Mine Rehabilitation and Closure Management Plan
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1 Introduction

Roșia Montană Gold Corporation S.A. (RMGC) is developing a gold and silver mine in the Transylvanian region of Romania. For the sake of simplicity, the combined elements of the proposed mining activity are called the Roșia Montană Project (referred to hereafter as the Project).

Figure 1.1. Location of Roșia Montană Project

An essential part of the Project is the development of a Mine Rehabilitation and Closure Management Plan that outlines a plan for decommissioning the facility and mitigating the Project’s impacts once mining and processing activities have ceased. The preparation of a rehabilitation and closure strategy prior to the development of the Project is an integral part of the closure design process. This approach to mine planning recognises that mining represents a temporary use of the land and that appropriate closure of the operation is in line with the sustainable use of available resources.

An initial version of this document was prepared as part of the Engineering Review Report completed for RMGC by MWH in 2005. This version of the Mine Rehabilitation and Closure Management Plan carries forward the concepts laid out in the earlier document in a manner that supports the Environmental Impact Assessment (EIA) process and the Environmental and Social Management System (ESMS) concepts discussed further in Section 2 of the EIA.

This management plan has been structured in line with the Annex 3 to MO 863 (Review checklist) which require the adoption of BAT and BEP. According to European and other international regulations and BAT, rehabilitation means "the treatment of the land affected by a waste facility in such a way as to restore the land to a satisfactory state, with particular regard to soil quality, wild life natural habitats, freshwater systems, landscape and..."
appropriate beneficial uses”. This means that definition of the Mine Rehabilitation and Closure Management Plan should consider the intended after-use scenarios and proceed to define the technical options to achieve the desired final state. This approach must also take into account the technical, social and economical conditions of the mining project.

The Mine Rehabilitation and Closure Management Plan addresses closure activities associated with four different scenarios:

- preparation and planning for closure during operations;
- rehabilitation measures during closure;
- rehabilitation measures during temporary suspension of operations; and
- rehabilitation measures during states of inactivity;
- activities in the post-closure phase.

Each of these scenarios is described in more detail in Sections 5 through 7 of this Plan.

This Mine Rehabilitation and Closure Management Plan does not address the closure and rehabilitation of the existing Minvest mine at Roșia Montană which is subject to separate provisions. More detailed and updated information on the governmental policy in this respect, as well as the financing strategy including funding by international organisations such as the World Bank, is provided by the Ministry of Economy and Commerce in the framework of the

- ”Mine Closure and Social Mitigation Project” and
- ”Mine Closure, Environmental and Socio-Economic Regeneration Project”.

With the exception of the Minvest Saliste tailings management facility, the Minvest mining areas are consumed or otherwise closed so that the Project can be developed.

### 1.1 General Guidelines for Closure

Guidance for environmental management and mine closure planning is provided by Romanian and the European Union regulatory bodies and other internationally accepted standards, such as the Province of Ontario (Canada), Rehabilitation of Mines – Guidelines for Proponents. Closure plans in Romania are required by the Mining Law, which outlines the closure of a mining operation. The Romanian Mine Closure Manual also includes requirements for the design of a Closure Plan.

The Project Mine Rehabilitation and Closure Management Plan addresses technical, environmental and economic elements.

According to Annex 3 of MO 863, direct, primary effects on demography, social and socio-economic condition in the area have to be described and appropriately quantified. This Mine Rehabilitation and Closure Management Plan does not directly address the social issues associated with mine closure which are separately addressed in Section 4.8 of the Environmental Impact Assessment and the RMGC Community Sustainable Development Plan.

The same holds for indirect effects on the environment caused by consequential development (i.e., other projects, not part of the main Project, stimulated to take place by implementation of the Project e.g. to provide new goods or services needed for the Project,
to house new populations or businesses stimulated by the Project) which have to be described, according to Annex 3 of MO 863. These effects, as far as they concern the closure and post-closure phase, are discussed in the RMGC Community Sustainable Development Plan.

It is understood that these documents will be adjusted in response to periodic evaluation and integration of changing future land use interests, regulatory changes, and other stakeholder input as part of the management review provisions in the Roșia Montană Project Environmental and Social Management Plan.

1.2 Objectives for Closure

Objectives for rehabilitation need to address regulatory requirements, site-specific aspects, RMGC policies and best industry practice, which include the following:

- protection of public health and welfare;
- achievement of agreed-upon goals for post closure land use;
- geotechnical stabilisation of mine-related structures;
- reclamation of landscape to minimise sediment transport, erosion, and potential environmental harm;
- water quality and quantity protection; and,
- air quality protection.

These objectives can be met by providing appropriate technical guidelines and standards used early in mine planning and closure designs.

Detailed rehabilitation objectives for the Project are listed below with a description of the elements within each item.

1.2.1 Safety and Security

Safety and security objectives include the following:

- a safe and secure environment for humans and wildlife for the long term;
- permanent securing of mine shafts, adits, and near-surface underground vaults;
- stabilisation of areas of subsidence created by underground workings;
- stability assessment of remaining underground mining voids where relevant to assess the potential for further ground movement and the need for controls such as barriers or fencing;
- stabilization of slopes (e.g. of pit walls, waste dumps, dams) so that no hazard to the public remains after final closure.
- temporary restriction of access to specific areas where appropriate to protect remaining equipment or facilities, or to ensure undisturbed development of vegetation which needs care and maintenance over several year. Over the long-term, there will
be no restrictions of access by the public, as all hazards to safety, property and health will have been removed.

1.2.2 Management of Environmental Effects

Objectives include the following:

- reduction or elimination of the need for a long-term management program to control erosion, water quality and to minimise the long-term environmental effects;

- removal of water storage dams that are no longer required and which will not be maintained by a public or private entity;

- control of acidic seepage and effluents containing dissolved metals, process chemicals and nutrients, ensuring no acutely toxic conditions remain that could affect birds, wildlife, or livestock;

- groundwater assessment and control where necessary;

- clean-up, treatment, or restoration of contaminated areas (e.g. soils contaminated by oil or fuel spills or spills of reagents) with contaminated material excavated and disposed of in an acceptable manner wherever necessary; and

- ensuring that vegetation conditions relating to metal absorption from soils will not cause adverse impacts to wild life or grazing animals.

1.2.3 Site Clean-up

Objectives include the following:

- removal of buildings, surface structures, scrap material and equipment;

- removal of all hazardous or designated substances and safe and acceptable disposal or storage;

- concrete structures levelled to ground pads at a minimum, with any rebar or exposed bolts cut off at the surface, and covered with topsoil to permit revegetation; and

- landfill sites properly covered and prepared for revegetation.

1.2.4 Erosion Protection

Erosion protection objectives include the following:

- stabilisation of mine development waste areas: dams, waste rock stockpiles, surface drainage basins, and diversion channels created by mining activity to protect against water and wind erosion;
1.2.5 **Productivity of the Site Vegetation**

Objectives include the following:

- provision of site conditions to allow the natural invasion of indigenous vegetation on the site to begin;

- establishment of a vegetation base that will enable natural species to begin the process of recovery toward the quality and productivity of the adjacent environment, depending upon the land use objective selected;

- scarification, fertilisation, and seeding of roadways and pads;

- seeding or hydro-seeding of sloped embankments, neutralisation and capping of tailings ponds, and placement and fertilisation of natural covers; and

- covering and hydro-seeding of waste rock stockpiles according to best management practice technology, where applicable.

1.2.6 **Aesthetics**

Objectives include the landscaping of highly visible rock stockpile slopes, pit slopes and dam faces to improve aesthetic appearance, as necessary, and in accordance with the defined after-use scenarios for the post-mining landscape.

1.3 **Objectives of the Mine Rehabilitation and Closure Management Plan**

The principal goal of the closure process for the Roșia Montană Project is to ensure that the potential environmental, economic, and social impacts associated with the decommissioned mine (together with their associated financial and legal liabilities) are identified at an early stage. In addition, these impacts will be minimised as a consequence of actions taken during the design, construction and operational phases of the Project. These actions will help to reduce the post-closure care required and overall closure costs at the end of mining. Another important goal is to design closure activities in a manner that minimises the need for extended care and maintenance operations by RMGC or whoever will assume responsibility for the rehabilitated mine over the long-term under agreed handover provisions.

Based on these goals, the objectives of the Project *Mine Rehabilitation and Closure Management Plan* are as follows:

- to transparently inform the public, regulatory authorities and all involved stakeholders about the closure and post-closure phase and the measures foreseen to achieve the...
beneficial after-use and minimize environmental impacts (as well as measures during temporary suspension of the mine)

- assist management in ensuring the protection of public health and safety during and following closure of the mine and associated facilities;

- allow progressive closure activities to commence before production ceases;

- reduce or eliminate long-term environmental impacts;

- restore disturbed land to a productive condition as soon as practical;

- minimise, to the extent practicable, sterilisation of any remaining mineral resources; and,

- serve as a resource to RMGC in project-specific budget and schedule planning activities.

**1.4 Approach to Mine Rehab and Closure Management Plan Development**

This version of the *Mine Rehabilitation and Closure Management Plan* was developed in consideration of guidelines presented in Romanian and EU mine closure guidance and regulations (see Section 3.2), supplemented as appropriate with North American mine closure guidance.

The *Mine Rehabilitation and Closure Management Plan* will be reviewed and updated as appropriate on a periodic basis following operational experience and assessment of the results of closure trialling. It will also be reviewed and updated as part of the management review process, since environmental legislation, reclamation practices, mine operations, and stakeholder interests are expected to change with time, as may other aspects of the Romanian *Mining Law* that will need to be addressed in later phases of the Project (see Section 2). This will ensure that the Plan addresses the current mine plan and legislation, and uses the most current and appropriate rehabilitation and closure practices, as required by the EU regulations. The applicable BAT will follow technical developments, and may therefore change, as explicitly foreseen in the IPPC Directive.

**1.5 Financial guarantee for mine closure**

RMGC is also aware of 35/2004/EC directive. RMGC takes all reasonable effort to minimize environmental damage and restore environment so that no environmental liability remains. Financial resources are secured for closure and post-closure phase to rehabilitate mine site and leave no environmental liability behind without sufficient financial resources to remedy any environmental damage.

Articles 7-2(d) of the EU Mine Waste Directive and the Terms of Reference (ToR) of the EIA require that the proponent has adequate arrangements by way of a financial guarantee or equivalent, as required under Article 14 of the EU Mine Waste Directive (2006/21/EC), so that "all obligations under the permit issued pursuant to this Directive, including after-closure provisions, are discharged".
There are three components which must be clearly distinguished:

- The technical concept of mine closure, time estimates of the activities including the post closure phase is contained in the Mine Closure and Rehabilitation Plan. Specific Waste Management issues are addressed by the *Waste Management Plan*.

- Cost estimates, which are broken down according to the relevant activities and time periods are provided as part of the Engineering Review Report\textsuperscript{xviii}.

- Arrangements of financial instruments to guarantee the funds are available when they are needed, including the calculations of the financial net present value (i.e. discounted future expenditures) etc. These are provided by RMGC in the appropriate form.
2 ESMS Considerations and Organizational Responsibilities

This Mine Rehabilitation and Closure Management Plan is one of a suite of environmental and social management plans that have been developed to support the Environmental and Social Management System (ESMS) separately described in the current version of the Roșia Montană Project Environmental and Social Management Plan. Collectively, this Mine Rehabilitation and Closure Management Plan and its companion management plans address key operational control needs that have been established for those areas for which the EIA process indicates that potentially negative environmental or social impacts exist or could potentially occur in later phases of the mine life cycle. Figure 2.1 illustrates the position of the ESMS within the framework of the overall Project management.

![Diagram of ESMS and Management Plans](image.png)

Figure 2.1. Structural Relationship of Management Plans in Environmental and Social Management System

The implementation of this management plan is also supported by a number of detailed, lower-tier Standard Operating Procedures (SOP) to be used by specified Project personnel on a day-to-day basis. These procedures will be developed once the environmental approval for the Project has been obtained and will be compiled in the RMGC Standard Operating Procedures Manual, the development, review, approval, distribution, and update of which is controlled by the Roșia Montană Project Environmental and Social Management Plan. Other specific document distribution, change control, personnel training, and records management needs associated with the implementation of this management plan are likewise addressed through the processes and procedures defined in the Environmental and Social Management Plan.

The Mine Rehabilitation and Closure Management Plan is subject to periodic review and update over the life of the mining operation, in response to internal and external reviewer comments, regulatory changes, changes in mining operations, stakeholder communications, internal audit and management review results, and other factors, as discussed in the Roșia Montană Project Environmental and Social Management Plan. Compliance with the requirements of this Plan will also be periodically evaluated in accordance with the Roșia Montană Project Environmental and Social Management Plan and procedure MP-13, “Internal Environmental and Social Management System Performance Verifications.”
Primary operational responsibilities for the implementation of this Plan reside with the Production Department, as noted in table 2-1. Closure monitoring responsibilities are divided between designated Production Department and Environmental Department staff as noted in the RMGC standard operating procedures that are cited to govern specific tasks. Management of workplace-specific safety issues is the primary responsibility of the Health and Safety Manager and assigned Health and Safety Co-ordinators, as noted in the RMGC Occupational Health and Safety Plan.

### Table 2-1. Rehabilitation and Closure Staff Roles and Responsibilities

<table>
<thead>
<tr>
<th>Position</th>
<th>Role</th>
<th>Responsibilities</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Manager</td>
<td>Overall Co-ordination</td>
<td>Senior operations and construction oversight Provides recommendations for improvement of the closure operations Co-ordinates with other areas of the mine that may impact the closure operations Co-ordinates other departments of the mine that will provide support for the closure operations Maintains relationships with external stakeholders related to closure issues</td>
<td>Has authority over the TMF operation and the necessary capital resources.</td>
</tr>
<tr>
<td>Process Manager</td>
<td>Overall Management</td>
<td>Senior operations and construction oversight Ensures mining operations are consistent with the Mine Rehabilitation and Closure Management Plan (waste rock fill plans, schedule for start of rehabilitation measures as soon as waste rock filling is complete, etc) Co-ordinates with other areas of the mine that might impact the closure operations Co-ordinates with other departments of the mine that will provide support for the mine closure operations Provides recommendations for improvement of the closure operations</td>
<td>Assignment of resources to Reclamation Engineer/Superintendent consistent with capital and operational budgets Hiring/supervision of Reclamation Engineer/Superintendent Taking decisions to divert flows to auxiliary systems during emergencies Co-ordinates activities of other departments related to the mine operations.</td>
</tr>
<tr>
<td>Process Manager</td>
<td>Manager of Tailings System</td>
<td>Implements Tailings Facility Management Plan; prepares reports and furnishes periodical updates as required Co-ordinates activities with Reclamation Engineer/Superintendent on the filling of the TMF basin to ensure compliance with Mine Rehabilitation and Closure Management Plan Monitors and updates the TMF elements of Mine Rehabilitation and Closure Management Plan as required</td>
<td>Takes decisions to divert flows to auxiliary systems during emergencies Hiring/supervision of TMF operational staff</td>
</tr>
<tr>
<td>Position</td>
<td>Role</td>
<td>Responsibilities</td>
<td>Authority</td>
</tr>
<tr>
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</tr>
<tr>
<td>Reclamation Engineer/ Superintendent responsible for mine closure activities</td>
<td>All Mine Rehabilitation Measures</td>
<td>Provides all planning for rehabilitation measures (e.g., filling plans, grading plans, re-vegetation plans, test plots, chemical and geochemical testing, Best Management Practices (BMP) planning) Provides recommendations for improvement of the environmental rehabilitation plan Implements project execution plans for sustaining capital investments Provides support for monitoring test plots and ongoing environmental rehabilitation measures Updates the Mine Rehabilitation Plan Liaises with and contracts specialist mine closure company(ies) to comply with Romania legislation procedures; Provides technical support Interprets operational monitoring results Supervises onsite during closure activities to ensure that all rehabilitation measures as outlined in the Mine Rehabilitation and Closure Management Plan are followed.</td>
<td>Carries out assigned duties/ responsibilities Recommends actions to Tailings Superintendent resulting from interpretation of dam monitoring data</td>
</tr>
<tr>
<td>Environmental Superintendent</td>
<td>Environmental compliance / regulatory reporting</td>
<td>Provides recommendations for improvement of the operations Implements measures as required by environmental permits Performs monitoring activities according to environmental permit requirements Ensures that RMGC environmental policies, guidelines and procedures are followed as defined by the Project Environmental and Social Management System Provides environmental training and technical support for all facility personnel Interprets environmental monitoring data Reports non-compliance issues to the Tailings Superintendent Validates environmental laboratory test results Downloads and processes meteorological data collected onsite</td>
<td>Carries out assigned duties/ responsibilities</td>
</tr>
<tr>
<td>Position</td>
<td>Role</td>
<td>Responsibilities</td>
<td>Authority</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Health and Safety Manager</td>
<td>Facility and personnel health and safety</td>
<td>Provides recommendations for improvement of the operations. Ensures environmental rehabilitation considerations are incorporated into the overall RMGC Occupational Health and Safety Plan, and that the Plan is properly implemented. Detects and communicates potential Health and Safety problems related the environmental rehabilitation operations to upper level management. Provides health and safety training for rehabilitation personnel. Ensures performance of all health and safety monitoring.</td>
<td>Elaborates and directs the development of the health and safety plan. Overseas plan implementation. Responsible for stopping activities deemed imminently dangerous.</td>
</tr>
<tr>
<td>Designer</td>
<td>Designs and modifies the Environmental rehabilitation activities</td>
<td>Provides recommendations for improvement of the environmental rehabilitation operations. Supports monitoring and design of monthly management reports. Provides technical support through the intermediary of the Rehabilitation Engineer/Superintendent</td>
<td>Acts by means of recommendations made to the Director, Production</td>
</tr>
</tbody>
</table>
3 Guidelines for Mine Closure

3.1 Romanian Guidelines for Closure

Romanian mine closure regulations are contained in the *Mining Law* and the Romanian *Mine Closure Manual.* This article takes into consideration the requirements of the mining laws, environmental laws and the social protection laws. As part of Romanian mine closure requirements, the following items must be addressed:

- “Initial Plan for Mine Closure”;
- “Activity Cessation Plan”; and
- “Technical Mine Closure Plan.”

In addition to its role in the EIA process and its long-term role as an element of the RMGC Environmental and Social Management System discussed in Section 2, the initial iteration of this Plan addresses the aforementioned requirement to develop an “Initial Plan for Mine Closure” as part of the mine feasibility study submitted to the Romanian government for the mine permit application. As the Project proceeds and the details of activity cessation and technical closure are more fully developed and understood, the scope and detail in the current version of this *Mine Rehabilitation and Closure Management Plan* will be expanded to fully address the remaining two planning elements as required by the *Mining Law*. Specific update requirements towards that end will be developed as an outcome of the annual management review that will be conducted in accordance with the Roșia Montană Project Environmental and Social Management Plan.

The specific components of the three planning requirements discussed above are described in the following paragraphs.

### 3.1.1 Initial Plan for Mine Closure

The “Initial Plan for Mine Closure” is the document drawn up by the mine operator, together with the feasibility study for opening the mine, as part of the documentation for obtaining the mine license. An initial closure plan was developed by IPROMIN as part of the mine licensing effort. The objective of the Initial Plan for Mine Closure is for the mine operator to provide information regarding the operations required for physical closure of the mine. In addition, the Initial Plan for Mine Closure addresses the environmental remediation, social protection for redundant personnel and economic reconstruction of the affected areas, along with the associated costs.

The Initial Plan for Mine Closure comprises:

- environmental impact assessment, detailing major environmental risks and the measures to be taken to reduce those risks in the event of mine closure;
- discussions of the actions proposed to minimise the aforementioned risks;
- technical measures proposed for conservation, decommissioning, and physical closure of the mine;
- evaluation of the social impact as a result of mine closure, as well as suggested action to minimise such impact; and
an estimate of the overall costs for implementing the measures required for mine closure as part of the Engineering Review Report\textsuperscript{xxii} based on a preliminary closure study prepared by IPROMIN\textsuperscript{xxiii}.

The requirements of the “Initial Plan for Mine Closure” are the basis for this version of the Mine Rehabilitation and Closure Management Plan. However, this plan focuses on the physical components of closure. The social aspects of mine closure are addressed in detail in the Community Sustainable Development Plan.

3.1.2 Activity Cessation Plan

The “Activity Cessation Plan” is to be developed by the mine operator at the time of cessation and will include the technical, economic, environmental and social documentation required to justify closure.

The objective of the Activity Cessation Plan is to provide details of the actions required for accomplishing mine closure. According to the Mining Law 85/2003, the mine operator initiating the mine closure process is required to contract with a specialised company for completion of the Activity Cessation Plan.

At an appropriate time the Project Mine Rehabilitation and Closure Management Plan will be revised to incorporate Activity Cessation Plan requirements, which will include the following documentation:

- technical and financial documentation (i.e. a feasibility study) justifying cessation of mining, drawn up on the basis of the information provided by the mine operator; the mine operator must provide the closure designer with information on the mine status at cessation, and must update this information during the time period from activity cessation up to the beginning of the closure works;

- a description of the program for care and maintenance of the closed components, based on mining records and drawings provided by the mine operator illustrating the state of the underground and surface workings; the mine operator is obliged to provide the designer with all the information required to develop the program for care and maintenance;

- a discussion of the social protection program (i.e. the RMGC Socio-economic Development Plan, which will be developed in consultation and together with the stakeholders) for the personnel who will be displaced by the mine closure, including:
  - measures to redistribute/re-train, financial compensations, local development programmes, new jobs creation;
  - financial assessment of the measures;
  - financing sources for the measures; and
  - responsibilities;
the environmental rehabilitation program, drawn up according to the legislation in force, which must include:

- A description of the site, including topography and existing land use, identifying existing vegetation and wildlife habitats, all existing surface structures such as treatment plants; industrial and administrative buildings; mining works, shafts, adits, drifts, tunnels, or boreholes; entombed equipment, if any; and any caved-in mining works (without access ways);

- description of all existing waste stockpiles, seepage characteristic and receiving streams, including both physical and chemical characteristics and identifying any potential impacts on the environment;

- description of the physical status regarding slopes stability and any information included within the geotechnical studies in order to ensure slopes stability,

- description of all existing surface waters, including chemical characteristics and contaminants;

- description of the physical and pedological characteristics of the soil, including a detailed analysis identifying both potential contaminants and nutrient content; and

- suggestions on future land use considering the value of the site to local communities with regard to both agriculture and amenity.

The mine operator may obtain the information from the local environmental authority, the specialised local and central institutions, and from analysing the reports available to the designer. The Community Sustainable Development Plan will be prepared in consultation and with the support of the affected communities, and will be subject to public debate.

3.1.3 Technical Mine Closure Plan

The “Technical Mine Closure Plan” (TMCP) must include the legal provisions concerning public acquisitions; it will assess the measures and the actions required by the Activity Cessation Plan, from technical and environmental remediation points of view. The TMCP is meant to operate in conjunction with a social protection plan (i.e. the Project Community Sustainable Development Plan) prepared in consultation with the affected communities. The TMCP must include:

- a planning section, including baseline data; a discussion of risks and mitigation actions, assessment of alternatives; and selection of the preferred alternative;

- a mine closure work section, including a technical description of the physical work for mine closure, and description of the environmental rehabilitation plan; and

- a “task book” or listing of the specific tasks necessary to accomplish final closure.
This version of the Mine Rehabilitation and Closure Management Plan only addresses the engineering and environmental issues associated with the initial plan for mine closure. Subsequent versions will more fully address social issues and will fulfil the “activity cessation plan” and “technical mine closure plan” requirements of the Romanian regulations.

3.2 EU and international regulations, guidelines, conventions and BAT

3.2.1 Overview

Important EU regulations applicable to this Project are as follows:

- the EIA Directive
- the Water Framework Directive
- the Mine Waste Directive
- the IPPC Directive

Important international conventions applicable to this Project are as follows:

- the Aarhus Convention
- the Espoo Convention

According to the Ministerial Order MO 863, the Project must comply with the following according to the relevant activities:

- Best Environmental Practice (BEP);
- Best Available Techniques (BAT);
- IPPC databases/BREFs;
- Recommendations of the Helsinki Commission (HELCOM).

