

## **5. PLANNING, IMPLEMENTATION AND REVIEW PROCESS**

### **5.1 Planning**

#### **5.1.1 Introduction**

Planning for closure provides the methods and means for site rehabilitation and restoration to ensure that the closure of a mine will not compromise environmental quality in the future and will limit the extent of any prospective liabilities. Planning should be incorporated into the mine project life cycle at the earliest possible stage.

#### **5.1.2 Objective of Planning**

The objective of closure planning is to ensure that the process of closure occurs in an orderly, systematically, timely and cost effectively manner.

Closure plan when implemented should ensure that:

- § Once the mine ceases operations, any adverse socioeconomic and environmental effects of cessation of mining are minimized;
- § Effective physical and chemical stability of disturbed areas is done so that the time for long-term monitoring is reduced;
- § The after use of land is beneficial and sustainable;
- § Maintenance is reduced by establishing physical and chemical stability;
- § Public health and safety are not compromised; and,
- § Environmental resources are not subject to further deterioration.

#### **5.1.3 Types of Closure Plan**

Closure plan is dependent on legislation, guidelines, operations and industry practice through the life of a mine. Atleast two types of closure plan will be required; a project phase closure plan (i.e. Conceptual Closure Plan) and operations phase closure plan (i.e. Main Closure Plan). A number of subsidiary plans need to be developed like: a rehabilitation plan, a decommissioning plan, a maintenance plan and a monitoring plan. Maintenance plan and monitoring plan can be jointly named as: post closure plan.

#### **Conceptual Closure Plan:**

Project phase plan/ Conceptual closure plan is developed during the exploration, feasibility and design stages that means it is the plan developed during the early stages of

a mine life. This plan indicates the objectives of mine closure, which is helpful for the project development and design. This plan can be used to establish a baseline for closure costs and should include broad land use objectives. Project phase plan can further be used to determine additional technical, environmental and regulatory assessments (if required). This plan does not preclude land use objectives being varied through the mine life due to change in technology, knowledge and work culture.

**Main Closure Plan:**

Operations phase closure plan or Main closure plan is developed during construction and operational stages of the life of mine. This plan is based on the framework of conceptual closure plan. The aim is to know that developments during construction and operational stages are consistent with previously defined objectives of closure. The plan needs to locate completion criteria, final closure options, designs for each component of the operation and costs associated with options. Operations phase closure plan must indicate issues related to closure such as: social, environmental, safety, financial, regulatory and stakeholders. The main thing is that this plan should be updated regularly.

Rehabilitation plan is the key component of closure plan. It identifies the research and activities required for on going rehabilitation i.e. progressive rehabilitation, post closure land use objectives and activities required for minimizing on going contamination and final costs by confirming or modifying completion criteria. Rehabilitation plan should include strategies for long-term stability, sustainability and time limit with respect to rehabilitation.

Decommission plan should be developed towards the final stages of operation. It identifies activities that are required to be undertaken post cessation of operations and prior to closure and deconstruction of site. It has the objective of leaving the area in a safe and stable condition that is consistent with physical and social environment. It includes: the demolition of infrastructure, making safe excavations, decontamination, makes safe requirements for active mine areas and waste repositories.

Maintenance and Monitoring plan identifies maintenance and monitoring requirements. Maintenance and Monitoring plan can be jointly called as post closure plan. This plan follows decommissioning activities and prior to lease relinquishment. If progressive

rehabilitation has been successful, the last stage may be shortened. This plan should be established against pre-determined closure criteria.

#### **5.1.4 Principles of Planning**

Planning principles (ANZMEC, 2000):

- § To reflect the status of project or operation, closure plans should be developed.
- § To ensure that closure is technically, economically and socially feasible, closure planning is required.
- § To reflect change, regular and critical review of closure planning is required.
- § Both cost and uncertainty should be reduced by risk-based approach to planning.
- § Mine closure should be integral to the life of mine.

#### **5.1.5 Contents of a Closure Plan**

Closure plan is developed by taking into account both the legal requirements and the economic, environmental and social parts of the operation. The typical contents of a closure plan are:

- § Project description;
- § Objectives of closure;
- § Legal and other obligations;
- § Completion criteria;
- § Baseline environment data and socio-economic scenario;
- § Stakeholder involvements;
- § Risk based assessment;
- § Closure action plan;
- § Closure costs;
- § Records management; and,
- § Tenement relinquishment.

