is reflected in the definition of sustainable use in the Convention on Biological Diversity: using the "components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of future generations. A threshold is the point at which there is an abrupt change in an ecosystem quality, property or phenomenon, or where small changes in an environmental driver produce large responses in the ecosystem.

X. BIODIVERSITY ASSESSMENT

173. The maintenance of healthy and productive ecosystems is fundamental to the survival of all life on Earth. Protecting the integrity of ecosystems and the life that depends upon them for their survival, maintenance and development is a major responsibility of all those engaged in mining projects.

What are Ecosystems?

174. Ecosystems are complex entities comprising water, air, land, and the communities of plants, animals and microorganisms that live in them, and within which they interact with one another and their non-living environment of matter and energy. Ecosystems exist in terrestrial (forests, deserts, grasslands etc.) and aquatic (e.g. marine, estuarine, lake, river etc.) environments. The components of ecosystems can be thought of as the 'natural' infrastructure that support life - in a similar way to that in which engineered infrastructure supports economic growth and development.

What are Ecosystem Services?

175. Ecosystems provide services or benefits to humans' and all living creatures and these are important for their survival and wellbeing. While some ecosystem services contribute directly to human wellbeing, others do so indirectly. For example, livestock production provides direct value to human wellbeing through income generation or providing food for subsistence, whereas grazing lands contribute indirectly, by supporting livestock production. Ecosystem services are generally classified into four types:

i. *Provisioning services* (such as water, food, fuel etc.);
ii. *Regulating services* (such as flood prevention, climate regulation, disease control);
iii. *Supporting* services (such as soil formation and nutrient recycling); and
iv. *Cultura*l services (such as spiritual and recreational benefits).

176. Degradation or loss of ecosystems may result in a reduction in the services provided and benefits obtained of/from an ecosystem. Understanding the inter-relationships between humans and ecosystem services is a crucial requirement of EIA.

Biodiversity

177. Biodiversity is the measure of the number, variety and variability of living organisms living in a specific area. The components of biodiversity, as defined in the UN Convention on Biological Diversity (1992/3), include ecosystems and habitats, species and communities, and genes and genomes, all of which have social, economic, cultural and scientific importance. Biodiversity and Ecosystems are intricately interrelated concepts. Biodiversity plays an important role in the way ecosystems function and in the many services they provide. For the maintenance of ecosystem services, the abundance as well as diversity of species is important.

178. Human actions, however, have led to irreversible losses in terms of diversity of life on Earth and these losses have been more rapid in the past 50 years than ever before in human history. Many animal and plant populations have declined in numbers, geographical spread, or

both. (Millennium Ecosystem Assessment, 2000). Biodiversity loss has negative effects on several aspects of human well - being, such as food security, vulnerability to health hazards and natural disasters, energy security, and access to clean water and raw materials. Poorly planned and operated mining projects may escalate the decline and degradation of ecosystems.

A. Mining, Ecosystems and Biodiversity.

179. Depending on their location, mining projects will potentially affect a variety of ecosystems and the services they provide for people and wildlife. It will change or modify ecosystems directly and indirectly. For example, land clearance can lead to the direct loss of habitats for wildlife and water abstraction may indirectly reduce water availability for other users. These trade-offs, need to be understood and must inform decision makers about the value of services that will be irreversibly lost. They need to decide if these long-term losses will exceed the short-term benefits that are gained from mining.

180. It is a fundamental requirement of EIA to identify and assess the potential impact of a mine on "priority ecosystem services" and indicate the potential management responses needed to avoid or minimize the negative impacts of a mining project on ecosystems and biodiversity. This requirement will be on-going throughout the life cycle of a mining project- including through to post- mining when the restoration of disturbed ecosystems- including specific habitats - is important. An EIA should also identify rare or endangered wildlife species and the habitats (shelter, feeding areas, migration routes etc.) for their survival.

181. In addition, an EIA must also consider the importance of ecosystem services for a mine itself. For example. a mine will be dependent upon a supply of clean and reliable water for mineral processing activities and for its personnel. Vegetation cover may also be important to protect a mine site from flooding. Mining developments have to be located close to the ore bodies that they plan to exploit. Locational options for mines are, therefore, very restricted and conflicts between mining and conservation interests seem almost inevitable. Although some impacts of mining are inevitable, responsible mining will ensure that biodiversity and ecosystem integrity are not impaired, degraded or destroyed as a result of a mining project if this can be avoided or mitigated. This responsibility extends to an area much larger than a project's direct area of impact (i.e. not just the immediate mine site). It calls for an approach that recognizes the values that all stakeholders gain from ecosystem services and the need for a responsibility of shared 'stewardship' over these resources.

1. Impacts on Biodiversity

182. Exploration activity may disturb sensitive areas and conditions because of the need to construct camps, access trails and roads, survey cut lines etc. These will result in the generation of noise, dust, hazardous wastes from drilling activities etc. The simple presence of people will also cause disturbances in areas where few have encroached before. Indirectly, the opening of remote areas may increase accessibility for illegal resource exploitation (logging and poaching) and may lead to the introduction and spread of invasive exotic plant species in previously undisturbed areas.

183. During the **Planning and Construction** phase mine projects (and their associated infrastructure) can cause fragmentation, degradation or destruction of ecosystems and habitats

by the clearance of vegetation and removal of topsoil. This will also reduce CO_2 absorption properties. Dust blow (potentially contaminated with heavy metals) and acid rock drainage from newly exposed sub strata can lead to pollution and increased sediment levels in downstream water bodies. Construction activities will likely create 24-hour lighting, noise, traffic, conveyors, fences, powerlines etc. all of which act as disturbances to wildlife and potential barriers to its movement.

184. **Operational** impacts include those affecting air and water quality. The availability of good quality **water (surface and groundwater)** are key to ecosystem functioning and livelihoods (including sometimes to areas some distance from a mine site)**.** Gaseous emissions during transporting and processing activities etc. will include unintended and irregular (fugitive) and regular releases, both of which will contribute CO_2 etc. to the atmosphere. Milling an ore (e.g. grinding it to a fine particle size to allow better extraction of the ore) may result in noise and dust hazards. Physical or chemical separation processes may create added risks and challenges such as waste rock and tailings needing storage or hazardous chemicals (e.g. cyanide) needing management.

2. Mitigation Hierarchy

185. The initial general principles to be applied are:

i. Pro-active Avoidance of negative impacts, because prevention is often better than having to provide expensive remedies after problems arise; and
ii. A Precautionary / ‘No Regrets’ approach, because this is preferable in situations when the environmental consequences of mining cannot be confidently predicted and thus reliably managed.

186. These principles are incorporated into*,* the “Mitigation Hierarchy” This follows a prioritized sequence as follows:

1. **Avoid** negative impacts wherever possible;
2. **Minimize** (or Reduce or Mitigate) negative impacts where avoidance is not possible;
3. **Restore** disturbances where this is feasible; and then
4. **Offset**.

187. The result of an EIA may indicate that a mine development would not be acceptable in some circumstances. This may be because:

i. A mine proposal will be incompatible with the current or future options or values for/of the area (the negative impacts would outweigh the positive benefits of a mine); or
ii. The potential negative impacts on a highly valued area cannot be predicted with sufficient confidence that the environmental or social consequences of a mine could be successfully managed to avoid significant irreversible impacts.

188. In all other situations, during the consideration of the *pros and cons* of a mining project, the preference must still be to **avoid** significant negative impacts on ecosystems and biodiversity whenever possible. However, if this is not possible, the options to **minimize** negative impacts or r**estore** habitats and conditions to those of the baseline conditions must be developed and implemented.

189. The last resort will be to consider how to **"offset"** any residual impacts. An offset is a measure taken to compensate for any significant adverse impacts that cannot be avoided, minimized and / or restored. They can take the form of positive management interventions such as setting aside and protecting areas of equivalent high value habitat to that being lost because of the mine development. This could involve regenerating areas degraded by other non-mining related activities.

190. The Goals of "No Net Loss" or "Net Gain" of Biodiversity and Human Welfare. A responsible mining company will aim to ensure that there is, at least, '**No Net Loss** (NNL)' to biodiversity (and human welfare) caused by their mining activity. This can be achieved, for example, by ensuring a priority species will have the same chances of long-term survival with a mining project in place as without it, and should have access to similar amounts of suitable habitat as described in the *baseline* situation in an EIA.

191. The preference, however, would to be to go further and aspire to '**Net Gain** (NG)' of biodiversity (and human welfare) wherever feasible. 'NG' can be achieved by improving the quality of ecosystems (such as returning water to a river that is of better quality than when it was taken into a mining process).

3. Mining and Protected Areas

192. As knowledge about geological resources increases, technology developments and financial benefits increase, mineral exploration for new mining prospects encroach into remote areas. These areas have often been left undisturbed by industrial development and have relatively healthy ecosystems. They may be areas of high conservation value or the last refuges of rare or endangered species. The EIA process must identify any high value conservation areas (such as priority ecosystems or their habitats) that will be potentially at risk from a mining proposal. Most obviously these will have received some form of *legal* protective status. The first requirement is to consider if the potential mine site's location conflicts with this status.

193. Species under various degrees of threat of extinction are listed in the International Union for the Conservation of Nature's (IUCN's) "**Red List or Red Data List of Threatened Species"**. The list is based on criteria to evaluate the extinction threat to thousands of plant and animal species. Nine categories exist but those of most relevance to mine developments are the three reflecting different degrees of vulnerability - Critically Endangered, Endangered, and Vulnerable. The list is regularly updated**.** Some countries also produce their own regional/national Lists.

World Heritage Sites.

194. At the top of the hierarchy are World Heritage Sites (WHS) - areas designated for protection of their globally important cultural and natural values determined by the United Nations Educational, Scientific and Cultural Organization. WHS are to be regarded as sacrosanct and generally off-limits to mining.[13] WHS are considered to be so sensitive that industrial developments would be incompatible with their values. However, in some exceptional

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[13] The "Convention Concerning the Protection of the World Culture and Natural Heritage" was adopted by UNESCO in 1972. In 2018 there were 1073 WHS properties (206 of which were Natural WHS areas), of which 54 were considered to be in danger.

circumstances de-proclamation of part or the whole of such areas has been considered to accommodate mining.

IUCN Protected Area Categorization.

195. The IUCN has developed a comprehensive system of protected area management categories (Box 10.1) to define categories protected areas and their objectives. This categorization is widely recognized as the global standard for defining and recording protected areas. In planning a mine project, a responsible mine investor will take cognizance of the level and objectives of the categorization of the area. All categories indicate that mining proposals in such areas need to be responsive to the values inherent to them, but one might expect that categories I to III will present specific permitting challenges for new 'green field' mining developments.

196. However, important conservation areas do not always have legal protection or designation. Consequently, the designation of an area should not be considered as the *only* indicator of importance, although this is a good starting point in an EIA process. The absence of such designation does not suggest that they are unimportant in conservation terms. They may be in line to receive such status, may not be, as yet, evaluated or important 'buffer' zones or corridors or connecting protected areas to allow for the migration of important species between them.

B. Myanmar Key Biodiversity Areas

197. Myanmar's Key Biodiversity Areas (KBAs), as shown in Figure 10.1. Using international criteria, stakeholders identified and prioritized 132 Key Biodiversity Areas (KBAs) throughout the country. These sites are defined as areas holding significant populations of species of high conservation concern. The information used to identify and prioritize KBAs is patchy and often outdated, and new information is required. As of 2013, only 25% of these KBAs were afforded legal protection.

Box 10.1 IUCN Categories

(**Ia) Strict Nature Reserve**: Strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values.

(Ib) Wilderness Area: Usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

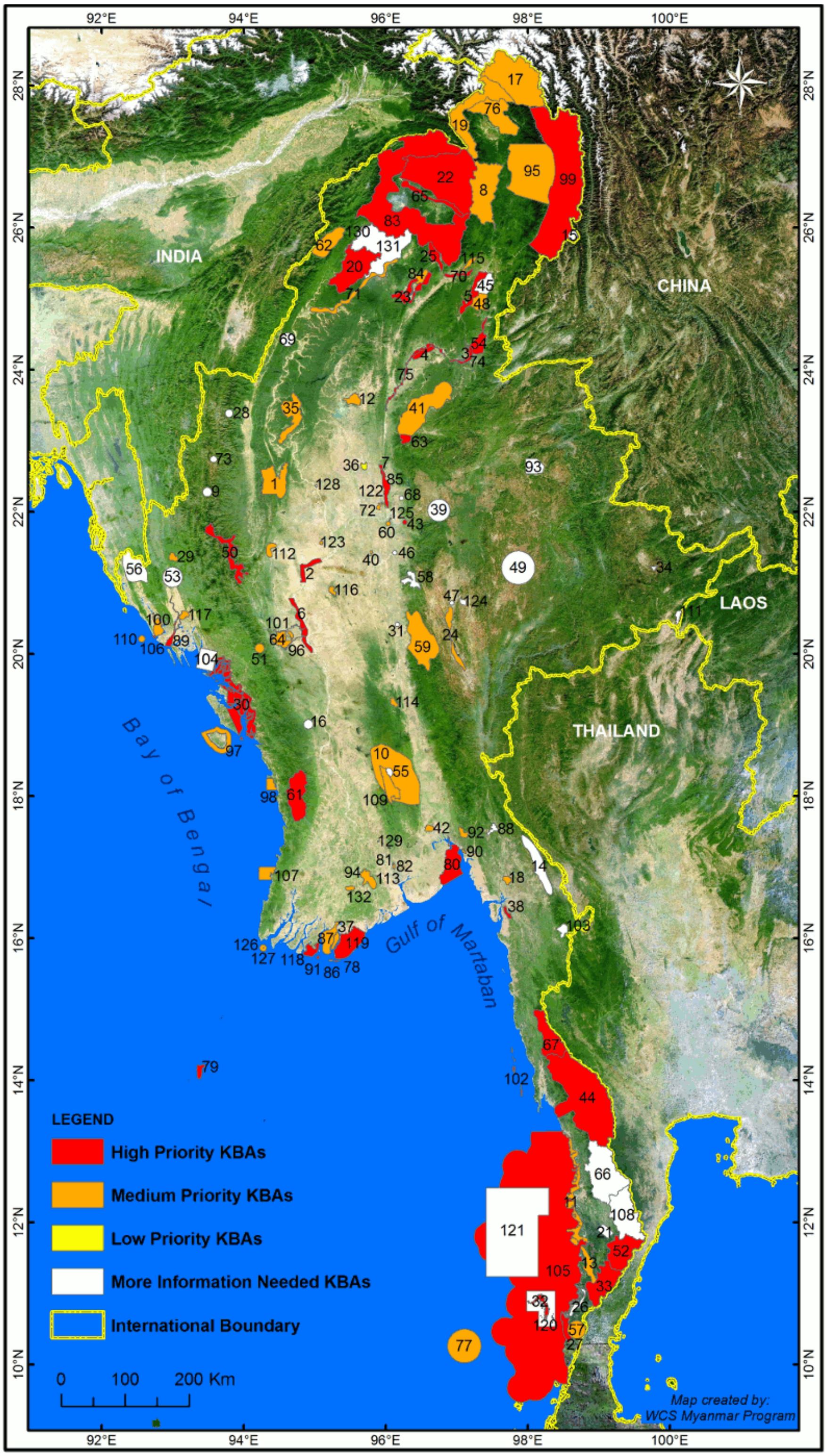
(II) National Park: Large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

(**III) Natural Monument or Feature**: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected area

(IV) **Habitat/Species Management Area**: Areas that aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

(V) Protected Landscape/ Seascape: A protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

(**VI) Protected area with sustainable use of natural resources**: Areas that conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.



Source: https://myanmarbiodiversity.org/key-biodiversity-areas/ (Accessed October 5, 2017)

Figure 10.1 Key Biodiversity Areas in Myanmar.

C. Biodiversity Assessment

198. Before consideration of the ecological and biodiversity impacts, an EIA process must establish the boundaries of the affected area of the potential mining project (see Box 10.2). Having established the boundaries, the benefits that people get from ecosystems in the affected area must be described. It needs to be established how ecosystem services are currently being affected by existing factors and the projected implications of the social and biophysical changes associated with a proposed mining project for these services must be described. An EIA must consider both the *financial and non-financial* benefits that people derive from ecosystem services, their level of dependence on them and their ability to maintain them through alternative means if they lose access to these services because of a mining project.

199. The activities that will take place need to be established and used as the basis for identifying which biodiversity features and ecosystem services are likely to be exposed to impacts and how they will respond. Management responses will vary according to the circumstances (e.g. they will be very different between water rich and water stressed areas).

200. Even if changes are predicted as a result of the project, not all of the ecosystem services in the affected area will be impacted by the proposed mine in ways that will have *significant* implications on the wellbeing of beneficiaries. The EIA therefore must focus on *"priority"* ecosystem services. Prioritization requires information on the extent of the benefits that people derive from the ecosystems they use, as well as the extent to which they rely on these benefits to maintain their wellbeing and livelihoods. The prioritization process should screen out ecosystem services with readily available alternatives or for which levels of dependence are low.

Box 10.2 A 6-step process is recommended to ensure adequate inclusion of Ecosystem and Biodiversity aspects in the EIA process:

Step 1 – Determine the spatial and temporal boundaries of the project.

Step 2 – Identify significant ecological and biodiversity components – including designated protected areas, priority ecosystems and biodiversity 'hot spots' etc.

Step 3 - Identify the users and beneficiaries of ecosystem services and select "priority ecosystem services" (i.e. those on which beneficiaries have high levels of dependence, with limited or no available alternatives - including those of importance to the mine proposal).

Step 4 – Establish the baseline for the priority ecosystem services by assessing the present condition of these components and the existing and potential external stresses affecting them and their future.

Step 5 – Project potential impacts of a mine (and its infrastructure) on priority ecosystems and the services they provide (their supply, use or benefit. Analyze the potential mine induced impacts and their significance over the ecological and biodiversity components; and

Step 6 – Define and develop the management strategies to address the predicted negative impacts on priority ecosystem services - ensuring avoidance wherever possible- ensuring NNL or NG outcomes.

1. Establishing the Significance of Ecological Impacts

201. The responses of ecosystem components to mining project activities will vary according to the following key considerations:

- ***Whether the component will be exposed to an activity or its effects.***

(This depends on the temporal and spatial relationship between a project activity (e.g. a noise or dust) and the component)

- ***The sensitivity of the component to the activity or its effects (how will it respond?).***

(Individuals of a species might be exposed to increased levels of noise during construction, but if they are not sensitive to noise, they will not be exposed to a significant impact as a result of elevated noise levels.) [14]

- ***The vulnerability of the component to impacts (will it decline or be damaged?).***

("Vulnerability" refers to the consequences of a change caused by a project activity for a component that is both exposed and sensitive to an impact. Specialists should be engaged to consider the extent to which the impacts identified might threaten the status or viability of component throughout their range or distribution.)

- ***The ability of the component to recover independently without intervention.***

(In order to achieve a NNL outcomes for biodiversity, any component exposed to an adverse effect must either recover spontaneously without the need for any intervention, or must be restored to pre-impact levels or condition through mitigation*).* [15]

202. The Implications of a project as a whole (or of a specific project activity) may then established as:

i. **Neutral:** no detectable change occurs, or the affected biodiversity/ ecosystems are able to accommodate the change without any long-term consequences. The changes are within bounds of normal variation, or spontaneous recovery is likely. Therefore, no specific mitigation measures are necessary beyond general good practice measures.

ii. **Moderate/ not significant with effective mitigation**: The project causes detectable changes relative to baseline conditions and these changes are outside the bounds of

[14] A "resilient population" can be defined as one able to recover quickly and to a level within the bounds of normal variation without mitigation. Similarly, resilient habitats are able to re- establish through natural regeneration, without restoration.

[15] For example, species that are mobile, adaptable and breed readily are more resilient than species with slow population growth that are highly specific in their habitat requirements and relatively immobile. It is also generally easier for populations to recover if a relatively small proportion of the original population is lost as a result of an impact.

normal variation. Mitigation is needed to reduce or minimize impacts, or to assist recovery but proven mitigation measures are available to allow recovery.

iii. **Significant:** significant impacts occur if the project will cause populations of species or ecosystems to decline or be degraded below baseline conditions, despite mitigation. If there might be residual loss of "natural habitat" or a long-term decline in the range, distribution or population size of any species, scope for biodiversity offsets to achieve a NNL or Net Gain outcome should be considered. Use of offsets that have sufficient assurance regarding likely success may reduce a significant residual impact to a moderate level.

iv. **Significant/ Not Offsettable**: there may be significant adverse impacts that cannot be offset because an effective outcome cannot be assured, given available conservation or restoration techniques, or because suitable offset locations cannot be identified or secured or because it is not possible to restore habitats or species populations in reasonable timeframes.