3.2.2 Best Environmental Practice (BEP)

BEP is defined by HELCOM Recommendation 13/6 to mean the application of the most appropriate combination of measures. In selecting for individual cases, at least the following graduated range of measures should be considered with respect to Mine Closure and Rehabilitation:

- In determining what combination of measures constitute best environmental practice, in general or individual cases, particular consideration should be given to:
  - scale of use;
  - potential environmental benefit or penalty of substitute materials or activities;
  - advances and changes in scientific knowledge and understanding;
  - time limits for implementation;
  - social and economic implications;
  - the precautionary principle;
• if the reduction of inputs resulting from the use of best environmental practice does not lead to environmentally acceptable results, additional measures be applied;
• in order to attain the objectives, the intensified exchange of information and knowledge regarding best environmental practice be promoted;
• the definition of best environmental practice be revised when appropriate.

### 3.2.3 **Best Available Techniques (BAT)**

BAT is defined by HELCOM Recommendation 12/3\textsuperscript{xxxii} to mean the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges. In determining whether a set of processes, facilities and methods of operation constitute the best available technology in general or individual cases, special consideration should be given to the following, with respect to Mine Closure and Rehabilitation:

- comparable processes, facilities or methods of operation which have been recently successfully tried out;
- technological advances and changes in scientific knowledge and understanding;
- the economic feasibility of such technology;
- time limits for application;
- the precautionary principle;
- if the reduction of emissions resulting from the use of best available technology does not lead to environmentally acceptable results, additional measures be applied;
- in order to attain the objectives, the intensified exchange of information and knowledge regarding best available technology be promoted;
- the definition of best available technology be reviewed, when appropriate.

BAT is also defined by the IPPC Directive 61/96/EEC\textsuperscript{xxxiii}, in Article 2 to mean the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole, whereby the following definitions apply:

- ‘techniques’ shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- ‘available’ techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;
- ‘best’ shall mean most effective in achieving a high general level of protection of the environment as a whole.

### 3.2.4 **BREF Documents**
The following BREF documents are of particular relevance for this Project:

- the Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities
- the Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Non Ferrous Metals Industries on certain aspects of water treatment
- the PIRAMID Guidelines for semi-passive water treatment;
- IPPC Reference Document "General Principles of Monitoring".

As a reference for mining practice throughout the EU, the study "Management of Mining, Quarrying, and Ore-Processing Waste in the European Union", prepared by BRGM for the European Commission, DG ENV, has some relevance.

### 3.2.5 Other HELCOM Recommendations

Other HELCOM Recommendations which have been identified to have a relation to Mine Closure and Rehabilitation of the Roșia Montană Project are listed below:

- HELCOM 24/5 recommends that industrial emissions and discharges of hazardous substances and nutrients be minimized by effective use of BAT;
- Although the HELCOM 24/5 on waste handling does not apply to this Project which falls under the Mine Waste Directive, the general principles set out in this Recommendation are complied with.

### 3.3 International Guidelines for Mine Closure

There are no binding international standards on the closure and remediation of closed tailings management facilities and waste rock dumps, which would have to be adopted by individual states such as Romania. However, there is number of guidelines which may provide guidance on the closure, remediation, monitoring and long-term maintenance of these facilities.

The most comprehensive document is the BAT (Best Available Techniques) Document for the Management of Tailings and Waste-Rock in Mining Activities and the Province of Ontario (Canada), Rehabilitation of Mines – Guidelines for Proponents. Other international projects which have the objective of defining the state of the art are the MIRO (Mineral Industry Research Organization), the CLOTADAM project and regional initiatives.

The EU BREF Document has been developed as a supportive document to the EU Mine Waste Directive. In the development of this document, a number of other reference documents, recommendations and guidelines have been taken into consideration, such as the following:

- ICOLD documents;
- The Canadian Guide to Tailings Management;
- International Network for Acid Prevention (INAP),
- and many others.
While this document does not set legally binding standards, it is meant to give information for the guidance of industry, EU Member States and the public on achievable performances, emissions, etc. Multinational research programs such as the CLOTADAM (CLOsure of TAilings DAMs) have been initiated on the EU level which have contributed to the BREF documents.

Table 3-1. Criteria for the closure of tailings and mine waste facilities

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closure Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Stability</td>
<td>All remaining anthropogenic structures are physically stable</td>
</tr>
<tr>
<td>Chemical Stability</td>
<td>Physical structures remaining after closure are chemically stable</td>
</tr>
<tr>
<td>Biological Stability</td>
<td>The biological environment is restored to a natural, balanced ecosystem typical of the area, or is left in such a state so as to encourage and enable the natural rehabilitation and/or reintroduction of a biologically diverse, stable environment</td>
</tr>
<tr>
<td>Hydrological and hydrogeological environment</td>
<td>Closure aims at preventing physical and chemical pollutants from entering and subsequently degrading the downstream environment - including surface and ground waters</td>
</tr>
<tr>
<td>Geographical and climatic influences</td>
<td>Closure is appropriate to the demands and specifications of the location, of the site in terms of climatic (e.g., rainfall, storm events, seasonal extremes) and geographic factors (e.g., proximity to human habitations, topography, accessibility of the mine)</td>
</tr>
<tr>
<td>Local sensitivities and opportunities</td>
<td>Closure optimizes the opportunities for restoring the land and the upgrade of land use is considered whenever appropriate and/or economically feasible</td>
</tr>
<tr>
<td>Land use</td>
<td>Rehabilitation is such that the ultimate land-use is optimized and is compatible with the surrounding area and the requirements of the local community</td>
</tr>
<tr>
<td>Funds for closure</td>
<td>Adequate and appropriate readily available funds need to be available to ensure implementation of the closure plan</td>
</tr>
<tr>
<td>Socio-economic considerations</td>
<td>Consideration must be taken of opportunities for local communities whose livelihoods may depend on the employment and economic fallout of the mining activities. Adequate measures are made to ensure that the socio-economic implications of closure are maximized.</td>
</tr>
</tbody>
</table>

Chapter 2.6 ("Closure, rehabilitation and after-care of facility") of the BREF states the following general principles:

"In many cases, the tailings and waste-rock do not contain any substances that are harmful to the environment. In these cases, during the closure phase the operator will ensure that the water is drained from the tailings pond to safeguard the physical stability, and then the dams will be flattened to allow access for machinery. Ponds and heaps will then be prepared for subsequent use, which in most cases, means covering the ponds and/or heaps with soil and vegetating them.

If tailings and waste-rock facilities contain substances that can be hazardous to the environment, other measures need to be taken. These measures are aimed at the stability of the tailings and waste-rock facilities whilst minimising future monitoring. Generally, the major issues to be considered for the reclamation and closure of tailings and waste-rock management facilities include the long-term:

- physical stability of constructions
- chemical stability of tailings and waste-rock and
- successive land use.
The TMF areas of a mine site should be stable under extreme events such as floods, earthquakes and perpetual disruptive forces, including wind and water erosion, such that they do not impose a hazard to public health and safety or to the environment.

(...) It is at the closure phase of an operation, when usually the water level within the tailings drops and air enters the voids, that pyrite oxidation can occur and create a problem.

The rehabilitation of a site usually aims to turn the area into something that the local society needs and can make use of. This, of course, has to be compatible with the long-term stability of the site."

In conclusion, closure planning remains a technical challenge with no unified and authoritative approachxlix. It has always strongly site-specific in approach.
4 Description of the Project

4.1 General

The Project is situated in and immediately adjacent to the village of Roșia Montană in Albă County, approximately 80 km northwest of the regional capital of Albă Iulia, and 95 km north-northeast of the city of Deva in west-central Romania. This location is within the existing Roșia Montană mining district located immediately northeast of the town of Abrud. The Project is located in a region known as the Golden Quadrilateral in the Metaliferi Mountains, which belongs to a larger, regional mountain unit, called the Apuseni Mountains of Transylvania. The Golden Quadrilateral has been an important gold producing region in Europe for over 2,000 years.

The site lies within the 2,388 ha Roșia Montană mining exploitation concession licensed to RMGC, one of two mineral concessions maintained by the company in the region. The Roșia Montană mining licence gives RMGC the right, subject to granting of required permits and authorisations, to develop and mine the gold-silver and polymetallic resources and reserves based on the mining parameters specified in this document.

The existing mine, the CNCAF MINVEST SA Deva, the Roșiamin branch (Roșiamin), is a small-scale and degraded open pit mine owned and operated by Roșiamin, a subsidiary of the state-owned company CNCAF MINVEST SA Deva. The Roșiamin mineral processing plant and associated facilities fall outside the Roșia Montană mining license. The proposed Project will be developed to replace the existing mine and will be a large scale modern mine with an advanced metals recovery process plant and waste and water management systems largely lacking in the Minvest operation.

Operations will be continuous over 16 years based on the presently defined ore reserves upon which this development proposal is based. The operational period may extend as a result of further exploration. The Project will comprise at least 25 years of activity, which includes closure activities, with subsequent monitoring and follow-up work.

Closure is aimed to be progressive in nature, beginning in year 5 of the operations phase, with regrading and covering the Cetate waste rock dump. The schedule of closure activities is presented in detail in Section 8.

The proposed development comprises activities beyond the mine and gold recovery plant as it also includes the following:

- mitigation of environmental impacts related to centuries of ancient and more recent mining;
- cultural property activities (archaeological surveys, assessments, cataloguing and preservation of artefacts);
- assistance for the closing of the current government-subsidised mining operation (Roșiamin); and,
- resettlement of persons and facilities in impacted areas and the social support activities related to these activities.
It should be recognised that, unlike many other industrial facilities whose designs remain fixed, mining projects by their nature are dynamic and will continue to evolve in order to react appropriately to environmental circumstances. RMGC will therefore institutionalise a process of continual improvement (within the context of the ESMS described in Section 2) to ensure that the Project design and operations, and supporting management plans and Standard Operating Procedures, are also dynamic and adaptable toward improved compliance through the life of the Project.

The development of the Roşia Montană mine will involve a wide range of activities. These will include the following:

- development of open pit mines, processing operations, tailings management facilities, and various support facilities;
- management and mitigation of the environmental and social impacts of mining activities;
- restoration and rehabilitation of mined areas;
- assistance in the closing of the current government-subsidised mining operations; resettlement and relocation activities;
- archaeological surveys, assessments, and other cultural heritage preservation activities;
- mitigation of environmental impacts caused by historical mining operations; and,
- support for various local and regional development planning efforts; and other activities.

More detailed background discussions of the scope of the Project may be found in Chapter 2 of the Roşia Montană Project Environmental Impact Assessment and Chapter 2 of the EIA document.

4.2 Waste rock segregation strategy

With respect to mine closure and rehabilitation, it is especially important to manage mining wastes properly and ensure that the negative long-term impacts on the environment are minimal.

Mining activities at Roşia Montană will expose sulphide-bearing rock that may be potentially acid generating (PAG). Waste rock will be segregated into non-acid generating rock (NAG) and potentially acid generating rock.

Segregation and blending of waste material according to its acid generation potential is BAT, is environmentally advantageous and saves effort in mine closure with respect to the management of ARD.
Standard operating procedures (SOP) will be developed to mitigate ARD generation by segregating PAG and NAG material. General guidelines on these procedures are presented here:

- Drill cuttings from each drill hole will be collected and provided to the assay laboratory to be analyzed for relevant metals and elements before explosives and blasting agents are loaded into the holes.
- The samples will also be analyzed for sulphur content using the LECO methodology and applying the criteria for percent sulphur. Alternatively other analytical methods may be utilized if more effective.
- Test results must be verified by the Grade Control Engineers prior to blasting.
- The drill pattern will not be finalized until the Mine Department obtains the test results from the site assay laboratory.
- Blasting will occur only after the drill plan has been classified as NAG or PAG waste.
- Ore, PAG and NAG will be classified by the placement/attachment of clearly identifiable markings, such as flagging, colored tape, placards or signs, along the dig lines. Visual characteristics (e.g. black breccia) will also assist in properly flagging the material.
- All quantities of ore and waste rock will be recorded in the Project database.
- The mining Dispatch software will keep track of the exact location of each truck that carries any of the above material. Clearly marked destination points will receive the correctly dispatched material type.
- An established chain of command and documented quality assurance procedures will be in operation to ensure that all procedures for the identification of PAG rock are followed.
- The waste rock facility will be designed in such a way that multiple dumping faces will be available at the same time. Two dumping techniques will be utilized: “end dumping” and “stack dumping”. “End dumping” will be used for NAG material in the outer part of the waste rock facility and in the contact of the facility with the virgin topography. This occurs when trucks empty the load at the edge of a bench with a high slope beneath so that physical segregation of the grain sizes occurs. This results in larger rocks that are placed at the toe and finer material closer to the dumping point. This creates a type of a “French drain” which assists the preferential flow. “Stack dumping” will be used for PAG material placed in designated cells in the inner parts of the waste rock facility. Trucks empty their loads one next to the other on the inner part of a designated bench of the waste rock facility. A dozer flattens the surface and trucks drive on top of the new surface repeating the process. This results in compaction and water infiltration is avoided.
During operations all benches in the waste rock facility are maintained with slopes that direct precipitation water away from the center of the waste rock facility to the edges where NAG material was placed.

Wherever technologically feasible, PAG material which is end-dumped according to the mine plan will be covered and encapsulated with NAG material which is re-handled after the end of the operations phase, in order to minimize the amount of sub-soil and top-soil needed for a more elaborate cover.

The TMF starter dam will be constructed from “borrow” material from Sulei andesite quarry or from a comparable source, so that ARD potential is minimized.

The material which will be backfilled to the open pits will be sorted so that PAG material will predominantly be placed at the bottom of the backfill, minimising oxygen contact with the PAG material.

Wastes backfilled into the pits are covered with at least 10 metres of NAG material.

A more detailed outline of the testing method used for the waste segregation is described in a separate Technical Memorandum iii.

4.3 Closure of the pits

4.3.1 General objectives and requirements

Mining out the pits means that most of the underground mine workings are eliminated, and with them a large proportion of ARD generating host rock and ore which is exposed to air and infiltration water. This process leads to the substantial ARD generation which is observed at present at the 714 adit and further downstream in the Roșia valley. In particular, the pits will eliminate the mine workings where the highest concentration of sulphides and hence the largest ARD generating potential exists (see figure 4.1). After closure of the mined-out pits, only the pit walls are left which may generate acid drainage to accumulate in the pit lake and eventually drain to the Roșia valley. The total exposed surface of the pit walls is only a fraction of the existing exposed surface:

- Currently, known historic underground mine workings have a total length of more than 140 km. If an average cross section of the drifts of 4 m² is assumed (i.e., a circumference of the drifts of around 8 m), the surface of the mine workings is around 1.1 million m². However, most of the acid generating surfaces are not on the drift walls but located in porous areas, residual ore scattered along the drifts, and collapsed parts of the workings. This considerably increases the effective ARD generating surface of the existing mine workings.

- On the other hand, the surface of the pit walls which is exposed to air after flooding can be calculated based on the pit mine design, resulting in approximately 500,000 m² of a relatively flat surface, compared to the porous underground mine workings.

(It needs to be noted that the old historical workings followed the late clay-carbonate-quartz-base metal veins which tended to be softer thus easier to mine, higher grade, thus profitable but contained clays and sulphides thus generate acid. Historical mining inadvertently exposed material that contains more base and toxic metals, and although volumetrically small was more ARD producing).
Figure 4.1. Plan View of Mine Workings
According to European\textsuperscript{iv} and International\textsuperscript{v} regulations and BAT, rehabilitation means “the treatment of the land affected by a waste facility in such a way as to restore the land to a satisfactory state, with particular regard to soil quality, wildlife natural habitats, freshwater systems, landscape and appropriate beneficial uses”\textsuperscript{vi}.

The pits are important in the closure and rehabilitation of the entire site under many aspects which include, but are not limited to, the following\textsuperscript{vii}:

- **Landscape**: pits are central elements of the new landscape which is created during the mine life.
- **Biodiversity**: pits can provide outstanding potential for biodiversity which is often much greater than in pre-mining undisturbed land.
- **Waste management**: the pits can serve as repository for waste rock from the mining process.
- **Water management**: the pits can form a hydraulic sink which may play an important role in the site water management during and after closure.
- **Cultural identity**: pits may become part of the identity of a mining region, in that they embody a community’s pride of its mining history.
- **Tourism, recreation**: depending on the remediation of pits, there are various scenarios for recreation and tourism.
- **Education, Research**: Due to their ecological and hydrological specifics, mine pits can become the focus for education and research.

There are numerous EU and international examples of how pits can be turned into a cultural and environmental asset:

- **Federal Landscape Architecture Exhibition BUGA 2007 Gera-Ronneburg (Thuringia)**: The landscape of a former mining area will be remodelled with wetlands etc. cultural and mining heritage, including a strong educational aspect.
- **Similar examples exist in Lower Lusitania (Saxony, Brandenburg)** where a Federal Landscape Architecture Exhibition was held in 2001 in a former lignite mine area with dozens of flooded pits. Other EU examples include the Lousal Sulphide Mines (Portugal)\textsuperscript{viii}, the Castlecomer Mine (UK)\textsuperscript{lix}, and the numerous mine pits in Cornwall (UK)\textsuperscript{lx}.
- **International successful examples include the Butte Mine (Montana/USA), the Waihi Gold Mine (New Zealand), Kennecott Ridgeway Mine (South Carolina/USA), San Manuel copper mine (Arizona/USA)**.

Due to their importance, a careful planning of the after-use of the pits is essential to ensure the community can optimally benefit from the opportunities mine pits can offer. There are no general rules for pit closure, and a “one fits all” approach is inadequate. Instead, a site-specific approach taking into account BAT and the local specifics and expectations of the community is required.\textsuperscript{x}

It is BAT\textsuperscript{xii} to backfill waste rock into mine pits if transfer mining can be used, i.e., during the mining process, transferring the waste rock from the active pit to another pit which is already mined out.
4.3.2 Pit Closure Scheme

In the Roșia Montană Project, according to the waste rock balance of the mine plan, the following scheme has been adopted:

- the Jig pit is fully backfilled by transfer mining
- the Orlea and Cârnic pits are partially backfilled by transfer mining
- transfer mining is not applicable to the Cetate pit which is mined last.

The closure options which exist for the Jig, Orlea, Cârnic and for the Cetate pit, are discussed in the following sections:

The pit walls which are not covered by backfilled waste rock are left in a safe and stable condition. Loose blocks will be scaled off so that there is no risk to the public under the intended after-use scenarios (hiking, scientific und education trails). Like naturally steep slopes, climbing outside the pathways and trails is not recommended, and warning signs will be erected.

There could be an option to undertake rehabilitation blasting - which makes the faces still more natural in appearance - the faces rougher and "scree" at the foot of slopes. Rougher slopes can be revegetated more easily - either adventitious or by pocket planting of, for example, climbing plants. However, stability will remain the priority.

Table 4-1. Physical characteristics of the open pits

<table>
<thead>
<tr>
<th>Pit name</th>
<th>Amount (1000 tonnes)</th>
<th>Footprint (ha)</th>
<th>Backfill amount (1000 tonnes)</th>
<th>Backfilled with material from … pit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cârnic</td>
<td>227,355</td>
<td>27.43</td>
<td>34,221</td>
<td>Cetate, Jig, Orlea</td>
</tr>
<tr>
<td>Jig</td>
<td>15,525</td>
<td>18.2</td>
<td>13,944</td>
<td>Cetate</td>
</tr>
<tr>
<td>Orlea</td>
<td>66,022</td>
<td>26.51</td>
<td>16,850</td>
<td>Cetate</td>
</tr>
<tr>
<td>Cetate (south area)</td>
<td>162,930</td>
<td>4.93</td>
<td>1,936</td>
<td>Jig</td>
</tr>
<tr>
<td>Total</td>
<td>471,832</td>
<td>77.07</td>
<td>66,951</td>
<td></td>
</tr>
</tbody>
</table>

4.3.3 Jig Pit

The Jig Pit will be completely backfilled with waste material from the Cetate pit, using BAT transfer mining. The final landform will be such that no remnants of the pit remain (such as depression or uncovered slopes).

4.3.4 Orlea and Cârnic pits

4.3.4.1 Partial backfilling

The Orlea and Cârnic pits will be partially backfilled and covered using BAT transfer mining, so that a slight slope ensures surface water runoff without formation of wetlands. Neutral, undisturbed water running off the pit walls will be captured by trenches and diverted gravitationally directly to the Rosia or Corna valley. If water contains elevated concentrations of metals or a low pH, this is directed to the ARD treatment system for neutralization.
The mine plan also foresees a visual protection of the protected zone, so that there is no direct visual impact from Cârnic. However, visitors and the local population who want to walk to the recultivated pit surface can do so without any barrier.

Again, bare pit walls can be desirable as niches for endangered species, and can also be vegetated\textsuperscript{lxiii} (hydroseeding or planting climbing plants such as ivy).

A hiking trail or education trail (e.g., on mining and mining history) may be constructed which can attract visitors and create identity and pride of the mining heritage.\textsuperscript{lxiv}

4.3.4.2 Complete backfilling

Alternatively, the Orlea and Cârnic pits can be further backfilled using waste rock from the waste dumps. However, the slopes are very steep so that large amounts of waste material would be required to create a landscape form which is geotechnically stable, leading to excessive costs. This material is not available in the material balance of the transfer mining concept, so that waste rock material would have to be handled twice.

The disadvantages of backfilling the Orlea and Cârnic pits further than is foreseen in the mine plan are, in principle, the same as for backfilling the Cetate pit:

- **Landscape:** the bare or greened slopes enrich the landscape and may provide important niches for some species.
- **Noise, air quality:** If material has to be handled twice (which would be necessary in case of further backfilling the Orlea and Cârnic pits, there would be additional noise and an additional negative impact on air quality during the hauling of material.
- **Cost:** Backfilling the Orlea and Cârnic pits would incur considerable extra cost due to double-handling waste material.

4.3.4.3 Partial backfilling with wetland formation

As another alternative, partial backfilling the Orlea and Cârnic pits could also offer the opportunity to create wetlands if a slight depression is maintained on their surface. Wetlands forming on top of a partially backfilled pit have been successfully used for ARD neutralisation in open pits (e.g., Kinross Haile gold mine\textsuperscript{lxv}). Additionally, a wetland cover serving as an oxygen barrier which further prevents the generation of ARD from the underlying wastes is considered BAT.\textsuperscript{lxvi} The water which is collected in the depression eventually seeps through the backfill and is captured by the underground mine workings and led finally to the Cetate dam. An advantage of this alternative solution is that the wetland is an integrated part of the cover system. However, due to the uncertainties associated with the eventual water balance and sustainability, this wetland alternative is not the preferred solution and was therefore discarded as an option.

4.3.4.4 Preferred option

In summary, the closure objective of a more diversified, ecologically attractive after-use with an integrated water semi-passive management component can be better achieved and at less cost by a partial backfill according to transfer mining (BAT). This solution also ensures that undisturbed runoff water and low-pH runoff from parts of the pit slopes can be separated and drained freely, without formation of a wetland.

4.3.5 Cetate pit
The Cetate pit will be **flooded** which is international practice if transfer mining is not possible.

The Cetate pit offers an opportunity to create a unique landscape with a pit lake, new ecological habitats, recreational and cultural opportunities for the following types of activity, as examples:

- sports, hiking, mountain biking;
- picnicking;
- historic mining trail;
- education, research, bird watching;
- ecological niches for endangered species and development of unique biodiversity in a micro-climatically protected area.

According to the hydraulic model of the pits, the water table in the Cetate pit will rise to a final level of between 715 and 745 m a.s.l., depending on the hydraulic conductivity of the host rock, fractures and historic underground mine workings. With the lake bottom at 650 m a.s.l., the lake will have a depth of 65-95 meters. Together with the protected micro-climate of the pit this provides unique limnological conditions and a potential retreat for rare species.

Due to the natural mineralogical conditions at the site, there is some potential that water with low pH and elevated metal contents may be generated by the pit walls. Non-neutral pond water and mineralization create conditions conducive to the establishment of ecological niches for plants and animals with particular requirements. Water management must carefully be planned so that the water quality does not pose a threat to birds and other animals (e.g., via ingestion or the washing oil off the feathers).