**Project Description:** Project description should cover the following information like: Project name, Owner's name, Land area, Land lease tenure, Previous use of the project site, Method of mining, Production schedule, Life of the project, Reasons for closure, Expected date for closure, etc.

The nature and activities related to operation should be properly defined. All environmental issues should be properly mentioned. Post-closure issues should be identified. Potential impacts on the reason should be considered.

**Closure Objectives:** The aim behind closure is to ensure that decommissioning and associated rehabilitation can be successfully achieved. This part would identify the objectives for closure with respect to company. The objectives are based on environmental, social, safety and financial issues. The objectives should be clear and properly communicated to the communities likely to be affected.

**Legal and Other Obligations:** Based on the legislation, site specific permits, licenses, ministerial commitments, objectives of the company's legal obligations should be identified. It should be defined properly and referenced.

**Completion Criteria:** Completion criteria establishes a baseline from which a standard or level of performance is designed. It is a set of environmental indicators. It should be established in collaboration with stakeholders in line with the post closure land use and the associated plans. Completion criteria should be clear, flexible and simple. It should reflect the set of environmental, economic and social circumstances.

Completion criteria should be reviewed regularly. To ensure that the completion criteria is properly reflected on the work practices and improved knowledge, the continual improvement principle should be applied. Closure planning for the development of completion criteria needs to cover issues like (The Chamber of Minerals and Energy of Western Australia, 1999):

- § Public health and safety;
- § Regulatory requirements;
- § Company policy;
- § Geotechnical stability of the final land form;
- § Sustainability of the revegetated areas;
- § Site specific indicator species;
- § Priority flora and fauna;
- § Expectations of stake holders; and,
- § Post closure land use objectives.

**Baseline Environmental Data and Socio-Economic Scenario:** To show the pre-mining environmental conditions of the core and buffer zone, baseline environmental data should be given. Socio-economic scenario should be included at the time of mine closure. This socio-economic scenario should be of the core and buffer zone.

**Stakeholder Involvement:** The objective behind stakeholder involvement is to consider the interests of all stakeholders during the process of mine closure.

The principles of stakeholder involvement are (ANZMEC, 2000):

- § To ensure the effectiveness of consultation process, adequate resources should be allocated.
- § To manage potential impacts of mine closure, work with communities (Wherever practical).
- § Effective consultation should occur throughout the mine life. It is an inclusive process. It helps in encompassing all parties.
- § Stakeholders and interested parties identification is an important part of the process of closure.
- § The needs of the stakeholder groups and interested parties should be reflected by a targeted communication strategy.

Three broad categories such as: the company, the community and the state are there in stakeholder groups.

#### **(i) The Company**

Employees: The employees should be made knowledgeable regarding the mine closure.

Shareholders: Shareholders should be fully informed of their company's obligations for closure.

Management: The aim and duty of the management is to ensure that there is clear accountability and adequate resources for the implementation of closure plan. Environmental personnel and selected managers should be encouraged to continue their involvement beyond the cessation of production. For the success conducting the operation safely, cost effectively and on time should be fundamental.

#### **(ii) The Community**

Local business and service providers: To assist local business and service providers in their own planning for the transition, consultation is important.

Land holders, neighbours and nearby residents: This group can be incorporated into rehabilitation planning. Because, the closure of mine may physically affect this group.

Local government: To minimize disruption to community services, early consultation and planning with local government is essential.

NGOs and community groups: These groups often represent elements, which are physically and financially affected by mine closure.

### **(iii) The State**

The responsible authority and the regulators: The responsible authority and the regulators key role is to coordinate the functions and needs other government agencies with accountabilities in the area.

The land management agency: The land management agency requirements are an integral component of the closure process.

Other government agencies: Effective consultation with other government agencies is important to minimize potential effects of closure on the community and individuals.