203. In cases where *significant* adverse effects are predicted, management measures must then be proposed to ensure that benefits from these ecosystem services can be maintained. Results of ecological surveys can be used to inform project design modifications, technology choices and lay-out of the mine to avoid or mitigate disturbances in line with the mitigation hierarchy. Dialogue between the engineering and biodiversity teams and others involved in studies for the EIA will consider the feasibility of such measures and their appropriateness to achieving NNL/NG.

2. Biodiversity Action Plan

204. An EIA may be supported by:

i. A detailed "Natural and Critical Habitat Assessment" (NCHA) that examines the implications of a project in detail for specific biodiversity and ecosystems and identifies actions needed to achieve NNL/NG of these.

ii. "Species Action Plans (SAPs)" for any critical habitats and species significantly affected by a project.

iii. If appropriate, "A Biodiversity Offset Strategy (BOS)" will describe the mining company's commitment and approach to off-setting residual impacts. This will detail the additional survey work needed to enable design of the offset to achieve NNL/NG.

205. These Plans will be developed and enhanced as the additional research work proceeds, and eventually they will evolve into a **Biodiversity Action Plan (BAP)**- which should be a condition of the permitting process. In most cases A BAP will be an integral part of a mine's **Environmental Management Plan (EMP)** and implemented as part of it (but details will be provided in a separate document).

206. The BAP will indicate what (and how) management measures will be implemented to comply with international standards, national laws and internal company policies relating to biodiversity and ecosystem services. It will describe the actions to be undertaken as part of the design, construction, operation and decommissioning of the project and associated infrastructure, along with responsibilities, timeframes and monitoring requirements. In some cases, outcomes may remain uncertain because the information needed to predict impacts is not yet available.

Where this is the case, plans to obtain the required information should be detailed in the project BAP. If this is significant need it must be provided before a permit is given.

207. As part of the development of a project's BAP, priority biodiversity components may be identified for which it is considered necessary to develop a dedicated strategy (SPAs) to demonstrate an explicit NNL or NG outcome through the mitigation hierarchy. These components may be chosen for various reasons including:

i. Species protected in the Red List registers;
ii. Species considered by specialists to be threatened or declining in the project area or in the region or globally;
iii. Important areas of natural habitat;[16]
iv. Habitats or ecosystems which are considered "critical" [17]; and
v. Areas legally protected for nature conservation and/or their designated features.

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[16] Defined by the International Finance Corporation as "land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions." (IFC Performance Standard 6)

[17] "Includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregator species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities. "(IFC Performance Standard 6).

XI. AIR QUALITY, NOISE, AND VIBRATION

208. This guidance provides information on common impacts and mitigation measures for air quality, noise, and vibration.

A. Air Quality Impacts

209. Air quality impacts from mining are mainly associated with the releases of airborne particulate matter. Operation of vehicles and generators can also lead to releases of greenhouse gases and various air contaminants, including sulphur oxides, nitrogen oxides, carbon monoxide and particulate matter.

210. Releases of airborne particulate matter can result from various activities, including blasting, crushing, loading, hauling, and transferring by conveyor. Open pits, waste rock piles, tailings management facilities, and stockpiles are potential sources of wind-blown particulate matter.[18] The US EPA Guidelines describe the common sources (see below)[19]

211. **Dust** - Dust is created at all stages of the mining process, including land clearing, road construction, excavation, blasting, crushing grinding, dumping and transportation. Despite the best attempts to control dust, there are areas in any mining operation where there are elevated dust concentrations. A large part of dust is made up of large particles, with diameters greater than 10 microns. This coarse dust usually settles gravitationally within a few hundred meters of the source. The smaller particle size fractions (PM_{10}), however, can be carried by wind in dust clouds for great distances and may be deposited on or near populated areas. The dust may contain heavy metals. As a result, human health and/or environmental problems may arise through direct inhalation, soil deposition, deposition on plants or accumulation within a water body.

212. **Emissions from Vehicles and Mining Equipment** - Particulate and gaseous air pollutant emissions are associated with vehicle and equipment exhaust. Particulate emissions (including PM_{10} emissions), carbon monoxide, unburned hydrocarbons (volatile organic compounds), nitrogen oxides and sulfur dioxide result from fuel combustion in vehicles, heavy equipment (including crushers and grinders), and generators associated with mining. For underground operations, a serious hazard results from exhaust gases released by vehicles and mining equipment as well as from fumes produced during blasting. These exhausts produce carbon monoxide and nitrogen oxide gas that can collect in underground cavities. Workers exposed to high concentrations of these gases risk serious illness and death.

213. PM_{10} emission rates may be modeled for the various parts of the mining process: dust generated during overburden, waste rock and ore removal as well as operation of vehicles on

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[18] Environmental Code of Practices for Metal Mines. Environment Canada. https://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=CBE3CD59-1&offset=1&toc=show

[19] EIA Technical Review Guideline: Non-Metal and Metal Mining, Volume 1. May 2011. Regional Document prepared under CAFTA DR Environmental Cooperation Program to Strengthen Environmental Impact Assessment (EIA) Review. United States Environmental Protection Agency (U.S. EPA), Agency for International Development (U.S. AID), and/or the Central American Commission on Environment and Development (CCAD).

unpaved roads; emissions from operation of vehicles, heavy equipment, mining shovels or excavators, conveyors, crushers and grinders, and generators.

214. **Organic and Chemical Fumes and Gases** - Hydrometallurgical beneficiation processes may create large quantities of sulfur dioxide, carbon monoxide and organic and chemical fume emissions. Gold and silver leaching operations can produce hydrogen cyanide gas. In addition, modern mining techniques require the acids and cyanide, which, in the event of an accidental spill can result in fumes which can impact mine employees and nearby residents. Thermal processes such as autoclaves, roasters, and carbon regeneration kilns can release mercury and other hazardous air pollutants.

215. **Smelter Emissions** - Smelting, without controls, can produce a large amount of particulate matter and heavy metals. Thermal processes also can release significant amounts of mercury, which can then be deposited locally or regionally, or can contribute to global atmospheric mercury.

216. **Example**. The Letpadaung Copper Mine Environmental and Social Impact Assessment identified the following sources of emissions.[20]

Pollutant	Activity
Particulates	Earthmoving for construction of roads
	Land clearing activities such as dozing and scraping of vegetation and topsoil
	Vehicles and construction equipment activity on the unpaved roads during construction and operations
	Drilling and blasting of waste rock and ore
	Tipping of material onto dumps and stockpiles
	Conveyor transfer points
	Erosion from exposed Waste Rock Dumps, stockpiles and Heap Leach Pads
	Primary and secondary crushing
Gases and particles	Emissions from vehicles
	Acid mist from the Solvent Extraction/Electro-winning Plant

[20] Myanmar Wanbao Mining Copper Ltd. Letpadaung Copper Project Environmental and Social Impact Assessment prepared by Knight Piesold Pty Limited submitted dated PE701-00022/13, Rev 6, January, 2015.

B. Mitigation Measures

217. **Airborne Particulates**[21]. Common methods to minimize releases of airborne particulate matter include:

i. spraying water to maintain sufficient surface moisture;
ii. using environmentally acceptable chemical sprays to stabilize the surface;
iii. revegetating the parts of the mine site that will not be disturbed in the future;
iv. controlling dumping or transfer rates of materials;
v. covering dump trucks or rail cars to minimize releases during the transportation of material;
vi. establishing speed limits on unpaved surfaces that are low enough to minimize dust from vehicle operations, considering local weather conditions;
vii. storing ore or concentrate in storage bins, hoppers or other buildings to eliminate dusting concerns and position the material for loading or transfer;
viii. covering or enclosing conveyor lines;
ix. using baghouses or precipitators for point sources of releases such as stacks from ore concentrate driers;
x. covering stockpiles or other material that may be a source of releases; and
xi. temporarily ceasing operations if weather conditions are such that the risks of significant releases of airborne particulate matter are unacceptably high.

218. **Gaseous Emissions**. One source of gaseous emissions22 are from combustion of fuels in power generation installations, mobile emissions, methane emissions and from drying, roasting, and smelting operations. Another source is acid mist associated with leaching (e.g., heap leaching of copper) and chemical fumes associated with gold beneficiation processes.

219. **Smelting and Roasting**. General recommendations related to smelting and refining may be found in the IFC EHS Guidelines for Base Metal Smelting and Refining23. However, there are a few issues which are specific to the roasting and smelting of precious metals. Many producers of precious metals smelt metal on site prior to shipping to off-site refineries. Typically, gold and silver is produced in small melting / fluxing furnaces which produce limited emissions but have the potential for mercury emissions from certain ores. Testing should be undertaken prior to melting to determine whether a mercury retort is required for mercury collection.

220. Operations roasting concentrates are often associated with elevated levels of mercury, arsenic and other metals as well as SO_2 emissions. Recommended management strategies include: (i) operations at controlled temperature (higher temperature roasters generally cause more problems of contaminant control); and (ii) inclusion of an appropriate gas scrubbing system

[21] Environmental Code of Practices for Metal Mines. Environment Canada. https://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=CBE3CD59-1&offset=1&toc=show

[22] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.

[23] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.

221. Smelting of Platinum Group Metals is similar to nickel and aluminum smelting. Care should be taken to avoid formation of nickel carbonyl and chromium VI during smelting. Where methane drainage (venting) is practiced, consideration should be given to beneficial utilization of the gas.

222. **Mitigation Measures.** In general, all facilities must be located as safe distances from any potential sensitive receptors to ensure that there are no impacts on community health. All staff, workers, and visitors must be provided with personal protection equipment to avoid exposure.

223. **Air Quality Risk Assessment Plan**. An air quality risk assessment plan is to be prepared which will:

i. Identify zones (or areas) of different severity levels with respect to their vulnerability to potential impacts of air emissions;
ii. Help identify emissions or sources of greatest risk to beneficial uses of the environment;
iii. Provide for assessment of the environmental and health impacts of air emissions and establishment of air quality management priorities;
iv. Serve as a basis for selecting locations for dust and gaseous emission monitoring and for establishing mitigation measures;

224. An air quality emergency mitigation plan is to be prepared which will:

i. Outline procedures for coordinating activities with local authorities and local health institutions to develop an Emergency Abatement plan;
ii. Specify arrangements and procedures for having local communities report adverse health effects experienced as a result of release of dust and gaseous emissions into the environment; and
iii. Establish air pollution alert procedures and protocols; implementation strategy for an emergency abatement plan if the concentration of air quality indicator is predicted to exceed the standard limit.

C. Noise

225. **Noise**[24]. Sources of noise emissions associated with mining may include noise from vehicle engines, loading and unloading of rock into steel dumpers, chutes, power generation, and other sources related to construction and mining activities. Additional examples of noise sources include shoveling, ripping, drilling, blasting, transport (including corridors for rail, road, and conveyor belts), crushing, grinding, and stockpiling.

226. Explosives and heavy machinery are used regularly at mining sites, resulting in potentially harmful amounts of noise pollution. Miners subject to high noise levels for extended periods of time may become permanently deaf. Noise also can affect wildlife by causing stress and disrupting behavior.

227. **Mitigation.** Good practice in the prevention and control of noise sources should be established based on the prevailing land use and the proximity of noise receptors such as communities or community use areas. Recommended management strategies[25] include:

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[24] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.
[25] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.

i. Noise levels at the nearest sensitive receptors should meet the noise guidelines in the Myanmar Environmental Quality (Emission) Guidelines;

ii. Where necessary, noise emissions should be minimized and controlled through the application of techniques which may include:

- Implementation of enclosure and cladding of processing plants
- Installation of proper sound barriers and / or noise containments, with enclosures and curtains at or near the source equipment (e.g. crushers, grinders, and screens)
- Installation of natural barriers at facility boundaries, such as vegetation curtains or soil berms
- Optimization of internal- traffic routing, particularly to minimize vehicle reversing needs (reducing noise from reversing alarm) and to maximize distances to the closest sensitive receptors

D. Vibration[26]

228. The use of explosives for excavation is common in surface mining and causes significant vibration. Control of vibration damage to natural formations and manmade structures is therefore an important environmental consideration. Damage to natural formations has been observed up to 500 meters away from blasting sites. Many mines limit the number of explosions, using millisecond delays between blasts to minimize concussion and noise, especially near population centers, natural scenic formations, wells, and stream channels.

229. The most significant vibrations[27] are usually associated with blasting activities; however, vibrations may also be generated by many types of equipment. Mines should minimize significant sources of vibration, such as through adequate design of crusher foundations. For blasting-related emissions (e.g. vibration, air blast, overpressure, or fly rock), the following management practices[28] are recommended:

i. Mechanical ripping should be used, where possible, to avoid or minimize the use of explosives;

ii. Use of specific blasting plans, correct charging procedures and blasting ratios, delayed / micro-delayed or electronic detonators, and specific in-situ blasting tests (the use of downhole initiation with short-delay detonators improves fragmentation and reduces ground vibrations);

iii. Development of blast design, including a blasting-surfaces survey, to avoid over confined charges, and a drill-hole survey to check for deviation and consequent blasting recalculations;

iv. Implementation of ground vibration and overpressure control with appropriate drilling grids; and

v. Adequately designing the foundations of primary crushers and other significant sources of vibrations.

[26] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.
[27] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.
[28] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.

XII. MINE SITE GOOD PRACTICES

230. This guidance describes common mine site good practices:

i. Conservation of top soils by proper removal, storage and replacement;
ii. Proper handling, storage of hazardous materials;
iii. Personal Protective Equipment provided to workers.

A. Topsoil Management[29]

231. Topsoil management is needed to preserve soil conditions as near as possible to its pre-mining state to allow successful mine-site rehabilitation. The topsoil management is to be initiated during clearance of topsoil in preparation for mining activities. Topsoil management includes procedures for storage of topsoil during the life of the revised Project and appropriate use of topsoil during progressive pit closure and rehabilitation.

232. It is recommended that a topsoil management plan (TMP) be prepared with the contents:

i. a description of the existing soils within the mine site;
ii. a topsoil stripping procedure that aims to maximize volumes of suitable topsoil removed thereby maximizing topsoil available for mine closure and rehabilitation works;
iii. a stockpile design and maintenance procedure;
iv. erosion control techniques – for stockpiled topsoil and exposed subsoil following stripping and during mine rehabilitation;
v. a topsoil application procedure – to be used during mine rehabilitation; and
vi. reporting and review requirements.

1. Existing Topsoil Resources

233. The first step is to understand the composition of the existing soils within the mine site. Topsoil and subsoils (the layers below the topsoil) should be selectively handled (stripping depth and depth of return) dependent on the soil type, and either directly returned or stockpiled for later use dependent on the rehabilitation requirement and the stage of mine development. Topsoil and subsoil stockpiled for later use in rehabilitation will require different management during storage and reuse. Subsoil recovery for re-vegetation purposes may be limited due to its general adverse subsoil conditions (e.g. sodic and/or saline).

2. Topsoil Stripping

234. Topsoil stripping is necessary wherever land is planned to be disturbed by mining activities to recover the soil resource for rehabilitation purposes. Topsoil stripping will be undertaken in

[29] This section is abstracted from New Hope Group. Topsoil Management Plan, New Acland Coal Mine Stage 3 Project. January 2014. http://eisdocs.dsdip.qld.gov.au/New%20Acland%20Coal%20Mine%20Stage%203/EIS/EIS%2024Dec13/Appendices/Appendix%20J-3%20Topsoil%20Management%20Plan.pdf – accessed 2 March 2018.

areas of planned mining activity including the ore preparation and handling plants, the active pit areas, out-of-pit dumps, haul roads, hardstands, access roads and other general infrastructure.

235. Suitable topsoil should be stripped for use in the rehabilitation program. The topsoil should be stockpiled until suitable re-contoured areas are available, or preferably be directly returned immediately across the areas to be rehabilitated.

236. As the mine site expands, there should be more opportunity to strip topsoil and apply it directly to re-contoured areas, thus avoiding topsoil stockpiling. Freshly stripped and placed topsoil retains more viable seed, micro-organisms and nutrients than stockpiled soil. Vegetation establishment is generally improved by the direct return of topsoil and is considered 'best practice' topsoil management.

a. Topsoil Stripping Supervision

237. The mine's Environmental Health and Safety Department should be responsible for the supervision of the recovery, handling and management of site soils. These Department's responsibilities will include:

i. clearance of vegetation prior to stripping – this will enable salvage of all suitable topsoil material and avoid loss of stripped topsoil quality caused by mixing with unsuitable soils;
ii. training of earthmoving plant operators so that stripping operations are conducted in accordance with Topsoil Stripping Procedures and in situ soil conditions;
iii. supervision of stripping to determine recovery depths and to identify suitable soils;
iv. delineation of areas to be stripped and date of stripping;
v. delineation of suitable stockpile areas (as required);
vi. delineation of planned areas for direct return of topsoil (as required);
vii. maintenance of acceptable dust levels during topsoil stripping;
viii. recording of volumes stored; and
ix. management of topsoil placement within storage and/or direct return locations, with due consideration of economic factors, mine access constraints, machine availability, weather conditions and ground conditions.

b. Topsoil Stripping Procedure

238. Covering vegetation can make the removal of specific topsoil depths difficult and excessive quantities of vegetative matter in long-term stockpiles may promote chemical and biological degradation of the seed reserves that are a future source of natural regeneration during rehabilitation. Therefore, prior to stripping, vegetation should be removed or reduced by grazing and/or clearing. All cleared vegetative material may be buried in-pit, or if suitable, placed as habitat within the proposed or current conservation areas. In general, the requirement to clear larger vegetation (shrubs and trees) within the Study area is comparatively small as a result of the area's long history of agricultural production. If feasible, cleared vegetation may be chipped to provide a cost-effective mulch and soil amendment.

239. A recommended general protocol for soil handling during topsoil stripping is presented below and includes soil handling measures which optimize the retention of soil characteristics (in

terms of nutrients and micro-organisms) favorable to plant growth and propagules for natural regeneration (e.g. seed banks). Topsoil should be recovered using appropriate equipment. Depending on compaction and recovery rates, deep ripping may be required to maximize topsoil recovery with care taken not to mix topsoil with sodic subsoil.

i. During the stripping process there may be some unexpected changes in the depth and the nature of the soil. Where practical the inclusion of obviously poorer quality material should be avoided such as subsoil clay with mottles, saline material and material dominated with stones.
ii. It is preferable for material to be stripped when it is in a lightly moist condition; soil is slightly moist when color is darker than when it is dry and the soil cannot be rolled by hand into a bolus.
iii. Contractors bringing machinery onto the site should be required to present such machinery in a weed-free condition. Advice regarding local weed species should be obtained from the local government or the Forest Department.
iv. Disturbance areas should be stripped progressively, as required, to reduce erosion and sediment generation, to reduce the extent of topsoil stockpiles and to utilize stripped topsoil as soon as possible for rehabilitation. Rehabilitation of disturbed areas, such as roads and embankments, should be undertaken as soon as practicable after completion or as areas are no longer required for operational purposes.

3. Topsoil Stockpiling

240. **Stockpile Location**s. The stockpile locations should be subject to the following management actions.

i. Grazing stock, machinery and vehicles should be excluded.
ii. Overland water flow onto or across stockpile site should be kept to a minimum.
iii. Where possible, stockpile sites should be selected to maximize protection from `the prevailing winds, particularly if the material is friable in nature (e.g. sand or silt).
iv. All long-term topsoil material stockpiles should be located outside the active mine path and away from drainage lines.
v. Drainage from should be diverted around stockpile areas to prevent erosion.
vi. As required, sediment controls should be installed downstream of stockpile areas to collect any run-off.
vii. Topsoil stockpile locations should be strategically located to assist the sequence of future rehabilitation.