The 15 m broad berms of the pit which have served as haul roads are vegetated with trees and grass. If generation of low pH water from the pit walls cannot be prevented, an appropriate drainage ditch will be installed which keeps the runoff from the steep slopes away from vegetated surfaces.

Bare pit walls (merely geotechnically secured) can be desirable as niches for endangered species (such as nesting sites for birds of prey), but can also be vegetated using hydroseeding or climbing plants (e.g., ivy). There are numerous examples of vegetated pit walls (including those with steep slopes such as in the Cetate pit). Based on the after-use scenarios which are currently envisaged, vegetated pit walls are the preferred option.

Numerous scientific and industrial activities and the attention of governments and the mining industry are devoted to the sustainable management of pit lakes. Established methods, further developed through scientific progress, will provide a site-specific solution to the management of the Cetate pit lake. Pit lake water management includes one or more of the following measures:

---

1 Due to the continued ARD generation in the unsaturated underground mine workings which remain unaffected by the pit mining, treatment of the effluent is likely to continue for a long time after closure, independent of the closure option for the mine pits.
gravitational diversion of low-pH runoff from sulphide-rich parts of the pit walls so that this water does not cause a deterioration in the pit lake quality;

in-pit treatment by lime addition has proved a successful option provided the generation and inflow of low-pH water can be minimized\footnote{loxx}, \footnote{loxiv}. This is achieved by

- fast flooding after the end of active mining so that sulphide-rich rock surfaces are submerged as soon as possible;
- securing the pit walls from failing (which would open new surfaces to oxidation);
- neutralising the sulphide-rich generating portions of the pit walls with suitable methods such as;
  - Strategic placement of mixtures of limestone and organic matter;
  - Application of proprietary products (e.g., bactericides or chemical sealants) on relevant areas;
  - Application of oxygen-consuming biological methods ("biomats") which also neutralize low-pH runoff;
  - Covering sulphide-rich areas with a mineral or synthetic layer;

adding a sufficient amount of alkalinity to the pit lake as an In-pit treatment method (e.g., excess alkalinity from on-shore treatment) which safely neutralizes the acidity rinsed off the upper layer of the pit walls for a limited period of time;

(semi-) passive in-pit treatment by the addition of organic matter, fostering the growth of Sulphate-reducing bacteria. Wood sawdust, spent mushroom compost, hay and straw, partially treated cattle manure, sewage sludge from the Project sewage treatment plant, and waste potato skins are among the organic waste materials that have been more or less successfully used in acid mine water remediation.\footnote{loxxv}

placement of coarse-grained limestone in the pit to provide the Carbonate buffer necessary for neutralization;

careful diversion of undisturbed drainage away from the pit and prevention of drainage from waste rock facilities from entering the pit.

In-pit treatment (alkalinity production) using Sulphate-reducing bacteria (SRB) has been shown at different mine sites to be a viable and long-term sustainable method to manage low-pH pit water.\footnote{loxxvi} A condition for in-pit treatment is that the zones with high SRB activity are not stirred and dispersed in a storm event, which could be the case in a deep pit such as Cetate. Methods used to stimulate SRB activity will include the following:

- neutralisation to raise the pH level into a range suitable for SRB activity;
- organic addition to develop anoxic conditions and encourage and feed sulphate-reducing bacteria; and,
- fertilisation to stimulate natural organic production in the lake.

With respect to the safety of visitors and local population, the following provisions will be made:

- an earthen perimeter berm of 2 metres height will be erected along the perimeter and vegetated with grass and shrubs, 7 meters from the first inward slope;
beyond this 7 m broad plain strip, the first berm will be regraded during closure so that there is no abrupt steep slope. People and animals approaching the pit are thus made aware of an increasing steepness of the slope;

- a pathway may lead hikers, mountaineers or mountain bikers down into the pit, and an outlook platform may be built, reducing the risk of people climbing down on unstable ground out of curiosity;
- signs will be posted, warning people against bathing in or drinking the pit water as it does not correspond to the national and EU standards for bathing and drinking water.

4.3.5.1 Backfilling option

Alternatively, the Cetate pit can be backfilled using waste rock from the waste dumps. This would have the following advantages:

- Generation of low-pH runoff from sulphide-rich parts of the pit walls would be further reduced;
- Reduced risk of an unregulated landfill in the pit ("fly tipping");
- Backfilling takes 2-4 years after which closure is completed, whereas creation of the pit lake will take 5-30 years, depending on the final lake level.

However, there are numerous disadvantages in backfilling the Cetate pit, which is the last pit and, therefore, cannot be included in the transfer mining strategy employed for the other pits as outlined below:

- Landscape: From the point of view of a diversified landscape and the availability of protected habitats, given that all other pits in the project footprint have been fully or partially backfilled, a lake is clearly preferable;
- Noise, air quality: If the Cetate pond were backfilled, there would be additional noise and an additional negative impact on air quality during the hauling of material. This impact would not exist if the pit is flooded;
- Cost: Backfilling the Cetate pit would incur additional cost of the order of 100 million US$. This is an order of magnitude more than the cost estimated for long-term pit water management;
- Inter-dependence with other closure and remediation activities: The open Cetate pit serves as a reservoir for TMF decant pond water which is removed from the impoundment area within a short time in order to start consolidation and covering of the TMF in the shortest possible time. Backfilling of the Cetate pit would bar this option, unless extra water treatment capacity is installed to remove the residual cyanide from the decant pond water, or waiting a sufficient time (several months to years according to model calculations) until natural degradation has led to a cyanide concentration below 0.1 mg CN\text{tot}/l;
- Loss of potentially mineable reserves: Backfilling of the pit would potentially sterilise ore resources which could otherwise become recoverable in the future.

4.3.5.2 Preferred option

In summary, the ecological, socio-economic and cultural objectives for the rehabilitation of the Cetate pit can be achieved more cost-effectively by the creation of a pit lake. Given the numerous opportunities a pit lake can offer, it is the preferred option.
4.4 Water quality predictions and water treatment

4.4.1 Applicable effluent standards

Table 4-2. Effluent quality standards to be observed in the project

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Romanian Standard NTPA 001/2005, in mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>0.1</td>
</tr>
<tr>
<td>Aluminium (Al)</td>
<td>5</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.2</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>300</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>500</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>1</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>1</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.1</td>
</tr>
<tr>
<td>Fluoride</td>
<td>5</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>5</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.2</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>100</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>1</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.05</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>0.1</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.5</td>
</tr>
<tr>
<td>Nitrates (NO3)</td>
<td>25</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>0.1</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>0.1</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.5</td>
</tr>
<tr>
<td>Ammonia (NH4)</td>
<td>2</td>
</tr>
<tr>
<td>Nitrites (NO2)</td>
<td>1</td>
</tr>
<tr>
<td>pH</td>
<td>6.5 to 8.5</td>
</tr>
<tr>
<td>Sulfate (SO4)</td>
<td>600</td>
</tr>
<tr>
<td>TSS (Total Susp. Solids)</td>
<td>35</td>
</tr>
<tr>
<td>Cyanide (CNtot)</td>
<td>0.1</td>
</tr>
<tr>
<td>TDS (Total Dissolved Solids)</td>
<td>2000</td>
</tr>
</tbody>
</table>

4.4.2 Cetate pit lake

According to the mineralogical composition of the pit walls, the quality of the pit water can be roughly predicted, as documented in the Engineering Review Report.
Table 4-3. Pit lake quality scenarios

<table>
<thead>
<tr>
<th>Parameter (mg/L)</th>
<th>Acid Rock Drainage Water VXB01</th>
<th>Non-acid Rock Drainage Water VXB10</th>
<th>Mixed Water (10:90)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (std. units)</td>
<td>2.0</td>
<td>6.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Eh (mV)</td>
<td>430</td>
<td>194</td>
<td>326</td>
</tr>
<tr>
<td>Aluminium(1)</td>
<td>100</td>
<td>0.005</td>
<td>10.1</td>
</tr>
<tr>
<td>Iron</td>
<td>1,657</td>
<td>0.07</td>
<td>167</td>
</tr>
<tr>
<td>Copper</td>
<td>20.5</td>
<td>0.0021</td>
<td>2.06</td>
</tr>
<tr>
<td>Nickel</td>
<td>1.44</td>
<td>0.0001(3)</td>
<td>0.14</td>
</tr>
<tr>
<td>Zinc</td>
<td>4.26</td>
<td>0.006</td>
<td>0.43</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.67</td>
<td>36.4</td>
<td>32.8</td>
</tr>
<tr>
<td>Magnesium</td>
<td>6.09</td>
<td>2.67</td>
<td>3.01</td>
</tr>
<tr>
<td>Potassium</td>
<td>14.5</td>
<td>0.82</td>
<td>2.19</td>
</tr>
<tr>
<td>Sodium</td>
<td>1.03</td>
<td>2.59</td>
<td>2.43</td>
</tr>
<tr>
<td>Chloride(2)</td>
<td>20.6</td>
<td>8.88</td>
<td>----</td>
</tr>
<tr>
<td>Sulphate</td>
<td>2,616</td>
<td>11</td>
<td>273</td>
</tr>
<tr>
<td>Alkalinity as HCO3</td>
<td>0</td>
<td>91.5</td>
<td>0</td>
</tr>
</tbody>
</table>

The following components are likely to exceed the NTPA 001/2005 standards and therefore need treatment before any pit water can be discharged into the environment outside the project confines.

Table 4-4. Components in pit water exceeding the NTPA 001/2005 standard

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ARD</th>
<th>Non-ARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>4.5 units</td>
<td>-</td>
</tr>
<tr>
<td>SO4</td>
<td>4.5</td>
<td>-</td>
</tr>
<tr>
<td>Al</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Fe</td>
<td>320</td>
<td>-</td>
</tr>
<tr>
<td>Cu</td>
<td>200</td>
<td>-</td>
</tr>
<tr>
<td>Zn</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>Ni</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

The exact composition of the pit lake water is not known and strongly depends on the ratio between sulphidic and neutralizing minerals in the pit walls, but the hypothetical mixing of ARD with non-ARD in the fourth column of table 4-3 shows that even for a mixing ratio of ARD:non-ARD = 10:90 the pH of the pit water will fall below the NTPA 001/2005 limit. The portion of low-pH producing material in the pits was estimated from the geological exploration results to be 34%\(^{\text{xxx}}\), so that it is likely that the pit water will need treatment when flooded.

The water in the pit lake can be neutralized with suitable methods such as liming (see Section 4.3). This method will generate sustainable improvements in water quality if the sulphidic parts of the pit walls are sealed.

It must be emphasised that a more detailed prediction of the pit lake quality will be possible only during the operations phase, when more statistically relevant mineralogical samples become available. This Mine Closure and Rehabilitation Management Plan and other Management Plans within the Project's ESMP (see Section 2) will be continuously updated accordingly. However, this does not invalidate the general pit closure strategy described in Section 4.3.

**4.4.3 Waste rock dumps**
The ABA testing of waste material presented in the *Engineering Review Report, Appendix B – Geochemistry Characterisation Study* has revealed the following geochemical characterization of the waste rock which is expected throughout the mine life.

**Table 4-5. Relative amounts of minerals in the waste rock, and related acid generation potential**

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Percent of Waste Rock</th>
<th>ABA Classification (Acid Generation Potential)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andesite</td>
<td>3.6 %</td>
<td>None</td>
</tr>
<tr>
<td>Black Breccia</td>
<td>15.3 %</td>
<td>Likely</td>
</tr>
<tr>
<td>NSIK Dacite</td>
<td>16.9 %</td>
<td>Possible</td>
</tr>
<tr>
<td>SIK Dacite</td>
<td>2.2 %</td>
<td>Likely</td>
</tr>
<tr>
<td>Existing Waste Rock Dumps</td>
<td>0.2 %</td>
<td>Likely</td>
</tr>
<tr>
<td>Sedimentary Rocks</td>
<td>5.3 %</td>
<td>None</td>
</tr>
<tr>
<td>NSIK Vent Breccia</td>
<td>52.5 %</td>
<td>None</td>
</tr>
<tr>
<td>SIK Vent Breccia</td>
<td>4.0 %</td>
<td>Likely</td>
</tr>
<tr>
<td>Weighted Median Classification</td>
<td>100 %</td>
<td>None</td>
</tr>
</tbody>
</table>

Note: Potential ARD characteristics are only partially predictable by lithology.

"None" and "low-acid generating potential" account for 61.4% of the waste rock (i.e., clearly dominating the geochemical characterisation), while material rated "likely" or "possibly" ARD generating accounts for 38.6%. Overall, there is a net neutralising potential of the waste rock material which will be placed on waste rock facilities or backfilled into the open pits through transfer mining.

RMGC will implement a waste segregation strategy as described in Section 4.2.

The main conclusion relevant to the waste rock seepage quality predictions drawn from the geochemical testing program is that it is likely to have the characteristics of a neutralised ARD, with neutral pH, low concentrations of heavy metals but elevated contents of Sulphate, Calcium, Magnesium and TDS. It is expected to be similar to the Cetate waste dump seepage (third column of table 4-6).

**Table 4-6. Examples of waste rock seepage**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Cetate Seepage (Station S031)</th>
<th>Field Column Leachate (VXB07)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Std. Units</td>
<td>6.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Conductivity</td>
<td>mS/cm</td>
<td>489</td>
<td>3340</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>62.4</td>
<td>327</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>18.4</td>
<td>458</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/L</td>
<td>6.12</td>
<td>14.4</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/L</td>
<td>140</td>
<td>2168</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/L</td>
<td>0.0048</td>
<td>0.0093</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/L</td>
<td>0.0024</td>
<td>ND</td>
</tr>
<tr>
<td>Chromium</td>
<td>mg/L</td>
<td>0.0019</td>
<td>0.0181</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>0.0058</td>
<td>0.0171</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>1.1</td>
<td>0.06</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L</td>
<td>0.675</td>
<td>0.50</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/L</td>
<td>0.0049</td>
<td>0.0397</td>
</tr>
<tr>
<td>Selenium</td>
<td>mg/L</td>
<td>0.0092</td>
<td>0.0426</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/L</td>
<td>0.0226</td>
<td>0.186</td>
</tr>
</tbody>
</table>

While the Cetate seepage quality shown in table 4-7 in the field column leachate is likely to exceed the NTPA 001/2005 standards and therefore needs treatment before waste rock seepage can be discharged into the environment outside the project confines.
Table 4-7. Components in waste rock seepage exceeding the NTPA 001/2005 standard

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cetate seepage</th>
<th>Field column leachate (VXB07)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Exceeding NTPA 001/2005 by factor...</td>
</tr>
<tr>
<td>Ca</td>
<td>-</td>
<td>1.1</td>
</tr>
<tr>
<td>Mg</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>SO4</td>
<td>-</td>
<td>3.5</td>
</tr>
</tbody>
</table>

The Geochemistry Characterisation Report states that the waste rock seepage quality may be similar to that associated with the current Cetate waste rock dump.

With the encapsulation of PAG material by either stack-dumping or placing a more sophisticated cover on the end-dumped PAG material, seepage from the NAG portions will clearly dominate the seepage, and the resulting seepage quality from the waste dumps can be discharged without treatment.

If the seepage quality has elevated concentrations such as those shown in the last columns of table 4-6 and table 4-7, the collected seepage will be directed to the ARD treatment plant before it is discharged, but this is unlikely given the generally benign chemistry of the water and the waste segregation/encapsulation strategy to be implemented by RMGC.

In the operations phase, when more statistically relevant waste rock samples become available, the predictions for the chemical composition of the waste rock seepage will be continuously updated.

4.4.4 TMF decant pond and seepage water

The chemical composition of the water in the decant pond is determined by the quality of the tailings slurry water pumped from the detoxification plant to the decant pond as presented in table 4-8. It has been described in detail in the Engineering Review Report.

Three samples were tested representative of ore blends from the first seven years of mining. The samples are described as follows:

- Sample RM1 – Dacite dominated with 80 percent from Cârnic and 20 percent from Cetate, representative of Years 1 through 3;
- Sample RM2 – Dacite and mixed breccia with 33 percent from Cârnic and 67 percent from Cetate, representative of Year 4; and
- Sample RM3A – Dacite dominated with 100 percent from Cârnic, representative of Years 5 to 7.
Table 4-8. Composition of TMF decant water (detoxification plant effluent), laboratory results

<table>
<thead>
<tr>
<th>Component</th>
<th>RM 1</th>
<th>RM 2</th>
<th>RM 3A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cyanide</td>
<td>1.13*</td>
<td>5.09*</td>
<td>3.29*</td>
</tr>
<tr>
<td>WAD Cyanide</td>
<td>0.37*</td>
<td>0.77*</td>
<td>0.22*</td>
</tr>
<tr>
<td>Thiocyanate</td>
<td>70</td>
<td>69</td>
<td>91</td>
</tr>
<tr>
<td>Cyanate</td>
<td>390</td>
<td>390</td>
<td>350</td>
</tr>
<tr>
<td>Thiosalts</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>2.50</td>
</tr>
<tr>
<td>Ammonia</td>
<td>6.6</td>
<td>7.3</td>
<td>25</td>
</tr>
<tr>
<td>Gold</td>
<td>0.0085</td>
<td>0.043</td>
<td>0.0165</td>
</tr>
<tr>
<td>Silver</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Aluminium</td>
<td>&lt;0.2</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.30</td>
<td>&lt;0.2</td>
<td>0.20</td>
</tr>
<tr>
<td>Boron</td>
<td>0.20</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>Barium</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Beryllium</td>
<td>&lt;0.02</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Bismuth</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Calcium</td>
<td>401</td>
<td>675</td>
<td>707</td>
</tr>
<tr>
<td>Cadmium</td>
<td>&lt;0.5</td>
<td>&lt;0.1</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Cerium</td>
<td>&lt;0.010</td>
<td>&lt;0.010</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0.40</td>
<td>0.40</td>
<td>0.80</td>
</tr>
<tr>
<td>Chromium</td>
<td>&lt;0.2</td>
<td>&lt;0.2</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Cesium</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Copper</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Dysprosium</td>
<td>&lt;0.010</td>
<td>&lt;0.050</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td>Erbium</td>
<td>&lt;0.010</td>
<td>&lt;0.050</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td>Europium</td>
<td>&lt;0.002</td>
<td>&lt;0.050</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Iron</td>
<td>0.20</td>
<td>1.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Gallium</td>
<td>&lt;0.2</td>
<td>&lt;0.1</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Gadolinium</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Germanium</td>
<td>&lt;0.5</td>
<td>&lt;1</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Hafnium</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Potassium</td>
<td>142</td>
<td>136</td>
<td>132</td>
</tr>
<tr>
<td>Lanthanum</td>
<td>&lt;0.010</td>
<td>&lt;0.010</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td>Lithium</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Magnesium</td>
<td>5.4</td>
<td>14.4</td>
<td>8.2</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.30</td>
<td>0.80</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.4</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Sodium</td>
<td>725</td>
<td>900</td>
<td>705</td>
</tr>
<tr>
<td>Niobium</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Neodymium</td>
<td>&lt;0.010</td>
<td>&lt;0.010</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.20</td>
<td>0.40</td>
<td>0.20</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>&lt;1</td>
<td>&lt;0.5</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Lead</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Praseodymium</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Rubidium</td>
<td>0.35</td>
<td>0.35</td>
<td>0.50</td>
</tr>
<tr>
<td>Sulphur</td>
<td>660</td>
<td>1030</td>
<td>962</td>
</tr>
<tr>
<td>Sulphate(1)</td>
<td>1980</td>
<td>3090</td>
<td>2886</td>
</tr>
<tr>
<td>Antimony</td>
<td>0</td>
<td>0.28</td>
<td>0.06</td>
</tr>
<tr>
<td>Scandium</td>
<td>&lt;0.5</td>
<td>&lt;0.1</td>
<td>&lt;0.5</td>
</tr>
</tbody>
</table>
Seepage quality will be dominated by the process water quality for years after closure. Seepage transport modeling of cyanide suggests that process water will not appear at the Secondary Containment Dam sump for as many as eight years after start-up. Moreover, cyanide may never exceed the NTPA 001/2005 standard in the seepage due to natural attenuation processes. An ARD component in the seepage is not expected because operation of the TMF will inhibit ARD generation due to the rapid accumulation of tailings. Prompt closure of the TMF and placing a cover containing an oxygen barrier will also prevent ARD generation. In addition, the large mass of initially alkaline tailings at closure will help to neutralise any ARD infiltrating into the tailings.

It is assumed that the TMF dam seepage water collected at the Secondary Containment Dam in the Corna valley will have the same compositions as the decant water. This assumption is very conservative having regard to the following considerations:

- heavy metals and metalloids such as Arsenic are very likely to be retarded (mainly by adsorption on the tailings and soil particles in the dam and underground); and,
- cyanide will naturally degrade, given the long migration time through the tailings body.

The components set out in table 4-9 are likely to exceed the NTPA 001/2005 standards and therefore need treatment before decant pond water and dam seepage can be discharged into the environment outside the project confines.
Table 4-9. Components in TMF dam seepage and decant pond water exceeding the NTPA 001/2005 standard

| Parameter | Exceeding NTPA 001/2005 by factor...
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CNtot</td>
<td>10-50 (laboratory results), 100-150 (expected for large-scale operations)</td>
</tr>
<tr>
<td>NH4</td>
<td>3-13</td>
</tr>
<tr>
<td>As</td>
<td>2-3</td>
</tr>
<tr>
<td>Ca</td>
<td>1.3-2.3</td>
</tr>
<tr>
<td>Mo</td>
<td>3-4</td>
</tr>
<tr>
<td>SO4</td>
<td>3-5</td>
</tr>
</tbody>
</table>

The long-term evolution of the seepage water quality is determined by the infiltration rate and oxygen diffusion. The results obtained from modeling the cover system are schematically shown in figure 4.2xxxvii.

**Figure 4.2.** Schematic representation of the basic parameters used for predicting the long-term behaviour of the tailings seepage

Content of buffer material (Calcite, Dolomite) in tailings bears some uncertainty. Modeling shows that acidification (low pH) will be effectively prevented due to oxygen-barrier in cover system and siderite buffer. However, elevated iron concentrations may appear after some decades if no sufficient calcite buffer is present in the vadose zone. Therefore, the addition of lime, limestone in later phases of tailings deposition, disposal of alkaline concrete rubble during demolition phase, ashes from thermopower plants (e.g., from Mintia) is foreseen to provide enough buffer capacity in case lack of Calcite is confirmed.

The water treatment technology that is employed is described in more detail in Section 4.1 of the EIA and the Water & Erosion Management Plan which will be regularly updated as more information on water quality become available.

**4.4.5 Water treatment technologies to meet the NTPA 001/2005 standards**
4.4.5.1 Active treatment

As is evident from the comparison of the expected water quality at different sources (see table 4-4, table 4-7, and 4-9), the water treatment plant must cope with the following:

- pH;
- heavy metals;
- metalloids (Arsenic);
- neutral salts (Sulphate, Calcium).

It is BAT to use lime precipitation to treat ARD, possibly adding ferric salts to remove arsenic. However, lime precipitation alone does not achieve the low Romanian standards for Sulphate and Calcium in effluent (and TDS which, as a sum parameter, is closely related to both). Therefore, additional treatment technologies which can serve as an add-on to simple lime treatment have been investigated and compared. A detailed evaluation of feasible technologies and the selection of the technology which is preferred under the current knowledge is contained in Section 5 (Alternatives) of the EIA.

The following technologies have been considered as options to treat ARD, waste rock seepage and TMF dam seepage water with respect to heavy metals, Arsenic, pH, Sulphate and Calcium:

A. Ettringite precipitation (Walhalla process, proven technology which also reduces Calcium in the water to the NATP 001/2005 limits, but produces considerable volumes of wastes);
B. Use of BaCl₂ to precipitate BaSO₄ (feasible in principle but expensive and will lead to a Chloride problem, and does not remove Calcium);
C. ThioPaques process (reactor-based biological SO₄ reduction, difficult to control but with a small volume of residues; does not remove Calcium);
D. GypCIX process (combination of precipitation and ion exchange processes);
E. Reverse Osmosis (which may cause problems with scaling on the membranes, and unresolved question of brine disposal).