The benefits of a successful stakeholder involvement are:

- § Minimize potential effects on the community and individuals;
- § Safe and cost effective operations;
- § Acceptance of closure decisions;
- § Improved relations with government and the community;
- § Encouragement for the staff;
- § Work within stipulated time frame;
- § Satisfactory rehabilitation of mine site;
- § Anticipate requirements concerning the closure, post mining land use and monitoring;
- § Improved company' reputation and public image;
- § Improved community interests to future mining proposals;
- § Understanding internal and external stakeholder issues;
- § Minimizing dependency on the company; and,
- § Developing realistic employee, community and regulatory expectations.

**Risk Based Assements:** Knowing and understanding the risk associated with closure is an important part. Risks involved with past, present and future activities must be understood properly for effective closure plan and if liabilities are to be minimized.

**Closure Action Plan:** Closure planning requires critical review to reflect changing circumstance. For any change in technology, operations or regulations, closure plan should be modified and comprehensively reviewed on a regular or cyclic basis (e.g. every 3 to 5 years). Planning should always be flexible enough to cope with unexpected events. Management of social as well as environmental issues should be included in the plan.

The conceptual plan should be considered as part of the EMP for open cast mines. It should cover identification of potential impacts, post mining water condition, timing and content of decommissioning audits and rehabilitation plan and outline decommissioning plan.

Closure action plan should include the following:

- § Human resources/ responsibilities.
- § Progressive rehabilitation.
- § Decommissioning.
- § Remediation/ Remedial actions.
- § Geotechnical assements.
- § Landform establishment.
- § Revegetation.
- § Aesthetics.
- § Heritage.
- § Health and safety.
- § Post closure maintenance and monitoring.
- § Survey of remaining structures and areas of contamination.
- § Current conditions and activities on the site.
- § Security measures employed on the site.
- § Plan showing the location and use of equipments.
- § Plan showing the boundaries of the proponent's surface rights.
- § Expected life of the project.
- § Dams and other drainage control structures and details of watercourses.

- § Mining and milling process to be employed in the operation of the project and production level in tonnes per day.
- § Development work description and schedule that would cause disturbances at the site or adjoining the site.
- § The location and nature of systems for the treatment, management or disposal of waste and storage of hazardous substances and toxic substances.
- § An assessment of the effect of mine opening on the stability of the surface areas.
- § Expected conditions and uses of the site following permanent closure.
- § A schedule of the practices and procedure by which progressive rehabilitation of the site will be carried out during the whole life of the project and at each stage of closure.
- § The monitoring to be carried out at the project site during the life of the project and at each stage of closure.
- § Procedures to be used to evaluate and verify compliance with the plan.
- § Documentation/ reporting/ records.

Protective measures must include the following:

- § All mine plans should be up to date and are deposited for safekeeping.
- § All personnel employed should be competent to carry out the work required.
- § The work should be carried out as per the method statement.
- § The protection of every mine opening, building and other structures against unauthorized person's access.
- § The maintenance all hydraulic mechanical and waste management systems.
- § The mine closure team and contractor will view all unexpected conditions and s method agree on its treatment
- § Supervision of all contractors will be required from a central mine closure team.
- § Changes required to the programme due to unforeseen circumstance are agreed prior to that change occurring
- § All aspects of the work including financial control will be discussed.
- § If there is additional work/ cost, there will be a process that will allow the contractor to seek additional payment
- § The securing of all chemicals, hazardous substances and toxic substances.



- § The rendering all dams, tailings rock and waste resulting from work done in a safe and stable condition.
- § The control of all contaminated effluents
- § There will be monitoring for the site, surrounding areas for ground water condition, stability of waste dumps etc.
- § The continuation of all monitoring programs.

**Closure Costs:** Determining the costs associated with closure and representing these costs during the life of the operation is a fundamental part of closure planning. Companies are required to make internal accounting provisions annually to cover mine closure costs. In general, the objective of financial provision is to ensure that the cost of closure is adequately represented in company accounts and that the community is not left with a liability. Determining a closure provision during a feasibility stage is an important thing in determining if a project is economically feasible.

Principles of closure costs are (ANZMEC, 2000):

- § From the closure plan, a cost estimate should be developed.
- § Closure costs should be reviewed on regular basis.
- § Real cost should be reflected by the financial provision.
- § Adequate securities should protect the community from liabilities of mine closure.
- § Accepted accounting standards should be the basis for closure costs.