241. **Topsoil Stockpile Management**. Stockpiling of topsoil should preferably be kept to the shortest possible period. Where it is necessary to store material over more than one growing season, some form of protective surface cover is likely to be needed. In general, topsoil stockpiles should be managed so that:

i. storage time is minimized;
ii. locations are accurately surveyed and data recorded relating to the soil type and volume;
iii. stockpiles are located in areas away from drainage lines or windy areas in order to minimize the risk of soil and wind erosion;

iv. stockpile surfaces are seeded (if natural revegetation does not provide adequate cover);
v. good vegetative cover should be maintained on stockpiles and on top-dressed areas until ground cover is well established by excluding stock and controlling weed growth;
vi. appropriate weed control strategies are implemented particularly for any noxious weeds (Immediate revegetation will provide vegetative competition to assist with the control of undesirable plant species.);
vii. where practical and applicable, stockpiles will have sediment control measures installed and be located within the catchment of sediment control dams;
viii. stockpiles are delineated to avoid vehicle and pedestrian traffic and accidental removal/disturbance; and
ix. topsoil stockpiles possess a suitable embankment grade to limit the potential for erosion of the outer pile face.

4. Erosion Potential and Control

242. **Erosion Hazard**. The main potential erosion hazard for topsoils is early in the rehabilitation process while returned topsoils are awaiting the re-establishment of vegetation. Site clearance ahead of infrastructure developments such as haul roads, hard stands, pipes and access tracks, under the right conditions may also predispose these areas to erosion risks. Erosion hazard within the revised Project site is primarily driven by sodicity, slope angle, slope length and the status of vegetation cover.

a. Erosion Control

Table 12.1 Erosion Control Measures

Area	Control Measure
Erosion control and cleared land	• restrict clearing to areas essential for the works • windrow vegetation debris along the contour • minimize length of time soil is exposed • divert run-off from undisturbed areas away from the works • direct run-off from cleared areas to sediment dam
Exposed Subsoils	• mulching • revegetation • soil binders and surface stabilizers • surface roughening • sediment fences • check dams • grass filter traps • rock filter traps • compost/mulch berms • gypsum application on exposed sodic soils
Contour cultivation	All cultivation used to prepare the rehabilitation area should be on the contour. On steep slopes, the land is to be terraced or benched.

Area	Control Measure
Contour Deep Ripping or 'Contour Furrowing'	These procedures should be used to relieve soil compaction and improve water infiltration on exposed sodic subsoils and the Sodosol topsoil stockpile. These actions should be undertaken in conjunction with gypsum application.
Contour or Levee Banks	Earth mounds or similar structures are the most common physical control measures. The size of these structures is determined by the size of their catchment area. These structures should not be constructed out of dispersive or highly erodible materials.
Absorption and Pondage Banks	These banks are similar in design to contour banks but laid out such that they pond water - thereby causing greater infiltration and less run-off. They are applicable only to low slopes (less than 1%) and should be avoided in materials which become dispersive when saturated. They should not be used on spoil dumps.
Diversion Banks	These banks are commonly used to reduce or eliminate the catchment to the heads of gullies. They need to be located such that they spill water to stable areas - preferably away from the rehabilitation area.
Spillways/Grassed Waterways	These structures are used to confine run-off from any or all of the above structures into a stable vegetated flow path. Because these structures effectively take all excess run-off from a rehabilitation area, they should be installed first and well vegetated prior to the actual construction of the diversion structures. However supplementary irrigation water may be required to sustain the vegetation.
Lined Waterways	Additional treatment and special precautions may be required to protect waterways from erosion. The on-site suitability of the following available treatment measures will be made: • jute mesh may be used to line channels • rip-rap or stone pitching involves the use of stone • concrete filled bags with an underlying filter blanket of sand and gravel • gabions and mattresses (rockfilled wire baskets)
Sedimentation Dams - Gully Trap Dams	These structures are an interim measure to confine the movement of soil to the rehabilitated area. In effect they act as settling areas to ensure that soil eroded from the rehabilitated area does not pass beyond that area. Ideally their role in erosion control should diminish over time as the rehabilitated area is stabilized by other measures.
Sodosol Erosion Control	Gypsum should be applied to Sodosols to improve aggregate stability (gypsum displaces sodium ions with calcium ions). Where practical, half the recommended dosing rate will be applied to the surface of the soil material prior to stripping. The other half should be applied to the top-dressed material immediately after spreading. Alternatively, gypsum will be applied to the soil surface after its spreading and incorporated into the soil by ripping. The use and quantities of gypsum will be determined on a site by site basis prior to topsoil stripping.

Source: New Hope New Hope Group. Topsoil Management Plan, New Acland Coal Mine Stage 3 Project. January 2014.
http://eisdocs.dsdip.qld.gov.au/New%20Acland%20Coal%20Mine%20Stage%203/EIS/EIS%2024Dec13/Appendices/Appendix%20J-3%20Topsoil%20Management%20Plan.pdf – accessed 2 March 2018

5. Topsoil Application Procedure

a. Post Mining Land Use

243. The overriding principle for the rehabilitation program of the revised Project is to ensure the disturbed land is returned to a post-mine condition that is stable, self-sustaining, requires minimal maintenance and supports the proposed post mine land use. The revised Project's Final Land Use and Rehabilitation Plan will reference this plan and will require the successful application of this plan to ensure its rehabilitation outcomes are achieved to promote a sustainable final land use for the revised Project.

b. Mine Rehabilitation

244. A progressive rehabilitation program will be implemented throughout the life of the revised Project and reported in each Plan of Operations, and will commence when areas become available within the operational land. The main features of the progressive rehabilitation process are:

i. use of suitable topsoil, sourced either from stockpiles or respread immediately after stripping across available recontoured areas;
ii. contour ripping as an erosion control measure;
iii. seeding with an appropriate seed mix (grass, shrub and tree species) prior to the commencement of the wet season to maximize the benefits of subsequent rainfall;
iv. application of appropriate fertilizer for plant establishment if required; and
v. application of soil amendments if required.

c. Topsoil Application Procedure

245. The volume of growth media material available will be reconciled with the estimated volume needed for successful rehabilitation. The application procedure is essentially the reverse of the stripping procedure. First, the overburden materials will be profiled or landformed to the design slopes, then if suitable, secondary media (subsoil) should be placed in position, followed by the primary media (topsoil). The mine rehabilitation strategy may include the following measures which are designed to minimize the loss of topsoil material respread on rehabilitated areas and promote successful vegetation establishment.

i. Balance the topsoil requirement for rehabilitation areas against stored stockpile inventories and proposed stripping volumes;
ii. Maximize the opportunities for direct placement of topsoil from pre-strip to rehabilitation areas;
iii. Minimize the length of time that topsoil material is to be stockpiled;
iv. During removal of soils from the stockpiles, take care to minimize structural degradation of the soils;
v. Respread topsoil material in even layers at a thickness appropriate for the landform and land capability of the area to be rehabilitated;
vi. Contour rip to encourage rainfall infiltration and minimize run-off;
vii. Construct contour banks in accordance with the applicable landform design criteria to limit slope lengths and control run-off:
viii. Construct collection drains and sedimentation dams to collect run-off and remove suspended sediment;

ix. Regularly inspect and maintain rehabilitation areas to facilitate sediment and erosion control and revegetation success; and
x. Regularly inspect rehabilitated areas for declared plants and environmental weeds, and control significant weed outbreaks using chemical or mechanical control methods.

d. Post Mine Land Form

246. The primary design objective is the creation of stable final landforms that are compatible with the surrounding landscape and the proposed final land use. In general, stable landforms will be established following mining, using soils capable of supporting vegetation communities adapted to the local environment. The stability of the post-mine landform will be achieved by applying sound rehabilitation practices. The disturbed land will be rehabilitated to a condition that is self-sustaining or to a condition where the maintenance requirements are consistent with the proposed post-mining land use.

247. Surface run-off from all disturbed areas will pass through sedimentation controls to reduce the levels of suspended solids. Where possible, sedimentation dams will discharge to an environmental dam before eventual discharge off-site. Water in the environmental dams will be recycled to minimize the potential for off-site discharge.

6. Review and Improvement Process

248. The effectiveness of the topsoil management practices should be regularly reviewed in conjunction with overall rehabilitation assessments. The review will reflect changes in environmental requirements, technology and operational procedures. The review will include soil depths, topsoil stockpiling locations and topsoil budgets for the proposed mining period.

249. Results of the assessments will be incorporated into future rehabilitation planning to continually improve the success of the program. The performance outcomes for the TMP are:

i. soil survey is conducted prior to stripping;
ii. soil stripping is scheduled to minimize exposed areas;
iii. soil material suitable for reuse is recovered and utilized in an appropriate manner; and
iv. procedures are in place detailing methods to be used for the stripping and stockpiling of soils.

B. Hazardous Materials

1. What are Hazardous Materials?

250. Hazardous materials can occur at all stages of processing minerals, from exploration, mining and processing to transport, refining and smelting. Some materials originate from the ore body, others from chemicals used or generated during processing and degradation, and some remain in waste materials. The different types of hazards can occur at different parts of the mining and mineral processing operation's life cycle.

251. **This guidance applies to handling, storage, and disposal of hazardous materials used in ore processing or general use at a mine.**

2. Process and general-use hazardous materials[30]

a. Cleaning agents

252. Cleaning agents are made up of a variety of chemicals, many of which may be classified as hazardous materials. They vary from organic compounds for general cleaning and chlorine-based cleaners through to hydrofluoric acid to clean aluminum metalwork. Care needs to be taken in the selection and handling by staff. Serious injuries have occurred through misuse, poor supply of personal protective equipment, and staff mixing their own cleaning mixtures from existing products.

b. Cyanide

253. Sodium cyanide is used for gold recovery in large operations. The *Cyanide management* leading practice handbook provides extensive information about sodium and calcium cyanides, paying particular attention to toxicity in mammals and environmental impacts. Environmental best practice, and the major goldminers, adhere to the International Cyanide Management Code for the Gold Mining Industry.[36] The code covers the production, transport, use and disposal of cyanides.

254. The risk of cyanide poisoning arises from ingestion and exposure to workplace vapors, mists and solutions. Small quantities of hydrogen cyanide are generated when sodium cyanide is exposed to moist air or acids. Current controls include the management of the pH of process streams, coupled with the use of personal and area hydrogen cyanide gas monitoring devices.

c. Fumigants

255. When items from overseas are received in shipping containers, care should be taken because the containers may have been fumigated. Containers are typically fumigated with a methyl bromide and chloropicrin mixture. There have been cases of worker exposure in Australia when containers have been inspected at the port or unloaded at explosives stores..

d. Polymeric compounds

256. Polymeric compounds are chemicals used as resins throughout the mining industry in strata binding, drilling and void filling. Most use occurs in underground coal mines. Three types of resins are currently approved for use in underground coal mines and they are broadly classified as polyurethane (PUR), urea silicate and phenolic resins.

257. The PUR and urea silicate resins contain methylene diphenyl diisocyanate) in the catalyst component. Exposures to isocyanates are known to cause health effects ranging from acute irritation to permanently debilitating respiratory conditions. The most significant of the conditions is occupational asthma resulting in respiratory sensitization. There is a growing body of epidemiological evidence to link skin absorption of diisocyanates and polyisocyanates to respiratory sensitization.

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[30] Definitions drawn from Hazardous Materials Management. Leading Practice Sustainable Development Program for the Mining Industry. September 2016. Government of Australia.

e. Explosives

258. Explosives are a special category of hazardous materials with specific implications for workplace health and safety and civil and national security.

f. Oil and fuel

259. The main hazard is fire, as it is classified as a combustible fuel. Repeated skin contact may cause drying of the skin and dermatitis. Since considerable quantities of hydrocarbons may be stored on a mine site, their presence also constitutes a security hazard because they could be targeted in an attack. There are also potential impacts on the environment from spills, storage tank leaks and accidental discharges.

g. Paints, pesticides and laboratory chemicals

260. Stored oil-based paints are fire hazards, while pesticides and laboratory chemicals may have human health impacts, environmental impacts, or both. Old and new containers may contain residual chemicals that pose risks to human health and the environment. They should be disposed of safely. Cleaned containers might not be hazardous, and collection and recycling options may be available for plastic and metal containers in which pesticides have been supplied.

h. Polychlorinated biphenyls (PCBs) from transformers

261. As a result of earlier efforts to remove PCBs from service, many transformer oils are dilute solutions of PCB in paraffin. Where the PCB content is 50 mg/kg (50 ppm) or greater, the material must be treated to destroy PCBs and reduce the level to 2 ppm or less. Although complete phase-out may still be some years away, most PCB-containing oil has been removed from service and treated as required.

i. Quicklime

262. Quicklime (calcium oxide, CaO) and slaked lime (calcium hydroxide, $Ca(OH)_2$) are widely used in the mining industry for pH control in processing gold and base metals, as well for neutralizing waste streams before deposition in tailings storage facilities. Quicklime can either be slaked on site or sometimes directly added to crushed ore before further processing. It reacts vigorously with water and can cause damage to the eyes and respiratory system.

j. Solvents used in extraction plants

263. Hydrocarbon solvents, such as kerosene, are used in solvent extraction plants for separating complex metal ions. As for petroleum products, there are flammability hazards and security risks.

k. Sulphuric acid

264. Large amounts of sulphuric acid can be used to leach ores containing metals such as copper and nickel. Some mines produce the sulphuric acid required by burning imported sulphur, while sulphur dioxide can also be recovered from smelter off-gases to produce sulphuric acid.

265. Sulphuric acid is a corrosive chemical and can severely burn the skin and eyes. It may cause third degree burns and blindness on contact. Exposure to sulphuric acid mist can irritate the eyes, nose, throat and lungs, and at higher levels can cause a build-up of fluid in the lungs (pulmonary oedema). Asthmatics are particularly sensitive to the pulmonary irritation. Repeated exposures may

cause permanent damage to the lungs and teeth. The IARC has classified ‘occupational exposures to strong-inorganic-acid mists containing sulphuric acid’ as carcinogenic to humans.

266. Sulphuric acid will also severely burn plants, birds or land animals exposed to it. It has moderate chronic (long-term) toxicity to aquatic life.

l. Xanthates

267. Xanthates are a group of chemicals typically used in sulphide flotation in mineral processing applications. Common xanthate products are sodium ethyl xanthate (SEX), sodium isopropyl xanthate (SIPX), sodium isobutyl xanthate (SIBX) and potassium amyl xanthate (PAX).

268. High levels of moisture and high temperatures during transport and storage increase decomposition, producing toxic and flammable decomposition products such as carbon disulphide (CS_2) and mercaptans. Ultimately, solid xanthates can spontaneously combust, producing sulphur dioxide, carbon monoxide and carbon dioxide.

269. Low-level exposure to CS2 and mercaptans causes nausea and irritation of the eyes, skin and respiratory tract. Symptoms of higher exposures include tremors, dyspnoea, vascular collapse and increased susceptibility to heart disease.

270. When disposing of solid xanthates, they should be dissolved in water before transfer to the disposal site, such as a tailings storage facility (TSF), if permitted under the site license. Bags of xanthates that have been thrown intact into a TSF have survived decades before causing health concerns when uncovered during retreatment of the tailings.

m. Mercury

271. Mercury is still used in in Myanmar for the amalgam process for extracting gold. Mercury and mercury compounds are toxic to human health and the environment.

3. Hazardous Materials Management

272. Basic steps in preparing in Hazardous Material Management Plan

i. Prepare a comprehensive list of all hazardous materials to be used, stored, transported, or disposed of during all phases of activity;
ii. Develop a hazardous materials program providing for adequate storage, use, transportation and disposal (interim and final) for each item in the comprehensive list;
iii. Identify potential solid and liquid waste streams and develop determination, inspection and waste minimization procedure;
iv. Provide secondary containment for all on-site hazardous materials and waste storage, including fuel: and
v. Develop waste-specific management and disposal requirements.

273. **Hazardous Material Management Plan.** A Hazardous Material Management Plan should:

i. Describe procedures and responsibilities for hazardous materials determination, inspection and waste minimization;
ii. Include a spill prevention and response plan for storage, use and transfer of fuel and hazardous materials, including spill prevention measures, training

requirements, material -specific spill response actions, spill response kits, and notifications to authorities;

iii. Identify local and national emergency response requirements;

iv. Include a pesticide management plan with a recycling strategy to be practiced by workers during all project phases;

v. Describe procedures for containerization and periodically removal wastes for disposal at appropriate off-site permitted disposal facilities, if available.

vi. Describe procedures for document accidental releases as to cause, corrective actions taken, and resulting environmental or health and safety impacts.

4. Example Hazardous Materials Handling and Storage - Letpadaung Copper Mine

274. The main hazardous materials used at the mine are listed in Table 12.2

Table 12.2: Hazardous materials used for the Letpadaung Copper Mine

Description	Unit	Quantity
Sulphuric Acid	Tonnes per year	30,350
Diesel	Tonnes per year	22,650,000
Extractant	Tonnes per year	450
Solvent naphtha 260#	m3/year	4,500
Flux oil	Tonnes per year	4,500
Cobalt sulphate	Tonnes per year	75
Engine oil	Tonnes per year	1466.8
Granular ammonium nitrate	Tonnes per year	9,024
Powder ammonium nitrate	Tonnes per year	2,560
Explosion initiation devices	Explosions per year	42,386

Source: Letpadaung Copper Project Environmental and Social Impact Assessment prepared by Knight Piesold Pty Limited PE701-00022/13, Rev 6, January, 2015.

a. Hazardous Material Storage Plan

275. The following elements are included in the Mine hazardous material storage plan:

Worker Safety and Training

- Workers are to be trained in the handling and storage of hazardous substance;

Storage Areas

- Storage areas will be designed to adequately and safely store a sufficient quantity of substances required for the Project;

- The storage area will be properly designed to contain and prevent contamination of the environment, particularly soil and groundwater;
- Floor, curbing, walls and roofs will be designed to adequately contain spills and protect the storage area from weather where necessary;
- Storage of liquid hazardous materials (including waste oil and solvents) will be provided with 110% capacity secondary containment for the largest single container in bunded containment area.

Storage Practices

- Drums, containers, and storage areas will be properly labelled, marked and secured;
- Sufficient storage space between containers will be allowed for safe access and handling of containers;
- Volatile hazardous materials storage areas will be designed to ensure adequate ventilation to prevent the build-up of explosive or harmful airborne pollutants.
- Bulk fuel storage will be equipped with pressure relief valves to reduce a build- up of pressure which could cause leaks.
- The condition of bulk storage tanks for fuels and lubricants will be inspected annually.
- Incompatible (e.g.,bases and acids) materials, which are potentially reactive when combined, will not be stored in the same containment area and will be stored in safe manner and with hard separation barriers and distance to prevent accidents;
- To provide a safe work area, walls, dykes, berms, or separate facilities of other means will separate incompatible materials;

Record Keeping

- Material safety data sheets (MSDS) for each material will be stored on a database accessible to all personnel and placards containing the MSDS will be placed in the storage containment area for each material stored;

Accident Prevention

- No smoking or electronic devices such as hand phones or hand-held radios will be allowed in storage areas; and
- Fire prevention and management practices will be developed specific to the materials being stored.

Emergency Response

- Spill kits, protective equipment, and other necessary equipment will be in the storage area or approximate to the storage area to clean and mitigate spills;
- Fire prevention systems will be designed to be appropriate and adequate to the material being stored;

b. Explosives Storage and Handling Practices

276. All blasting activity will be performed by a specialist contractor, qualified to Myanmar standards who will be responsible for blasting design, explosives calculations, delivering blasting agents to the blast-holes, placing powder or emulsion in the holes, charging the holes, placing detonators and boosters, filling the holes with stemming material and tie-in patterns.

277. The blasting contractor will supply the explosives, boosters and detonators, transport them to site and store them in the explosive magazines, until required for blasting. The contractor will also supply mixing and delivery trucks.

278. Explosive magazines will be constructed away from receptors at designated limits in accordance with Myanmar legislation. A plan has been produced of explosives storage locations and submitted for approval.

c. Hazardous Material Transport

279. The main hazardous materials transported to the Mine site are explosives, diesel fuel and sulphuric acid.

280. **Explosives** – transported by road from China using the border crossing at the town of Muse. These materials will be transported in convoys that will deliver supplies monthly and are likely to comprise 50 – 100 vehicles per convoy;

281. **Diesel fuel** – transported by barge to Letpadaung or Pakokku, then by truck to site. Approximately 1 barge/week; and

282. **Sulphuric acid** - transported by barge to Letpadaung or Pakokku, then by truck to site. Approximately 1-2 barge(s)/week.

d. Hazardous Waste Disposal

283. Liquid waste procedures apply to solvents and reagents, waste oils, solvents or greases from maintenance or workshop areas:

i. Any spills of oils, grease, solvents or other hazardous materials in the maintenance areas, fuel storage areas or loading/unloading areas will be cleaned up using absorbent materials and placed in bins, not washed;
ii. Waste oils and solvents will be stored in separate drums on bunded pallets, on paved areas equipped with secondary containment and protected from the weather; drums will be clearly labelled with their contents; waste rocks, containing re-used chemicals in the process will be placed in HLPs.
iii. Waste oils will not be stored for extended periods in underground sumps; tanks and sumps will be emptied and inspected regularly for any signs of cracks or holes. The findings of the inspection will be recorded; any cracks or holes will be repaired, and any repairs conducted will be recorded;
iv. If waste oil or solvents are not of suitable quality for onsite use, they will be collected by a licensed contractor for offsite recycling and copies of contractor licenses will be retained onsite;
v. Unused explosives will be removed by the blasting contractor;
vi. Spill clean-up and fire extinguishing equipment will be available in the storage area, and personnel will be trained in its use; and
vii. There will be no onsite disposal of waste oils and solvents direct to the soil surface or storm water collection system.

e. Hazardous Materials Inventory Management

284. All hazardous materials will be subject to strict inventory control from the time they enter the site. The Mine will maintain an inventory of all hazardous substances purchased, delivered,

stored and used at the mine site. This inventory will be updated on a monthly basis. Logs will be kept as required for inspection by the regulatory agencies.