Only options A and D satisfy all requirements of the NTPA 001/2005 standard (except cyanide and nitrogen compounds). Of these two, Ettringite precipitation is more cost efficient than the GypCIX process and is therefore chosen as the preferred option on which estimates for amounts and characteristics of water treatment wastes are based.

This comparison cannot replace a detailed technology comparison which will be carried out in the construction phase, but it can serve as a basis for a reasonable estimate on technological parameters and wastes streams.

The water treatment process and the corresponding waste amounts of the Gypsum/Ettringite process have been modelled in a report based on the current Adit 714 mine effluent, using a code (AquaC) which is mainly based on PHREEQC. The objective was to achieve the NTPA 001/2005 standards. The optimal solution was found to be the following combination of Gypsum and Ettringite precipitation:

1) Lime precipitation to pH=10.5, separation of the Gypsum sludge;
2) Ettringite precipitation to pH=11.5, separation of the Ettringite sludge;
3) re-neutralisation to pH=8.5 by HCl or CO₂.
Conservatively assuming Sulphate concentrations of around 2000-3000 mg/l and total Iron concentrations of 300-600 mg/l, a specific waste generation of 10 kg/m³ of dry residues is a reasonable and sufficiently conservative prediction.

4.4.5.2 Removal of cyanide and degradation compounds

There are the following options for secondary cyanide treatment to achieve the NTPA 001 discharge standard of 0.1 mg/l CN_total:

- Reverse Osmosis (RO), generating a brine which requires disposal or further treatment
- Adsorption on Activated Carbon or Bone Char, both generating spent sorbents which are classified as hazardous waste
- A peroxide process which does not generate waste

A detailed engineering design study including pilot tests will be carried out in the construction phase, followed by a detailed design, so that the detailed design of the secondary CN treatment system is in place and ready for construction (if required) when the production phase starts.

It is most likely that the peroxide treatment will be the preferred option because most quantitative data is available for the design and piloting the treatment system, and it does not generate waste, which also best satisfies the objectives of RMGC’s waste management strategy where waste avoidance is of highest priority.

4.4.5.3 Semi-passive treatment

Over the long term, conventional water treatment plants become more and more inefficient, as their operating costs are largely independent on the contaminant load to be removed, which decreases with time. Semi-passive systems then become increasingly attractive, as they require only a low level of maintenance, consumables (if at all) and care. Recent research and practical experience from numerous semi-passive treatment systems for mine effluents in the EU and worldwide show that semi-passive water treatment techniques are becoming more and more an established and proven option.

The semi-passive treatment systems will be developed based on the guidelines developed by the PIRAMID Consortium, which was funded by the European Commission.

A series of two cells and one pond will be constructed to form the entire semi-passive treatment system. The cells and pond will be operated in series with an anaerobic cell used for initial treatment, followed by an aerobic cell, and then a mixing pond. The mixing pond will be used to provide a single discharge point where “clean” site runoff and Wastewater Treatment Plant (treated ARD) water can be co-mingled and discharged to the environment. The anaerobic cell will function to consume acidity (if present), generate alkalinity, and remove metal contaminants. In addition, the anaerobic lagoon will be effective in removing cyanide if it is present in the seepage. Anaerobic conditions are achieved using organic matter that produces a strong reducing environment and promotes certain bacteria that result in chemical transformation of metals, sulphate and cyanide. Water is allowed to permeate through a layer of organic compost into an underlying limestone gravel layer and then is discharged from the system. The organic layer acts as the reducing environment and the limestone gravel increases alkalinity, if ARD is present. Nitrogen compounds, such as
nitrate, will also likely be present in the seepage due to the degradation of cyanide. De-
nitrification will also reduce the concentration of these compounds and produce nitrogen gas.

The aerobic lagoon will polish the water by removing additional metal constituents and 
oxigenating the water prior to discharge into the mixing pond. The aerobic wetland will 
remove additional metals by sedimentation of suspended flocs, filtration of flocs by plant 
stalks, adsorption of aqueous metal species, precipitation of hydroxides on plant stalks and 
by direct plant uptake. Common reed species such as *Typha latifolia* and *Phragmites 
australis* are commonly used in aerobic cells. Any remaining nitrogen compounds will act as 
fertilizer for the plant growth and will be consumed.

The mixing pond is used to mix water coming from the aerobic lagoon and water from Corna 
stream and act as a final sedimentation pond. After mixing of the two water types in the 
pond, the resulting water will be discharged back into the Corna drainage.

The design criteria for the passive water treatment system will be established more precisely 
during the test period. Even more advanced approaches are likely to be developed 
throughout the next few years, as numerous intense R&D activities on passive biological or 
semi-passive cyanide removal have been launched recently. Even if the assumptions 
made for the CN treatment rates in the Engineering Review Report have to be modified, 
there is enough space to accommodate larger lagoons. Moreover, after closure, the seepage 
rate will significantly drop due to the cover placed on the TMF, so that the flow rate the 
lagoons will have to deal with is smaller.

4.5 **Cover systems design approach for mining wastes**

4.5.1 **Waste rock stockpiles**

Due to the segregation strategy, the stack-dumping of large parts of the occurring PAG and 
the selective covering of end-dumped PAG material which will be pursued by RMGC during 
the operations period, seepage from the waste rock piles is expected to be environmentally 
benign. The design criteria for the cover on the waste rock dumps are summarized in the 
following.

4.5.1.1 **Cover on NAG material**

For the NAG material and portions of the waste rock dumps where PAG material is stack-
dumped and "encapsulated" by NAG material, design criteria for the cover systems are as 
follows:

- prevention of inadvertent access to the wastes;
- support of vegetation;
- improvement of visual appearance;
- prevention of dust blown off the wastes;
- erosion control.

The minimum thickness for achieving the design criteria for NAG material is 30 cm, 
consisting of the following:

- 10 cm topsoil; with vegetation cover
- 20 cm subsoil of clayey silt.
By contrast to the cover on PAG material discussed below, the much thinner cover on the NAG material forming the upper part of the pit backfill will not (and does not need to) have a significant effect on the infiltration rate so that 25-30 % is assumed for the water balance, which is comparable to the infiltration rate into uncovered waste or natural soils. The prime function of this cover is to provide a suitable medium for supporting vegetation.

4.5.1.2 Cover on PAG material

Additionally, for the PAG material which is end-dumped separately without encapsulation by NAG material, the design criteria additionally include the following:

- minimization of water infiltration into the wastes;
- minimization of oxygen entry to the wastes.

To achieve these additional design criteria, the cover must be significantly thicker, and possess sufficient long-term stability of its hydraulic and gas transport properties.

The cover design also draws from international practice and experience. One of the biggest mine closure projects in Europe, but also worldwide, is the Wismut remediation project (Germany). Under this mine closure program various types of soil covers are being constructed for some 30 individual waste rock dumps, backfilled open pits, and tailings ponds at about ten individual mining and milling sites, with a total area of about 1000 ha. The cover types designed by Wismut according to BAT include the types foreseen for Roșia Montană, i.e. simple thin-layer covers, which must fulfill the minimum cover requirements (erosion control, re-vegetation, prevention of access to the waste rock or tailings), as well as more sophisticated store-and-release covers as described above. Much experience has been obtained concerning the performance of these SRC systems, as they are the most common cover type at Wismut sites and elsewhere.

It must be emphasized that the primary material parameter for a store and release cover is the water storage capacity of the cover profile, which is defined by the effective field capacity of the soil multiplied by the effective thickness of the profile. On the other hand, evapotranspiration over dry periods must be high enough to “empty” the soil pores which have been filled over the wet seasons. Pure SRC systems have only limited functionality in humid or wet areas in terms of percolation, as they rely on the annual climatic water balance of the site (precipitation vs. evapotranspiration). Cover performance in terms of infiltration control is a function of the precipitation, evapo-transpiration and storage capacity. Very simple estimates of the percolation have been described in various references, and a more accurate prediction based on Richards’ equation should be modeled, using site specific meteorological data, soil properties, and vegetation characteristics.

Experience from the Alternative Cover Assessment Program (ACAP) clearly indicates the performance of SRC’s as a function of the precipitation/evapotranspiration ratio (P/PET): as long as P/PET is < 0.5, percolation rates smaller than 10 % of the annual rainfall can be achieved. If, however P/PET is ≥ 1, mean percolation rates increase up to ≥ 20 %. At a site in the Erzgebirge mountains (Germany, cover thickness 1.0 m, mean precipitation 804 mm/a, P/PET =1.5), average percolation rate for a 6-year-period was in the order of 20-30 %, with percolation rates up to 40 % for the 2002 wet year (rainstorm event in August 2002). Cover performance was found to be clearly dependent on slope exposure, with higher percolation at NE-exposed slopes in comparison to slopes with SW-exposure.

For the cover on end-dumped PAG portions of the waste rock facilities (and the TMF, see Section 4.5.3), an SRC with an additional compacted clay barrier has been proposed (see above) to provide the following:
ensures the development of a capillary break with the underlying waste rock; and,

additional minimizes percolation and oxygen flux due to the low hydraulic conductivity of this layer.

Based on international experience, adapted to the climatic conditions, the following Store & Release Cover (SRC) complemented by a layer of low oxygen diffusion is proposed (this is comparable to similar cover systems across the EU):

- 10 cm topsoil; vegetated by shallow-rooted plants such as grass to prevent erosion and assist evapo-transpiration
- 80-140 cm subsoil of clayey silt;
- 30-40 cm subsoil of compacted clayey silt as an oxygen barrier.

The thickness of the cover layers on PAG material has been chosen in order to minimize deterioration effects and deliver a satisfactory long-lived performance according to BAT. Similar systems have been described in the BREFs.

Due to compaction, the oxygen barrier maintains a high pore saturation and thus effectively inhibits oxygen diffusion (oxygen diffusion is highly dependent on the saturation of soil pores with water). The use of water-saturated oxygen barriers as part of a cover is BAT. Long-term stability of the oxygen barrier can be guaranteed if frost cracking, root penetration and other long-term perturbation effects are safely precluded. The Romanian standard for frost-safe constructions is 90 cm. The test plots described in Section 4.5.4 will demonstrate under site-specific conditions that root penetration by local species will not damage the oxygen barrier and, if this turns out to be a potential problem, the cover configuration will be changed.

Along with its significant reduction of oxygen diffusion, the PAG cover will also reduce infiltration. Based on international experience with similar cover systems and water balance/oxygen diffusion models carried out for different cover configurations including the cover foreseen for the PAG sections of waste rock dumps, the infiltration rate for comparable cover systems under similar climatic conditions as in Roşia Montană is in a range of around 10 to 25 % of the annual precipitation.

Comparable modeling results from the Wismut Project, supported by monitoring data of time series of up to 10 yrs confirm such infiltration rates. The Wismut data are relevant to (and comparable with) the Roşia Montană Project since the climatic conditions at the various sites (average annual rainfall ranges from some 600 to some 800 mm, estimated P/PET-ratio ≈ 1…1.5, comparable temperature curves) are similar to Roşia Montană.

However, cover performance can vary over a wide range depending on the site specific conditions such as the following:

- soil properties and their long-term behaviour;
- properties of the vegetation;
- variation (annual, seasonal) of the climatic conditions.

Over its entire lifetime, the cover profile, at least its uppermost part, undergoes substantial changes due to perpetual disruptive forces, as follows:
- erosion (wind and water erosion);
- biotic activity (root penetration, burrowing animals);
- frost action;
- desiccation; and,
- chemical weathering.

These effects may lead to structural changes in the soil accompanied by a loss of effectiveness of the cover. Extreme events, such as floods, droughts, earthquakes, forest fires etc., can dramatically enhance this development. Accordingly, over a prediction period of decades or even centuries, the performance of a cover cannot be derived from data gained during or immediately after construction. Time series of infiltration data longer than 15 yrs are extremely scarce, and the reliability of these datasets is questionable. However, numerous case studies clearly indicate that covers lose their functionality if they are not constructed properly. Therefore the minimum thickness of any “barrier” cover has to be carefully selected following consideration of such processes and effects.

For re-vegetation, there are specific regulations in Romania laid down in the Technical Instructions 2/1996 which will be observed.

4.5.2 Backfilled pits

Due to the backfill regime where PAG material will be covered with at least 10 meters of NAG material, there is little concern about ARD generation. Therefore the cover design criteria are the same as those described above for the NAG sections of the waste dumps:

- 10 cm topsoil; with vegetation cover
- 20 cm subsoil of clayey silt.

The same remarks as made on the cover performance for NAG material apply here, too.

4.5.3 TMF

It is BAT to prevent acidification of tailings at the outset and only then to manage (treat) the ARD if that is required. During operations with tailings saturated, acidification will not be an issue, but with decreasing pore water level in the tailings body during closure, it may become a problem, as the geochemical analyses of the tailings material show. Once acidification has started, it is harder to stop and mitigate than if it is prevented by appropriate measures from the beginning.

If oxygen diffusion is sufficiently suppressed, acidification can be prevented. Therefore the same design principles are applied as for the PAG sections of the waste dumps, i.e. as follows:

- 10 cm topsoil; vegetated by shallow-rooted plants such as grass to prevent erosion and assist evapo-transpiration;
- 80-140 cm subsoil of clayey silt;
- 30-40 cm subsoil of compacted clayey silt as an oxygen barrier.
The hydraulic properties and the range of the infiltration rate which can be plausibly assumed is the same as for the PAG sections of the waste dumps, i.e., 10-25 % of the annual precipitation.

The TMF dam will be constructed of NAG material where a simple cover (like that on the waste rock facilities) will suffice, i.e.,

- 10 cm topsoil; with vegetation cover
- 20 cm subsoil of clayey silt.

4.5.4 Test plots

Test plots will be installed during operations which will substantiate the design of the cover systems on the TMF, the waste dumps and the backfilled pits, especially with respect to the key factors, as follows:

- oxygen transport through the barrier layer;
- water balance (total infiltration, internal water balance within the cover system);
- optimum vegetation and root penetration depth;
- frost penetration depth;
- effects of burrowing animals.

The test plot concept presented and discussed in Appendix R, Annex C of the Engineering Review Reportcxx forms the basis of the testing configurations. In their design, the test plots are complemented with additional variants:

- different thicknesses of cover layer(s);
- different slope angles;
- different seed mixtures, vegetation patterns and care/maintenance scenarios (unrestricted natural succession, controlled succession);
- different degrees of compaction;
- insertion of additional layers such as an oxygen consumption layer;
- use of additional materials such as fly-ash which occurs as a by-product of coal power plants (Mintia/Deva) and could have a beneficial effect on the neutralization of the tailings and waste rock, or alternatively subsoil from other disturbance areas (such as Roşia Poieni) if additional cover material with similar geotechnical properties is needed.

4.5.5 Summary of cover areas and material needs

Based on the cover design criteria described above, table 4-10 provides a summary of the areas to be covered and the material (subsoil, topsoil) needed.
Table 4-10. Summary of waste areas to be covered and material required for covers

<table>
<thead>
<tr>
<th>Facility</th>
<th>Footprint (m²)</th>
<th>Subsoil (m)</th>
<th>Topsoil (m)</th>
<th>Volume Subsoil (m³)</th>
<th>Volume Topsoil (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetate Pit</td>
<td>52,227</td>
<td>0.2</td>
<td>0.1</td>
<td>10,445</td>
<td>5,223</td>
</tr>
<tr>
<td>Cârnic Pit</td>
<td>385,971</td>
<td>0.2</td>
<td>0.1</td>
<td>77,194</td>
<td>38,597</td>
</tr>
<tr>
<td>Orlea Pit</td>
<td>299,630</td>
<td>0.2</td>
<td>0.1</td>
<td>59,926</td>
<td>29,963</td>
</tr>
<tr>
<td>Jig Pit</td>
<td>182,881</td>
<td>0.2</td>
<td>0.1</td>
<td>36,576</td>
<td>18,288</td>
</tr>
<tr>
<td>Cetate WR Stockpile***</td>
<td>368,804</td>
<td>0.2</td>
<td>0.1</td>
<td>73,761</td>
<td>36,880</td>
</tr>
<tr>
<td>Cârnic WR Stockpile***</td>
<td>1,390,059</td>
<td>0.2</td>
<td>0.1</td>
<td>278,012</td>
<td>139,006</td>
</tr>
<tr>
<td>TMF Dam</td>
<td>438,246</td>
<td>0.2</td>
<td>0.1</td>
<td>87,649</td>
<td>43,825</td>
</tr>
<tr>
<td>TMF Impoundment</td>
<td>3,122,674</td>
<td>1.1**</td>
<td>0.1</td>
<td>3,434,942</td>
<td>312,267</td>
</tr>
<tr>
<td>Total</td>
<td>6,240,493</td>
<td></td>
<td></td>
<td>4,058,505</td>
<td>624,049</td>
</tr>
</tbody>
</table>

* current minimum assumptions
** of which 0.3 m compacted clayey silt
*** It is assumed that all material can be stack-dumped in the waste dumps.

Table 4-11. Volumes of topsoil and subsoil stored (Figures taken from Waste Management Plan)

<table>
<thead>
<tr>
<th></th>
<th>Subsoil</th>
<th>Topsoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume stored</td>
<td>3,893,061</td>
<td>1,041,512</td>
</tr>
</tbody>
</table>

4.6 Water Management Strategy

4.6.1 General Overview

The water management strategy during operations is described in detail in the Water and Erosion Control Management Plan as well as in Chapter 4.1 of the EIA and will only briefly be summarized in the following Sections for comparison. It is based on the water management strategy developed by MWH.cxxi The various phases of this strategy from operational to post-closure are also illustrated in figure 5.18-1.

The requirement to manage water will be reduced after mining and processing operations are ended. In closure, both process water and domestic wastewater flows will be eliminated. ARD wastewaters will also be reduced due to removal of the low-grade ore stockpile, which will be processed, and closure of other potentially ARD-generating waste rock facilities and of the TMF tailings surface. However, some residual ARD seepage may continue from these facilities. Portions of the mine pit walls and remaining underground mine workings may also be ARD-generating. Overall, with the implementation of the closure source controls (e.g. covering of potential ARD-generating waste rock and tailings with soil), the net ARD generation at the site is expected to be less than in current conditions (since the current conditions originate from more numerous and smaller diffuse sources, most of which will be removed by the Project). Any remaining ARD will be managed to ensure that it does not impact downstream water quality.

An additional water quality concern in closure will be the long-term seepage from the tailings contained in the TMF. To a certain extent, this water quality will likely continue to reflect the diluted chemical composition of the process water for many years after closure. Although not likely, the potential exists for seepage to contain low levels of cyanide. The seepage flow rate will gradually decrease as the tailings consolidate and drain down, but some level of
treatment may be needed for a number of years. In addition, concentrations of nitrogen compounds (e.g. NO₃, NH₄, CN), major ions such as Calcium and Sulphate, and some metals may potentially be an issue, and will have to be evaluated against the discharge standards.

A series of semi-passive treatment cells will therefore be developed to address TMF seepage flow and quality in closure (see Section 4.4.5.3); this semi-passive system will be developed during the operations phase, while pumping TMF seepage back to the TMF supernatant pond (and recycling through the process plant) is still an option. Construction of this facility is foreseen for the early operations phase so that adequate testing and demonstration of the facility can occur before closure. Similar systems for treating discharge from gold mine tailings impoundments are recognised within the EU as a proven technology, as noted in the PIRAMID Engineering Guidelines for the Passive Remediation of Acidic and/or Metalliferous Mine Drainage and Similar Wastewaters. cxxii

In summary, as a result of the residual ARD flows and TMF seepage, water will need to be managed in both the Roșia and Corna Valley watersheds at closure. The primary strategy will continue to be to route clean water around the Project area and to collect and treat water impacted by the Project, as needed. At closure, the majority of the ARD sources that are currently impacting the Roșia and Corna Valleys will have been removed, and the management strategy will be largely focused on the features constructed or impacted as part of the Project. The advantage of this is that the Project facilities have known conditions and discrete boundaries or footprints, which will simplify the development of any necessary water management and treatment schemes.

An important component of this strategy for all facilities is the source control that results from the closure activities. For example, the covers that will be placed on the TMF and PAG sections of the waste rock stockpiles will reduce water and oxygen contact with the materials contained in these facilities, and thereby reduce the generation and transport of any ARD. However, such source controls are not likely to be fully effective in immediately mitigating seepage and some long-term water management needs will exist in both the Roșia and Corna Valleys. The water management strategy at closure for both drainages is presented in Sections 4.6.2 and 4.6.3 below.

Construction of this facility is foreseen for the early operational phase so that adequate testing and demonstration of the facility can occur before closure. Similar systems for treating discharge from gold mine tailings impoundments are recognised within the EU as a proven technology, as noted in the PIRAMID Engineering Guidelines for the Passive Remediation of Acidic and/or Metalliferous Mine Drainage and Similar Wastewaters. cxxiii

An important component of the pit lake management scheme will be accelerated flooding of the pit lakes. This flooding will help reduce potential ARD generation by submerging potential ARD-generating rock, and will help ensure the continuity of closure operations so that a prolonged period does not occur between site closure and completion of the lake formation. The flooding will be accelerated by use of the remaining TMF decant water at closure (under the condition that residual cyanide in the decant pond is either degraded naturally or removed by appropriate installations). This offers an additional benefit by facilitating closure of the tailings surface sooner than may otherwise be possible. Residual cyanide concentrations will be managed (see Section 4.4.5.2) or naturally degraded below levels of concern by the time this water is used for the flooding of the pits.

It should be noted that seepage from the Cârnic and Cetate waste dumps is summarized as "Waste dump seepage" because both streams are managed in the same way: During operations and at closure before placement of the cover, the seepage from both dumps is collected and treated by the ARD treatment plant and discharged according to the provisions
of the Water Management Plan. Later, if closure is complete, it is most likely that none of the waste rock seepage will need treatment anymore, so that the seepage will be discharged untreated into Corna valley (Cârnic waste rock dump) and Rosia valley (Cetate waste rock dump), respectively.

**The main flows to be treated during closure and post-closure are summarized in**

. For comparison, also the flow rates during operations are shown in this table.

### Table 4-12. Flows to be treated or discharged during operations, closure and post-closure (average, in m³/h)

<table>
<thead>
<tr>
<th>Flow*</th>
<th>Operations (Average of years 1-16)</th>
<th>Closure (Years 18-21)</th>
<th>Post-closure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Cetate dam to ARD treatment plant (#27)</td>
<td>280 m³/h</td>
<td>221 m³/h</td>
<td>221 m³/h</td>
<td>Conservative assumption for post-closure phase</td>
</tr>
<tr>
<td>Cârnic waste drainage holding pond to ARD treatment plant (#31)</td>
<td>32 m³/h</td>
<td>0</td>
<td>0</td>
<td>Treatment needed until closure of Cârnic waste dump in year 12</td>
</tr>
<tr>
<td>Cârnic Waste Drainage Holding Pond to Corna Valley (#41)</td>
<td>13 m³/h</td>
<td>44 m³/h</td>
<td>44 m³/h</td>
<td>Discharge starts after closure of Cârnic Waste dump in year 12</td>
</tr>
<tr>
<td>SCD pond to TMF reclaim pond (#19)</td>
<td>54 m³/h</td>
<td>-</td>
<td>-</td>
<td>Pumped to ARD treatment plant and secondary CN treatment only after storm events if reclaim pond must be emptied</td>
</tr>
<tr>
<td>SCD pond to ARD treatment plant (#19)</td>
<td>-</td>
<td>77 m³/h</td>
<td>68 m³/h (assuming 200 mm/a infiltration through cover)</td>
<td>Including CN removal in secondary treatment system</td>
</tr>
<tr>
<td>TMF reclaim pond to Cetate pit</td>
<td>-</td>
<td>2-3 million m³</td>
<td>-</td>
<td>No residues generated, only CN treatment by INCO/peroxide process (or natural degradation)</td>
</tr>
<tr>
<td>On-shore/In-pit treatment</td>
<td>-</td>
<td>1000</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

* The numbers in parentheses refer to the Water Balance Schematic which is also part of the Water and Erosion Management Plan and Section 4.1 of the EIA.