Developing a provision will assist in determining the real costs associated with rehabilitation, decommissioning, impacts on community and surrounding environment, site monitoring, site maintenance, treatment and relinquishment. A provision is a mechanism for ensuring funds available for the closure so that closure costs do not become a burden. Another important thing is that the social cost analysis should be included in the closure costs which should be reviewed periodically and reassessed to account for any change in plan and legislation.

**Records Management:** To validate targets for relinquishment with regulatory agencies and for confirmation that this criteria have been achieved, databases developed during the permitting and operational phases of mine should be maintained properly. Records management should be reviewed on regular basis and should be updated. Records management needs to consider (The Chamber of Minerals and Energy of Western

Australia, 1999): types of records to be held, method of storage, archiving and retrieval, persons responsible for records management during operation, decommissioning and post-closure, regular internal/ external or both auditing and management of central data e.g. licenses.

**Relinquishment:** The objective of relinquishment is to reach a stage, where the company has met agreed completion criteria to the satisfaction of the responsible authority.

The responsible authority with other involved regulatory agencies including the future land controller will make a judgment on the achievement of agreed completion criteria. When the responsible authority has agreed to relinquishment of the site, the management and maintenance of the site would rest with subsequent owners.

The principles of relinquishment are (ANZMEC, 2000):

- § A responsible authority should be identified and held accountable to make the final decision.
- § Once the completion criteria has been met, the company may relinquish their interest
- § To facilitate future land use, records of the history of a closed site should be preserved.

## **5.2 Implementation of Closure Plan**

### **5.2.1 Introduction**

Planning and implementation are two phases of closure programmes. For cost-effective, safe and systematic closure, proper planning and implementation are necessary.

### **5.2.2 Objective**

The objective of implementation is to ensure that there is clear accountability and adequate resources for the implementation of the closure plan.

### **5.2.3 Principles**

The principles of implementation are (ANZMEC, 2000):

- § For resourcing and implementing the closure plan, the accountability should be clearly identified. If there is a dedicated team structure, the closure process will be enhanced. Responsibilities and roles should be clearly established.

- § To assure conformance with the closure plan, adequate resources must be provided. To ensure that sufficient funds are available for closure process, provisioning is designed. If the provisions are inadequate, other sources should be identified for funds.
- § To achieve maintenance free final land use, the on-going management and monitoring after closure should be assessed and adequately provided for. Closure scenarios like treatment of acid mine drainage needs long-term, active management and monitoring of the closed site.
- § For implementing the closure plan, a closure business plan provides the basis. Closure business plan provides the basis for measuring progress and changes needed to the closure process. It includes: time frames, resources, a schedule of actions and responsibilities. A closure project should be complete with comprehensive business plan.
- § The status of operation should be reflected by the implementation of the closure plan. Closure may be initiated in a number of scenarios like: planned closure, sudden closure, temporary closure maintenance and monitoring.

### **Closure Scenarios**

**Planned Closure:** Planned closure is based on the mine planning, biophysical, socio-economic, development and surrounding environment details. It requires decommissioning plan and systematic implementation of this plan. It should be regularly updated. To reflect changes in operations, mine development, technology culture and environment conditions, it should be refined on regular basis. It involves the preparation of project phase plan/ conceptual closure plan.

**Unplanned Closure:** Unplanned closure involves the immediate preparation of decommissioning plan based on site's non-operational status. This plan should be implemented immediately. Decommissioning plan should be prepared based on pre-existing closure plan. If funds are inadequate, funds should be provided from other sources of the company.

**Temporary Closure:** Mining/Milling activity may cease due to various reasons like: economic, operational, political, etc. This results in shutdown of operation on a temporary basis. The situation requires immediate preparation and implementation of a

decommissioning plan. Decommissioning plan should be prepared with a vision of the potential for future operations at the site. It is recommended that where possible, rehabilitation should be undertaken.

***Management and Monitoring:*** Management and monitoring define the point at which decommissioning activities have ceased and post closure activities have commenced. Monitoring should be designed to demonstrate that the site is safe, stable and have achieved the objective of land use. Past experience and good planning can minimize risks. When accounting, maintenance, etc. are no longer readily available, it is important for the development of support mechanisms for this phase. If opportunity exists, relinquishment should be taken.