285. The Mine Construction Manager will conduct routine inspections of all hazardous substances storage areas, and worksite areas to look for spills, leaks, overflows and compliance with the procedures. Where necessary corrective actions will be recommended. The Environmental Manager will monitor all activities to do with explosives use and storage. The Mine will collect and maintain records on hazardous substances for the following:

i. Reconciled bulk inventory;
ii. Weekly use summaries;
iii. Weekly reconciliation for each storage area;
iv. Overfill alarm tests;
v. Pressure tests (if applicable);
vi. Inspections and maintenance checks of storage tank system, piping and delivery system;
vii. Any alteration to the system;
viii. Reports of leaks or losses;
ix. Reports of spill responses; and
x. Records of training.

C. Personal Protective Equipment

286. Personal Protective Equipment (PPE), ensures the basic health protection and safety of mine workers. PPE is any device or appliance designed to be worn by an individual when exposed to one or more health and safety hazards. PPE includes all clothing and other work accessories designed to create a barrier against workplace hazards, and using PPE requires hazard awareness and training on the part of the user. Workers must be aware that the equipment does not eliminate the hazard; if the equipment fails, exposure will occur. To reduce the possibility of failure, equipment must be properly fitted and maintained in a clean and serviceable condition[31].

287. Mine operators are required to assess the workplace to determine if hazards that require the use of head, eye, face, hand, or foot protection are present or are likely to be present. If hazards or the likelihood of hazards are found, employers must select, and have affected employees use, properly fitted PPE suitable for protection from these hazards. Before doing work requiring the use of PPE, employees must be trained to know when PPE is necessary, what type is necessary, how it is to be worn, and what its limitations are, as well as its proper care, maintenance, useful life, and disposal.

288. The consequences of not having proper PPE may lead to injuries, loss of a limb or part of a limb, a permanent physical defect, or even a fatality. An added impact is increased downtime, which translates into reduced profits and greater overheads.

[31] Environmental Health and Safety Program, University of California at Santa Cruz https://ehs.ucsc.edu/programs/safety-ih/ppe.html

289. The International Labor Organization's encyclopedia provides excellent summary of PPE needed for mining[32].

1. Head Protection

290. Miners must be provided with, and must wear, safety caps or hats. Protective hats for head protection against impact blows must be able to withstand penetration and absorb the shock of a blow. In some cases, hats should also protect against electric shock. When working on the surface, a hard hat with a chin strap must be worn to ensure optimal protection of the head area. The hard hat inner band must be adjustable to ensure a correct fit. The frame or rim of the hard hat is aimed at deflecting falling objects. Underground mineworkers should wear hard hats or caps with a cap-lamp mounting bracket at the front for a light source to ensure visibility underground.

291. **Cap Lamps.** In areas of the mine where permanent lighting is not installed, the miner's cap lamp is essential to permit the miner to move and work effectively and safely. The key requirements for a cap lamp are that it be rugged, easy to operate with gloved hands, provide sufficient light output for the full duration of a work shift (to illumination levels required by local regulation) and that it be as light as possible without sacrificing any of the above performance parameters.

292. In addition to its primary function of providing lighting, the cap lamp and battery have recently been integrated into mine safety communications systems. Radio receivers and circuitry embedded in the battery cover permit the miners to receive messages, warnings or evacuation instructions through very low frequency (VLF) radio transmission and enable them to be made aware of an incoming message by means of an on/off flashing of the cap lamp.

2. Eye and Face Protection

293. Most mining operations around the world have compulsory eye protection programs which require the miner to wear safety spectacles, goggles, face shields or a full face piece respirator, depending on the operations being performed and the combination of hazards to which the miner is exposed.

294. To protect the eyes, safety glasses or goggles should be worn, preferably with anti-fog and anti-scratch properties, so they do not have to be removed and cleaned within the work area, thus minimizing risk and downtime. In addition, they should have a seal around the eye area to prevent the ingress of dust and sand.

295. The dust and dirt in many mining environments, most notably hard-rock mining, can be highly abrasive. This causes scratching and rapid wear of safety glasses with plastic (polycarbonate) lenses. For this reason, many mines still permit the use of glass lenses, even though they do not provide the resistance to impact and shattering offered by polycarbonates, and even though they may not meet the prevailing standard for protective eye wear in the

[32] Personal Protective Equipment in Mining - Peter Pickerill. http://www.iloencyclopaedia.org/part-xi-36283/mining-and-quarrying/123-74-mining-and-quarrying/personal-protective-equipment-in-mining

particular jurisdiction. Progress continues to be made in both anti-fog treatments and surface hardening treatments for plastic lenses.

296. **Face shields**. A face shield may be worn where the miner requires full-face protection from weld spatter, grinding residues or other large flying particles which could be produced by cutting, chipping or scaling. The face shield may be of a specialized nature, as in welding, or may be clear acrylic or polycarbonate. Although face shields can be equipped with their own head harness, in mining they will normally be mounted in the accessory slots in the miner's safety cap. Face shields are designed so that they can be quickly and easily hinged upwards for observation of the work and down over the face for protection when performing the work.

297. **Face Mask**. A face mask is essential when working in environments containing potentially hazardous gases, many of which are odorless and tasteless. A half-face mask protects miners from breathing in dangerous gases underground, depending on the gas levels. A full-face mask protects the eyes and skin, in addition to a breathing apparatus to facilitate breathing, preventing hazardous gases from entering the mask by means of replaceable cartridges. These cartridges must be replaced immediately when the air within the mask is contaminated with chemicals and/gases, which may affect breathing.

298. **Respirator.** A full-face piece respirator may be worn for face protection when there is also a requirement for respiratory protection against a substance which is irritating to the eyes. Such operations are more often encountered in the above ground mine processing than in the below ground mining operation itself.

3. Ear Protection

299. Exposure to high noise levels can cause hearing loss or impairment. It can create physical and psychological stress. There is no cure for noise-induced hearing loss, so the prevention of excessive noise exposure is the only way to avoid hearing damage. Specifically designed protection is required, depending on the type of noise encountered and the auditory condition of employee. A Signal-To-Noise Ratio (SNR) test should be conducted at every area of a mine to determine the decibel level, which will indicate what type of ear plugs should be worn.

300. Underground vehicles, machinery and power tools generate high ambient noise levels which can create long-term damage to human hearing. Protection is normally provided by ear muff type protectors which are slot-mounted on the miner's cap. Supplementary protection can be provided by wearing closed cell foam ear plugs in conjunction with the ear muffs. Ear plugs, either of the disposable foam cell variety or the reusable elastomeric variety, may be used on their own, either because of preference or because the accessory slot is being used to carry a face shield or other accessory.

301. Reusable ear plugs are recommended, in order to counter perspiration and increase mineworker comfort levels during the day. These can simply be cleaned with soap and water, and used for three to four months. Custom-molded ear plugs are highly recommended for complete hearing protection.

302. Disposable earplugs should be used once and thrown away; non-disposable ones should be cleaned after each use for proper maintenance. Earmuffs need to make a perfect seal around

the ear to be effective. Glasses, long sideburns, long hair, and facial movements, such as chewing, can reduce protection.

4. Arm and Hand Protection

303. Burns, cuts, electrical shock, amputation and absorption of chemicals are examples of hazards associated with arm and hand injuries. In addition, certain mining operations may cause skin irritation. Work gloves are worn whenever possible in such operations and barrier creams are provided for additional protection, particularly when the gloves cannot be worn.

304. A wide assortment of gloves, hand pads, sleeves, and wristlets for protection from these hazards is available. Rubber is considered one of the best materials for insulating gloves and sleeves. Other glove and clothing materials such as latex, nitrile, butyl rubber, neoprene, etc. are available. Each material is thoroughly tested and rated against specific chemical compounds. You need to know what hazard you are protecting against to choose the correct material.

305. Special gloves may be needed to protect engineers and workers involved in mechanical operations, affording protection against penetration from sharp objects. These gloves feature a synthetic fiber or fiberglass shell, with a grey polyurethane coating, for up to 20 times better cut resistance, as well as abrasion, tear and puncture resistance, for optimal protection.

5. Torso Protection

306. Many hazards can threaten the torso: heat, splashes from hot metals and liquids, impacts, cuts, acids, and radiation. A variety of protective clothing is available, including vests, jackets, aprons, coveralls, and full body suits. Fire retardant wool and specially treated cotton clothing items are comfortable, and they adapt well to a variety of workplace temperatures. Other types of protection include leather, rubberized fabrics, and disposable suits.

307. A two-piece 100% cotton Conti Suit is recommended. Recommended safety indicators include reflective stripes on the arms and legs, a cross at the back, and two reflective stripes above the pocket on the chest. These safety indicators must be reflective or visible in low-light or dark areas.

6. Foot and Leg Protection

308. For protection of feet and legs from falling or rolling objects, sharp objects, molten metal, hot surfaces, and wet slippery surfaces, workers should use appropriate foot guards, safety shoes, or boots and leggings. Leggings protect the lower leg and feet from molten metal or welding sparks. Safety snaps permit their rapid removal.

309. The standard footwear for optimal foot and leg protection are heavy-duty boots. Knee-high boots with an anti-slip polyurethane surface on the sole and a metaguard on top are highly recommended, together with steel-cap toes and an anti-static mid-sole and ankle guards. For added protection, knee pads should also be worn when working underground.

310. The mining work boot may be of either leather or rubber construction, depending on whether the mine is dry or wet. Minimum protective requirements for the boot include a full puncture-proof sole with a composite outer layer to prevent slipping, a steel toe-cap and a metatarsal guard. Metatarsal guards are now available in molded fiber, replacing the steel hoops

and saddles that were once common. They provide equivalent protection with less weight and less risk of tripping.

7. Respiratory Protection

311. Respirators protect against occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, and vapors.

312. The most commonly needed respiratory protection in mining operations is dust protection. Coal dust as well as most other ambient dusts can be effectively filtered using an inexpensive quarter face piece dust mask. The type which uses an elastomer nose/mouth cover and replaceable filters is effective. The molded throw-away fiber-cup type respirator is not effective.

313. Welding, flame cutting, use of solvents, handling of fuels, blasting and other operations can produce air-borne contaminants that require the use of twin cartridge respirators to remove combinations of dust, mists, fumes, organic vapors and acid gases. In these cases, the need for protection for the miner will be indicated by measurement of the contaminants, usually performed locally, using detector tubes or portable instruments. The appropriate respirator is to be worn until the mine ventilation system has cleared the contaminant or reduced it to levels that are acceptable.

314. Certain types of particulates encountered in mines, such as asbestos fibers found in asbestos mines, coal fines produced in longwall mining and radionuclides found in uranium mining, may require the use of a positive pressure respirator equipped with a high-efficiency particulate absolute filter. Powered air-purifying respirators which supply the filtered air to a hood, tight-fitting face piece or integrated helmet face piece assembly meet this requirement.

8. Other Protective Equipment

315. Depending on local regulations and the type of mine, miners may be required to carry a self-rescue device. This is a respiratory protection device which will help the miner to escape from the mine in the event of a mine fire or explosion that renders the atmosphere unbreathable because of carbon monoxide, smoke and other toxic contaminants. The self-rescuer may be a filtration type device with a catalyst for carbon monoxide conversion or it may be a self-contained self-rescuer, i.e., a closed-cycle breathing apparatus which chemically regenerates oxygen.

316. Portable instruments (including detector tubes and detector tube pumps) for the detection and measurement of toxic and combustible gases are not carried routinely by all miners, but are used by mine safety officers or other designated personnel in accordance with standard operating procedures to test mine atmospheres periodically or before entry.

317. Improving the ability to communicate with personnel in underground mining operations is proving to have enormous safety benefits and two-way communication systems, personal pagers and personnel locating devices are finding their way into modern mining operations.

9. Thermal Stress

318. Heat stress in the mining industry has been a cause for concern for over 100 years[33]. Radiant heat from the sun and rock face accounts for a large proportion of the heat affecting miners working in open cut mining operations. Mines located in tropical areas have the additional burden of high humidity to add to the heat load. Working in confined conditions or in close proximity to hot machinery increases heat stress, particularly if this work requires the wearing of vapour or water impermeable protective clothing.

319. In underground mines, heat is a problem. Ambient temperatures may be high because of the depth of the mine below ground or because it is located in a hot climate.

320. Protection from heat stress and potential heat stroke can be provided by special garments or undergarments which can accommodate frozen gel packs or which are constructed with a network of cooling tubes to circulate cooling fluids over the surface of the body and then through an external heat exchanger. In situations where the rock itself is hot, heat resistant gloves, socks and boots are worn. Drinking water or, preferably, drinking water with added electrolytes must be available and must be consumed to replace lost body fluids.

[33] Heat Stress in Mining. Sue Leveritt. http://ergonomics.uq.edu.au/eaol/leveritt.pdf - Accessed 4 March 2018.

XIII.WATER MANAGEMENT, WASTE ROCK MANAGEMENT, AND EROSION PREVENTION AND CONTROL

A. Water Management

321. Water management in mining entails handling of water from supply through use and treatment to discharge. It considers quality as well as quantity. The primary water management goal is that each facility will be able to:

i. operate without significant risk of harmful or illegal discharges;
ii. minimize the amount of fresh water consumption within technically and economically feasible constraints; and
iii. position the operation for an efficient closure.

1. Preparing the Environmental Baseline

322. The first step in best practice for water management is preparation and activation of a sitewide water balance model to complete the site water baseline study. Water balance refers to the accounting of, and relationship between, individual inlet and outlet flows of water associated with a mine and milling and/or leaching operation.

a. Characterization of existing climate

323. Rainfall is a major concern at mine sites. In fact, rainfall can determine the environmental acceptability of a proposed mining project. In the tropics, high rainfall generates large quantities of runoff. In contrast, mines in arid areas need only cope with small quantities of runoff, but may have difficulty optaining enough water for mining and ore processing. Mining projects in many tropical areas are fraught with environmental risk. These projects not only threaten pristine ecosystems, but high rainfall and heavy storms overwhelm mining facilities and mitigation measures for preventing environmental disasters. An especially rainy climate can, by itself, deem a proposed mining project environmentally unacceptable. The following should be included in the description of the existing climate at the proposed mine site:

i. Rainfall patterns including magnitude and seasonal variability of rainfall must be considered. Extremes of climate (droughts, floods, cyclones, etc.) should also be discussed with particular reference to water management at the proposal site; and

ii. Climatic conditions (precipitation, evaporation, climate type, seasonal/long-term climatic variability, dominant wind directions, typical storm events, temperature) for locations at or close to mine.

b. Surface Water Characterization

324. Surface water quality should be characterized to provide detailed information on the location, distribution, quantity, and quality of all water resources that could be affected by a project and its alternatives. The data and analysis should be detailed enough to understand the conditions of the environmentally significant geographic areas surrounding the mine site. Water quality characterization should consider the local and regional uses of water (domestic, industrial, urban, agricultural, recreational, others) and the ecosystem (in relation to the life of plant and animal communities). Water quality studies should be compared to water standards and other legal guidelines for each water use.

325. Quantity must reflect several aspects such as watershed distribution, hydrological processes, and availability for different water uses at local and regional levels.

326. Characterization of surface water should include:

i. Identification of surface water bodies including rivers, lakes, streams, wetlands, floodplains, and coastal areas. Drainage basins and subdrainage basins are to identified. The locations of all surface water features are to be clearly indicated on topograpical maps;
ii. Hydrology. The annual hydrological or surface water flow regime should be characterized in terms of flows and sediment transport. Minimum flows should be highlighted and stream velocity estimated.
iii. Applicable water quality standards;
iv. Common water quality parameters: Physical, chemical: pH, turbidity, suspended solids, temperature, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Solids, salinity, conductivity. Common contaminants of concern include ammonia, arsenic,cadmium, copper, chromium, cyanide, iron, lead, manganese, mercury, molybdenum, nickel, nitrate/nitrite, sulfate, thallium, uranium, vanadium, and zinc.

327. **Sampling Design**. Surface water quality data reports are to include sampling and analytical methods. Each mine facility must have a sampling and analysis plan that contains a clear description of water sampling methods, and the number and exact location of sampling points.. These should be representative of the area of influence of a project and of all the surface water resources that would be affected by a project. Also, water quality data should include the results of laboratory analysis. Frequently, this information is presented in tables and figures and the laboraory reports are included as annexes. Surface water quality data must be compared to existing water quality standards, according to the uses categorized in national laws or international guidelines.

c. Groundwater Characterization

328. Depending on the area, groundwater can be located at low depth with strong interaction with surface waters, or deep with much less or no interaction with surface water. Groundwater can also have different uses, such as agricultural, human consumption, and industrial. The basline should include the following basic information about groundwater resources:

i. Depth to groundwater under different seasonal conditions
ii. Geology and locations of aquifers, thicknesses, and their hydraulic conductivity ranges
iii. Groundwater flow directions
iv. Locations/flows of springs and seeps
v. Groundwater discharge locations in streams; and

d. Water Balance Preparation

329. The relationship between input and output of water in the project location is called "water budget and balance". The water balance:

i. Accurately identifys, maps and quantifies all major inflows and outflows;
ii. Accounts for seasonal factors such as monsoon storms (snowpack/ice accumulation and spring thaw);

iii. Predicts inflows, outflows and storage volumes from the current condition forward through the life of mine and closure;
iv. Clearly defines input assumptions and calibration factors;
v. Allows for analysis of water balance conditions for a range of production inputs and climate conditions (wet, dry years, drought and extreme precipitation events), and
vi. Tracks past performance of observed conditions vs. projected performance to allow evaluation and calibration.

330. A water balance model utilizes historical rainfall and hydrological records for a representative period of time. Historical rainfall data are used to generate a synthetic runoff record for the site and this along with any other recorded or known flows (e.g., underdrains, underground discharge etc) is discharged into the receiving water flow record for the same period. An example water balance model conceptual diagram (Figure 13.1.[34]) illustrates the relationship between major water balance components, overall impact on mine site water supply, and the potential to affect mine water supply and potential for discharge.

331. The rainfall-runoff balance is checked to ensure a realistic set of model drivers such as baseflow and runoff coefficients, are being used. Where possible empirical data is compared with prediction to verify and calibrate the model.