The following diagrams are intended to show the principal features of the water management strategy, i.e., which main water streams that are managed. Therefore, they do not show details such as the Cârnic seepage holding pond.
Figure 4.3. Water management during operations

- **Water management – operation phase (it is not at scale; simplified scheme)**
  - **Arieș River**
  - **Cetate Dam**
  - **Low grade ore dump and Cetate tailings dam**
  - **Călimănești Dam**
  - **ARD pond**
  - **Processing Plant**
  - **Cyano DETOX Plant**
  - **ARD Treatment Plant**
  - **Secondary cyanide treatment plant**
  - **Tailings Dam**
  - **Secondary containment Dam**
  - **Passive semi-treatment cells**
  - **Water diversion channels**
  - **Tests during the final phase**

- **Rogoș Valley**
  - **Cetate Dam**
  - **714 Adit**
  - **Low grade ore dump and Cetate tailings dam**
  - **Processing Plant**
  - **Cyano DETOX Plant**
  - **ARD Treatment Plant**
  - **Secondary cyanide treatment plant**
  - **Tailings Dam**
  - **Secondary containment Dam**
  - **Passive semi-treatment cells**
  - **Water diversion channels**
  - **Tests during the final phase**

- **Treated fresh water**
- **Treated industrial wastewater**
- **Treated wastewater**
- **Basically clean water**
- **ARD**
- **Normal operation conditions**
- **Unplanned events**

- **The discharge of the water which has not contacted the project site**

**Sections:**
- **Section 4: Description of the Project**
Figure 4.4. Water management during temporary cessation

Water management – temporary cessation of the activity (it is not at scale; simplified scheme)
Figure 4.5. Water management during closure

- Tailings stored on the tailings dam, prior to installing the covering system of the tailings dam.
- Tailings stored on the Ceatau pond (after the tailings dam was rehabilitated).
- If the effluent resulted from the passive treatment systems does not comply with NTFA 001, then the water will be recirculated towards the ARD treatment plant, or towards the secondary cyanide treatment plant, as per the type of pollutants.

Normal operation condition
Insufficient capacity of the secondary cyanide plant
Figure 4.6. Water management during post-closure

Water management – post-closure phase
(it is not at scale; simplified scheme)

The discharge of the water which has not contacted the project site

Open water drain

Tailings dam

Secondary containment dam

Semi-passive treatment cells

Coma Valley

Normal operation conditions
* effluent treated within the semi-passive cells does not comply with the wastewater discharge conditions

Abnud River

Semi-passive treatment cells

Coma, Rosia or Cetate cond

Treated wastewater

ARD treatment plant

Water diversion channels

Water which has not contacted the project site

The discharge of the water which has not contacted the project site

Cetate Pit

Cetate Dam

714 Adit

Cetate Dam

Arteș River

Semi-passive treatment cells

Rosia Valley

Section 4: Description of the Project
4.6.2 Rosia Valley Water Management Strategy

4.6.2.1 Normal operating conditions

- Water from the Rosia valley disturbance areas (pits, waste rock dumps, 714 Adit, low grade ore) will be pumped directly from these sites or are collected behind the Cetate Dam and pumped to the ARD treatment plant;
- Runoff from undisturbed areas will be diverted around the Cetate dam and discharged into the Rosia Valley;
- Flow rates to be treated in the ARD treatment plant for years 1 to 7 are expected to be approximately 400 m³/h;
- Flow rates for years 7 to 16 are expected to be approximately 650 m³/hour;
- The ARD water will be treated by lime precipitation which is expected to meet all NTPA 001/2005 standards except for Calcium, Sulfate and TDS;
- A secondary treatment system will be used to achieve all NTPA 001/2005 standards;
- The selection of the preferred secondary treatment system is discussed in Section 2 and 4.1 of the EIA and summarized in Section 4.4.5 of this Mine Closure and Rehabilitation Management Plan.
- No cyanide-containing wastewater will be normally managed in the Rosia Basin. During or after extreme precipitation events the reclaim pond may need to be reduced in size to maintain storage capacity. In this case, cyanide-containing water will be treated to NTPA 001/2005 standards and discharged.
- Discharge to Rosia Creek will be in compliance with NTPA 001/2005. This discharge will be used to help maintain the project water balance and to supplement the biological baseflow in Rosia Creek when needed.

4.6.2.2 Storm conditions

- The Cetate impoundment will be operated with the water level sufficiently low to allow for rainwater buffering of any ARD water in the impoundment to meet NTPA 001/2005 standards. Modelling results indicate that all standards can be met except pH. However, the spillway and face of the dam will be constructed with limestone that will adjust the pH in during a storm event so that the spillway flow would meet all NTPA 001/2005 standards including pH.
- The ARD treatment plant will continue to operate and discharge as during normal operating conditions. It is presumed that this plant will be operated at a maximum rate to reduce storm water storage in the water management system. This may necessitate utilization of the contingency cyanide treatment (see Section 4.6.3) to reduce the volume of process water in the system.

4.6.2.3 Temporary Cessation

- During temporary cessation, the Cetate pond, ARD treatment plant and secondary treatment system will remain operational. In addition, the Cârnic collection pond and pumping system will remain operational.
- Depending upon the stage of the project additional water storage capacity may be available in the mine pits. This may allow for some additional flexibility in water management.
4.6.2.4 Closure

- During closure the ARD treatment plant will remain operational. A detailed engineering study will show whether its location shall be retained or whether it shall be relocated to the pits. The plant will treat any water collected behind the Cetate dam.

- In order to accelerate flooding of the Cetate pit, undisturbed water from the surface drainage system, the TMF reclaim pond (with CN$_{tot}$ meeting the NTPA 001/2005 standard), and the water captured by the Cetate dam and treated in the ARD treatment plant will be pumped to the Cetate pit.

- Seepage water collected in the Cetate impoundment will also be treated in a series of treatment cells constructed below the Cetate dam. However, it is not certain that the effluent from the biological treatment cells will be able to fully meet the Calcium and/or Sulfate standards. Therefore, the option to pump this water back to the pits or directly to the ARD plant is retained should this be required.

- An additional on-shore treatment system (adding lime to water pumped from the pond and recycling the lime slurry back to the pit for sedimentation) will be installed in order to accelerate neutralization of the pit lakes, depending on the acid potential which is observed in the flooded pit lake.

- The sludge from the ARD treatment plant which is assumed to be a Gypsum/Ettringite sludge will be disposed of in the TMF as long as it is not covered. Then the ARD sludge will be pumped to the Cetate pit for settlement. There, the underflow solids will be submerged and therefore will not be subject to oxidation and leaching.

- A bulkhead in the 714 Adit with a valving system will eventually allow for a controlled discharge from the pit lake and underground workings.

- Cetate pond levels will be operated at sufficiently low levels to allow storm water runoff to provide dilution to meet NTPA 001/2005 standards, except pH. The slight pH exceedances will be mitigated by construction of the spillway and Cetate dam face with limestone.

- While the pit lake system is filling, the requirement to discharge treated water will be reduced to that needed to supplement biological baseflow.

4.6.2.5 Post-closure

- The Cetate dam will be breached in year 19 in order to minimize the need for stability monitoring at the dam. The water reporting to the Rosia valley from the flooded Cetate pit and the underground workings is collected in a little pond behind the breached Cetate dam and is either treated by the semi-passive lagoon system or pumped back to the ARD treatment plant if the discharge quality of the lagoon system does not meet the NTPA 001/2005 standards.

- Cetate pond levels will be operated at sufficiently low levels to allow storm water runoff to provide dilution to meet NTPA 001 standards, except pH. The slight pH exceedances will be mitigated by construction of the spillway and Cetate dam face with limestone.

- A bulkhead in the 714 Adit with a valving system will eventually allow for a controlled discharge from the pit lake and underground workings.
The 714 Adit downstream of the bulkhead will act to intercept pit lake seepage and direct it to the Cetate pond.

The lagoons (semi-passive treatment cells) which are designed using the results of the pre-closure trialling in the Corna valley will be in place and operational.

If the semi-passive treatment lagoons are not capable of achieving the NTPA 001 standards, the water can be pumped back to the ARD treatment plant and then discharged to the environment.

### 4.6.3 Corna Valley Water Management

#### 4.6.3.1 Normal operating conditions

- Seepage from the Tailings Management Facility (TMF) will be collected by the seepage collection system, which at its downstream point includes the Secondary Containment Dam (SCD) pond. This pond is actually a sump that will be used to depress the groundwater table and will act as a hydraulic sink.

- A line of three to five monitoring wells will be installed downstream of the SCD to confirm by monitoring that the TMF water is being contained by the seepage collection system. If TMF components are ever detected in the monitoring wells, groundwater recovery using wells will become a component of the seepage collection system.

- Seepage water from the SCD pond (and/or recovery wells) will be pumped back to the reclaim pond for recycling in the process.

- The process plant tailings discharge is expected to contain 10 to 15 mg/L total cyanide (see table 4-8). Natural degradation of cyanide will occur in the TMF further reducing the concentration in the reclaim/decant pond and to a lesser degree in the pore spaces of the tailings mass.

- Runoff and seepage from the Cirnic Waste Rock dump will be collected in the Cirnic holding pond and allowed to flow into the TMF if the water quality is not significantly impacted by Acid Rock Drainage (ARD). If impacted by ARD, the seepage and runoff will be captured and pumped to the ARD treatment plant.

- Biological baseflow requirements will be maintained using treated water from the ARD treatment plant that meets the NTPA 001/2005 standards, and/or water from the freshwater system, as needed.

- A contingency treatment system will be constructed during the operational period to treat any water containing low concentrations of cyanide in order to meet existing NTPA 001/2005 cyanide standards (0.1 mg/L total cyanide). This system will be in place so that a surplus of cyanide-containing water in the water balance could be treated and discharged. An option likely to be chosen is the utilization of the detoxification plant where an additional treatment system could be located. Such a discharge would likely also have to be treated for sulfate and total dissolved solids (TDS) and would therefore need to be commingled with the Rosia ARD treatment plant inflow.

#### 4.6.3.2 Storm Events

- The SCD pond/sump will be operated a very low levels due to the necessity of maintaining a hydraulic sink.
During a storm event there will be sufficient dilution in the SCD Pond for cyanide and other TMF constituents to allow a spillway discharge to Corna Creek and while meeting the NTPA 001/2005 standards. This calculation has been done using a conservative assumption that the seepage will resemble the TMF decant pond quality. Actually, seepage attenuation will likely result in lower concentrations in the SCD pond.

The TMF dam will provide containment of runoff from the entire drainage basin for two Probable Maximum Floods (PMFs) (2.7M m³).

Undisturbed runoff from the Cirnic waste rock stockpile will be allowed to flow into the TMF. If impacted by ARD, the runoff will be pumped to and treated at the ARD plant. If the Cirnic storm water exceeds the capacity of the collection pond or ditches, it will flow into the TMF. This flow is accounted for in the PMF calculation.

### 4.6.3.3 Temporary Cessation

- Recycling of water from the reclaim pond will stop. The reclaim pond will then grow due to a positive water balance. However, due to a large reserve storage capacity, there will be excess capacity in the reclaim pond above that required for extreme storm events. The amount of excess capacity will depend upon the stage of the Project and required storm capacity storage.

- During temporary cessation of mining activities, there is sufficient capacity in the TMF reclaim pond to hold seepage water from the SCD for several years. For instance, it would take seven years to fill one PMF volume in the TMF basin at a dam seepage rate of approx. 400,000 m³/year and an available capacity in the TMF of one PMF (i.e., 2.7 million m³).

- Once the excess capacity is filled in the pond, water would have to be treated and discharged through the secondary treatment system (see Section 4.4.5.2) to remove Cyanide to a level required by NTPA 001 before discharging the water into the environment.

- Seepage collected in the SCD pond will continue to be pumped to the reclaim pond.

- The contingency cyanide treatment capacity and ARD treatment will be available to correct the water balance, if needed.

- As there is sufficient capacity in the TMF, water management in the Corna valley during a period of temporary cessation is not a concern. There is sufficient time to decide to implement final closure or resume operations.

- Seepage and runoff from the Cârnic waste rock stockpile will be allowed to flow to the TMF unless the water quality would impact restart of the process. In this case, the runoff and seepage would be pumped to the ARD treatment plant.

- If a test lagoon system for semi-passive treatment has already been taken into operation below the Secondary Containment dam, it will be kept operational.

### 4.6.3.4 Closure

- Water from the reclaim pond will be pumped to the Cetate pits (after removal of any residual Cyanide to levels compliant with NTPA 001/2005) to facilitate pond formation.

- Seepage water in the SCD pond will continue to be pumped to the TMF decant pond as long as it is present. Once the TMF decant pond is removed the seepage water will be pumped to the mine pits. If necessary, the water will be treated prior to
discharge to the pits. Alternatively, it may be treated in a series of treatment cells below the SCD and discharged to Corna Creek.

- There is sufficient capacity in the Cetate pit to accommodate the reclaim pond volume.

- The CN levels are expected to drop rapidly after processing is stopped:
  - There will be dilution from the mixing of precipitation with the reclaim pond (the amount will depend on the volume of the pond at closure);
  - Additionally, there will be an accelerated decay of CN due to aeration and UV degradation in the reclaim pond;
  - Based on these mechanisms, the CN\textsubscript{tot} concentrations are expected to drop below 0.1 mg/l within less than a year\textsuperscript{xxv}, according to the numerical cyanide modeling results contained in the Engineering Review Report\textsuperscript{xxvii}. More conservatively, a time period of around 3 years is assumed for the Cyanide concentration to drop below 0.1 mg/l, as indicated in the conclusions drawn from the numeric modeling\textsuperscript{2}.

- In the case that CN does not degrade quickly enough to acceptable levels before it is pumped to the Cetate pit for storage, a secondary treatment for CN will be operational to achieve the limit of 0.1 mg/l for CN\textsubscript{tot}. The principal technology alternatives of this secondary treatment and the alternative preferred at this time are described in Section 4.4.5.2.

- Seepage from the Cirnic waste rock stockpile will be pumped to the Cetate pit lake if impacted by ARD where it will be treated in-situ or through the ARD plant (especially as long as the cover system on end-dumped ARD-generating portions, reducing water and oxygen inflow, has not yet been placed). Otherwise, the water will be allowed to discharge to the Coma Basin.

### 4.6.3.5 Post-closure

- The reclaim pond will no longer be present during the post-closure period.

- Surface water runoff from the basin will be routed around or off the TMF and discharged into Corna Stream below the SCD.

- The lagoons (semi-passive treatment cells) which have served for testing purposes will be finalized in order to have a long-term solution in place. Most likely the footprint of the lagoons can be diminished due to the cover placed on the tailings which reduces the seepage rate.

- The Secondary Containment Dam will eventually be breached in order to minimize stability monitoring needs. The seepage water will be collected in a sump or little pond.

- Seepage water in the SCD pond will be pumped to the pits, after residual cyanide has been removed.

- The series of semi-passive treatment cells below the SCD will be kept operational further optimized to discharge seepage to Corna Creek, when the pit flooding is complete.

\textsuperscript{2} See Page 10, point 1 of the Modeling Report prepared by Elbow Creek and Page 26 of the Tailings Management Facility Geochemistry and Water Quality Report prepared by MWH (both part of Appendix F to the Engineering Review Report)
If the semi-passive treatment lagoons are not capable of achieving the NTPA 001/2005 standards, the water can be pumped back to the ARD treatment plant and then discharged to the environment.

If required, the secondary CN removal stage will be kept operating in order to meet the 0.1 mg/l limit for $\text{CN}_{\text{tot}}$ according to NTPA 001/2005.

The Cirnic waste rock stockpile will have been covered and undisturbed runoff will be directed to Corna Creek. Seepage will be greatly reduced. If present in a quantity and quality that requires additional management, this water will be pumped to the mine pits, which, however, is unlikely given the waste segregation strategy, stack-dumping and cover design on potentially ARD generating portions of the end-dumped waste rock material.

### 4.7 Estimate of activity timescales at closure and post-closure

#### 4.7.1 Time scale estimates for individual activities

When planning for closure of the mine site after the viable ore reserves have been mined out, a time estimate for the closure period and some processes such as long-term water treatment in the post-closure period must be made. For clarity, closure and post-closure periods are distinguished. They may be different for each facility on the mine site:

1. The closure period starts when a facility is no longer used for its original purpose and ends when it has either been removed, rehabilitated and transferred to a future use, or has reached its final physical state.
2. Some facilities or objects may have a post-closure period which is characterised by continuous activities such as water treatment or maintenance, even when the physical state of the object is stable.

An estimate of the time needed to treat any effluent from a mining site, flooded pits, TMF etc. is usually beset with large uncertainties, especially if neither the precise composition of the effluent nor the exact details of the contaminant sources and pathways are known, as is normally the case prior to construction and operation of a mining project.

However, approximate estimates can be made based on simplistic and conservative assumptions which provide at least an order of magnitude for the time scales to be plausibly expected. There are significant differences between the various Project elements (TMF, flooded pits), so that they are discussed separately in the following.

#### 4.7.1.1 TMF decant water

The decant water quality is conservatively characterised in table 4-8 and table 4-9. One objective is to remove the decant pond water from the TMF as quickly as possible in order to achieve the following:

- stabilize the tailings surface which can then support the heavy machinery which is needed to place the cover;

---

3 This distinction between closure and post-closure has been made on a purely technical basis. There is no clear-cut distinction between closure and post-closure in the applicable EU regulations such as the Mine Waste Directive.
assist flooding of the Cetate pit and submerge its potentially ARD-generating rock surfaces.

Whereas the overall quality of the pit water and the TMF decant water is comparable with respect to the main components, the TMF water contains cyanide which the pit water does not, and pumping of the TMF water without cyanide removal would mean an unnecessary and unacceptable spread of a contaminant to another water body. Two strategies exist to cope with this situation:

- actively treating the TMF decant water (i.e., removing cyanide) when pumping it from the reclaim pond to the pits using the secondary CN treatment system (see Section 4.4.5.2). This strategy has no restrictions with respect to time and can be used immediately after discharge of tailings into the TMF has ceased;
- waiting a period of time after cessation of tailings discharge until the cyanide has degraded so that it meets the standard NTPA 001/2005 for cyanide, i.e. 0.1 mg/l. Model calculations which are summarized in the Engineering Review Report show that the natural degradation of CN is a fast process and the acceptable level of 0.1 mg/l for CN_{tot} will be reached within a matter of months after the end of tailings disposal. On the conservative side, the estimate for the time needed for the reclaim pond water to reach this level would be around 3 years.

Both strategies are feasible and can also be combined to give an optimized solution. For the time being, it is assumed that active cyanide removal will be required.

4.7.1.2 TMF seepage

The TMF seepage quality during and at the end of the operations phase is very conservatively assumed to be the same as the decant pond water (table 4-8 and table 4-9). Under the assumption, that ongoing oxidation of PAG tailings can be excluded due to the soil cover described in Section 4.5.3 which acts as an effective oxygen barrier, the evolution of seepage water quality with time is mainly determined by the following:

- the time the pore water needs to travel through the tailings body and be replaced with fresh water;
- the accompanying geochemical processes within the tailings body such as sorption, chemical reactions, or dispersion, which lead to lower concentrations in the dam seepage than if hydraulic transport alone is considered.

It is conservative to consider hydraulic transport alone, but this may grossly over-estimate the time needed for the seepage water to improve in quality and render it amenable to semi-passive treatment in the lagoons and eventually reach an acceptable quality so that it can be discharged into the environment without further treatment. Nevertheless, for the purpose of the EIA the conservative approach is retained, i.e., that further treatment is required.

At the end of operations and during the first years of closure, a seepage rate of 77 m³/h is expected based on water balance models. If this rate remains constant, the time needed to flush the tailings pore volume of 63 million m³ once is of the order of 90 years. In order to bring the seepage quality to a level so that it can be discharged without treatment, at least 3-4 pore volumes will have to be exchanged, provided there are no additional dissolution or mobilization processes within the tailings body. It follows from this model that the seepage would require continued treatment far into the foreseeable future.
With an infiltration-minimizing cover placed on the tailings, the amount of seepage water collected at the Secondary Containment Dam sump decreases, while the characteristic time needed to flush the tailings body increases correspondingly. It is anticipated that with the cover described in Section 4.5, the infiltration will decrease to a range of 10-25% (or 80-200 mm/a) of the annual precipitation, with an according drop of the seepage rate. Thus, the annual load of contaminants released by the TMF dam is smaller, but the time frame over which treatment will be needed to achieve all NTPA 001/2005 limits increases inversely proportional to the infiltration rate.

### 4.7.1.3 Cetate pit lake

The Cetate pit will be flooded mainly using natural recharge, assisted by TMF decant water and TMF seepage from which cyanide will have been removed, and waste dump seepage. The flooding time is estimated in the Engineering Review Report to be 8 years to reach the 715 m a.s.l. level (5 years if TMF decant pond water is used), and 25-32 years until the water table reaches a final level of around 745 m a.s.l.\(^{xxx}\)

If it is assumed that acid generation at the pit walls will cease when they are submerged in lake water, and the portions of the pit walls which are above the lake level will be appropriately treated to reduce ARD generation potential (see Section 4.3), dilution with the natural recharge will be the dominant process that determines the time dependence of the contaminant concentrations. Without active pit-water treatment, the concentrations will follow an exponential law of the type \(c(t) = c(t=0) \exp(-t/\tau)\), with the time constant \(\tau\) determined by the recharge rate at equilibrium water level and the pit volume. The time constant \(\tau\) is of the order of 20 years based on the following assumptions:

- an effective flooded pit volume (including pore and fracture volume and underground mine workings) of 9.75 million m\(^3\) if flooded to the 745 m level; and,
- a maximum steady-state flow rate passing through the pit of no more than 54 m\(^3\)/h (i.e., the total amount of water captured at the Cetate dam from the catchment area)\(^{xxx}\).

Realistically, the groundwater flow and precipitation into the pond will be smaller, so that the time needed for flushing the pit will be greater. The pond water will have reached an acceptable quality after a few pond volumes are exchanged, i.e., after several decades, during which time it is assumed that the pit water will have to be treated.

This time will be shortened because the pit water is actively treated during and after flooding by an on-shore liming plant, which in effect means that the flow rate through the pond is increased, while the contaminants in the pond water are removed and precipitated as sludge in the pit. A treatment rate of 1000 m\(^3\)/h is assumed for the on-shore treatment plant, which means the treatment time will shrink to 2-3 years.

These estimates are based on the assumption that no dissolution processes will take place in the pit after flooding, and no sources outside the pond will add to the contaminant content in the pit water. Whether these processes can be entirely precluded or will still play a role after flooding will have to be determined during the operations phase when more details on the mineralogical composition of the pit materials becomes available. Biological and/or engineered methods of passivating the pit walls will be optimized based on these results as well, so that at closure an optimized strategy of pit water treatment will be in place.

It must be kept in mind that the underground mine workings will continue to generate ARD, so that the time frame for treatment of water captured at the Cetate dam will also be determined by the underground mine effluent inflow. With the current knowledge it cannot be
estimated for how long ARD generation will continue in the unsaturated underground mine workings. The fact that ARD effluent has been observed for a long time suggests a continuing need to treat the mine water. However, the fact that the most ARD generating parts of the underground mine will be mined out during the Project also indicates that there will be a significant reduction of the acidic load and a shorter treatment time as compared to the existing situation.