#### **5.2.4 Implementation of Closure for Site Components**

The components that are important to closure may be divided into the following functional components:

- Open Pit.
- Waste Rock Dump.
- Water Management Systems.
- Tailings Storage.
- Milling Plants.
- Heap Leach Facilities.
- Equipment.
- Infrastructure.
- Exploration Sites.

**Open Pit:** Problems associated with open pits include - illegal access, illegal dumping, pollution of surface water and/or ground water, unstable slopes and unstable pit walls. To overcome these types of problems, open pit operators/planners should take into consideration of issues like slope stability, geotechnical stability, water management, proper location for dumping and safety.

**Waste Rock Dumps:** Problems associated with waste rock dumps include - unstable slopes, illegal access, illegal dumping, pollution of water and pollution due to dust. To

overcome these types of problems, issues like slope stability, geotechnical stability, proper locations of dumping, water management and safety should be considered. In overburden piles, similar types of issues should be considered.

**Water Management Systems:** It includes facilities such as reservoirs, dams, pumping systems, pipelines, settling ponds, tailings dams, water treatment plants, dewatering systems, sewage treatment systems, etc. Problems associated with water management systems include: Uncontrolled discharges, contamination of ground water and/ or surface water, impact on human safety and health, impact on fauna, etc. Implementation issues with respect to water management systems include: physical stability, chemical stability, environment stability and safety. To minimize impacts with respect to water management systems, all efforts should be made.

**Tailings Storage:** The problems associated with tailing storage include - unstable foundation, seepage of tailings water, leakage of tailings water, not of adequate dimension, wind erosion, safety, physical stability, chemical stability, embankments and appurtenant structures. To overcome the above types of problems proper dimension of tailings storage, good and stable foundation, stable slopes, efforts to maintain leakage and seepage free tailings storage should be considered.

**Milling Plants:** The issues associated with milling plants include - safety, physical stability, chemical stability and environmental stability. To overcome problems related to milling plants, efforts should be made.

**Heap Leach Facilities:** The issues associated with heap leach facilities include - i) erosion; ii) long-term stability; iii) removal of tailings; and, iv) leaching of pollutants.

**Equipment:** All equipment engaged in mining operations and other activities related to mining operations should be removed (except for specific functions) during closure implementation.

**Infrastructure:** It includes water supply pipelines, railways, roads, power supply systems, towers for communications, offices, workshops, concrete foundations, etc. The infrastructure components should be decommissioned and removed.

**Exploration Sites:** The issues related to exploration sites include - filling of trenches and costeans, rehabilitation of drill pads, filling of exploration holes and removal of geological core, core boxes and sample bags.

## **5.3 A Closure Plan Review Process**

### **5.3.1 Introduction**

The closure plan should be modified as a result of any operational change, new technology or new rules and regulation and should be comprehensively reviewed on a regular and predetermined cycle. It should remain flexible enough to cope with unexpected events. The plan should include the management of social as well as environmental issues.

### **5.3.2 Principles for Reviewing A Closure Plan**

The following basic principles to be followed while reviewing a closure plan:

- § A transparent decision making process.
- § Institutional arrangement should be appropriate. The laws enacted must be specific, enforceable and mandatory.
- § A closure plan design should be oriented towards efficient implementation.
- § Stipulations, if any, in the environmental clearance should be backed by an effective compliance monitoring.
- § Provisions should be for identifying best options. This can not be achieved without critical examination of the objectives of the project and feasible alternative.
- § Adhere to sustainable criteria like: local, national and global.
- § Ensuring that all types of projects having significant impacts for environmental sustainability are required to carry out environmental impact assessment studies.

### **5.3.3 Factors for the Effectiveness of A Closure Plan**

For studying the effectiveness of a closure plan, the following factors should be considered:

- § Policies, acts, rules, regulations and circulars related to mine closure,
- § Administrative framework,
- § Status of mine closure,
- § Stage by stage actions for mine closure,
- § Compliance monitoring and enforcement,
- § Availability of resources,
- § Implementation of a closure plan, and

§ International interactions.