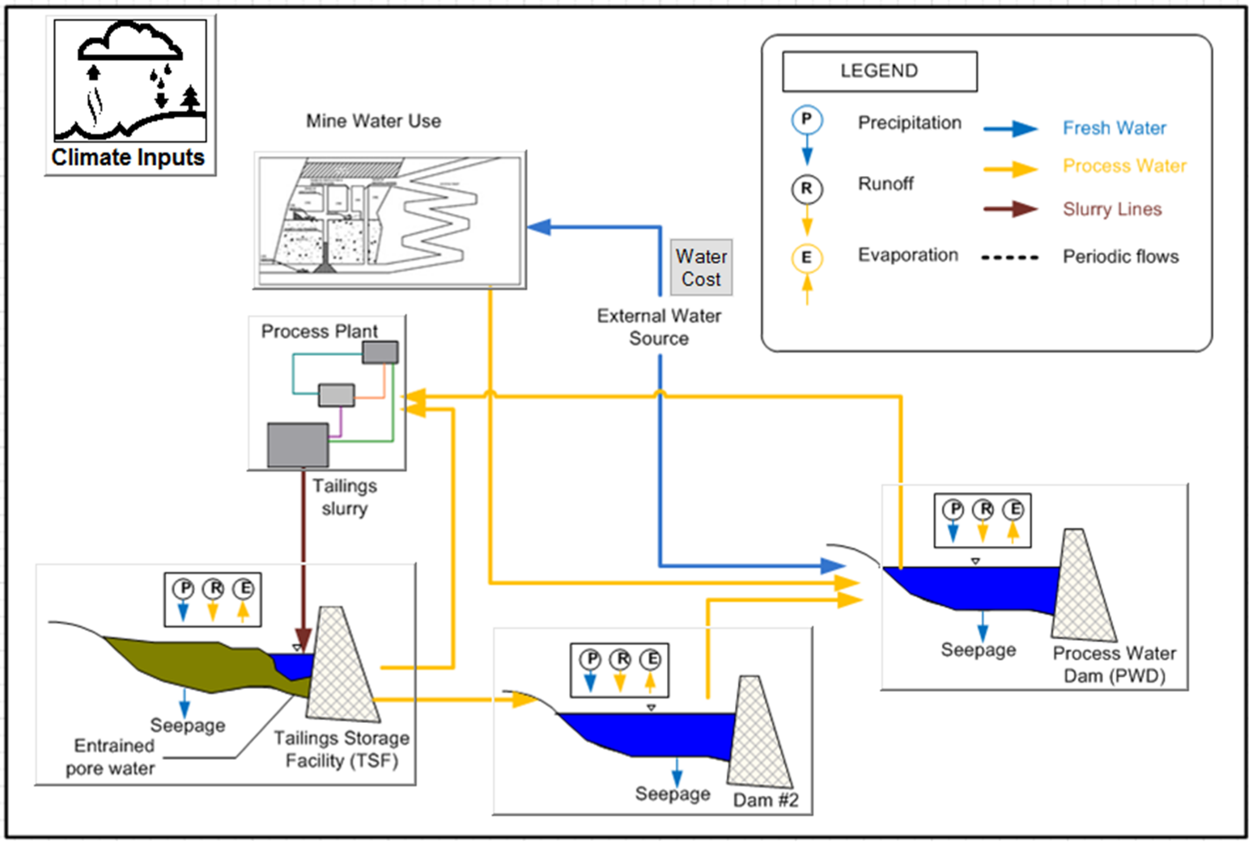
332. Chemical values are assigned to flows and discharge chemistry and step-wise receiving water chemistry is predicted. A model uses a simple mass approach to chemistry. Input chemistry is based either on sophisticated chemical modelling using both mass and solubility chemistry, or on empirical data from the mine site monitoring program.

333. Open pit and underground chemistry can be modeled using a combination of agreed model parameters and empirical data. Site process water and tailings chemistry inputs can also be modeled using empirical data and monitoring data. The model should include:

i. Model hydrology, including receiving water hydrology
   - Open Pit Discharge
   - Site Surface Water Discharge
ii. Predicted Discharge Chemistry and Effects
   - Chemistry in the Model
   - Open Pit Discharge
   - Site/Surface Water Chemistry
   - Underground Discharge Chemistry

334. The water balance should be updated periodically once the mine is operating and revised annually, prior to maximum precipitation, or more frequently if necessary, depending on water management changes and other factors.

[34] Environmental Systems Applications Mine Water & Waste Mine Water Balance, Water Quality and Waste Management Modeling, 2018 GoldSim Technology Group.



Source: Environmental Systems Applications Mine Water & Waste Mine Water Balance, Water Quality and Waste Management Modeling, 2018 GoldSim Technology Group.

Figure 13.1. Illustrative Water Balance Model Diagram

335. All major influent and effluent streams making up the water balance to a mine operation should be equipped with flow measurement devices and will be sampled for chemical analysis on a regular basis. Equipment should be provided to measure rainfall and evaporation as appropriate. There should be proper QA/QC procedures for calibration of all equipment.

336. In the absence of specific regulatory requirements, storm event containment for tailings and heap leach systems should demonstrate the capability to withstand and contain the 100-year, 24-hour precipitation event in conjunction with a 24 hour loss of power (draindown condition) without unpermitted discharge at any point in time for the life of the operation.

e. Mine Water Management Plan

337. Each mine site should have a water management plan that includes:

i. A comprehensive, life of mine, probabilistic water balance;

ii. Assigned responsibility and procedure for periodic water balance updates to incorporate operating and meteorological data, as well as planned changes in facilities and/or operations;

iii. Contingency procedures for upsets in the water balance, such as extreme precipitation events, procedures to be followed when inspections and monitoring identify a deviation from design or standard operating procedures, and procedures for temporary closure;

iv. A plan for minimizing the volume of water that requires treatment and/or special handling and to minimize the use of fresh water for makeup;

v. Design criteria and flow capacities for stormwaterconveyances (ditches, pipes and channels);

vi. Inspection and maintenance schedules and procedures for conveyances;

vii. Inspection, calibration and maintenance schedules and procedures for flow measurement devices;

viii. A plan for the conduct of periodic surveys, as necessary, to verify volume calculations for impoundments; and

ix. Storage impoundments must be sized to contain the runoff from the 100-year 24-hour storm while maintaining adequate freeboard. Mine management is encouraged to consider the storage requirements that would be necessary to contain the excess water produced by an abnormally wet month or season.

f. Process Solution

338. Process solution is defined as any internal water-based solution that is used in the processing of ore. It includes reclaimed water, tailings solution, barren solution and pregnant solution. The goal of mine management should be to ensure that there is no release of process solution or wastewater other than through controlled discharges that meet all regulatory requirements for surface water and groundwater protection.

339. Seepage through tailings dams and other wastewater/ process solution containment structures must be: (i) prevented, or (ii) captured and pumped back, or (iii) managed in accordance with written criteria prepared by the mine, specific to design parameters for the source of seepage.

340. Routine inspections should be conducted of all containment structures. Inspections should include observations of seepage, physical conditions of the structures and freeboard. All inspection observations must be documented. Written operating and maintenance instructions including training requirements shall be prepared for any wastewater treatment system.

g. Stormwater Management Plan

341. Each mine site should develop and implement a Stormwater Management Plan, designed to address the following objectives[35]:

i. All pollutants and their sources, including sources of sediment associated with construction, construction site erosion and all other activities associated with construction activity are controlled.

ii. All non-stormwater discharges are identified and either eliminated, controlled, or treated.

iii. Site best management plans (BMPs) are effective and result in the reduction or elimination of pollutants in stormwater discharges and authorized non-stormwater

[35] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.

discharges from construction activity to the Best Available Technology/Best Control Technology (BAT/BCT) standard.

iv. Calculations and design details as well as BMP controls for site run-on are complete and correct, as per results of the sitewide water balance.

v. Stabilization BMPs installed to reduce or eliminate pollutants after construction is completed.

vi. Identify post-construction BMPs, which are those measures to be installed during construction that are intended to reduce or eliminate pollutants after construction is completed.

vii. Identify and provide methods to implement BMP inspection, visual monitoring, Rain Event Action Plan (REAP), and Construction Site Monitoring Program (CSMP) requirements to be consistent with the License to operate.

viii. The Mine and/or its contractors will manage all run-on and runoff from the project site. For example, this could include installing berms and other temporary run-on and runoff diversions. The following are the minimum run-on and runoff control BMPs that must be implemented for the project:
   - Effectively manage all run-on, all runoff within the site, and runoff that discharges from the site
   - Direct run-on away from disturbed areas of the site.

342. BMPs to be considered include, but are not limited to: re-seeding, preserving existing vegetation, stormwater diversion channels with rip rap and flow impeding material, temporary fiber rolls, stormwater retention basins, gravel bag berms, drain inlet protections, street sweeping, permanent or temporary covers over waste material, vehicle and petrochemical storage BMPs.

2. Assessing Potential Environmental, Economic, and Social Impacts

343. Mining-influenced water (MIW) is defined as any water whose chemical composition has been affected by mining or mineral processing and includes acid rock drainage (ARD), neutral and alkaline waters, mineral processing waters and residual waters. MIW can contain metals, metalloids and other constituents in concentrations above regulatory standards. The following is a list of possible mine construction, operating and waste materials and activities that will be performed that will have the potential to contribute pollutants, other than mine waste rock, tailings and sediment, to stormwater runoff and general surface and groundwater quality.

344. BMPs that will be implemented to control potential pollution from:

i. Demolition and removal of existing site materials and demobilization
ii. Sediment, spoils and dirt
iii. Clearing and grubbing
iv. Grading activities and excavation
v. Asphalt Concrete (AC) operations and related materials
vi. Cement Concrete operations and related materials
vii. Vehicle fluids, including oil, grease, petroleum and coolant
viii. Sanitary and septic wastes
ix. Paint, sealants, solvents, thinners, acids and adhesives; and
x. General construction waste and litter

3. Designing mitigation measures

345. Mitigating the effects of mine waste on water consists of either preventing contact, or treating water that has been degraded by mine waste. Many types of water diversion and mine waste isolation methods exist and should be the first methods used to protect water supplies. In the event that MIW is created and released by mining activities, many cost-effective and lower-maintenance treatment systems to decrease the costs and improve the efficiency of mine site cleanups. Passive treatment methods are generally the methods of choice due to lower costs, labor and maintenance requirements. Active treatment systems and passive-active hybrid systems may be required depending on the MIW chemistry and point of discharge compliance requirements. Resources that summarize these technologies include the Interstate Technology and Regulatory Council (ITRC) Mining Waste Treatment Selection technology overview webpage (http://www.itrcweb.org/miningwaste-guidance/technology_overviews.htm) and the Network for Acid Prevention's Global Acid Rock Drainage (GARD) Guide (http://www.gardguide.com/index.php/Main_Page).

346. Active or passive methods can remove or reduce the concentration of contaminants in MIW. The International Network for Acid Prevention's GARD Guide considers active treatment as technologies that require ongoing human operation, maintenance and monitoring, and have or use external sources of energy, infrastructure and engineered systems. Passive treatment refers to processes that do not require frequent human intervention, operation or maintenance, and that typically employ natural construction materials (e.g., soils, clays, broken rock), natural treatment media (e.g., plant residues such as straw, wood chips, manure, compost), and promote growth of natural vegetation. Passive treatment systems use gravity flow for water movement, and passive energy sources such as solar or wind power. In some arid climates, they might also include the use of evaporation or infiltration.

347. Both active and passive treatment methods potentially combine physical, biological and chemical approaches to treat MIW. The main purpose of both classes of technologies is to raise pH, lower dissolved metal concentrations, and lower sulfate. Active or passive treatment of MIW generally requires long-term maintenance and funding.

348. Key factors when considering MIW treatment technologies include:

i. amount of available land surface and its topography;
ii. system longevity and maintenance needs;
iii. flow rate and strength;
iv. site accessibility and remoteness;
v. availability of utilities (especially power sources);
vi. performance criteria;
vii. design, capital, and operation and maintenance costs; and
viii. and climate impacts on system effectiveness.

349. This Guideline should be used with applicable National regulatory or authoritative industry Guidelines or Standards. Treatment systems typically include multiple steps of treatment with more than one technology[36]. Although cost information is not available for all technologies, the U.S. Office of Surface Mining has developed an online program for evaluating cost of treatment methods, called AMDTreat. The program is available at http://amd.osmre.gov/ and is designed to predict approximate costs for various sets of treatment steps.

350. The US EPA's policy for reducing the environmental footprint of activities used to clean up contaminated sites is based on core element principles of reducing energy usage, air pollution, and impacts on water resources, improving waste management, and protecting ecosystem services. There are significant opportunities to reduce the environmental footprint associated with characterizing MIW and using passive treatment systems. EPA's green remediation best management practices for treating MIW can be found at http://cluin.org/greenremediation/docs/GR_factsheet_miningsites.pdf.

B. Mine Waste Rock

351. The type, amount, and properties of mine waste produced at different mines vary depending on the resource being mined, process technology used, and geology at the mine site. While many mine wastes are benign, mining companies manage their waste to deal with the large volumes of waste produced and to prevent the release of contaminants into the environment. Waste management plans are developed as part of the mine approval process in many countries as best practice, and consist of waste storage area selection and design, stormwater diversion and runoff management, strategies to address problematic waste, and long-term stabilization of waste as part of mine closure.

352. The soil and rock which is removed to gain access to buried ore, and the material (water, solids, and gases) left behind after the ore has been processed to remove the valuable commodities, are considered to be waste materials. However, the difference in mineral content between ore and waste rock can change depending on market conditions and available extraction technology, and there are a number of cases where material that was once considered waste has become a resource for modern mining operations.

1. Types of Solid Mine Waste

353. There are different types of solid waste materials which can be produced by a mine. These vary in their physical and chemical composition, their potential for environmental contamination, and how they are managed at mine sites. Types of mine waste include:

i. **Overburden**: Overburden includes the soil and rock that is removed to gain access to the ore deposits at open pit mines. It is usually piled on the surface at mine sites where it will not impede further expansion of the mining operation – moving large volumes of material is expensive. Overburden generally has a low potential for environmental contamination, and is often used at mine sites for landscape contouring and revegetation during mine closure.

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[36] U.S. Environmental Protection Agency, March 2014. REFERENCE GUIDE to Treatment Technologies for Mining-Influenced Water Office of Superfund Remediation and Technology Innovation, EPA 542-R-14-001, Washington, D.C.

ii. **Waste rock**: Waste rock is material that contains minerals in concentrations considered too low to be extracted at a profit. Waste rock is often stored in heaps or dumps on the mine site, but may be stored underwater with tailings if it contains a lot of sulfide minerals and has a high potential for acid rock drainage formation. Waste rock dumps are generally covered with soil and revegetated following mine closure, although there are cases of waste rock being re-mined due to an increase in mineral market prices or improvements in extraction technology.

iii. **Tailings**: Tailings are finely ground rock and mineral waste products of mineral processing operations. Tailings can also contain leftover processing chemicals and are usually deposited in the form of a water-based slurry into tailings ponds (sedimentation lagoons enclosed by dams built to capture and store the tailings), although offshore tailings disposal has been successful in some cases. Tailings dams are discussed in further detail below.

iv. **Slags**: Slags are non-metallic by-products from metal smelting, and were historically considered to be waste. Slags are largely environmentally benign, and are being used increasingly as aggregate in concrete and road construction.

2. Environmental Impacts of Mine Waste

354. The environmental impact of mine waste depends on its type and composition, which vary considerably with the commodity being mined, type of ore, and technologies used to process the ore. For instance, where waste rock and tailings contain significant quantities of sulfide minerals and are exposed to air and water, acid rock drainage (ARD) can occur. As a result, every mine requires its own waste characterization, prediction, monitoring, control, and treatment. Many mine wastes are environmentally benign, and can be used for landform reconstruction, vegetation covers, and road and dam construction.

355. The major environmental impacts from waste disposal at mine sites can be divided into two categories: the loss of productive land following its conversion to a waste storage area, and the introduction of sediment, acidity, and other contaminates into surrounding surface and groundwater from water running over exposed problematic or chemically reactive wastes.

3. Mine Waste Characterization

356. All mine waste should be subject to geochemical characterization as part of mine waste management best practices. Environmental baseline characterization includes: discussion of tests for predicting the acid generating and contaminant-leaching potential of mined materials and the information necessary for adequate characterization of existing water and air quality, wildlife, and socio-economic characteristics of project areas.

a. Characterization for Baseline

357. The environmental baseline should begin with a detailed characterization of the geological environment, including the metallic mineral ore reserve and materials comprising the overburden. These materials must be managed properly because they give rise to the high-volume waste that a mining project generates. Mined materials must be carefully characterized for concentrations of toxic substances and the potential to become acidic at any future time (creating the potential for acid mine drainage).

b. Mineralogy and whole rock analysis

358. Maest et al. (2005)[37] provide the following guidance about the kind of geochemical analysis a mining project proponent must include to predict possible water quality impacts, including the release of contaminants and acid drainage:

i. determine the lithology and mineralogy of the rocks at the mine site. Such analyses include the determination of rock type, alteration, primary and secondary mineralogy, the availability of acid-producing and - neutralizing and metal-leaching minerals (liberation, e.g., veins, disseminated, encapsulated, etc.), and the locations and dimensions of oxidized and unoxidized zones for all waste types, pit walls, and underground workings.
ii. Define the geochemical test units. Geochemical test units are rock types of distinctive physical and chemical characteristics. Depending on the results of the characterization, some of the test units may be grouped together in the mine waste management plan. Alternatively, if an initial unit designation provides a wide range of test outcomes, it may be necessary to subdivide the unit for waste management purposes.
iii. Estimate the volumes of each type of material to be generated and the distribution of types of material in waste, pit, and underground workings. The information on geochemical test units should be coordinated with the mine waste management plan.
iv. Conduct bench-scale testing of the ore, which involves creating tailings and/or heap leach materials in a laboratory. The general categories of geochemical testing that will be performed on the geochemical test units are whole rock analysis, static testing, short-term leach testing, and kinetic testing.

c. Acid generation potential – static and kinetic testing of mined materials

359. To determine the acid generation potential of mined materials and mine project wastes, an EIA should include the following test results:

i. **Static Tests** - Static testing should be performed on potential sources of acid drainage, including waste rock, pit wall rock, underground working wall rock, tailings, ore, leached heap materials, and stockpile materials. The number of samples for each unit will be defined by the volume of material to be generated. For acid-generation potential (AGP), the modified Sobek method using total sulfur is recommended. The mineralogy and composition of the sulfides should be confirmed using mineralogic analysis.
ii. **Kinetic testing.** Kinetic testing should be conducted on a representative number of samples from each geochemical test unit. Special emphasis should be placed on kinetic testing of samples that have an uncertain ability to generate acid. Column tests are recommended over humidity cell tests for all aerially exposed mined materials, including natural on-site construction materials, with the exception of tailings. However, either type of kinetic test can be useful depending on the objectives of the testing and if the available surface areas for reaction are determined in advance of the testing.
iii. **Contaminant leaching potential short- and long-term leach tests** Results from short-term leach tests can be used to estimate the concentrations of constituents of concern after a short event (e.g., a storm event) but are not appropriate to use for

[37] Predicting Water Quality at Hardrock Mines-Methods and Models, Uncertainties, and State-of-the-Art. 2005 Maest, Ann S., James R. Kuipers, Constance L. Travers and David A. Atkins. EARTHWORKS 1612 K St., NW, Suite 808, Washington, DC, USA 20006

estimation of long-term leaching. Standard short-term leach tests with a lower liquid:solid ratio can be conducted on samples from each geochemical test unit. However, using first flush results from longer-term kinetic testing will help coordinate the short-term and longer-term weathering results and will allow the determination of weathering on a per mass basis. The leachate samples should be analyzed for constituents of concern (based on whole rock analysis and known contaminants of concern) using detection limits that are at least ten times lower than relevant water quality standards (e.g., for arsenic, which has a US EPA drinking water standard of 10 µg/L, the detection limit should be 1 µg/L or lower). Major cations and anions should also be determined on the leachate samples, and the ation/anion balance should be checked for each sample.

iv. **Identification of contaminants of concern.** Characterization of the mined materials should include quantitative predictions of the concentrations of contaminants of concern (e.g., arsenic, lead, cadmium, nickel, chromium, and mercury). These would be found in polluted water that a mining project may, at any future point in time, release into the environment. These quantitative predictions should then be used to anticipate potential changes in groundwater and surface water quality.

v. **Characterization of existing seismic conditions -** If a mining project involves a wet tailings impoundment, there is a need to adequately characterize existing seismic conditions, including the risk of a major earthquake which could damage mine facilities and cause catastrophic consequences, such as a tailings dam failure. The IFC EHS Guidelines[38] explains that:“ Where structures are located in areas where there is a risk of high seismic loadings, the independent review should include a check on the maximum design earthquake assumptions and the stability of the structure to ensure that the design is such that during seismic events there will be no uncontrolled release of tailings; Design of tailings storage facilities should take into account the specific risks/ hazards associated with geotechnical stability or hydraulic failure and the associated risks to downstream economic assets, ecosystems and human health and safety. Environmental considerations should thus also consider emergency preparedness and response planning and containment/mitigation measures in case of catastrophic release of tailings or supernatant waters; where potential liquefaction risks exist, including risks associated with seismic behavior, the design specification should take into consideration the maximum design earthquake.”

4. Management of Mine Waste Impacts

360. Mine wastes require careful management to ensure the long-term stability of storage and disposal facilities, and to prevent and minimize air, water, and soil contamination. Waste management plans are frequently developed before a mine is constructed, and the reclamation of waste rock dumps and tailings ponds are increasingly incorporated into the designs of new mines. In addition, in many parts of the world authorities require a proper waste management plan before they will issue a mining permit.