4.7.1.4 Summary of time estimates

The following table summarizes the preliminary estimates for the closure and post-closure time periods, as defined in Section 4.7.1:
Table 4-13. Preliminary estimates of closure and post-closure periods for selected objects

<table>
<thead>
<tr>
<th>Facility</th>
<th>Closure phase</th>
<th>Post-closure phase</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings, technical equipment</td>
<td>2 years</td>
<td>10 years observation of revegetation success</td>
<td>Removed if not needed by local community, some facilities may remain such as domestic waste water treatment plant</td>
</tr>
<tr>
<td>TMF free water removal and cover placement</td>
<td>3 year to remove decant water (depending on CN\text{Tot} degradation to 0.1 mg/l, if no active CN destruction is used), 2-10 years for cover placement</td>
<td>2 years for maintenance of vegetation on cover, 10 years of observation of revegetation success on cover, 5-20 years of monitoring consolidation processes</td>
<td>Estimates are dependent on geotechnical properties of tailings material and consolidation, see also Section 5.1.1 Corrective measures may be required if cover (slopes) or vegetation are unstable</td>
</tr>
<tr>
<td>TMF dam seepage</td>
<td>-</td>
<td>50-100 years, flow rates will decrease after a few years when cover is placed and shows effect, continuous monitoring of seepage water quality over 10-20 years</td>
<td>The passive treatment lagoons remain.</td>
</tr>
<tr>
<td>TMF dam</td>
<td>2 years for regrading</td>
<td>time frame depending on dam stability regulations</td>
<td>see ESMP and TMF Management Plan for details</td>
</tr>
<tr>
<td>Pits to be backfilled (Orlea, Jig, Cîmic)</td>
<td>starts during operation phase as mined-out pits are backfilled by waste rock from active pits (transfer mining), and ends in year 21</td>
<td>2 years for maintenance of vegetation on cover, 10 years of observation of revegetation success on cover</td>
<td>Corrective measures may be required if cover (slopes) or vegetation is unstable</td>
</tr>
<tr>
<td>Flooded pit (Cetate)</td>
<td>25 years (using TMF decant pond water) to reach 745 m a.s.l.</td>
<td>2-3 years with on-shore treatment depending on technology and treatment rate (assumption: 1000 m$^3$/h), 2 years of monitoring of physical stability of pit walls until protection measures have taken hold on pit walls</td>
<td>Flooding time sensitively dependent on hydraulic conditions, permeability of host rock and underground mine workings</td>
</tr>
<tr>
<td>Waste rock dumps</td>
<td>beginning during operation phase, ending in year 12</td>
<td>2 years for maintenance of vegetation on cover, 10 years of observation of revegetation success on cover, 10 years of continuous monitoring of water quality</td>
<td>Corrective measures may be required if cover (slopes) or vegetation is unstable</td>
</tr>
<tr>
<td>Treatment of the Cetate dam water</td>
<td>-</td>
<td>depending on hydraulics and geochemistry of underground mine workings and pit lake, possibly several decades</td>
<td>The passive treatment lagoons remain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>strong improvement over existing situation due to removal of large portions of ARD generating underground mine workings</td>
<td></td>
</tr>
</tbody>
</table>
4.7.2 Long-term perspective of water treatment

The parameters which will require treatment over a long time in the post-closure phase are as follows:

- in the Corna Valley from TMF seepage:
  - Nitrogen compounds such as NH$_4$ (and, unlikely, residual CN)
  - metals and metalloids: As, Mo
  - major ions Ca, SO$_4$.

- in the Roșia Valley from unsaturated underground workings and pits:
  - acidity (pH)
  - metals (Al, Fe, Cu, Zn, Ni)
  - major ions: SO$_4$.

Of these, passive, low-maintenance and low-cost treatment techniques exist as BAT for nitrogen compounds, metals/metalloids and aciditycxxxii.

For the removal of Sulphate, treatment rates are also available (300...800 mmol/d per m$^3$ in anaerobic wetland cellscxxxiii). The area required for the corresponding lagoon size is available in both valleys, but the practical applicability of the technique is limited by the amount of sulphides or elemental sulphur resulting from a load of some 1000 kg/d.

Unlike Calcium, no passive treatment BAT exists to reach the NTPA 001/2005 standard. The discharge limits will be met using conventional BAT (Ettringite precipitation or equivalent) described in Section 4.4.5.1, as long as the discharge permit requires RMGC to do so.

Although no such assumption is made in the design of this Closure Plan, it is envisaged that discharge standards for the site could be adapted to harmonize with the common practice in EU States of setting site-specific discharge standards. In most countries, Calcium and Sulphate discharge standards are regulated in consideration of limiting permanent hardness in water which is abstracted by industrial users and households downstream and leads to scaling of surfaces (heating elements, vessels) and results from the presence of SO$_4$ and Ca. Toxicity of SO$_4$ and Ca is not a concern, and these components do not fall under the provisions of Article 18 of the IPPC Directivecxxxiv.

According to HELCOMcxxxv and IPPCcxxxvi, the economic feasibility of a treatment technology, the time limits for application, the nature and volume of the effluents concerned and their effect on a high general level of protection of the environment as a whole must be taken into account when defining BAT. The use of resources (treatment chemicals, disposal space for resulting wastes, energy) in order to remove Sulphate and Calcium is considerable. This suggests that over the long term, it may also be considered BAT not to remove Sulphate and Calcium.

According to the Water Framework Directive (WFD)cxxxvii, the Member States will establish a river basin management plan (Article 13) which will be based on the guiding principle of the WFD to "promote sustainable water use based on a long-term protection of available water resources" (Article 13) which means setting river quality requirements under realistic usage scenarios. It is expected that the increase of permanent hardness (Ca, SO$_4$) caused by the Project in the receiving streams will not be a concern and compliance with the River Basin Management Plan will be ensured. Both the IPPC Directivecxxxviii (Article 13) and the
Romanian Regulation NTPA 001/2005 provides the possibility of periodically reconsidering and, where necessary, updating permit conditions.

The following conclusions are drawn from this discussion:

- as long as required by the valid discharge permit, all discharge limits set by the Romanian standard NTPA 001/2005 will and can be guaranteed by technical measures;
- over the long-term, the establishment of a River Basin Management Plan, usage-based water river quality requirements and a consideration of resource consumption and environmental benefit could lead to agreement on the relaxation of effluent discharge limits in respect of Sulphate and Calcium.

4.8 Water impacts and generation of wastes in closure and post-closure phase

4.8.1 Surface water impacts

The following streams in the nearer environment are affected by the Project:

- Corna creek;
- Roşia creek;
- Abrud river;
- Arieş river.

In the context of the wider environment and transboundary impacts, other rivers and aquatic habitats downstream to the Danube river are potentially affected, too, but the forecast impacts are non-measurably small and negligible. A more detailed discussion of the impacts on local and wider surface water resources is contained in Section 4.1 of the EIA and this is summarised in the following.

Three scenarios are used as a basis for the evaluation and assessment of the Project's impact during closure and post-closure:

- dry periods;
- average conditions;
- wet periods.

The discharge from the mine site and the flow rate in the receiving streams are correlated, i.e., in dry periods, only a small amount of water will be discharged from the site, while at the same time the flow rate in the receiving streams will be lower than average, and vice versa for wet periods.

For the purposes of impact assessment, it is conservatively assumed that all discharges to the environment have the maximum concentrations allowed by NTPA 001/2005, even if individual components may have lower concentrations.

The results of the assessment of surface water impacts are contained in Section 4.1 of the EIA.
4.8.2 **Ground water impacts**

Potentially water-bearing rocks in the Project area include Jurassic-Cretaceous sedimentary rocks, the volcanic sequences, and the surficial deposits of alluvium and colluvium. The Jurassic-Cretaceous rocks found in the Project area include discontinuous sandstone and conglomerate beds that do not yield significant amounts of groundwater. Bedrock consists mostly of shale intercalated with sandstone, but deposits of dacite, andesite, andesite agglomerate, vent breccia and black breccia also occur. The hydraulic conductivity of the shale, which underlies the proposed TMF starter dam, Secondary Containment System, and Cetate Water Catchment Dam is low (less than 10^{-5} cm/s). Consequently, the underlying colluvium and shale are lower permeably layers that create a groundwater vertical flow barrier.

Surface and subsurface deposits in the mine site area predominantly consist of moderately permeable alluvial deposits, primarily along stream channels, and moderately permeable (weathered) to low permeability (unweathered) colluvium and bedrock. Alluvium occurs along the valley bottoms within the extent of the current stream channels. These surface deposits of alluvium in the stream valleys are up to 12 meters thick, and may act as local aquifers.

The majority of groundwater flow that occurs is contained in the narrow weathered bedrock horizon below the colluvial soils, which mirrors topography, and in the valley-bottom alluvium. The colluvium consists of a firm to stiff sandy to silty clay with a hydraulic conductivity in the range of 10^{-6} cm/s, whereas the hydraulic conductivity of the alluvial deposits was estimated to be relatively high within the range of 2 \times 10^{-4} to 3 \times 10^{-2} cm/sec. The shallow piezometric surface closely reflects the area topography indicating shallow groundwater flows from the high areas to the valley bottoms and the local streams. This flow pattern indicates that the stream is gaining groundwater flow along the length of the valley. This is supported by the downstream dilution of the existing acid rock drainage sources located at the head of the Corna Valley during all flow conditions as described in *Baseline Reports, Report 3, Hydrogeology Baseline Report*. These potentiometric conditions further indicate that inter-valley groundwater flow does not occur, with groundwater flow directed away from the ridges, as opposed to through the ridges.

Groundwater generally flows towards the valley bottoms in each of the affected watersheds and appears to become either alluvial groundwater flow or baseflow that discharges to the streams, which eventually flow to the Abrud River. So all contaminated groundwater from the Project Area, including the mine waters from the underground galleries, within the Rosia and Corna watersheds will be captured behind the Secondary Containment Dam and the Cetate Dam, or in the semi-passive treatment lagoons situated downstream.

At closure, the aquifer levels will be largely restored to the pre-Project situation. groundwater gradient around Cetate pit lake will be slightly higher to compensate for the zero gradient in the lake.

4.8.3 **Generation of ARD treatment wastes**

In the post-closure phase, the following sources have to be treated by the ARD plant:

- a) Cetate pit water (on-shore treatment);
- b) Water collected at the Cetate dam;
- c) TMF dam seepage water (possibly including the removal of residual cyanide).
4.8.3.1 Pit water treatment

On-shore treatment of the Cetate pit water is foreseen in order to neutralize any acidity and maintain an environmentally benign state so that the pit lake serves its intended beneficial post-closure purpose (see Section 4.3).

It is assumed that an on-shore treatment plant will be erected which will add lime to water abstracted from the pit, neutralize it and discharge it back to the pit. The pit is used as a settling pond for the precipitates which has the advantage that no separate waste management or disposal is required. Adding excess alkalinity to the water which is pumped back to the pit will help to maintain a pH buffer so that water quality remains benign until the sulphide-rich parts of the pit walls (which are below the level that can be collected and gravitationally drained to the Roșia valley for treatment) have ceased to oxidize and generate low-pH runoff.

As the pit water is not discharged into the environment beyond the project confines, pit water quality needs not achieve the NTPA 001/2005 standard, but it must be in a neutral range to accommodate the aquatic life and serve birds and animals as drinking and bathing water. Based on hydrochemical modeling, adding 0.65 kg Ca(OH)$_2$ per m$^3$ water is sufficient to neutralize the water and add some excess alkalinity (pH of the water discharged into the pit is 9). The specific amount of treatment waste resulting from in-pit treatment is 1.1 kg (solids) per m$^3$.

At a treatment capacity of 1000 m$^3$/h, exchanging the pit lake volume once would take approximately one year, so that approximately 10000 tons (solids) of gypsum and hydroxide sludge will settle in the pit annually. This amount is very small compared to the volume of the pit water body.

In-pit treatment (i.e., using the pit as a settling pond) is international practice and has the advantages that

- the neutralizing potential of the sludge can be used to buffer the pH of the pit;
- costs are lower because the underflow sludge must not be dewatered;
- no additional disposal site must be operated and maintained.

4.8.3.2 Cetate dam water

The water quality captured at the Cetate dam is determined by the effluent quality from underground mine workings discharging through the 714 Adit, and the water quality of the Cetate pit which also reports to the Cetate dam.

The largest part of the most ARD generating (sulphide-rich) surfaces will have been mined out by the Project, so that the mine effluent quality will be much better than at present, even though it is conservatively assumed that treatment is required to achieve the NTPA 001/2005 discharge standard.

The pit water quality which also discharges through the 714 Adit will be managed by in-pit treatment so that it will not add much to the treatment load. Nevertheless, it is assumed for this source that treatment also will be necessary to achieve the NTPA 001/2005 discharge standard.

A maximum flow rate of 221 m$^3$/h which will be captured at the Cetate dam has been modeled based on a water balance of the catchment area. As the NTPA standards have
to be achieved for the treated water, the application of a combined Gypsum/Ettringite technique is assumed (see Section 4.4.5.1) which generates waste on the order of 10 kg (solids) per m³ of treated water. This results in approximately 19400 tons (dry matter) sludge annually.

The period of time over which treatment of the Cetate dam water will be necessary can be estimated only after more is known about the final flooding level of the Cetate pit. The more permeable are the pit walls towards the Roșia valley with respect to the underground mine workings and geological faults, the lower the flooding level in the pits will be and hence some mine workings which are ARD generating will never be under the water level. Oxidation will continue so that the need to treat water will extend far into the future. This is not a consequence of this Project, however, but results from the historic mine workings. This Project provides the means of mitigating the existing ARD generation problem from the underground mine workings, either by their removal by mining or by flooding at closure.

4.8.3.3 TMF dam seepage water

The dam seepage water needs to be treated for several decades at least in order to remove Sulphate and Calcium according to the NTPA 001/2005 standard, according to Section 4.4.4. Heavy metals such as Molybdenum and metalloids (Arsenic) are likely to be retained by sorption within the tailings body and dam.

In a semi-passive lagoon which is foreseen as a long-term solution, sulphate will be reduced to sulphide, while Calcium is unlikely to be much affected. As there is some uncertainty as to whether the semi-passive treatment system alone will be effective in treating discharges to meet NTPA 001/2005, it is conservatively assumed that the treatment will take place in a conventional treatment plant based on Lime/Ettringite precipitation.

The amount of treatment wastes generated during closure will be proportional to the seepage rate. At closure, the seepage rate will be approximately 77 m³/h, which is reduced over time due to the placement of a cover system on the TMF. Again, as the placement and performance of the cover depend on a number of factors which cannot be determined with certainty today, it is conservatively assumed that the seepage rate of 77 m³/h remains constant over time.

These assumptions, together with the conservative estimate of a specific residue generation of 10 kg dry matter per m³ of water treated, indicate that an annual amount of approximately 6700 tons (solids) of Gypsum/Ettringite sludge will be produced.

Summary of waste generation by pH, SO4, Ca and metal treatment

The table 4-14 summarizes the wastes generated by pH, SO4, Ca and metal treatment in the closure and post-closure phase. It must be emphasised again that the assumptions on which these estimates are based are very conservative, as required by Annex 3 of MO 863\textsuperscript{cix} if uncertainties in these assumptions cannot be eliminated.
### Table 4-14. Waste generation by pH, SO4, Ca and metal treatment in the ARD treatment plant (Combined gypsum)

<table>
<thead>
<tr>
<th>Source of effluent</th>
<th>Approximate amount of water to be treated (m³/h)</th>
<th>Residues generated (dry substance) (t/a)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water collected at Cetate dam or pond</td>
<td>221</td>
<td>19400</td>
<td></td>
</tr>
<tr>
<td>TMF dam seepage</td>
<td>≤ 77</td>
<td>≤ 6700</td>
<td>amount will decrease as cover is placed on TMF</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>≤ 26100</td>
<td>sludge to be disposed in TMF, later in Cetate pit lake</td>
</tr>
<tr>
<td>In-pit treatment (Cetate pit)</td>
<td>1000</td>
<td>9636</td>
<td>sludge settled in Cetate pit, no separate waste disposal required</td>
</tr>
</tbody>
</table>

#### 4.9 Air and noise emissions

Noise, dust and gaseous emissions (such as NOₓ) during the rehabilitation works are mainly caused by the following:

- shaping/re-grading of slopes;
- hauling material to cover the TMF and waste rock facilities;
- demolishing buildings and facilities (processing plant) which are not used in the post-closure period (such as possibly the domestic sewage treatment plant);
- constructing the semi-passive treatment wetlands in the Roșia valley.

These emissions are managed according to the corresponding management plans:

- *Noise and Vibration Management Plan*;
- *Air Quality Management Plan*.

Sections 4.2 (Impacts - Air Quality) and 4.3 (Impacts - Noise and Vibration) of the EIA are specifically devoted to assessing the consequences of the project with respect to air emissions and noise, and contain subsections for the closure phase.
5 Reclamation Measures during Operations and Project Closure

According to Annex 3 of MO 863\textsuperscript{cdv} the activities involved in decommissioning the project (e.g. closure, dismantling, demolition, clearance, site restoration, site re-use etc) must be described.

This section describes the period during operations and later phases of mine life when the mine is in the process of being closed. The key objective of this period is to achieve the after-use objectives in the interest of the community, which includes an appropriate level of public safety, and chemical and physical stability.

Closure activities during the mining and processing phase of the Project include:

- regrading and covering the completed waste rock piles;
- regrading and covering the TMF;
- breaching the Cetate dam;
- breaching the Corna valley Secondary Containment Dam;
- installation of Corna valley semi-passive treatment;
- pit lake management;
- implementation of water treatment for the open pits;
- installation of a pumpback system at the Cetate Dam;
- removal of the Process Plant and storage tanks;
- removal of high voltage electrical equipment;
- reclamation of roads;
- closure of pipelines;
- removal and placement of the stockpiled topsoil materials;
- securing the open pits after completion of mining; and
- water treatment.

The following sections describe the reclamation measures to be implemented at closure of the Roşia Montană Project on a facility-specific basis. Drawings 1 through 4 depict the conditions and progressive reclamation activities that will take place at the end of Years 14, 16, 19 and 21.

5.1 Tailings Management Facility

5.1.1 Tailings Basin

The preparation for closure of the Tailings Management Facility (TMF) will commence prior to the cessation of mining, during the final years of operations. To the extent practical, the tailings will be deposited in a manner consistent with the final grading plans for the completed tailings surface. During this time, the preparatory work will include modification of the tailings disposal system to achieve a final landform that will require minimal additional work, for example, establishment of single point surface drainage discharge. Tailings discharge into the TMF in the later years of operation therefore will primarily take place at
the upstream end of the impoundment in order to move the decant pond towards the downstream end of the impoundment. This will minimise requirements for regrading of the tailings surface by earthmoving equipment, and will promote surface water drainage during post-closure.

Once tailings deposition is complete, the tailings delivery and distribution pipelines will be flushed with water and the wastewater directed to the Tailings Management Facility. The pipelines will be cut up for recycling as metal and/or high-density polyethylene (HDPE) scrap, re-sold, or disposed in a permitted landfill. The reclaim pump system and associated pipelines will be retained for the purposes of pumping down the TMF pond to allow for regrading and the installation of a soil cover.

A surface water discharge channel will be constructed along the north side of the TMF. The discharge channel will be used once the cover system is installed so clean surface water can be discharged from the TMF’s final closure surface configuration to a point downstream of the embankment (drawing 4). Installation of the surface water channel will also minimize infiltration through the cover system and into the tailings. The final configuration of the TMF surface and the discharge channel will be designed to accommodate the runoff from the Probable Maximum Precipitation (PMP) event in order to ensure that the embankment will not be overtopped.

A soil cover will be placed over the regarded tailings surface. The specific date for start of the final cover construction will depend on the rate of consolidation of the tailings and progress in the regrading required to facilitate surface water drainage to the discharge channel. Cover construction will be initiated as soon as possible to minimise the amount of time the tailings basin is left open and minimise infiltration of rainfall into the tailings mass.

The purpose of the cover system is as follows:

- reduce any potential acid rock drainage from the tailings by limiting infiltration and oxygen ingress;
- control infiltration of precipitation by shedding surface water off the cover and directing it via engineered grading and ditching towards the final location of the TMF surface discharge point;
- reduce wind and water erosion;
- provide a growth medium upon which to establish vegetation;
- reduce visual aesthetic impacts once vegetation has taken hold; and,
- reduce the potential for direct contact between the tailings and humans and wildlife.

Soils for the cover will be reclaimed from soil stockpiles located at the upstream end of the tailings impoundment created during the stripping of the TMF basin (shown on Drawings 1 through 4) and other operational areas during construction. The cover is designed to hold and store water, while minimising seepage into the tailings during wet seasons and then evapotranspiring the stored moisture back to the atmosphere during the dry season. The cover design criteria and the cover layer structure are described in Section 4.5.3.
During the operational phase, test cover sections will be constructed at the TMF site to verify cover section performance and finalise its design (see Section 4.5.4).

In areas where the fine-grained tailings may be too soft to support a soil cover, geotextile will be placed on top of the tailings prior to soil cover placement. An example of a potential geotextile is Typar 3801 (or equivalent) although the specific type will be developed upon the actual properties at the time of closure. If necessary, a geogrid will be applied in addition to the geotextile to improve stability of the tailings surface for heavy machinery.

Once a soil and vegetative cover has been established there will be a limited need for long-term maintenance and inspection. However, some periodic inspections will be required, for example, to ensure that drainage ditches and associated drainage features remain functional (see Section 9).

Water quality in the final reclaim pond will have only residual cyanide concentrations due to natural degradation of residual amounts in the tailings and reclaim pond (see Section 4.5.4). However, final residual cyanide concentrations in the reclaim pond cannot be predicted with absolute certainty. It is therefore planned that after tailings deposition is completed, any remaining reclaim pond water will be pumped to the Cetate pit as part of the pit lake development. If cyanide concentrations are above the NTTPA 001/2005 standards, cyanide will be removed by the secondary treatment system before the TMF decant pond water is discharged into the pit.

The most valid ARD concern is that ARD may be generated on the TMF surface during a prolonged mill/process plant shut down, or at the end of processing prior to closure and this could result in subsequent acidification of the decant pond. From this points of view, it is therefore of particular importance to start rehabilitation of the TMF as soon as possible. However, the placement of the cover system requires that the tailings are sufficiently consolidated to support heavy machinery. A well-balanced time schedule will therefore be developed and incorporated into the updated Mine Closure Management Plan once precise information on the tailings composition and geotechnical and hydraulic properties are available during operation.

Undisturbed surface drainage collected at the deepest point on the TMF cover will be collected and discharged by a channel to the Corna valley. The design of the channel will depend on the exact location within the basin. Energy dissipation will be required near the base of the valley. The spillway structure which will be designed to accommodate approximately 5 m$^3$/s peak flow at closure could consist of a 10 m wide spillway (based on formless flume) with a normal flow depth of approximately 0.4 m (constructed depth of at least 1m).

In summary, the following processes and requirements are closely intertwined and require an optimized time schedule for closure of the TMF area:

- Prevention of acidification: this requires that the surface of the tailings are either kept under water or are quickly covered with an oxygen barrier.
- The cover placement requires sufficient geotechnical stability of the tailings surface which is achieved only after some time of consolidation.
- The cyanide concentration in the decant water pond degrades within some months to some years to levels which may make active removal of cyanide redundant.
- On the other hand, fast flooding of the Cetate pit is desirable in order to prevent continued oxidation of the sulphidic parts of the pit walls.
5.1.2 TMF Dam

The downstream slope of the TMF dam will be terraced during construction to mitigate erosion and to facilitate access to embankment monitoring instrumentation. A cover system similar to the one placed on the waste rock stockpiles will be placed over the downstream slope of the embankment. Progressive rehabilitation (topsoil placement and revegetation) will be initiated in the final years on completed benches near the toe of the dam in approximately Year 16. Reclamation will provide the following:

- control infiltration of precipitation by shedding surface water off the cover and directing it via engineered grading towards the valley bottom;

- control erosion of the embankment;

- reduce any potential acid rock drainage from the embankment rockfill by minimising infiltration of water and oxygen;

- provide a growth medium upon which to establish vegetation; and,

- reduce visual impacts once vegetation has taken hold.

The regraded TMF dam will be inspected by a qualified professional engineer and certified with respect to static and dynamic stability. In addition, the TMF dam will be subject to ongoing monitoring, instrumentation, and inspection to ensure embankment integrity and stability are maintained consistent with statutory requirements (see Section 9).

5.1.3 Secondary Containment Dam and Pond

The Secondary Containment Dam (SCD) sump, and associated pond will be retained through the closure activities period to collect seepage from the TMF for discharge to the pit lake treatment system and/or routing to the semi-passive TMF seepage treatment system. Prior to closure of the TMF reclaim pond, a pumping and piping system will be installed at the end of Year 16 to convey collected water at the SCD to the pit lake system. Pumpback to the tailings impoundment will be discontinued when the reclaim pond draindown is initiated in order to minimise water inflow into the impoundment and to expedite the tailings impoundment closure.

It is anticipated that significant draindown of the TMF will continue for several years after removal of the TMF reclaim pond and installation of the cover system; therefore, it is estimated that the Secondary Containment Dam will be decommissioned in Year 19, and only a sump will remain to collect the seepage water which is either pumped into the conventional ARD treatment plant (including a CN removal system based on the technology described in Section 4.4.5.2) or treated in the semi-passive lagoons.