### **5.3.4 Criteria for Evaluating the Effectiveness of A Closure Plan**

Opinions on mine closure plan, on what should be expected from a complete mine closure plan, vary widely. An important source of disagreement is the inherent problem associated with the prediction of impacts. A synthesis of observations by various authors leads to the following criteria for evaluating the effectiveness of mine closure plan.

1. Provision of an appropriate screening subsystem to identify projects with significant environmental impacts.
2. To identify important activities and environmental parameters to be brought within mine closure plan, provision of scoping should be there.
3. Evaluation of both significance and magnitude of impacts.
4. Incorporation of assessment of uncertainties, risks and related hazards.
5. Ability to accommodate multiple objectives of decision-making.
6. Provision of unambiguous criteria for comparison of alternatives.
7. Identifications of beneficial and adverse impacts, temporary and permanent impacts, short-term and long-term impacts, reversible and irreversible impacts.
8. Ability to take into consideration interactions among various direct impacts and to assess second and higher order impacts by evaluating the synergic, potentiating and compensating effects.
9. Identification of surveillance and monitoring requirements during various phases of project life, namely construction, operation, closure and post closure periods.
10. Separate assessment of impacts during each phase of project life without any trade-off between impacts occurring over different phases of project life.
11. Consideration of ecosystem behavioral pattern under induced stresses and shocks.
12. Linkages to regional assimilative capacity at criteria (6) through (10).
13. Efficient communication of assessment results to decision makers.
14. Fulfillment of the objectives of the project activities.

It is proposed to judge the completeness of a mine closure process on the basis of following points.

§ Whether all the key impacts are identified and assessed?

- § Whether the environmental setting and the proposed project are described properly?
- § Whether project alternatives and mitigation majors are adequately considered?
- § Whether outcome of the study is effectively communicated?

The four points represent the review areas. All mine closure plan must also give adequate description of the proposed project activities. The project site details must also be properly described. Similarly mine closure plan study must adequately establish the environmental soundness of the proposed development. An absolute must for a good mine closure plan is proper identification and evaluation of key issues. Another important yardstick for reviewing a mine closure plan is assessment of mitigation process undertaken. The need for effective communication requires the evaluator to consider for a good mine closure plan.

### 5.3.5 Performance Rating of Various Review Topics

Following evaluation scheme should be adopted for performance rating of various review topics.

**Table 5.1:** Performance Rating of Various Review Topics.

SYMBOL	EXPLANATION
A	Generally well performed. No important tasks left incomplete.
B	Generally satisfactory and complete. Only minor omissions and inadequacies.
S	Can be considered just satisfactory despite omissions and/ or inadequacies.
D	Parts are well attempted but must, as a whole be considered just unsatisfactory because of omissions and/ or inadequacies.
E	Not satisfactory significant omissions or inadequacies.
F	Very unsatisfactory. Important tasks poorly done or not attempted.
NA	Not Applicable. The review topic is not applicable or irrelevant in the context of the project under consideration.

### 5.3.6 Review Areas

The quality of a mine closure plan can be assessed using review topics described below.



The review areas are:

- § Project description, the local environment and the baseline conditions.
- § Identification and evaluation of key impacts.
- § Alternatives.
- § Mitigation.
- § Communication of results.

**Project Description, the Local Environment and the Baseline Conditions:**

Review categories under this area are:

- i) Development Description,
- ii) Site Description,
- iii) Waste,
- iv) Environment Description and
- v) Baseline Conditions.

(i) Development Description: The main purpose (s) of undertaking the project should be explained. Quantity of raw materials, energy and human input needed during the construction and operation should be specified and a description of the method of working should be included.

- § The purpose(s) and objectives of the proposed project should be explained.
- § The working schedule, production plan and layout of the project diagrams with the help of plans or maps and visual aspects of the proposed project including physical presence and appearance during construction, operation and winding up phase should be indicated.
- § The proposed method of working during various phases of the project life should be described.
- § The nature of quantities of raw materials needed during both the construction and operational phases should be chalked out and presented in a well-formatted manner.
- § The expected rate of production should be spelled out.

(ii) Site Description: A description of the on-site land requirement along with necessary information on pre-project land use, proposed land use changes, the duration of each land use and the proposed post land use.