361. Mine waste management practices and storage facilities used at different mines are based on common design principles, but are optimized by mine engineers depending on specific site conditions. These designs take into account the potential for extreme events, such as

[38] International Finance Corporation, December 2007. Environmental, Health and Safety Guidelines for Mining.

earthquakes and floods. Guidelines on waste management and mine closure have been developed at international, national, and regional levels, and provide an advisory framework for best practices in mine waste management.

362. The usual approach to managing wastes is to contain and collect them at the point of production, treat the wastes to make them environmentally safe if necessary, and dispose of them to the land, water, or air. The waste management method used at a particular mine depends mainly on an evaluation of cost, environmental performance, and risk of failure. Successful management of tailings and waste rock is based on selecting appropriate waste storage locations, and proper material characterization, including the accurate prediction of long-term chemical behavior. Solid mine waste (overburden, waste rock, solidified tailings, slag, dust) can be used as backfill in underground or open pit workings, stored in piles on site or underwater to prevent ARD from occurring in the case of problematic wastes, used in construction of roads and dams at the mine, or recycled. Water can be recycled and reused for dust suppression and mineral processing or treated and discharged into the environment.

a. Waste Rock and Overburden Impacts

363. By virtue of the potentially large volumes involved, and the potential for leaching of metals or other constituents upon exposure to elements, waste rock and overburden management is a critical aspect of the operational controls at any mine site. The potential for leaching of acid, metals, or other constituents to surface or ground water should be evaluated during planning and design stage. Each operation should have a site-specific waste rock management plan that outlines procedures to identify and manage materials that may be subject to leaching. The waste rock management plan will account for site-specific geotechnical issues and waste rock dumps will be constructed in a way that provides long-term slope stability.

364. Regular inspections/evaluations will be conducted to ensure that waste dumps are maintained within the criteria established. Inspections/evaluations will evaluate the effectiveness of waste rock and overburden disposal with results predicted during the development of site specific criteria. Where inspections/evaluations show that waste rock disposal is not meeting site specific criteria, disposal practices should be appropriately modified.

365. Bedrock materials, including development rock that are being considered as a source of fill, road base, or other construction purposes should be tested to ensure the material is geochemically suitable for the planned application.

b. Tailings Environmental Impacts

366. Because tailings are composed of fine particles (sand, silt, and clay-sized material), and often have a high-water content, they are particularly troublesome to manage. In the past, tailings were deposited directly into rivers or wetlands, which would introduce sediment and contaminates into those water bodies and in many cases adversely affect aquatic life. Tailings are currently used as backfill in underground mines, stored in open pits, dried and stacked, or pumped into tailings ponds on site. Research into recent tailing dam failures have resulted in improved tailings dam design and execution. In response to concerns over tailings dam failures and water contamination, some mines are opting to produce thickened tailings, which are pressed or have chemicals added to remove excess water. Thickened tailings can be mixed with cement and used in construction or as backfill in underground mines. Although producing thickened tailings is often

more expensive than storing the tailings in a pond, the use of thickened tailings is increasing, especially in arid areas where water availability is an issue.

c. Tailings Facility Design

367. A stage raised embankment design is the most common construction technique for tailings storage facilities (TSFs). The three principal design methods involve Upstream, Centerline and Downstream embankment raises, which designate the direction in which the embankment crest moves in relation to the initial starter dam. Of these methods the Upstream method, although of low cost, poses the greatest risk and has been associated with 70% of tailings dam failures on a world-wide basis. It is specifically not a suitable design for sites in highly active seismic regions and where fine slimes tailings, such as gold tailings, are involved.

368. A TSF design is designated "Upstream" where essentially all of the dam crest up to the upstream toe moves over tailings during each stage raise lift. Essential to this method is the formation of a wide drained and stable beach of primarily sand tailings and not slimes tailings. The Centerline method, or the Modified Centerline method, require less construction material compared to the Downstream method and where properly designed, provide adequate stability. With the Centerline method the embankment is raised vertically above the starter dam and the centerline of each subsequent raise remains coincident with the centerline of the starter dam. In the Modified Centerline method, the centerline of each raise above the starter dam is displaced slightly in the upstream direction, with only the upstream nose beyond the crest edge of each stage lift being supported on tailings. The method therefore relies on development of a suitable supporting tailings beach by spigotting from the dam embankment, or alternatively provision of a stable rock fill platform. Where slimes tailings are being deposited, some instability of the upstream edge of each stage lift during construction or after a major seismic event may occur, requiring appropriate defensive design measures.

369. The Downstream method is the conventional method used for design of water storage dams. Its height is not restricted by the static or dynamic (liquefaction) behavior of tailings and pond water can be stored directly against the upstream face without negative impact on stability. It also provides the greatest assurance that as-built performance will be in conformity with design expectations during all operational and post mine closure stages. It is generally the least risk alternative and most stable under large seismic events.

d. Tailings Design, Construction, Operation and Closure

370. Secure tailings management requires design, construction, operation and closure of retention facilities that (1) are robust and physically stable under all anticipated climatic and operational conditions; (2) meet or exceed regulatory and international standards of best engineering design, construction and management practice; (3) are chemically stable so that the quality of seepage or surface runoff does not endanger groundwater, surface water, human health or the environment; and, (4) can be closed at the end of mine life and reclaimed in a manner that requires minimum on-going maintenance and is in compliance with environmental standards and guidelines.

371. The following is a brief summary of salient aspects of technical guidance for tailings dam design, construction, operation and closure [39] [40]:

1) Design of tailings storage facilities (TSF) requires selection and engagement of a specialist geotechnical engineering company. The design of each phase of TSF construction, from starter dam to final raise, must satisfy site specific geotechnical, geological, hydrological, hydrogeological and climatic conditions, as well as operating criteria related to tailings deposition and water management. Tailings facilities require ongoing review, as defined in this standard, during all stages of design, construction, operation and closure.
2) A Dam Break Analysis should be performed to establish the hazard classification for the TSF (using the Canadian Dam Association classification system or a comparable system). This analysis should be done once a preliminary concept has been developed for initial and final raising of the TSF to ultimate crest elevation. A primary purpose of the classification is to select appropriate design criteria and the methodology of dam stage raising to reduce the element of risk, as the potential for loss of life and/or property damage increases. Second, the inundation zone identified in the Dam Break Analysis is an important consideration in the design of operational controls, monitoring systems, and emergency response planning.
3) The chemical toxicity of process solutions disposed with the tailings affects the containment and management of TSF seepage and must be considered in design. Geochemically unacceptable seepage must be prevented from escaping the TSF, or be intercepted and contained in a suitably lined facility.
4) The design basis of a new TSF must be documented for review and approval as a design basis report including:
    a. Analysis of alternate siting options,
    b. Analysis of alternative dam zoning and raising techniques,
    c. Characterization of site climatic and seismic events,
    d. Description of environmental protection requirements,
    e. Regulatory design and permitting requirements and
    f. Operational, decommissioning and reclamation considerations.

5) Documented design criteria reports provide the basis for the TSF design, from the initial to the final stage raise, on which basis operational, maintenance and monitoring practices and procedures are developed. The Design Report shall include:
    a. Project Criteria,
    b. Plant process and tailings production,
    c. Expected Life of Mine tailings storage volume required,
    d. Construction program (methodology, schedule, mine or contractor equipment),
    e. Source, quality and availability of embankment materials for seal, filter and drainage zones,

[39] A Guide to the Management of Tailings Facilities, The Mining Association of Canada, September 1998

[40] Technical Report Design and Evaluation of Tailings Dams, Michael P. Davies, Peter C. Lighthall, Steve Rice and Todd E. Martin 2002 Keynote Address Tailings and Mine Waste Practices SME, AGM Phoenix AZ USA

f. Geochemical properties of all dam embankment materials, including acid generation and metals leaching potential,
g. Dam design standards and guidelines to be followed (international and local),
h. Tailings physical and geochemical properties including acid generation and metals leaching potential,
i. Assessment of site hydrogeology, groundwater flow directions, baseline surface and groundwater quality, criteria and locations for environmental compliance,
j. Assumed tailings percent solids by weight at discharge, average in-situ tailings dry density and deposition beach slopes,
k. Supernatant (solution) water chemistry,
l. Methodology of assessment of site seismicity and design seismic parameters,
m. Methodology of assessment of Static and Dynamic (Seismic) Stability including design soil parameters (foundation, embankment materials, tailings) and minimum Factors of Safety,
n. Methodology of seepage assessment and design phreatic conditions,
o. Embankment seepage control, capture, monitoring (lining/seal zones, cut-offs, chimney/blanket drains),
p. Method of assessment of site hydrology (precipitation, evaporation, run-off parameters),
q. Impoundment flood management (design flood event to be stored, wave run-up, required freeboard),
r. Temporary and permanent spillway flood routing, diversion channel(s) and/or cofferdam hydrologic design criteria and
s. Where applicable, method of Deformation Analysis under the Maximum Credible Earthquake for determination of horizontal and vertical dam crest movements.

6) Freeboard design height shall account for (i) storage of at least the 1:100 year 24 hour precipitation event above maximum operating pond level without discharge through the spillway, (ii) wave run-up caused by the most critical wind speeds with pond water at maximum flow level through the spillway during passage of the inflow design flood and (iii) dam crest settlement due to static consolidation and dynamic (seismic) displacements.

Tailings Facility Construction

7) The Engineer of Record should submit detailed specifications and drawings (plans and sections) of all required dam embankment, foundation and seepage monitoring instrumentation to be installed in the initial starter dam construction and subsequent stage raises. The Engineer of Record should also outline the methodology of installation and methodology and frequency of required readings.
8) Construction quality assurance documentation should be developed to ensure that all critical TSF design requirements and specifications, or modifications, are adequately verified by field quality control testing procedures and reporting.
9) Construction Quality Control documentation should include daily reports, drawings and certifications, all materials testing Quality Control results, final as-built geometry and quantity surveys. All changes or deviations from drawings approved for construction should be documented and certified by the Engineer of Record.

   During construction of the Tailings Storage Facility the Engineer of Record should obtain and promptly interpret the results of all field instrumentation monitoring and prepare a monthly report with graphic plots and written analysis of all the findings.

Tailings Facility Operations[41]

10) An Operating, Maintenance, and Surveillance (OMS) Manual consisting of all plans, schedules and other relevant documents for the tailings facilities should be maintained. A qualified person should be assigned the task of following and executing all of the OMS Manual requirements and to liaise with both the Mining Manager and the Engineer of Record. Periodic and annual performance reports should be prepared for all water retaining TSFs. Reports should effectively communicate material monitoring data issues, changes in TSF performance, and corrective action status.
11) Any abnormal or unusual monitoring results not meeting design expectations must be promptly reported and a remedial action plan prepared and implemented.
12) Emergency response procedures should identify potential failure modes, corrective actions, roles and responsibilities, legal requirements and commitments, available resources and equipment, mutual aid agreements, public relations plans, and telephone lists. Defined emergency escalation levels should describe internal and external communications, security, evacuation, and response requirements as well as a process to terminate the emergency and appropriate follow-up procedures.
13) All TSFs having active (retaining water) control structures (dams, dikes, decants, spillways, weirs) should be inspected by a qualified TSF design engineer at least annually. Reviews should ensure that facility designs, operations and performance criteria are being maintained.
14) Periodic independent reviews of new TSF design, major expansions, and active TSFs should be performed by an expert to provide management assurance of major facility performance, hazard management, and corrective action verification. Independent reviews shall occur no less than every three years and more frequently as necessary based on Hazard Classification and performance. Additional guidance for implementing the principles of a tailings management framework through the operating stage of the life cycle are provided in the Mining Association of Canada's tailings management guidance: "Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities".

e. Heap Leach Design

372. The heap leaching process to extract precious metals like gold, silver, copper and uranium from ore by placing them on a pad (a base) in a heap and sprinkling a leaching solvent, such as cyanide or acids, over the heap. This process dissolves the metals and they collect at the bottom of the pad where the "pregnant" solution is collected and channeled to a processing facility for extraction. Heap leach methodology is mostly used for low-grade ores, and the basic processing steps involve crushing and sometimes grinding of the ore before placing it on a pad, which must be lined with geotextile and prepared subgrade, using the geochemical and geotechnical processes and guidance as discussed above for tailings design[42].

373. Conceptually there are a number of designs of heap leach pads to consider. The design will be determined by the geography, amount of space available or climate. The principal types available are: (i) Reusable Pad; (ii) Expanding Pad; and (iii) Valley Method. Each of these designs

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[41] Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities, The Mining Association of Canada, June 2003

[42] http://technology.infomine.com/reviews/heapleachpads/welcome.asp?view=full

must consider optimal leach solution management, ore control, and dust management as part of the heap leach best practices.

f. Heap Leach Operation and Management

374. The stages for heap leaching can be described as:

i. Ground Preparation and pad construction: Here the soil on a slightly sloping ground is compacted and covered by an impermeable pad (can be made of plastic).
ii. Ore stacking: Then the crushed ore is stacked in the form of big heaps. The amount of fines is decreases as low as possible to improve permeability.
iii. Then the leaching agent such as cyanide or acid is sprayed over the heap.
iv. As, the reagent passes through the heap; the valuable metals get dissolved in it.
v. The solution containing metal is drained from the heap and collected in a pond and the solution is sent for subsequent process for metal recovery.

375. As with tailings, leach pads and associated facilities must be monitored and inspected to ensure integrity of operations, and that no process solution is exiting the system either to ground surface, surface or groundwater. Additionally, the leach pad should not generate dust.

g. Heap Leach Closure

376. Once the operator has determined that the heap facility is ready for closure, it is recommended that a conceptual heap decommissioning plan be prepared for approval. The conceptual heap leach closure plan should include, but not be limited to:

i. Discussion of the methods of testing done on the spent ore;
ii. Presentation of all data generated from the tests;
iii. Interpretation of test results, geochemical modelling, and discussion of the feasibility of detoxification of the spent ore, time estimates for how long it will take to detoxify the heap and implications of precipitate formation;
iv. Details of leach rinsing and detoxification procedures including volumes, scheduling, duration, and factors that indicate when rinsing and detoxification will cease;
v. Design criteria and preliminary design for the closure treatment system;
vi. Discharge effluent quality that protects the aquatic resources in the surrounding environment, and sludge disposal;
vii. A discussion of the risks and uncertainties associated with the conceptual plan;
viii. An evaluation of possible failure modes, contingencies in place, and an evaluation of any risks or uncertainties;
ix. Description of ongoing or planned studies, objectives, and scheduling; and how study results will be incorporated into the heap decommissioning plan; and
x. Activities to be implemented in the case of a temporary closure including criteria to define when temporary closure constitutes permanent closure and final reclamation measures are to be implemented[43].

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[43] http://technology.infomine.com/reviews/heapleachpads/welcome.asp?view=full

h. Covers

377. The use of covers to isolate and close heap leach pads can be temporary or permanent. However, the use of temporary covers also known as Raincoat Liners (RCLs) are now used in areas where a significant amount of rainfall can occur in a relatively short amount of time or extended throughout the month-to-month wet season. There are a number of advantages to using these systems, particularly, the avoidance of a surplus water balance which requires recycled storage within the ore heap, treatment and discharge to the environment, or both. Thiel and Smith also include their temporary cover in their "State of Practice" paper on heap leaching[44].

378. A permanent cover is placed over the heap leach pad after the mine has ceased production. The style of cover is designed to limit the infiltration of water into the heap leach where it could mobilize acidity and solution. Cover material can be geosynthetics liner over the pad, followed by waste rock and topsoil which is then reseeded. While it is common practice to line heap leach pads with geosynthetics, capping is usually done with soil mixtures only, using a geosynthetic liner if heap leach could possibly negatively impact the surrounding environment[45].

C. Erosion Prevention and Control

379. **Disturbed land** is land that has been cleared of vegetation and/or soil to facilitate mining or extractive activities, such as for exploration, roads, open-cut operations, siting of plant or equipment for processing and treating ore, construction of tailings storage facilities or waste rock, and infrastructure including site offices, workshops and parking areas. Environmental challenges due to land disturbance can include: soil erosion, dust, noise and water pollution, and impacts on local biodiversity. Best management for erosion control requires assessment of potential disturbance of the immediate environment to define the existing conditions, identify potential problems and incorporate mitigation measures to correct and prevent land disturbance. Impacts to land including surface and ground water, soils, local land use, native vegetation and wildlife populations are required to be minimized at all stages of operation.

380. The following are the expectations for managing land disturbance to protect the natural environment, amenity and cultural values, and landscape character from the adverse effects of earthmoving and natural vegetative cover and should apply to land disturbance management at all sites including any activity with potential to create hazardous situations.

1. Land Disturbance Evaluation

381. Each mine facility should:

i. Assess potential for planned activities to cause disturbance

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[44] State of the Practice Review of Heap Leach Pad Design issues, Thiel, Richard and Mark Smith. https://doi.org/10.1016/j.geotexmem.2004.05.002

[45] FINDINGS OF INTERNATIONAL REVIEW OF SOIL COVER DESIGN AND CONSTRUCTION PRACTICES FOR MINE WASTE CLOSURE Maritz Rykaart, Daryl Hockley, Michel Noel, Michael Paul. Paper presented at the 7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006, St. Louis MO. R.I. Barnhisel (ed.) Published by the American Society of Mining and Reclamation (ASMR), 3134 Montavesta Road, Lexington, KY 40502

ii. Evaluate extent of disturbance; and

iii. Develop best land management practices that will allow retention of cultural, natural and physical environment during land disturbance. These practices will promote careful management of any activity involving land disturbance that could adversely affect these values and avoid degradation of:

- landscape or landscape features;
- ancestral/archeological/historical areas;
- indigenous vegetation and habitats of indigenous fauna;
- existing water quality in adjacent or nearby water bodies;
- values of estuaries, harbors and wetlands; and
- recreational amenity values.

382. Geochemical characterization should be performed on any material to be disturbed. Written water management, including stormwater management procedures should be incorporated into land disturbance management protocols. Closure and post-closure landforms and reclamation should be addressed.

2. Land Disturbance Management

383. Each mine site should have an Environmental Management Plan (EMP) that includes details on land disturbance management, including:

i. Details of land disturbance and planned rehabilitation, including

- the total current area of land disturbed;
- the area disturbed during the last reporting period;
- the area *rehabilitated* over the last reporting period;
- the percentage of area that has been revegetated (with local native vegetation);
- weed control;
- the area of tailings dams and/or other geologic material storage area; and
- estimate of the current rehabilitation liability for the license area.

ii. Details of any environmental management initiatives implemented. These must promote “final stabilization” which is the establishment of perennial vegetation with an optimum coverage rate of 70% of the soil surface – this may be a combination of herbaceous or woody species and durable mulch; covering the soil with a hard surface such as a structure, concrete, bituminous material or riprap.

3. Land Disturbance Control Measures

384. Each facility should develop land disturbance control measures to achieve, to the maximum extent practicable, a reduction of sediment load carried in runoff, on an average annual basis as compared with no sediment or erosion controls, until the site is stabilized. (1) Erosion and sediment control BMPs may be used alone or in combination to meet the sediment reduction goal, or as required by the site’s regulatory framework.

385. All control measures necessary to meet the requirements for compliance with the regulatory framework, shall be maintained to ensure adequate performance and to prevent nuisance conditions.

386. Control erosion and other land disturbances in the following:

i. slopes of more than 20 degrees
ii. disturbances within an area of channelized flow; including the installation, repair or removal of any underground pipe or other facility within the channel cross-section
iii. sites where actual or potential severe erosion problems warrant corrective action.
iv. Site dewatering. Water should not be discharged in a manner that causes off-site erosion or sedimentation.

387. Site erosion control can be attained by:

i. All site developments and land disturbances shall be implemented to best fit of the terrain, minimize exposed area, and retain as much existing vegetation as possible.
ii. Runoff from areas adjacent to the site should be diverted around disturbed areas;
iii. All land disturbance activities on the site should be conducted in accordance with the approved environmental management plan. To the maximum extent practicable, the areas of bare soil exposed at any time should be minimized.
iv. Cuts and fills planned and constructed to minimize length and steepness of slopes.
v. Channels and other concentrated flow areas properly designed and constructed to control runoff within and from the site in a manner that will not erode the conveyance and receiving channels.
vi. Sediment should be contained on-site through best management practices.
vii. Earth storage piles should be protected with perimeter controls such as silt fence, a vegetable buffer straw bale barrier, or temporary stabilization.
viii. Final grade of the site should be such that runoff from the site is discharged at non-erosive velocities. Discharges should be to locations that do not adversely impact adjoining properties or natural waterways.