The impoundment area will be cleaned of any sediment (primarily insoluble hydroxides), which will be hauled to the open pits. Then the SCD embankment will be removed and the dam footprint will be regraded and revegetated and residual TMF seepage be discharged via the semi-passive treatment system, as noted in the following sections.
5.1.4 Semi-Passive Treatment System

A semi-passive system of bioreactive cells will be constructed in the early part of the operational phase of the mine just downstream of the Secondary Containment Dam. These ponds will be constructed at this time to allow refinement of the design and pond management, prior to full commissioning. The preliminary design of these ponds as presented on Drawing 2 is based on the design guidelines presented in the PIRAMID engineering guidelines. The approximate location of these ponds is also shown in Drawing 2. The calculations for the pond dimensions based on these flow rates are presented in the Engineering Review Report.

Once the Secondary Containment Dam is removed in Year 19 and pumping to the wastewater treatment plant stops any remaining seepage will be routed through the semi-passive treatment system and, assuming that the system outlet water quality is acceptable, discharged offsite. If the semi-passive treatment system cannot treat seepage to acceptable water quality standards, pumping to the ARD treatment plant (complemented with removal of residual cyanide) will continue until the discharge standards are achieved by the semi-passive treatment system.

A series of two cells and one pond will be constructed to form the entire semi-passive treatment system. Their function is described in Section 4.4.5.3.

Monitoring wells will be installed downstream of the SCD pond. These wells also may be used as production wells should monitoring show an unexpected rise of contaminant concentrations in the groundwater. The captured groundwater will then be pumped back to the TMF or ARD treatment plant.

5.2 Waste Rock Stockpiles

Waste rock from open pit development will be used to construct the TMF embankment and other impoundment structures. In addition, a portion of the waste rock will be deposited in the Cârnic open pit after the pit has been completely mined in Year 10. The remaining waste rock will be deposited in the Cârnic and Cetate stockpiles as indicated in the following table.

Table 5-1. Physical characteristics of waste rock stockpiles at closure

<table>
<thead>
<tr>
<th>Waste rock stockpile name</th>
<th>Amount (million t)</th>
<th>Footprint (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cârnic</td>
<td>109.391</td>
<td>139.0</td>
</tr>
<tr>
<td>Cetate</td>
<td>21.300</td>
<td>36.8</td>
</tr>
<tr>
<td>Total</td>
<td>130.691</td>
<td>175.8</td>
</tr>
</tbody>
</table>

Significant work has been completed to characterise the geochemical nature of the waste rock. This work has included ABA testing, column testing, mineralogical studies, and short-term leachability tests. This indicated that the waste has a net low potential to generate ARD, but slightly less than 50 percent of the future waste rock tested does have some potential to generate ARD. This is offset by rock that has net neutralizing potential. A small percentage of the waste rock types can be confidently classified as ARD generating or non-ARD generating. The most dominant waste rock types have highly variable ARD character, and a waste segregation strategy (see Section 4.2) will be implemented by RMGC to minimize the generation of seepage which must be treated.
The waste rock stockpiles will be placed during the operational phase of the mine. Mining from the open pits will be completed at the end of Year 14. On the basis of the current mine plan, waste rock placement at the Cârnic waste stockpile will occur from the inception of mining operations and conclude in Year 9; therefore, the start of waste rock stockpile reclamation will begin shortly after deposition is concluded. Although dumping at the Cetate stockpile will be completed at the end of Year 4, the Low Grade Ore stockpile that is located adjacent to the east of this stockpile will not be completely removed until the end of Year 16. The reclamation of the Cetate waste rock stockpile will be conducted in parallel with the removal of the low-grade ore stockpile.

The Cârnic and Cetate waste rock stockpiles will be constructed with overall (top to bottom) average slope angles of 2.5H:1V comprising 30 meter high lifts with angle of repose slopes and flat 41 meter wide catch benches (see Drawing 5). This profile has been planned to minimise the amount of regrading that is necessary for closure.

At closure the slopes will be regraded to ensure that the resultant final slopes maintain the overall 2.5H:1V slope with 6 metre wide benches every 75 metres horizontally required to establish vegetation and minimise the amount of ongoing (see drawing 5). Benches will be graded to drain at 1% to allow drainage of collected surface water off the waste rock stockpiles.

Once regrading has been completed, a soil cover will be placed over the slopes, catch benches and top surface to prevent access to the wastes, reduce infiltration of precipitation and to provide a growth medium for self-sustaining vegetative cover. The final configuration will be stable under seismic and static criteria. Preliminary stability analyses indicate that the design discussed above is stable using typical criteria and site-specific design earthquakes (Operating Basis Earthquake = 0.082g, and Maximum Credible Earthquake = 0.14g)\textsuperscript{clii}.

The proposed cover system (see Section 4.5.1) provides for a 20 cm thick subsoil cover, and a 10 cm thick sequence of topsoil at the surface to support vegetation. As with the TMF, soil for the cover will be obtained from the plant site excavation stockpile developed during initial Project construction and located at the upstream end of the tailings impoundment. The vegetative soil will be obtained from the topsoil stockpiles located on site.

Surface water collection ditches will be installed on the benches to collect and convey surface water off the waste rock to minimise the potential for infiltration into the stockpile, thereby further minimising the potential for acid rock drainage generation. Collector ditches will conduct the runoff water into the overall surface water diversion system, which will route the water to either the Rosia or Corna Valley.

During operations and stockpile cover construction, seepage water from both the Cetate and Cârnic waste rock stockpiles will continue to be directed to the wastewater treatment plant if it does not meet the NTPA 001/2005 standard for direct discharge. However, after placement of the cover system and surface water collection ditches, it is anticipated that acid rock drainage flows from the waste rock stockpiles will be eliminated. Seepage that requires treatment from the Cetate waste rock stockpile will be routed to the semi-passive treatment system that will be constructed downstream of the Cetate Water Catchment Dam (see Drawing 3). An option to pump the seepage to the pit lake system will be available should semi-passive treatment be ineffective.

Semi-passive treatment system installation has been planned for the end of Year 16 downstream of the Cetate Water Catchment Dam (see drawing 2). This semi-passive treatment system will be similar to the system downstream of the TMF, which has been described in Section 5.1.4. The semi-passive treatment cells will be constructed based on
the experience gained during operation of the cells in the Corna Valley during the operational phase.

5.3 Open Pits

During the operating phase, transfer mining will be used to backfill mined-out open pits with the waste material obtained from mining another pit. There are four pits mined by the Project:

- Cârnic;
- Jig;
- Orlea;
- Cetate.

These have physical characteristics as set out in table 5-2.

Table 5-2. Physical characteristics of the open pits

<table>
<thead>
<tr>
<th>Pit name</th>
<th>Amount (1000 tonnes)</th>
<th>Footprint (ha)</th>
<th>Backfill amount (1000 tonnes)</th>
<th>Backfilled with material from pit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cârnic</td>
<td>227,355</td>
<td>27.43</td>
<td>34,221</td>
<td>Cetate, Jig, Orlea</td>
</tr>
<tr>
<td>Jig</td>
<td>15,525</td>
<td>18.2</td>
<td>13,944</td>
<td>Cetate</td>
</tr>
<tr>
<td>Orlea</td>
<td>66,022</td>
<td>26.51</td>
<td>16,850</td>
<td>Cetate</td>
</tr>
<tr>
<td>Cetate (marginea de sud)</td>
<td>162,930</td>
<td>4.93</td>
<td>1,936</td>
<td>Jig</td>
</tr>
<tr>
<td>Total</td>
<td>471,832</td>
<td>77.07</td>
<td>66,951</td>
<td></td>
</tr>
</tbody>
</table>

The physical configuration of the pits at closure is shown in Drawing 1 through Drawing 4.

The sequence of mining and backfilling of the pits is summarized below.

The mine pits will be backfilled to the maximum extent feasible. The Jig pit will be backfilled to the approximate original contours prior to mining. The Orlea and Cârnic pits will be
backfilled to elevations that are expected to eliminate a pit lake from forming. There is only a very limited amount of backfill placed on the upper perimeter (southern rim) of the Cetate pit.

The pit walls (and underground workings) are left in a safe and stable condition. Loose blocks will be scaled off so that there is no risk to the public under the intended after-use scenarios (hiking, scientific and education trails). Like naturally steep slopes, climbing outside the pathways and trails is not recommended, and warning signs will be erected.

There could be an option to undertake rehabilitation blasting - which makes the faces still more natural in appearance - the faces rougher and "scree" at the foot of slopes. Rougher slopes can be revegetated more easily - either adventitious or by pocket planting of, for example, climbing plants. However, stability will remain the priority.

At the completion of mining, a qualified professional engineer will evaluate the overall stability of the mine pits. Any underground workings that have disturbed or are likely to disturb the pit walls will be stabilised and secured to prevent access.

Perimeter berms will be placed around the Cetate pit and any steep pit walls which remain after partial backfilling of the Cârnic and Orlea pits as a safety precaution and to control vehicle access to the pits. The construction of berms around the pits will be ongoing during operations and will be completed at the end of mining but before the end of ore processing. The material used for the berms generally will be NAG waste rock material from the mining operations. Safety berms will be augmented with appropriate warning signs.

The 15 m broad berms of the pit which served as haul roads will be vegetated with trees and grass. If generation of low pH water by the pit walls cannot be prevented, an appropriate drainage ditch will be installed which keeps the runoff from the steep slopes away from the trees. The pit walls which are not covered by water or backfill material will be revegetated, using hydroseeding or climbing plants.

5.3.1 Pit Lake Management

The long-term management of the resulting Cetate pit lake will be a key component of the closure planning. Considerations in the closure planning for the mine pits include the hydrology, limnology and the geochemistry of the resulting pit lake.

During mining, water that flows into the pits will be discharged to the Cetate dam and treated through the acid rock drainage Wastewater Treatment Plant. However, this will not be an efficient system at closure; therefore, a pit lake management plan has been developed to address this issue. Because of probable water quality issues, the pit lake will need to be managed at closure. Due to the volume of water, the pit lakes will be used as the focal point for water treatment during the closure period. Use of the pit lake will be transitioned over a period of several years starting at the end of Year 16 after the termination of ore processing. Pit lake management will consist of measures implemented during and after operations.

The volume of the Cetate pit to be flooded including the pore volume of the backfilled pits is estimated 9.7 million m³, if a maximal flooding level of 745 m a.s.l. is assumed. Flooding progress of the Cetate pit lake will depend on the hydraulic conditions, groundwater inflow/outflow balance, and the actual climatic conditions at the time of flooding. An estimate of the time required for flooding (including sensitivity analyses) has been performed. Modelling to evaluate the rate of filling of the mine pit system with groundwater and surface water (e.g., precipitation) estimated that filling will occur in a nominal 8 years to the 714 Adit level and 32 years to the maximum water table level of 745 m a.s.l. With TMF water used to help flood the pit this is reduced to 5 and 24 years, respectively.
5.3.2 Operational Measures to Reduce ARD in Mine Pits

The development and persistence of acidic pit lakes is affected by measures implemented during mining. One of the most important of these measures is diversion of acidic runoff from mine wastes away from the mine pit(s). The waste rock piles will be positioned in areas not directly adjacent to the pits at Roșia Montană, such that runoff from the waste rock piles will not impact the open pits. With the waste rock segregation strategy described in Section 4.2 and the placement of infiltration-reducing cover systems of end-dumped PAG parts of the waste rock facilities, the seepage is very unlikely to need treatment after closure.

If disturbed watershed areas contribute water to the mine pit, these areas will be reclaimed as quickly as is practical. Alkalinity (limestone) addition in these areas within the pit lake watersheds will be completed to help remediate acidic lakes. Diversion of water at closure into the pits from reclaimed watersheds may be implemented if alkalinity addition has resulted in elevated runoff alkalinity. This will be evaluated on an area-by-area basis at closure.

Measures that may be implemented in highly sulphidic areas of the mine pit walls have been discussed in Section 4.3.5.

Another key method to reduce the acid rock drainage that could accumulate as a portion of the pit lakes water volume is to limit acid rock drainage flowing from the underground workings. Measures to reduce acid rock drainage flowing from the underground workings include the following:

- placement of airtight bulkheads in mine workings exposed during open pit mining;
- installation of airtight bulkheads and doors in portals and shafts to underground workings where access is not needed; and
- identification of areas of focused water flow into underground workings (e.g., glory holes or open stopes) and covering and/or grouting these features.

Such measures will be considered on a case-by-case basis during operation as the closure plan is finalised.

5.3.3 Measures to Reduce ARD Generation at Closure

An effective method to reduce acid rock drainage generation in the mine pit(s) is to flood the pit with water as quickly as possible. Once the sulphides in the wall rock are submerged, the availability of oxygen is limited, and oxidation and acid rock drainage generation is very slow. Diversion of water from undisturbed land, the TMF decant pond (after removing residual cyanide) and TMF dam seepage into the pits will accelerate flooding. This method has been demonstrated as effective at other open pit mines (e.g., at Island Copper Mine open pit in British Columbia, Canada).

Mine pit flooding will be implemented by installing a bulkhead in the 714 Adit. The most available water source of significant volume, besides natural precipitation in the pits, is the reclaim water in the TMF. Water from the TMF will be pumped to the pits to reduce the time to flood the pits and provide a source of alkalinity to the pit lakes to buffer against pH decreases caused by pit wall runoff.
Other water that could be directed to the pit lakes to accelerate flooding and reduce acid rock drainage generation includes non-acid rock drainage affected storm water, and discharge from the acid rock drainage treatment plant. Moderately acidic water could be neutralised with an in-line system designed for such a purpose and discharged to the pit lake. These options will be considered once mining is completed.

5.3.4 Pit Lake Water Treatment

If the pit lakes fill with a significant proportion of acid rock drainage, then treatment will be needed so that the water can be discharged to either surface water or groundwater. It is estimated that approximately 27 L/sec will have to be managed on an annual basis once the lakes fill (net inflow). Two general options exist for treating pit lake water. These are:

- in situ and
- on-shore treatment.

In situ treatment generally consists of using the pit lake as a chemical vessel and adding amendments to the lake to facilitate chemical reactions and/or enhance natural aqueous processes to increase pH and reduce concentrations of metals and inorganic ions.

On-shore treatment is typically a treatment plant.

In conditions such as will be present for the Roșia Montană Project, where some of the capital cost associated with post-closure treatment can be defrayed because an acid rock drainage treatment plant will already be constructed at the site, a combination in situ/on-shore treatment scheme will be implemented. This system will include an on-shore lime-based ARD treatment plant that will be constructed next to the open pits (Drawing 4). This will likely consist of relocating, with possible modification, the Wastewater Treatment Plant from the process area and is currently the preferred option.

However, an engineering evaluation will need to be conducted to determine whether using the plant in its processing plant location is a viable option. As the pit is filling, the plant will circulate water from the pit through the treatment plant back to the pit. This provides an effective method for liming the lakes. The pH of the pit lakes will be maintained at a desired level, with some metals precipitating in the pit. Clarification of the treated water will not be needed, as limed water will be pumped directly to the pit. In addition, excess alkalinity will be added to the discharge to help increase the pH in the lake as needed. It will have to be determined if both the Orlea and Cetate Pits would be treated or only the Orlea Pit, which is most downstream.

Another option which may be considered as a long-term solution is in-pit treatment based on Sulphate-reducing bacteria (SRB, see Section 4.3.5).

A buried pipeline leads from the Cetate pond to the ARD treatment plant. This pipeline is equipped with a leak detection system. If the pipeline breaks or leaks, the leak will be located and repaired. Even under the worst case condition that there is a complete rupture of the pipe, the leakage would drain down to the Cetate pond and be captured there. This situation would not be different from the normal conditions of groundwater of similar quality filtrating through the permeable host rock from the underground mine workings and the flooded Cetate pit.
5.4 Aggregate quarries (Șulei and La Pârăul Porcului)

In addition to the open pits where ore will be extracted, there will be two additional small pits (La Pârăul Porcului and Sulei) where aggregate will be obtained during the construction phase and as required through the life of the Project. The majority of the aggregate will be obtained during site construction with smaller amounts mined through the life of the Project.

These pits will be developed in rock types (andesite and sandstone) that do not generate acid rock drainage, and therefore do not require any special closure considerations. However, berms will be placed around the perimeter of the pits in conjunction with signs to warn people of steep slopes.

The Șulei quarry will have a natural drainage from the base on the southwest side of the pit at the 1040 elevation bench. This will prevent any ponding of water within the pit limits. Top soil will be placed over the base of the quarry to facilitate vegetation growth. In addition, topsoil will be placed on the larger slope benches where feasible to support vegetation.

A forest curtain will be planted at the base of the quarry, which will minimize further soil degradation.

The La Pârăul Porcului quarry will be excavated directly adjacent to the northern diversion ditch. The base elevation will be approximately 720 meters and the adjacent diversion ditch will be at approximately 740 meters. Therefore, the pit could be flooded after mining is completed. However, operational experience during mining will indicate if the pit will contain a year-round pond or if it will leak to the Rosia Drainage.

In the case of lake formation, future uses of the La Pârăul Porcului quarry could include a diving and/or bathing resort, as the water will be clear and fit for these purposes. There are numerous examples throughout Europe and worldwide where similar quarries have found such after-uses which makes them a magnet for local small sports and leisure entrepreneurs.

Public use after closure of the quarries requires stabilization of pit slopes (free from spalling and rockfalls) which will be ensured as part of the closure activities.

5.5 Cetate Water Catchment Dam

Water volumes routed to the Cetate Water Catchment Dam will diminish with time and quality will improve once the cover systems have been constructed over the waste rock stockpiles and TMF and other reclamation activities are implemented. Drainage from the 714 Adit will be intercepted upstream by the Cetate pit lake, as will water flowing from the underground mine workings, and historic ARD sources will have been removed. Based on previous project experience, it is anticipated that by the end of Year 21, the water collected in the pond created after the breach of the Cetate Dam will consist of a quality that can be treated with a semi-passive treatment system. This type of system will be installed at the end of Year 14 downstream of the Cetate Waste Dam. The semi-passive treatment system will be transitioned into water treatment between end of year 14 and final closure and will operate in conjunction with the Wastewater Treatment Plant.

In addition to the semi-passive treatment system, a collection and pumpback system will be constructed downstream of the Cetate Water Catchment Dam in Year 21 as an additional
precautionary measure. This system will collect and pump water to the open pit wastewater treatment plant only if the semi-passive treatment system is not adequately treating the water.

5.6 Plant Site and Facilities

5.6.1 General Considerations for Decommissioning Activities

All decommissioning work will be performed by trained personnel, in accordance with standard workplace health and safety procedures as noted in the Occupational Health and Safety Plan, as well as Emergency Preparedness Plan. Work will be carefully planned, sequenced, and scheduled so that functional installations are properly and safely segregated from those areas that will be subject to disassembly.

Particular care will be taken with regard to the use of portable and stationary ventilation systems, respiratory protection devices and other personal protective gear, as well as lockout/tagout procedures so that electrical equipment or machinery will not be inadvertently energised during disassembly. Work areas will be strictly delineated via temporary fencing, warning panels, visual and acoustic signalling and warning devices, or other appropriate means.

Care will be taken to minimise the accumulation of debris that could endanger workers engaged in further disassembly or demolition activities. At disassembly, all connectors and fasteners will be sorted by size as necessary to support potential future reassembly. The disassembly sequences for major equipment items will, in general, be the reverse of the assembly order. Heavy parts will be strapped, chained, or bolted to wooden pallets or skids to prevent inadvertent rotation and to facilitate forklift handling and truck loading operations.

**Major equipment items and ancillary equipment** will be sorted by function, placed on a bermed concrete pad, washed with detergents and/or solvents, and assessed for wear or damage.

All **drained waste oil or lubricants, washwater, and spent solvents** will be captured, segregated, and accumulated in tanks (double-walled or provided with bermed concrete secondary containments) for proper disposal in accordance with the Waste Management Plan.

Depending on their disassembled condition, all **decommissioned equipment** items will be sold for beneficial reuse or for their scrap or recycling value. Areas where equipment and tanks have been removed will be assessed for environmental contamination including sampling of subsoils where appropriate. If required the soil will be remediated.

**Concrete rubble** will be transported to the Inert Waste Landfill or, if permitted by the current approved version of the Waste Management Plan, may potentially be used as backfill material in the open pits.

**Insulation material** will be segregated for potential beneficial re-use or (depending on type) disposal as inert or municipal waste in accordance with Waste Management Plan

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4 This subsection does not address the ARD treatment plant which is kept operational during closure and possibly post-closure phase.
requirements. No asbestos insulation will have been permitted in the construction of the process plant or its ancillary facilities.

Decommissioning/demolition of all structures will comply with the provisions of applicable closure-phase regulations. Such regulations will be defined in the Project’s current register of regulatory requirements (see Environmental and Social Management Plan) and may include the current versions or successors of the following:


- Romanian State Standard STAS 1125/1 – 1981 – welding of metals;

- Romanian State Standard STAS 10564 – oxygen torch cutting of metals;

- P 54 – 80 – technical instructions concerning sectional steel structures;

- PE – 119 – 1982 – work safety standards for electric installations;

- general norms for fire prevention and extinction, approved by Ministry of the Interior Order No. 775/1998;

- Decision No. 678/1998 concerning the assessment and sanction of the contravention’s related to fire prevention and extinction; and

- technical norms for the design and building of structures – fire protection, P118/1999.

The demolition of concrete (simple and/or reinforced) and masonry structures may also be assisted by means of explosives. All explosives assisted demolition will be carried out in accordance with the current version or successor to Ministry of Work and Social Protection Order No. 838/1997, “Specific work safety standards concerning the storage, transport and use of explosive materials.”

5.6.2 Process plant area

The decommissioning of the process plant area will be divided into six major operations:

- decommissioning of the crushing plant and the crushed ore stockpile;

- decommissioning of the milling, classification and gravitational concentration plant;

- decommissioning of the cyanide leaching, carbon stripping, electrowinning, and smelting plant;

- decommissioning of the reagent management area, excluding the cyanide detoxification plant;
Section 5: Reclamation Measures during Operations and Project Closure

- decommissioning of cyanide detoxification plant; and
- decommissioning of administrative offices and utilities.

All of these activities may be scheduled and conducted in parallel, except that the cyanide detoxification plant will remain operational until all other process plant areas have been decommissioned. This will preserve an onsite capacity for the detoxification of any residual cyanide or accidental spillage encountered in the decommissioning of the cyanide leaching systems or reagent handling areas of the process plant. The detoxification plant could also be used (in upgraded and modified form according to Section 4.4.5.2) for the removal of cyanide from TMF pond water which is pumped to the Cetate pit for flooding.

5.6.3 Crushed Ore Stockpile Area and Other Process Plant Buildings and Industrial Structures

Decommissioning/demolition of industrial structures related to the ore crushing plant and stockpiling area of the Roșia Montană processing plant will generally follow the following sequence:

- completion of all electromechanical installations/equipment decommissioning and removal of such equipment from the Project site;
- dismantling of internal metallic structures (e.g. walkways, hand rails, platforms) by dismounting or by oxy-acetylene or arc cutting of reinforcing or support elements;
- removal of metal shrouds or shields by dismounting or by oxy-acetylene/arc cutting;
- removal of catwalks, ladders, and stairways;
- removal of insulation materials;
- removal of metal-framed doors and windows;
- removal of metal sheathing and roofing;
- disassembly of structural steel beams and joists; and
- demolition of vertical walls, cut-off walls, or berms made of concrete slabs or blocks via jackhammers or picks mounted on an excavator arm or other hydraulic equipment.

Major equipment items used in installations and equipment expected to be used in crushing operations, crushed ore storage, and reclamation from the crushed ore stockpile include the following:

- gyratory crusher;
- apron feeders;
- belt conveyors;
- pebble crushers;
- metal detectors;
- electromagnetic metal extraction equipment; and,
- scales/weighing devices.

Ancillary servicing, control, and automation equipment in this part of the process plant is also expected to include the following:

- cranes and other electromechanical hoisting devices;
- ventilation equipment for the crushers;
- electric pumps and piping systems, including fire suppression and wetting systems, climatisers, and dust control equipment (e.g. exhaust systems, ducting, bag-house filters);
- electric power, command, automation, and lighting systems;
  - emergency backup generator systems;
  - electric transformers;
  - electric cables;
  - various lighting armatures;
  - electric grounding circuits; and
  - power supply, distribution, command, control, protection, and regulation equipment; and various metal ducts, chutes, bins and material spill collection devices.