§ The land area to be acquired for the project should be defined and its location clearly shown on a map. The category of land such as: forestland or tenancy should be specified clearly.

§ The uses to which this land will be put should be described and the different land use areas demarcated.

§ The estimated duration of the construction phase, operational phase and decommissioning phase should be given.

§ The means of transporting raw materials and products to and from the site and the approximate quantities involved should be described.

(iii) Waste: The types and quantities of wastes likely to be produced should be estimated, the proposal scheme described.

§ An estimate should be provided of the various types of waste matter, energy and other residual materials likely to be produced at different stages of the project.

§ The proposed scheme for collection, treatment, handling and disposal of wastes and residuals should be indicated.

(iv) Environmental Description: The environmental setting of the area likely to be affected by the proposed project should be described.

§ The environment expected to be affected by the development should be indicated with the aid of a suitable map of the area.

§ The affected environment should be defined broadly enough to include any potential significant effects occurring away from the vicinity of the project site. These may be caused by, for e.g. the dispersion of pollutants, infrastructural requirement of the project, etc.

(v) Baseline Conditions: The pre-project environmental quality should be evaluated and the likely changes in the quality if the project were not to proceed, should be presented.

§ The important attributes of the affected environment should be identified and described. The methods and investigations undertaken for this purpose should be

disclosed and should be appropriate to the size and complexity of the assessment task. Uncertainty should be indicated.

§ Wherever practicable the existing data sources should be browsed if relevant, utilized.

§ Planning and policy documents in respect of the locality should be compiled and analyzed to arrive at the base line conditions.

### **Identification and Evaluation of Key Impacts:**

Review categories under this area are:

- i) Definition of Impacts,
- ii) Identification of Impacts,
- iii) Scoping,
- iv) Prediction of Impact Magnitude and
- v) Assessment of Impact Significance.

(i) Definition of Impacts: Potential impacts of the project on the environment should be investigated and described. Impacts should be broadly defined to cover all potential effects on the environment and should be determined as the predicted deviation for the baseline state.

§ A description should be given of the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project.

§ Impacts to be caused due to non-standard conditions such as an accidental spillage of effluents should also be described.

§ The impacts should be determined as the difference between the future state of the environment with project and without the same project. These differences may be accepted as the impacts caused by the project.

§ A cause-effect analysis of the identified impacts on human beings, flora and fauna, soil, water, air, climate, landscape and interactions between these should be systematically presented.

(ii) Identification of Impacts: All significant impacts warranting in-depth analysis should be identified.

§ Impacts should be identified using a systematic methodology such as project specific checklists, matrices, panels of experts, consultations, etc. Supplementary methods such as: cause-effect or network analyses may be needed to identify secondary impacts.

§ A brief description of the impact identification should be given.

(iii) Scoping: Key impacts should be identified using a systematic scoping process and the main stress of subsequent investigations should be centered on these.

§ There should be genuine attempt to involve the stakeholders and special interest groups including NGOs to apprise them of the project and its implications.

§ Key impacts should be identified and selected for more intense investigation.

(iv) Prediction of Impact Magnitude: The likely impacts of the project on the environment should be described in quantified units wherever possible.

§ Impact magnitudes should be predicted using reliable data. Quantum of data should be adequate for arriving at an acceptable prediction. If data is acquired from secondary sources the same should be clearly mentioned. Any gaps in the required data should be indicated and the means used to deal with them in the assessment should be explained.

§ Techniques used for predicting the impact magnitudes should be appropriate to the size and importance of the projected impact. The techniques used should be described.

§ As far as practicable impact magnitudes should be expressed in measurable quantities. Quantitative descriptions, where these are used, should be as fully defined as possible.

(v) Assessment of Impact Significance: The expected significance of the project impacts should be estimated. The sources of quality standards, together with the rationale, assumptions and value judgments used in assessing significance, should be fully described.

§ While assessing impact significance the relevant quality standards should be taken into account.

§ The choice of standards, assumptions and value systems used to assess significance should be justified.

- § The significance of predicted impacts on the environmental sustainability should be described and clearly distinguished from impact magnitude.
- § Where mitigating measures are purposed, the significance of any impact remaining after mitigation should be described.