388. Each mine facility should assign restricted areas, which may include, but not be limited to disturbance activities on slopes of 30% or steeper create an erosion hazard and that the potential for off-site damage to public and private property, or any environmentally sensitive area. Each mine facility should conduct inspections and audits on a regular basis to ensure that land disturbance is minimal and within the Site environmental management plan.

Definitions

Disturbed Land - land that has been cleared of vegetation and/or soil to facilitate mining or extractive activities, such as or exploration, roads, open-cut operations, siting of plant or equipment for processing and treating ore, site offices, car parks and workshops or construction of tailings storage facilities.

*Rehabilitation - R*efers to land where land forming has been completed and planting of vegetation undertaken. It is acknowledged that vegetation may not be uniformly established in all cases. Additionally, further land management (like pest, plant and animal control and erosion control works) may be required to ensure that the rehabilitation works are stable in the medium to long term.

Erosion - Refers to the process of detachment and movement of soil, sediment or rock fragments by water, wind, ice, or gravity and which may be facilitated by human activity.

XIV.MINE CLOSURE PLAN

A. Mine Closure Objectives

389. Mine closure is an integral part of the mining cycle. It is to be investigated and planned for before a mine begins to operate. Mine sites are rehabilitated and stabilized so they are suitable for a sustainable land use that is compatible with the surroundings. Former mine sites in US, Canada, Australia, New Zealand are now being used for farming, forestry, recreation and conservation.

390. Effective closure involves a range of issues. Closure must meet all regulatory requirements as laid down in the conditions of the Mining License and resource use consents. In addition, human resource management and community involvement and consultation is required.

391. Rehabilitation activities at a modern mine include: decommissioning the mine, providing surface drainage and erosion protection across the entire site, establishing self-sustaining vegetative cover, meeting water quality standards, and minimizing post-closure maintenance requirements.

392. All mines eventually close. In the past the traditional definition of mine closure was to surrender the mining license and walk away. This definition no longer applies. Changes in the mining industry have evolved along with changes in public expectations of stewardship for the future. Modern mines are planned with closure in mind.

393. In planning for closure, there are four key objectives that must be considered:

i. protect public health and safety;
ii. alleviate or eliminate environmental damage;
iii. achieve a productive use of the land, or a return to its original condition or an acceptable alternative; and,
iv. to the extent achievable, provide for sustainability of social and economic benefits resulting from mine development and operations.

B. Impacts to Be Considered During Mine Closure Planning

394. Impacts that may change conditions affecting these objectives of mine closure planning include:

i. **Physical stability** - buildings, structures, workings, pit slopes, underground openings etc. must be stable and not move so as to eliminate any hazard to the public health and safety or material erosion to the terrestrial or aquatic receiving environment at concentrations that are harmful. Engineered structures must not deteriorate and fail.
ii. **Geochemical stability** - minerals, metals and 'other' contaminants must be stable, that is, must not leach and/or migrate into the receiving environment at concentrations that are harmful. Weathering oxidation and leaching processes must not transport contaminants, in excessive concentrations, into the environment. Surface waters and groundwater must be protected against adverse environmental impacts resulting from mining and processing activities.
iii. **Land use -** the closed mine site should be rehabilitated to pre-mining conditions or conditions that are compatible with the surrounding lands or achieves an agreed alternative productive land use. Generally, this requires the land to be aesthetically

similar to the surroundings and capable of supporting a self-sustaining ecosystem typical of the area.

iv. **Sustainable development** - elements of mine development that contribute to (impact) the sustainability of social and economic benefit, post mining, should be maintained and transferred to succeeding custodians.

v. **Identification of succeeding custodian**[46].

395. These impacts and closure requirements must address the mine site components and regional considerations. Measures must be selected and resources allocated to address the major issues of the impacts identified during mine closure planning. To minimize the various impacts, risks and liabilities, it will be necessary to anticipate, as early in the process as possible, potential future liabilities and risks, and to plan for their elimination or minimization. Depending on the mine facility, much of the liability or risk is associated with the uncertainty of the requirements for closure and rehabilitation from the succeeding custodian (be it a government agency, community organization or corporate entity).

396. Early identification of the succeeding custodian, and their involvement in the development of the closure plan enables the closure requirements to be established and agreed and considered in the closure plan development. This allows the mining company to determine, and provide for, the requirements of the succeeding custodians, gain their support for the closure plan and minimize the risks and liabilities that may derive from succeeding custodian rejection or objection to the closure measures at the time of mine closure.

C. Steps in Mine Closure Plan Development

397. Typical steps for closure planning are shown in Figure 14.1 below[47]. These steps serve to order, develop and present the sections of a Closure Plan. These closure planning steps also provide a progressive description of the material required to understand the need for, nature of, effectiveness of, and cost the Closure Plan.

398. A mine facility closure plan must consider the long-term physical, chemical, biological and social/land-use effects on the surrounding natural systems, including: groundwater, surface water, flora and fauna, air quality, erosion prevention, etc. The first step in closure planning is to develop an understanding of the pre-mining environment (Step 1) and the effects of past and future mine development (Step 2) on the pre-mining environment. Operational control measures must be selected (Step 3) for implementation during mining in order to minimize the impact on the surrounding ecosystems. Impact assessments (Step 4) must be done prior to measures selection, and periodically during operations to determine the success of the measures implemented. Alternative mine closure measures are developed (Step 5) and assessed (Step 6) during mine design to ensure that there are suitable closure measures available to remediate the impact of the selected mine development.

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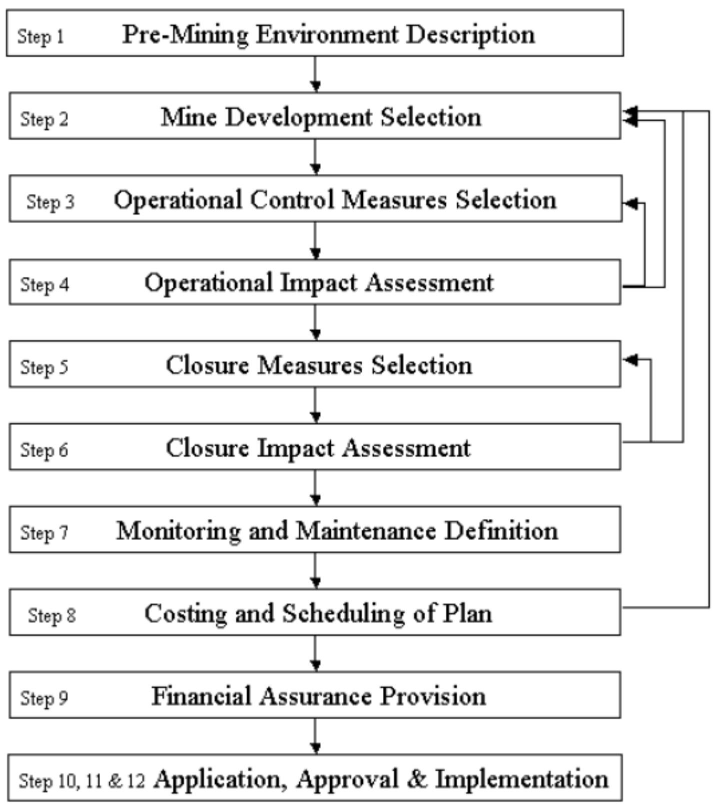
[46] The succeeding custodian is the organization or individual that will have responsibility for the management of the mine site after closure.

[47] INFOMINE E-BOOK Mine Closure, Robertson and Shaw; http://www.infomine.com/library/publications/docs/E-Book%2002%20Mine%20Closure.pdf

399. If suitable remediation or closure measures cannot be identified or achieved, then it may be appropriate to revise the type of mine development proposed (return to Step 2). Once a technically acceptable mine development and closure plan has been developed, a monitoring and maintenance plan (Step 7) to monitor system performance during operations and post-closure and provide for maintenance necessary to ensure long term functionality of system components. Throughout this process, costing and scheduling evaluations (Step 8) are completed and refined. If the costs are too onerous, or if fatal flaws in the design are identified, the process returns to the design phase (Step 2) and alternative measures are evaluated

400. Once the Closure Plan is completed, an acceptable form of financial assurance should be developed (Step 9) in order to cover the costs of plan implementation, long term operations, monitoring and maintenance of the site post-closure. The final stages of the closure plan process involve the application for (Step 10) and approval by (Step 11) the regulatory agencies of the Closure Plan, and implementation (Step 12) at the end of mine life.



Source: INFOMINE E-BOOK Mine Closure, Robertson and Shaw; http://www.infomine.com/library/publications/docs/E-Book%2002%20Mine%20Closure.pdf

Figure 14.1 Mine Closure Plan Development Process.

D. Management of Waste Following Mine Closure

401. Mine waste material is not recycling or reused, must be placed into storage facilities. Reclamation and long-term management of these facilities is an important part of modern mine development and mine closure. Regulators may require any waste storage structures to remain stable for a minimum of 100 to 200 years, which means they must withstand extreme events such as floods and earthquakes. Mine closure activities involve containing and covering tailings to prevent escape into the environment; minimizing the amount of water seeping from the tailings into surface or groundwater; covering waste rock piles and exposed materials with topsoil and planting vegetation to prevent erosion; and designing the final land formation to minimize erosion and post-closure maintenance. Plans for mine closure and site cleanup are required as part of the mine permitting process in many countries and these plans are updated after additional study. A preliminary Closure Plan is often updated annually and revised as some mine facilities are either closed or expanded.[48]

402. A mine closure plan, either preliminary or final, must contain sufficient detail to provide a basis for implementing the closure of each mine component, including relevant quantities of material needed, manpower, schedule and cost estimates. The closure plan should also comply with international best management objectives and Myanmar legislative requirements. A closure plan will define the objectives of closure, summarize technical studies and design work, describe activities that will be performed to close each mine site component, including water use and stormwater management after mining is complete; present the sequence of closure activities, and discuss post-closure monitoring and maintenance. Listed below are topics, studies and closure strategy requirements to complete a reasonable mine facility closure plan.

403. The closure plan objectives for any mine should always:

- Establish the final disturbed land surface and implement drainage improvements to effectively manage stormwater runoff.
- Construct barriers to AMD/ARD where soil covers are unfeasible, such as pit highwalls.
- Continue to monitor and remediate, if necessary all impacted groundwater and surface water in the area immediately downgradient of the mine site.
- Close the facilities way that will minimize environmental impacts.
- Implement a closure strategy that is reliable, and minimizes future maintenance requirements as well as being cost-effective.

E. Typical Closure Plan Outline

404. The following outline (Box 14.1) is based on recognized standards for reclamation and closure. It recognizes that closure is a dynamic process subject to rapidly changing technology and methods. Changes and updates to preliminary Closure Plans are encouraged as mining progresses. Updates are to be integrated into the Closure Plan as various components of the mine site/facility are closed and remediated.

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[48] Bureau of Mining Regulation and Reclamation, Preparation Requirements and Guidelines For Permanent Closure Plans and Final Closure Reports. State of Nevada Department of Environmental Protection.

Box 14.1 Mine Closure Plan Outline

Section 1 – Introduction

Section 2 – General Approach

Section 3 – Remedial Works Strategy

Section 4 – Current Setting

Section 5 – Open Cut Mine Reclamation

General Pit Closure Concept - Seal of pit base, backfill, notch cut if needed, stabilization and discharge of collected drainage Backfill design: Backfill volume, maximum RL, geometry and materials types

Open Pit Water Management – water quality issues, highwall revegetation or cover (shotcreting)

Section 6 - Underground Mine

Mine drainage management and treatment, groundwater quality protection, backfill or adit closure, geotechnical stability

Section 7 – Tailings Impoundment

General closure concept – peripheral capping and/or cover, permanent residual pond or dry cover, spillway design and stormwater diversion

Detailed cover design and construction techniques, Water Management specifics. These include: management of decant pond and underdrainage waters, and design and construction of permanent surface spillway.

Section 8 – Mine Waste Rock Surface Covers and Rehabilitation General cover design and reclamation approach and protocols:

Cover design and construction specifically including:

Materials and cover zone definitions

Design principles and cover depths

Schedules

Revegetation criteria Including: Revegetation process and land-use categories, Vegetation establishment materials, Distribution of vegetation

Section 9 – Water Management

General water management and phasing of waters to treatment.

Diversion to direct discharge based on performance criteria and consent requirements

Phasing out of treatment systems based on compliance and variability criteria

Management of water treatment sludges

Decommissioning of active mine and process water management structures

General water management approach

General water management final configuration

Section 10 – General Site Closure

Removal of equipment and supplies, buildings, remediation of impacted soils, removal of concrete recontouring and site monitoring.

Section 11 – Land Use

Land use planning criteria and schedules.

Economic activity, Public access issues

Landscape criteria, land and water conservation and ecological criteria

Section 12 - Closure and Reclamation Schedule

Section 13 - Interim Plan and Cost Estimate

Include Interim and Final Site Closure Configurations

Interim Reclamation Cost Estimate

Reclamation Production and Cost Estimation References

Reclamation Production and Costs

Maintenance and Monitoring

Financial Assurance Mechanism – Bonding

Final Cost Estimate

Appendix 1. Policy, Legal and Institutional Framework for Environmental Impact Assessment

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
Constitution of the Republic of the Union of Myanmar 2008	The Constitution of the Union of Myanmar is the supreme law of the country and has provisions regarding the protection of the environment in Myanmar. Articles in the Constitution relevant to environmental protection are Articles 37, 42 and 390.
Environment	
Environmental Policy 1994	To achieve harmony and balance between socio-economic, natural resources and environment through the integration of environmental considerations into the development process enhancing the quality of the life of all its citizens. Environmental protection should always be the primary objective in seeking development
National Environment Policy of Myanmar 2017	To provide long-term guidance for government, civil society, the private sector and development partners on achieving environmental protection and sustainable development objectives in Myanmar. It has been prepared to place environmental considerations at the center of efforts to promote economic and social development, reduce poverty, and mitigate and adapt to climate change and natural disasters.
Myanmar Agenda 21 1997	is a blueprint for all natural resource management and environmental conservation work and the pursuit of the activities contribute to biodiversity conservation throughout the country
National Sustainable Development Strategy for Myanmar 2009	Supports the goals to sustainable management of natural resources, integrated economic development and sustainable social development.
Environmental Conservation Law 2012	Provides the mandate for Environmental Impact Assessment and assigns the duty and power the Ministry of Environmental Conservation and Forestry to develop and implement “a system of environmental impact assessment and social impact assessment as to whether or not a project or activity to be undertaken by any Government department, organization or person may cause a significant impact on the environment”.
Environmental Conservation Rules 2014	Chapter XI Environmental Impact Assessment provides for environmental screening and where required – for proponent conduct and environmental impact assessment, and to prepare and submit and

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
	environmental impact assessment report to the Ministry 52 The Ministry shall determine the categories of plan, business, service or activity which shall carry out environmental impact assessment. 53. The Ministry may, so as to scrutinize whether or not it is necessary to conduct environmental impact assessment, determine the proposed plans, businesses service or activities which do not include in stipulation under rule 52 as the categories which are required to conduct initial environmental examination. 54. The business, department, organization or person who would carry out categories of plan, business service or activity stipulated under rule 52: (a) shall conduct environmental impact assessment for his plan, business service or activity; (b) submit to the Ministry in advance by which organization person or third person, the environmental impact assessment is intended to be carried out; (c) submit the environmental impact assessment report to the Ministry.
Environmental Impact Assessment Procedure (2015)	Provides the procedures for environmental screening, scoping, preparation of an IEE, preparation of EIA, preparation of and Environmental Compliance Certificate (ECC). Delineates responsibilities for monitoring compliance with Environmental Management Plans (EMPs) and ECCs.
Technical Guidelines for Environmental Impact Assessment (2017)	Provides technical guidance for assessing environmental impacts and preparation of the IEE and EIA reports.
National Environmental Quality (Emission) Guidelines (2015)	Provides emission and effluent discharges levels permitted for different sectors and technologies
National Ambient Water Quality Guidelines (in preparation)	Sets environmental guidelines for ambient water quality
Forest Policy 1995	Ensures that Myanmar's forest resources and biodiversity are managed sustainably to provide a wide range of social, economic and environmental benefits, and aims to maintain 30% of the country's total land area under Reserved Forest and Public Protected Forest and 5% of total land area as Protected Areas.

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
	The 30-year National Forestry Master Plan (2001/02 to 2030/31), prepared in the year 2000, has a goal of expanding PAs to 10% of the country's total land area.
Forest Law 1992 (repeal)	Provisions to conserve water, soil, biological diversity and the environment; sustain forest produce yields; protect forest cover; establish forest and village firewood plantations; sustainably extract and transport forest products
Forest Law (20 September 2018)	To implement forest policy; and natural resources and environmental conservation policy To perform forest, natural resources and environment conservation, climate change and disaster risk reduction with international agreements, and To protect forest cover and biodiversity reducing, and protect damage due to forest fire, pest and disease Establish forest and firewood plantation and Sustainably extract and transport forest products
Forest Rules 1995 and Amending 1998	Emphasis on increased formation and protection of reserved forests and protected public forests, sharing of forest management responsibility with the local communities, establishment of fast growing plantations on degraded forest lands to conserve soil, water and biodiversity and harvesting of timber and other forest products in an environmentally sound manner.
The Protection of Wildlife and Protected Areas Law 1994 (repeal)	To provide wildlife protection; To provide natural areas conservation; To carry out the protection and conservation of wildlife, ecosystems and migratory birds in accordance with International Conventions acceded by the State To protect endangered species of wildlife and their natural habitats; To contribute for the development of research on natural science Prohibits pollution or disposing of mineral pollution or causing water or air pollution in a protected area
The Protection of Biodiversity and Natural Protected Areas Law (May 2018)	To implement biodiversity policy and strategy To implement national natural protected area conservation policy To carry out the protection and conservation of wildlife, ecosystems and migratory animals in accordance with International Conventions acceded by the State To control smuggling or trafficking of wild animals and plants, their parts of body, and by products

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
	To protect prominent geological site, endangered species of wildlife and their natural habitats; To contribute for the development of research on natural science and awareness raising Establish the zoological and botanical garden to preserve wildlife
The Protection of Wildlife and Protected Areas Rule 2002	To provide the sustainability of ecosystems, habitats and biodiversity
The Conservation of Water Resources and Rivers Law 2006and Amending Law 2017	Protection of water from pollution from banks, including the disposal of soil from gold or resources production, into rivers and creeks or that may flow into rivers and creeks. Prohibits sand extraction, gold mining, and resource extraction in the river creek or waterfront boundary without approval. Ministry of Transport approval required for certain works
The Conservation of Water Resources and Rivers Rules 2013 and Amending 2015	Protection of water from pollution from banks, including the disposal of soil from gold or resources production, into rivers and creeks or that may flow into rivers and creeks. Prohibits sand extraction, gold mining, and resource extraction in the river creek or waterfront boundary without approval. Ministry of Transport approval required for certain works
Myanmar Climate Change Policy 2017 (draft?)	*Purpose*: To provide long-term direction and guidance to: • Take and promote climate change action on adaptation and mitigation in Myanmar; • Integrate climate change adaptation and mitigation considerations into Myanmar's national priorities and across all levels and sectors in an iterative and progressive manner; and • Take decisions to create and maximise opportunities for sustainable, low-carbon, climate-resilient development, ensuring benefits for all.
Myanmar Climate Change Strategy and Action Plan 2016-2030 (draft)	The long-term goal *by 2030, Myanmar has achieved climate-resilience and pursued a low-carbon growth pathway to support inclusive and sustainable development.*
Mining	
The Salt Enterprise Law 1992	Prohibitions on unlicensed production of salt or chemical salt/by-products, including the use of charcoal and wood fires in production (to prevent deforestation)
The Salt Enterprise Rules 1998	Application and Granting License for salt production and refining
The Myanmar Mines Law 1994 and Amending Law 2015	Law under amendment to prevent pollution, improve natural resource conservation, and mitigate/reduce environmental impacts related to mining activities

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
The Myanmar Mines Rules 1996 (repeal)	*Chapter IV*: Application and Granting of Large Scale Mineral Production Permit *Chapter XVIII*: Duties and Rights of the Holder of Integrated permit for more than one Operation out of the three operations of mineral prospecting, mineral exploration and mineral production *Chapter XIV*: Rights of Utilization of Land and Water for mineral Production *Chapter XIX*: Measures for Safety and Prevention of Accidents in the Mine *Chapter XXI*: Making Provisions to prevent Detrimental Effects due to Mining operations on the Environmental Conservation Works (105) The holder of a mineral exploration permit or a mineral production permit shall;- (a) backfill or otherwise make safe bore holes, excavations, surface of land damaged during the course of underground mining operations to the satisfaction of the Ministry or the Department. (b) establish forest plantations or pay compensation to as agreed when permission of the Ministry of Forestry was sought, if trees were cut and cleared for mineral exploration or mineral production within a forest land or in a land area covered with forests and which is at the disposal of the Government. (106) In disposing of liquids, wastes, tailings and fumes which have resulted from mineral production the holder of a mineral production permit or a manager shall undertake laboratory tests as may be necessary for the prevention of pollution of water, air and land in the environment and for the safety of living beings. When in the course of tests toxic materials are found, which are harmful to living beings, degradation shall be made by chemical means and systematic disposal shall be made only when it is assured that there is no danger.
The Myanmar Mining Rules (2018)	*Chapter XXIV*: Rights of Utilization of Land and Water for mineral Production *Chapter XXVIII*: Measures for Safety and Prevention of Accidents in the Mine *Chapter XXX*: Mine closure *Chapter XXXI*: Making Provisions to prevent Detrimental Effects due to Mining operations on the Environmental Conservation Works
Order for Permit Holder to comply with prevention of Detrimental Effects on the Environment due to Mining Operations (2004)	The order is issued under the Mining Law Article 39 (b) - It is the order for Mining Permit holder to discharge systematically of the waste rock and tailing from mining

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
	process to prevent river water pollution and watershed area
Gold Refining Procedure (13 February 2018)	It is for application and granting of gold refining permit with Environmental approval and management plan to prevent pollution
The Myanmar Gemstone Law 1995 and Amending Law in 2003 and 2016	Provisions to protect and conserve the environment during gemstone production operations
The Myanmar Gemstone Rules 1995	The rules is issued according to the Article 54 (a) of the Law. It provides the proposal submitting and granting the production permit and license
Order for Gemstone Permit Holder (1999)	The order is issued according to the Article 16 (f) and 54 (b) of the Law Provisions to protect worker/labor right, occupational safety and accidents and Making Provisions to prevent Detrimental Effects due to gemstone production operations on the Environmental Conservation Works
Order for Permit Holder to comply with prevention of Detrimental Effects on the Environment due to Mining Operations (2004)	The order is issued according to the Myanmar Gems Law Article 54 (b) - It is the order for Gemstone Permit holder of Lonkhin, Hpakhant and Uru river area to discharge systematically of the waste rock and tailing from gemstone production to prevent river water pollution and watershed area
The Myanmar Pearl Law 1995 and Amending Law 2014	Provisions to protect and conserve oyster fishing grounds; and to avoid overfishing, species extinction and the degradation of water environments
The Myanmar Pearl Rules 2000 and Amending in 2015 and 2016	Provisions to protect and conserve oyster fishing grounds; and to avoid overfishing, species extinction and the degradation of water environments
Investment Laws	
Myanmar Investment Law (2016)	The objectives of the law are: (a) to develop responsible investment businesses which do not cause harm to the natural environment and the social environment for the interest of the Union and its citizens; (b) to protect the investors and their investment businesses in accordance with the law; (c) to create job opportunities for the people; (d) to develop human resources; (e) to develop high functioning production, service, and trading sectors. (f) to develop technology, agriculture, livestock and industrial sectors; (g) to develop various professional fields including infrastructure around the Union;

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
	(h) to enable the citizens to be able to work alongside with the international community; (i) to develop businesses and investment businesses that meet international standards.
Myanmar Investment Rules (March 2017)	It provides the responsible business compliance with Environmental Conservation Law and EIA Procedure to prevent environment and social impact.
Myanmar Insurance Law (1993)	Requires that any business, that may pollute the environment are required to have compulsory general liability insurance
Occupational Health and Safety	
Draft Occupational Health and Safety Law under discussion in Parliament (August 2017).	
Pollution Prevention	
Prevention of Hazard from Chemicals and Related Substances Law (2013).	Establishes the licensing and approval system for the use of chemicals. Prohibited the operation of a chemical substances business without a license and prohibits the use of prohibited and unregistered chemicals or related substances
Coastal Authority Law (2015).	Prohibits the dumping of waste, oil and chemicals in coastal waters.
Explosives Act (1884) (repeal), Explosives Substance Act (1908). Control the use of explosives.	Control the use of explosives
The Occupational Explosive Material Law (June 2018)	- Systematically use, import, transport and storage of occupational explosive material - Safety use of blasting material and related substances at the project site
Boiler Law (2015). Requires the registration and licensing of boilers.	Requires the registration and licensing of boilers
Health	
Prevention and Control of Communicable Diseases Law (1995), Amending Law 2011	To prevent and control the communicable disease
Protection of Ethnic Nationalities and Cultural Property	
The Ethnic Rights Protection Law (2015). Rules under discussion (August 2017)	To obtain equal citizen’s rights for all ethnic groups and to preserve and develop their language, literature, arts, culture, custom, national character and historical heritage *Article 5*: The matters of projects shall completely be informed, coordinated and performed with the relevant local ethnic groups in the case of development works, major projects, businesses and extraction of natural

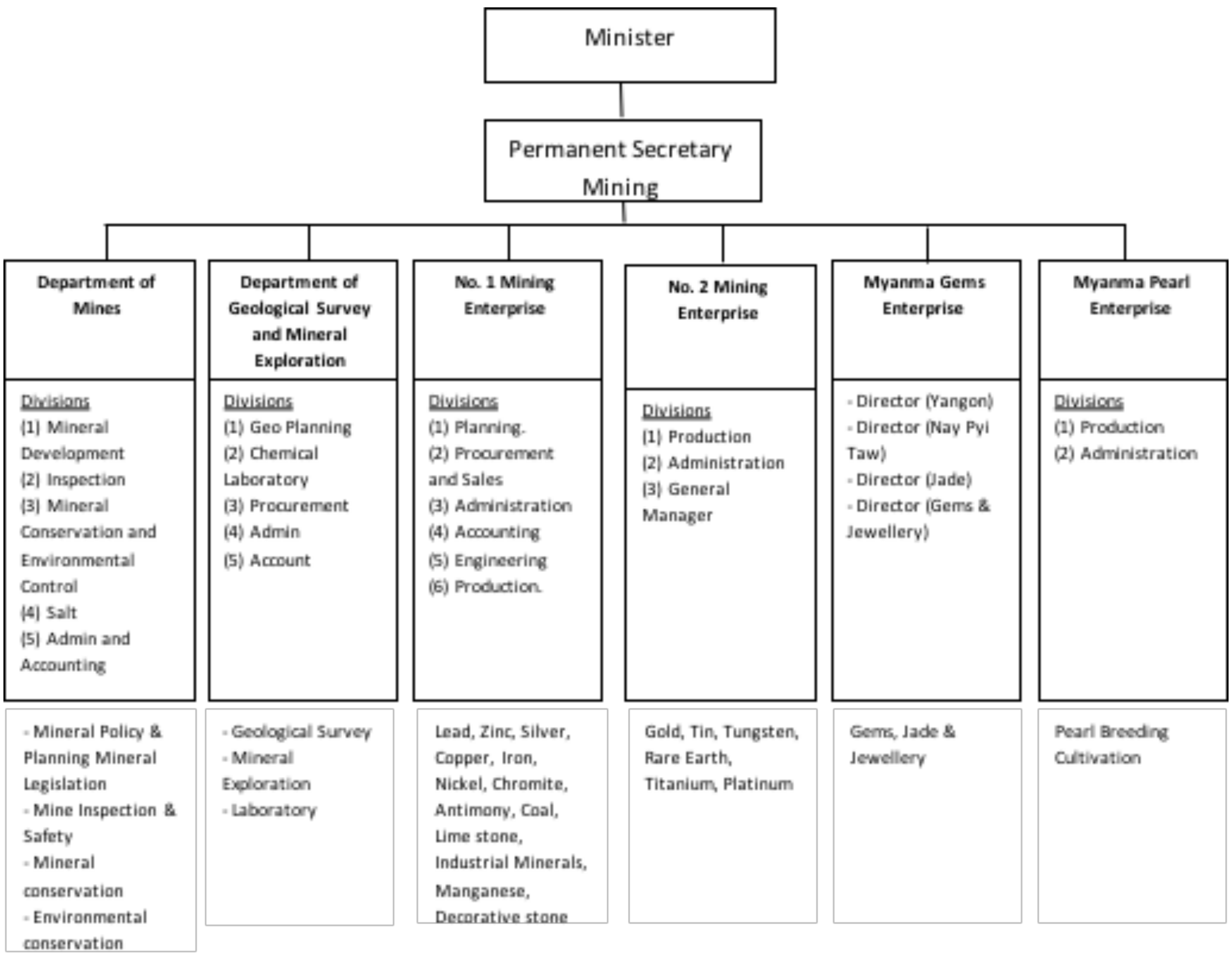
Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
	resources will be implemented within the area of ethnic groups.
Protection and Preservation of Cultural Heritage Regions Law (1998) and Amending Law 2009	Prohibits mining exploration in cultural heritage regions
Protection and Preservation of Ancient Monuments Law (2015).	Prohibits mining activities and waste disposal in the Ancient Monuments area.
Land Law and Land Tenures	
Farm Land Law (2012) and Farm Land Rules (August 2012). Currently under revision in Parliament.	Relating to land tenure
The Vacant, Fallow, and Virgin Lands Management Law (2012) and Amending Law (2018) and the Vacant, Fallow, and Virgin Lands Management Rules (August 2012)	Land Use To ensure the management task concerning the use of Vacant, Fallow and Virgin Lands for State Economic Development and Job Opportunities for land less citizen in relation to agriculture, livestock breeding, mining, and government allowable other purposes in line with law
Land Acquisition Act (1894) and Amending Law 1954. Currently under revision (draft)	The objectives of the draft law (2017) are: a) To provide a legal basis for the acquisition of land, prevention of illegal land acquisition and safeguarding the welfare of those who have had their land acquired; (b) To ensure that Affected Households and local communities who will be affected by the acquisition of land are transparently provided with information to enable them to freely negotiate and make decisions ; (c) To ensure that Affected Households receive appropriate and equitable Compensation and Damages (d) to provide for Resettlement as a consequence of losses and damages which have resulted from loss of housing and relocation due to the acquisition of land (e) to ensure the Restoration of Livelihoods of Affected Households (f) to prevent adverse environment and public socio-economic impacts caused by acquisition and use of land.
Labor Laws	
Minimum Wage Act (2013), (Notification No. 2/2015 (August 2015).	Applies to wages of Myanmar citizens.
Labor Organization Law (2011).	To protect the rights of the workers, to have good relations among the workers or between the employer and the worker, and to enable to form and carry out the labor organizations systematically and independently.

Laws, Regulation, or Guidelines	Relevance to Environmental Assessment
Settlement of Labor Dispute Law (2012) and Amending Law (2014)	For safeguarding the right of workers or having good relationship between employer and workers and making peaceful workplace or obtaining the rights fairly, rightfully and quickly by settling the dispute of employer and worker justly.
Employment and Skills Development Law (2013).	- Creation of employment opportunities - Implementing measures to reduce unemployment - Carrying out to enhance discipline and capacity of the workers - Carrying out for the skills development of the workers - Forming and guiding the Employment and Skills Development Agencies
Social Security Law (2012)/ Came into force 1 April 2014	To support the development of the State's economy through the increase of production to enjoy more security in social life and health care of workers who are major productive force of the Union by the collective guaranty of the employer, worker and the Union for enabling to fulfill health and social needs of the workers
The Leave and Holiday Act (1951) and amended in 1958, 1963,1964, 2006, and 2014)/ Adopted in 1951 and amended in 1958,1963, 1964, 2006, and 2014.	Leave and Holiday for the worker
Rights of Persons with Disabilities Law (2015). Rules currently under internal discussion between Ministry of Social Welfare and PWD groups (2017).	Applies to companies who are required to provide employment opportunities for PWD.
Child Law (1993).	Protection of children from exploitation.
Criminal Matters	
Penal Code (1861) and Amending Law 2016	Prohibits water pollution, air pollution and discharges of poisonous substances that may harm human health or cause injury. Prohibits explosives causing harm. Prohibits public nuisance

Appendix 2. Institutional Framework for Environmental Assessment and Management of Mines

Mining Agencies of the Ministry of Natural Resources and Environmental Conservation

1. The Ministry of Natural Resources and Environmental Conservation is responsible for policy, legislation, rules and regulations, and enforcement of the law in the mining sector. There are six mining agencies under Ministry (see Chart below).



2. The primary responsibilities of each agency are summarized in the Table below.

Mining Agencies in the Ministry of Natural Resources and Environmental Conservation

Agency	Main Responsibility
Department of Mines	• Mineral policy • Mining laws and regulations • Issuing mining licenses for all departments • Collecting royalties and dead rent from licensees • However, Gem Enterprise collects the royalty for Gems and Jade • Chief Inspector for Mines
Department of Geological Survey and Mineral Exploration	• Geological survey and mapping, mineral prospecting and exploration • Joint venture with foreign companies in mineral exploration and feasibility studies • Laboratory analysis
Myanmar Gem Enterprise	• Management of quarrying, production, selling of gems and jade according to the Gem Law • Collects the royalty for Gems and Jade • Jewelry
Mining Enterprise 1	• Economic management and supervision for overall 40 minerals including lead, zinc, silver, copper, iron, nickel, chromite, antimony, coal, limestone, industrial minerals, manganese, and decorative stone • JVs and production sharing agreements with Mining Companies • Collection of Government's share of revenue
Mining Enterprise 2	• Economic management and supervision of gold, tin-tungsten, heavy metals • Minerals: gold, tin, tungsten, rare earths, titanium, platinum • Production/revenue sharing agreements and Joint Ventures with Mining Companies • Collection of Government's share of revenue
Myanmar Pearl Enterprise	• Pearl Breeding and Cultivating

Issuance of Mining Permits.

3. The Department of Mines has the overall responsibility for issuance mining permits. The Department of Mines reviews proposed applications for mineral prospecting, exploration, processing and issue permits under Myanmar Mines Law.

Environmental Impact Assessment

4. For Mineral Production Permits, it is the responsibility of the mining companies to comply with the EIA Procedure (2015). Companies are responsible for preparing the necessary, environmental assessment documentation, whether it be an EMP, IEE, of EIA. These documents are then forwarded by the responsible mining agency to ECD for environmental review.

5. For exploration and prospecting permits, DGSME needs to seek advice of ECD on environmental and social impacts associated with applications for prospecting and exploration.

Environmental Management

6. The mining agencies, along with ECD, have responsibility of monitoring the implementation of the environmental management plans of the mining operations. The Department of Mines has an Environmental and Mineral Conservation Division, which has responsibilities for environmental inspection. This division has 14 staff - mostly engineers and mining professionals. There no environmental engineers or environmental specialists. The other mining agencies have no environmental units and no environmental staff.

Environmental Conservation Department

Environmental Impact Assessment

1. The Environmental Conservation Department (ECD) has responsibility for the administration on the environmental impact assessment process. It has responsibility for developing EIA regulations, guidelines, and procedures. It also has responsibility for the review of environmental assessment documents. It also has responsibility for supervision and monitoring compliance with environmental management plans associated with environmental impact assessments.

Environmental Impact Assessment Procedure (29 December 2015)

2. The Environmental Impact Assessment Procedure was approved on 29 December 2015. Under the Procedure, the MONREC has the responsibility and authority to:

i. define Project screening criteria;
ii. approve technical guidelines for IEE and EIA;
iii. review and approve IEE Reports;
iv. provide guidelines for, and approve TOR of, EIA;
v. review and approve EIA Reports;
vi. review and approve EMP, Construction Phase EMP and Operational Phase EMP;
vii. determine and impose conditions applicable to any Ministry approval of an IEE, EIA or EMP;

viii. monitor and enforce implementation of the EMP, including any amendments thereof occasioned once the detailed design of the proposed Project has been finalized or by or on account of experience during implementation of the Project;

ix. require any Project to update its EMP and to submit such updated EMP to the Ministry for review and approval according to a schedule defined by the Ministry; and

x. perform other duties and functions relating to IEE/EIA as stipulated by the Union Government.

Appendix 3. International Environmental Agreements

Theme	Convention/treaty/agreement	Status*	Focal point
Climate	United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification (UNCCD), Paris, 1994	Accession (1997)	MoNREC/ FD
Air and climate change	United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992	Ratification	MoNREC/ ECD, MOT/DMH
	Kyoto Protocol to the Convention on Climate Change, Kyoto, 1997	Accession (2003)	MoNREC/ ECD
	Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	Ratification (1993)	MoNREC/ ECD
	Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987 + amendments	Ratification (1993, 2012 for recent amendments)	MoNREC/ ECD
	ASEAN Agreement on Transboundary Haze Pollution, Kuala Lumpur, 2002	Ratification (2003)	MoNREC
	Paris Agreement to combat climate change and adapt to its effects, 2016	Ratification (2017)	MoNREC?
Pollution control	Stockholm Convention on Persistent Organic Pollutants (POPs), Stockholm, 2001	Accession (2004)	MoNREC/ ECD
	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Basel, 1989	Accession (2015)	MoNREC/ ECD
	International Convention for the Prevention of Pollution from Ships (MARPOL), London, 1973 plus amendments in 1978	Accession 4/8/1988	MOT
Biodiversity and natural resources	Convention on Biological Diversity (CBD), Rio de Janeiro, 1992	Ratification (1994)	MoNREC/ ECD
	Cartagena Protocol on Biosafety to the CBD, Cartagena, 2000	Ratification (2008)	MoNREC, MOAI
	Nagoya Protocol on Access and Benefit Sharing (ABS) to the CBD, Nagoya, 2010	Accession (2014)	
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington, D.C., 1973 + amendments (1979 Bonn, Germany)	Accession (1997)	MoNREC/FD

Theme	Convention/treaty/agreement	Status*	Focal point
	Agreement on Establishment of ASEAN Regional Centre for Biodiversity	Ratification (2009)	MoNREC/ FD
	ASEAN Agreement on the Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	Signatory (1997)	MOFA
	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 + amendments in 1982 and 1987	Accession (2004)	MoNREC/ FD
	MRC Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin – April 1995	Became Dialog Partner with MRC in 1996	Directorate of Water Resources and Improvement of River Systems (DWIR) Ministry of Transport (?)
	Agreement between International Union for Conservation of Nature (IUCN), and the government of the Republic of the Union of Myanmar to establish an IUCN Office in Myanmar. This laid the foundation for future collaboration on addressing challenges and maximizing opportunities related to biodiversity conservation and sustainable development in the country.	31 March 2016 Host Country Agreement (HCA) signed	Forest Department, MoNREC
	Mangroves for the Future (MFF) – MFF was founded on the vision, "Healthy coastal ecosystems for a more prosperous and secure future for coastal communities." The vision was supported by a mission statement, "To promote healthy coastal ecosystems through a partnership-based, people focused and policy relevant approach that builds and applies knowledge, empowers communities and other stakeholders, enhances governance, secures livelihoods, and increases resilience to natural hazards and climate change." https://www.mangrovesforthefuture.org/what-we-do/focus-areas-and-objectives/	In 2014, Myanmar joined as the 11th member country.	National Coordinating Body (NCB), which is chaired by the Director General of the Forest Department.
Cultural heritage	The Convention for the Protection of the World Culture and Natural Heritage, Paris, 1972	Acceptance (1994)	MOC
	Declaration on ASEAN Heritage Parks	Signatory (2003)	MoNREC/ FD

Theme	Convention/treaty/agreement	Status*	Focal point
	Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property, 1970	Ratified	National Cultural Central Committee
	Convention for the Safeguarding of the Intangible Cultural Heritage, 2003	Ratified	National Cultural Central Committee

Note: All of the terms (Ratification, Accession, Approval and Acceptance) signify the consent of a state to be bound by a treaty and consequently their legal implications are the same. All countries that have ratified, acceded to, approved or accepted a treaty are therefore Parties to it and legally bound by it. (The primary distinction is only between ratification and accession, as only states which have signed a treaty when it was open for signature, can proceed to ratify it. Afterwards, states which have not signed a treaty during the time when it is open for signature can only accede to it. The terms “acceptance” and “approval” are of more recent origin and apply under the same conditions as those that apply to ratification. The uses of these terms have to do with the diversity of legal systems.