**Alternatives:**

All feasible alternatives to the proposed action should be considered. The alternatives considered should be outlined and the environmental implications of each of them should be presented, and the reasons for their rejection briefly discussed.

- § Alternative sites may be considered where these are practicable and available to project proponent. The main environmental advantages and disadvantages of these should be discussed and the reason for final choice given.
- § Alternative process, designs and operating conditions should be considered at an early stage of project planning and the environmental implications of these investigated and reported where the proposed project is likely to have significantly adverse environmental effects.
- § If severe adverse impacts are identified during the course of the investigation, which are difficult to mitigate, alternatives rejected in the earlier planning phase should be re-appraised.

**Mitigation:**

Review categories under this area are:

- (i) Scope and Effectiveness of Mitigation Measures and
- (ii) Commitment to Mitigation.

(i) Scope and Effectiveness of Mitigation Measures: All significant adverse impacts should be considered for mitigation. Evidence should be presented to show the proposed mitigation measures would be effective when implemented.

- § Attempts must be made to mitigate all significant adverse impacts. Where practicable, specific mitigation measures should be put forward. Any residual impact should be indicated and justification offered why these impacts are not to be mitigated.

- § Mitigation methods considered should include modification of the project, impact compensation and the provision of alternative facilities as well as pollution control.
- § Clear indication should be given to the extent to which the adverse impacts would be reduced if mitigation measures are implemented.

(ii) Commitment to Mitigation: Developers should be committed to, and capable of, carrying out the mitigation measures and should present plans how they purpose to do so.

- § Commitment of the project proponent(s) to implement the mitigation measures must be recorded. Details how the mitigation measures will be implemented and function over the time span for which they are necessary should also be given.
- § In order to assess the conformity of the impacts with the predicted values and also to keep the environmental pollution under check, an appropriate scheme for impact monitoring should be put forward. Provision should be made to adjust mitigating measures where unexpected adverse impacts occur.

### **Communication of Results:**

Review categories under this area are:

- (i) Layout,
- (ii) Presentation,
- (iii) Emphasis and
- (iv) Non-Technical Summary.

(i) Layout: The layout of the statement should enable the reader to find and assimilate data easily and quickly. External data sources should be acknowledged.

- § A brief description of the project along with the objectives of the environmental impact assessment study and how those aims are to be achieved should be provided.
- § Information should be logically arranged in sections or chapters and the whereabouts of important data should be signaled in a table of contents.
- § Unless the chapters themselves are very short, there should be chapter summaries outline the main findings of each phase of the investigation.

§ When data, conclusions or quality standards from external sources are introduced, the original source should be acknowledged at the point in the text. A full reference should also be included.

(ii) Presentation: Care should be taken in the presentation of information to make sure that it is accessible to the non-specialist.

§ Information should be presented so as to be comprehensible to the non-specialist. Tables, graphs and other devices should be used. Unnecessarily technical or obscure language should be avoided.

§ Technical terms, acronyms and initials should be defined, either when first introduced into the text or in a glossary. Important data should be presented and discussed in the main text.

§ The statement should be presented, as integrated whole summaries of data presented in separately bound appendices should be introduced in the main body of text.

(iii) Emphasis: Information should be presented without bias.

§ Emphasis should be given to potentially severe adverse impacts as well as to potentially substantial favorable environmental impacts. The statement should avoid according space disproportionately to impacts that have been well investigated or are beneficial.

§ The statement should be unbiased. It should not lobby for any particular point of view.

(iv) Non-Technical Summary: There should be a clearly written non-technical summary of the main findings of the study or how they were reached.

§ There should be non-technical summary of the main findings and conclusion of the study. Technical terms, lists of data and detailed explanations of scientific reasoning should be avoided.

§ The summary should cover all main issues related to mine closure.

In order to obtain satisfactory mine closure all of the following points must also be adequately dealt with:

§ Method of working to be adopted.

§ Site details.

- § Pre-project, during project and post-project land uses.
- § Resource requirement during construction, operation, closure and post closure phase of the project
- § Waste generation, handling and treatment.
- § Environmental setting.
- § Pre-project baseline situation on the important environmental parameters.
- § Likely changes in the environmental parameters if the project under consideration is not undertaken.
- § Data adequacy to enable impact production with minimal error.