Major installations and equipment used in the process plant include the following:

- the SAG mill and ball mills;
- electromagnetic equipment for ball handling;
- cyclone clusters;
trash screens and bunkers; and,

associated shrouds and support structures.

5.6.4 Carbon-in-Leach, Carbon Stripping, Electrowinning, and Smelting Plants

Apart from general handling, cleaning, storage, and equipment condition assessment actions noted previously, all piping systems, tanks, and equipment items in the process plant that come in contact with cyanide compounds will be flushed and detoxified prior to decommissioning or disassembly, in accordance with the latest approved version of the Cyanide Management Plan and applicable regulatory requirements. As previously noted, the detoxification circuit within the reagent management areas of the process plant will be the final component to be decommissioned, in order to maintain an onsite capability for collection and detoxification of any potential spillage or residual cyanide compounds that may be encountered in the decommissioning of the carbon-in-leach (CIL) equipment or other systems and equipment.

The major equipment items used in installations and equipment used for the CIL, carbon stripping, electrowinning, and smelting sections of the process plant are as follows:

- carbon-in-leach tanks;
- thickener tank;
- carbon screens;
- detoxification tank;
- elution columns and heaters;
- carbon regeneration kilns;
- heat exchangers;
- induction furnaces;
- mercury retort system;
- filter press and scrubbers; and,
- the smelting furnace.

Ancillary servicing, control, and automation equipment in this part of the process plant will also include the following:

- cranes and other manual/electromechanical hoisting devices;
§ ventilation equipment;

§ process circuits for fluids conveyance and spills evacuation, including:
  • various electric pumps;
  • tanks, distributors, fittings, pipes, elbows and valves;

§ fire suppression systems;

§ electric power, command, automation and lighting units, consisting of:
  • power and lighting transformers;
  • electric cables;
  • various lighting armatures and grounding circuits;
  • electric equipment related to power supply, distribution, command, control, protection and regulation installations; and

§ various metal ducts, chutes, bins, and material spill/debris collection devices.

5.6.5 Reagent Management and Detoxification Circuit Areas

In addition to the general handling, cleaning, storage, and equipment condition assessment actions noted previously, all piping systems, tanks, and equipment items in the process plant that come in contact with cyanide compounds will be flushed and detoxified prior to decommissioning or disassembly, in accordance with the latest approved version of the Cyanide Management Plan and applicable regulatory requirements.

The detoxification circuit within the reagent management area of the process plant will be the final component to be decommissioned, in order to maintain an on site capability for collection and detoxification of any potential spillage or residual cyanide compounds that may be encountered in the decommissioning of the CIL equipment or other systems and equipment. Detoxified effluent from the flushing process will be routed to the TMF pipeline and tailings deposition system. Further dilution and/or natural decomposition of residual quantities of cyanide resulting from deposition of detoxified flush water in the TMF will add a substantial additional margin of safety.

Any residual cyanide that may be detected in the decommissioning of the detoxification plant itself will be neutralised using portable detoxification kits as noted in the Cyanide Management Plan and Emergency Preparedness and Spill Contingency Plan. All rinseate or cleanup compounds associated with detoxification plant decommissioning will be captured, placed in sealed containers, and transported to a licensed hazardous waste disposal facility.

The primary installations and equipment used in the reagent conditioning processes and the cyanide detoxification circuit include the following:
- cranes and other manual/electromechanical hoisting devices;
- ventilation equipment and climatisers, including ventilators, piping systems, fittings, and measuring and control devices;
- process circuits consisting of multiple electric pumps, tanks, distribution manifolds, pipes, fittings, and valves;
- fire suppression systems;
- scrubbers;
- metal silos;
- various electric power, command, automation and lighting units; and
- various metal ducts, chutes, bins, and material spill/debris collection devices.

### 5.6.6 Revegetation

The rehabilitation and restoration of land surfaces impacted by mining activities will be conducted as part of the closure and decommissioning activities and will be in accordance with selected elements of the *Biodiversity Conservation Plan*. This strategy will be guided by the future planned land use. In general, the rehabilitation and restoration of land areas impacted by mining activities will be divided into two major sets of activities, which are described as follows:

- **Mechanical stabilisation** of the surface, including surface levelling and scarification (to promote appropriate drainage patterns) and the backfilling of significant depressions or pits using appropriate borrow materials, typically spread in individually compacted layers;

- **Revegetation** of stabilised land surfaces, which includes:
  - covering of prepared (i.e. levelled, scarified, and compacted) rehabilitation areas with a topsoil material taken from reserved topsoil stockpiles or other appropriate borrow areas;
  - soil fertilisation, as necessary;
  - seeding with indigenous perennial herbage;
  - planting and organic fertilisation of indigenous deciduous tree species; and
  - watering of revegetated surfaces in stages.
The overall purpose of these activities will be to prevent erosion as well as harmonise the rehabilitated areas with the surrounding natural deciduous forest and assist in the enhancement of local and regional biodiversity.

At a minimum, revegetation procedures will consider the guidelines listed below:

- In order to avoid damaging the soil structure and site drainage capabilities, no planting operations will be carried out in unfavourable weather conditions or in excessively damp soils;

- Weeds will be mechanically removed and destroyed prior to replanting any area of the site;

- The use of excessively heavy equipment and repeated vehicle runs over the same replanting area will be avoided;

- After planting, no heavy equipment will be used on the planted areas. Any planted area affected by such inappropriate equipment, will be rehabilitated;

- The deposition of the borrowed/stockpiled topsoil over prepared soil beds and around saplings will be accomplished in layers not exceeding 150 mm. Each layer will be slightly compacted before spreading of a new topsoil layer;

- Large-diameter stones and refuse will be removed during topsoil reclamation and spreading;

- Adequately dried and workable topsoil will be levelled and sloped to ensure effective drainage. Any minor recesses, pits, or hillocks will be removed;

- Manufacturers’ recommendations will be followed concerning the storage, handling and spreading of fertilisers and herbicides. Empty chemical containers will be disposed of as municipal waste as specified in the Waste Management Plan;

- Prior to planting, deciduous tree species will be tested and approved by appropriate officials from the Romanian Ministry of Waters, Forests, and Environment;

- Planting will be scheduled in favourable conditions, when the weather is warm and humid and the soil is damp and workable. No planting will be carried out when persistent cold and dry winds are likely to occur, or when the soil is frozen, saturated with water or excessively dry;

- Planting of trees will occur in early spring or late autumn, as soon as possible after the delivery of trees to the site. If planting needs to be postponed, the plants will be protected against degradation or unfavourable weather conditions;

- Pits for saplings dug on inclined surfaces will have vertical edges and a horizontal bottom; diameters will be large enough to accommodate fully stretched roots.
All newly planted trees will be protected using protection fences and/or supporting stakes. A succession plan will be developed that contains supervision, care and intervention measures to help ensure successful vegetation establishment. Care and intervention measures may include removing weeds and other plant species disturbing the desired succession pattern, fertilizing, irrigation, reseeding and other measures as appropriate.

5.7 ARD Treatment Plant

The ARD treatment plant will remain operational to treat any acid rock drainage or other water as necessary during site closure activities. It will continue to operate as needed until water quality discharge criteria are met for the site through passive or other means.

Since the open pits will be the focal point for water management during and after active closure activities, it is likely that the ARD treatment plant will be relocated to the Cetate pit. It may be also possible that pumping to the existing Wastewater Treatment Plant would continue to be an option. An engineering evaluation will be conducted to assess the optimal location of the ARD treatment plant.

5.8 Storage Tanks

Careful inventory control will be implemented to minimise the quantities of reagents in storage tanks at the end of the mine’s operational life. The transportable cyanide storage tanks will be returned to the supplier for continued use. The diesel fuel, gasoline and lubricant tanks and dispensing systems may continue to be used, if deemed worthwhile, in the early years of closeout during which the covers are being installed and major earthworks are being carried out. The advantage of maintaining these tanks and dispensing systems will be to realise the benefits of existing infrastructure and to minimise the potential for accidental spills and pollution.

Storage tanks will be cleaned and sold or decommissioned in accordance with applicable environmental and safety regulations as noted in the Emergency Preparedness and Spill Contingency Plan, the Cyanide Management Plan; and the workplace health and safety procedures included in the RMGC Standard Operating Procedures Manual. This includes the use of personal protective and safety equipment, air quality and off-gas monitoring, draining/transferring of tank contents, removal of sludge, cleaning, cold or hot cutting of tanks, and removal by a licensed hauler to an approved facility. Many of the tanks that were fabricated onsite (including the CIL tanks and thickeners) will be cut up into scrap metal for removal.

5.9 Unused Explosives and Chemicals

Explosives and chemicals will be returned to the supplier or will be disposed of by a licensed contractor. Inventory control measures in the final years of operation will be implemented to reduce the quantity of explosives/chemicals remaining at closure. The explosive storage magazines will be decommissioned.
5.10 Temporary Hazardous Waste Storage Facility

The Temporary Hazardous Waste Storage Facility will be decommissioned after the decommissioning of the process plant, explosives magazines, fuelling facilities, warehouses, machine shop areas, and other Project facilities that may involve the use or storage of hazardous materials, in order to provide storage capacity for any hazardous wastes that might be generated or encountered during decommissioning.

The Temporary Hazardous Waste Storage Facility will be constructed as a series of identical modules, with the number of modules determined in part by operational needs, by actual spill cleanup volumes, and by the point in mine life at which a permanent licensed offsite hazardous waste landfill or disposal facility is actually identified. Once a permanent offsite disposal facility is identified, no further Temporary Hazardous Waste Storage Facility modules will be built, and the facility will be used to accumulate and store hazardous wastes for periodic offsite disposal shipments.

Decommissioning of the Temporary Hazardous Waste Storage Facility will involve the following steps:

- **Shipment of all remaining hazardous wastes:** All remaining drums of hazardous waste will be shipped from the Temporary Hazardous Waste Disposal Facility to the licensed offsite disposal facility prior to undertaking any decommissioning actions;

- **Review of facility logs and spill history:** The operational logs of the Temporary Hazardous Waste Storage Facility will be reviewed to determine whether or not any waste spills occurred over its operational lifetime. Cleanup actions associated with any such spills will be reviewed to determine whether any additional decontamination or cleanup actions are justified. Soil samples or concrete wipe samples may be analyzed as necessary to confirm decontamination status. Any suspect areas will be staked or marked for special consideration in facility demolition;

- **Physical survey of pad, drains, sumps, and fenced area:** A detailed physical survey of the entire security-fenced area around the Temporary Hazardous Waste Storage Facility will be conducted, along with physical inspection of all pad areas, drains, and sumps. Wipe samples will be taken for any discolored or suspicious areas and analyzed; any areas of confirmed contamination will be marked for special consideration in facility demolition;

- **Removal/recycling/disposal of portable concrete barriers:** The portable concrete waste segregation barriers in each facility module will be removed and inspected. Wipe samples will be taken for any discolored or suspicious areas and analyzed; any barriers with confirmed contamination will be set aside for special consideration in facility demolition. Clean barriers will be made available to the local community residents for other beneficial use; if no community interest is identified, the barriers will be disposed of in the final Inert Waste Landfill cell;

- **Removal/recycling of metal roofing:** Corrugated metal roofing will be removed and made available to local community residents for beneficial use; any roofing not used will be sold to an offsite metals recycler;
- Removal/recycling of roof poles: Metal roof poles will be cut off at ground level and made available to local community residents for beneficial use; any scrap poles not used will be sold to an offsite metals recycler;

- Demolition of pads, drains, and sumps: Concrete pads, drains, and sumps will be broken up with a mechanical hammer and excavated; pad areas with known or suspected contamination will be isolated, broken up, and the rubble separated for disposal as a hazardous waste. Any contaminated concrete barriers will likewise be broken up and set aside for separate disposal. Rubble from all uncontaminated pad areas will be disposed of in the final Inert Waste Landfill cell;

- Removal/recycling of security fencing: After removal of all rubble from the demolished pad areas, the security fencing and poles will be removed and made available to the local community residents for beneficial use. If no community interest is expressed, the fencing will be sold to an offsite metals recycler;

- Regrading, placement of topsoil, and revegetation: The ground surface will be regraded to permit the site to drain. Topsoil will be placed as necessary to support revegetation, and the entire regarded area reseeded with appropriate species of groundcover.

5.11 On-Site Access Roads

In general, the onsite access roads will be retained during the early years of closeout to maintain access to work areas undergoing closure reclamation activities. Lockable gates and appropriate signs will restrict use of the access roads required for closure activities. Once closure activities are completed, certain roads may be turned over to the local population to assist in the transportation of people and goods in the area.

Some roads will also be necessary in the closure and post-closure phase for access to monitoring and maintenance points.

If neither public nor technical needs exist for a certain road, it will be scarified and covered with subsoil and topsoil as needed to support vegetation.

5.12 Electrical Power Line and Electrical Transformers

The onsite electrical power line will be maintained during transition or closeout as long as necessary for the operation of the wastewater treatment plant. Once the electrical substation equipment no longer provides any use to the mine site, it will be dismantled, salvaged and the area reclaimed. This equipment will not be turned over to the local authorities because it does not match the power requirements that are used by the local population. However, the low and medium voltage power lines will be left in place for use by the community.
5.13 Potable and Process Water Supply

Water requirements will diminish during closure, as the number of onsite personnel decreases and process operations cease. Drinking water for closure activities will continue to be supplied by the onsite plant until no longer necessary. At that time the potable water supply and treatment will be turned over to a local municipal authority or will be decommissioned and the supply pipe sealed.

5.14 On-Site Sewage Treatment Plant and Pipelines

During closure activities the sanitary waste from offices and plant facilities, kitchen (e.g. toilets, wastewater from kitchen and wash facilities) will be routed to the sewage treatment plant within the process plant site. The treated effluent from the sewage treatment plant will be discharged to Roşia Creek in accordance with all applicable discharge standards.

At closure the onsite sewage treatment plant will be transferred to a local municipal authority or decommissioned.

5.15 Historical Mine Workings

As part of the RMGC operations, the existing open pit will be further developed as the Cetate open pit, with closure anticipated to be as described previously. The majority of the historical adits, declines, and stopes that currently exist will be removed as part of the excavation of the four open pits. For facilities that remain after open pit mining, plugs or bulkheads will be constructed at any opening that could present a hazard in term of public safety or discharge of waters from the mineralised materials. Subsequent versions of this Mine Rehabilitation and Closure Management Plan will specifically address the detailed requirements for closure of historical mine workings, as better understanding of the underground workings may arise during mining operations.

5.16 Maintenance and Site Security

Site maintenance and security will be ongoing activities during closure, and will be subject to periodic monitoring as described in the current version of the RMGC Environmental and Social Monitoring Plan. Ongoing maintenance of the vegetation, including re-seeding, if required, will be carried out to ensure successful revegetation. It is anticipated that ongoing vegetation maintenance will diminish with time due to ideal growing conditions at the site. This is evident by the natural vegetative growth that has occurred on historical waste rock stockpiles at the site. These stockpiles were never properly reclaimed, but became vegetated by the ingress of the surrounding ecosystem despite unfavourable physical surface conditions and lack of an applied growth medium.

Drainage systems will be maintained to ensure their continued integrity and proper function. Plant operators will continue to maintain the wastewater treatment plant.
Site security during the early years of closure will be an important concern as there will be varying numbers of contractors and workers onsite and relatively few mine employees overseeing the site. Security measures will include the use of lockable gates and signs as well as regular security checks.

### 5.17 Final Closure

Final closure activities will commence when it can be demonstrated that a steady state of physical, chemical, and biological stability has been reached. This includes achieving applicable water quality discharge criteria. Once these criteria are met, site run-off and drainage may be released directly to the environment, without treatment. The TMF closure discharge channel will be used for discharging surface water runoff within the Corna drainage basin. Runoff from facilities within the Roşia drainage basin will drain down the re-established Roşia valley channel.

Following these activities, the wastewater treatment plants and associated pumping system will be decommissioned and removed. No buildings or similar structures will be left on site, unless otherwise identified for post-mining land use purposes.

### 5.18 Description of the landscape forms and usage scenarios after closure

Annex 3 of MO 863 requires the following:

- direct, primary effects on the quality of the landscape and on views and viewpoints described and where appropriate have to be illustrated and the reinstatement and after use of land occupied temporarily for operation of the Project (e.g. land used for mining or quarrying) have to be described;
- permanent effects on the environment caused by construction, operation or decommissioning of the Project have to be described.

Arrangements have to be proposed to monitor and manage these residual impacts. Monitoring is discussed in Section 9. This section summarizes the long term technical and environmental effects.

By its very nature, the Project creates a significantly modified landscape which offers unique opportunities to develop a regional identity and pride of a mining history over 2000 years.

Drawing 1 through Drawing 4 visualize how the landscape will develop from operations phase to its final state. Figure 5.18-1 shows schematically how the areas used in the mine life will be released in the closure phase. This is also summarized in Table 5-3.
Table 5-3. Schedule for releasing rehabilitated land for public use

<table>
<thead>
<tr>
<th>Rehabilitated facility</th>
<th>Year of release</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Domestic Sewage Treatment Plant</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>TMF</td>
<td>25</td>
<td>restricted use</td>
</tr>
<tr>
<td>Jig Pit</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Orlea Pit</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Cârnic Pit</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Cetate Pit</td>
<td>18</td>
<td>flooding process may take longer</td>
</tr>
<tr>
<td>Cetate Dam</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Cetate Waste Rock Facility</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Cârnic Waste Rock Facility</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Sulei and La Piriul Porcului Quarries</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Plant area</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Low-grade ore stockpile</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Viewpoints and landscape formations are described in detail in Section 4.7 (“Landscape”) of the EIA. The following sections summarize the after-use scenarios for the rehabilitated facilities.

5.18.1 Tailings Management Facility (TMF)

- The TMF presents a unique opportunity for the Community to define how this space, comprising some 300 hectares of perhaps the largest piece of flat land in the area could be developed.
- On the TMF embankment, a footpath leading to an outlook point with a unique view into the downstream valley may be constructed.
- Towards the end of the life of the project requests will be sent throughout the Community from schoolchildren to adults to attract their ideas. Examples for after use at other mining sites include parks and nature reserves.
- A consensual approach will result in the most valued final use of the land, having regard to the technically based restrictions.

5.18.2 Jig Pit

- The Jig Pit will be completely backfilled, covered and revegetated.
- It will blend well into the surrounding landscape and will probably hardly be visible as mining heritagel.
- After-uses are the same as for the surrounding landscape. It is premature to definitively identify a preferred use.
- Backfilled area could be released to the local authorities for grazing or wildlife habitat after vegetation is established.
5.18.3 Orlea Pit and Cârnic Pit

- Pits are partly backfilled to allow free drainage of undisturbed water from the surface of the pit cover.
- Flat areas and areas with a low inclination are revegetated with grass, shrubs or trees, forming a landscape with no specific after-use. Hiking trails, pathways or picnic areas can be built, depending on the general development plan.
- A Mining History education trail could lead along the slopes, connecting contrasting landscape elements such as the Cetate pit (concave landscape form) with the TMF dam (convex landscape form) as a unique outlook point.
- Steep slopes are either left bare (merely geotechnically secured) or are greened using hydoseeding or climbing plants (e.g., ivy). Both forms can be visually attractive, contributing to a diversified landscape.

5.18.4 Cetate Pit

- The Cetate Pit is a central element of the new landscape which is created during the mine life.
- Biodiversity: pits can provide outstanding potential for biodiversity which is often much greater than in pre-mining undisturbed land.
- Cultural identity: pits may become part of the identity of a mining region, in that they embody a community’s pride of its mining history.
- Tourism, recreation: depending on the remediation of pits, there are various scenarios for recreation and tourism.
- Education, Research: Due to their ecological and hydrological specifics, mine pits can become the focus for education and research.
- Care must be taken by the community or entrepreneurs using the pit to prevent unregulated waste disposal (“fly tipping”).

5.18.5 Cetate Dam

- The Cetate dam will remain beyond mine life as a landscape element. However, the dam will be breached in year 19 in order to avoid any larger water build-up behind the dam and the associated stability problems.
- The dam will be covered and vegetated, appearing as a singular structure with a lake forming behind the dam, so that it will be released to the public in year 21.
- Impacted water reporting to the Rosia valley from the Cetate pit and the underground workings will be collected in a little pond or sump and will be directed to the semi-passive treatment lagoons which form a new landscape element, too.
- When the water accumulating in the pond behind the dam is of a quality so that health risk can be precluded, the lake area may be released for public use.
- Restaurants, rowing-boat rental stations might be established by local entrepreneurs, proactively marketing the mining history. Other potential after uses could be angling or bathing, depending on the water quality.
5.18.6 Waste rock facilities

- The waste rock facilities are covered and revegetated with grass, shrubs, or trees.
- They appear as flat, green hills.
- Could be turned over to local authorities for light industrial use, grazing, recreation, or wildlife habitat after vegetation is established or suitable foundation assessments are made for redevelopment.
- Hiking trails, pathways or picnic areas can also be built, depending on the general development plan.
- There is no specific after-use which would be favoured at this stage of planning.

5.18.7 Former plant areas

- The plant areas are revegetated and form a rather flat piece of land.
- Could be turned over to local authorities for industrial use, grazing, recreation, or wildlife habitat after vegetation is established.
- It may be used for other production or office buildings, facilitated by the presence of basic infrastructure (electricity supply, water pipelines, sewage plant nearby).
- The plant areas will be released to the public after vegetation has taken hold and does not need active care.

5.18.8 Low-grade ore stockpile area

- The areas will be cleaned up and revegetated.
- There is no specific after-use which could be preferred at this time, but there are no use restrictions either.
- It could be turned over to local authorities for light industrial use, grazing, recreation, or wildlife habitat after vegetation is established or suitable foundation assessments are made for redevelopment.

5.18.9 La Piriul Porcului Quarry

- The La Piriul Porcului quarry will be surveyed by a professional engineer to identify the need for geotechnical stabilization measures. In case any measures are necessary to guarantee the long-term stability, these will be taken in order to release the quarry in a safe and stable state.
- A pond will form in the quarry with benign quality, based on the geological conditions.
- No specific after-uses have been defined so far, but will be defined during the consultation phase, in order to meet demands from the affected stakeholders.

Diving or general water sports resort would be an attractive after-use, given numerous similar examples throughout the EU and elsewhere, in the case that a lake will form in the quarry.
6 Rehabilitation Measures in the Event of Temporary Suspension of Operations

6.1 General measures

RMGC will take all statutory and reasonable measures in line with policies, guidance and BAT to protect public safety and minimise environmental impacts, if mining operations are in a condition of temporary suspension. Temporary suspension means the planned or unplanned suspension of operations with protective measures (including continuous monitoring) in place. Under such circumstances efforts will be focussed toward returning the mine to normal operational conditions at the earliest time.

In the event of a temporary suspension of operation, RMGC will notify appropriate government agencies. Although in such circumstances RMGC would have the full intention of resuming operations as soon as possible, a temporary suspension could conceivably entail a lengthy period when the circumstances leading to the interruption in operations are outside of RMGC control.

The following minimum rehabilitative measures will be implemented as necessary for the Roşia Montană Project in the event of a temporary suspension:

- reasonable measures will be taken to restrict access to the site and buildings and other structures to authorised persons only;
- mine openings that are potentially dangerous will be closed-off against uncontrolled and unauthorised access;
- electrical systems will be protected from uncontrolled and unauthorised access;
- mechanical and hydraulic systems will be shut down and secured where possible;
- physical, chemical, and biological monitoring programs will be continued;
- contaminated effluents will be controlled;
- waste management systems and sites and petroleum products, chemicals and waste will be made secure;
- portable cyanide tanks will be returned to the manufacturer; the cyanide handling systems in the cyanide storage and processing areas will be flushed and any residual cyanide detoxified as noted in the RMGC Cyanide Management Plan;
- explosives will be secured, disposed of, or removed from the site; and
- waste rock and overburden stockpiles and tailings, water and other impoundment structures will be maintained in a stable and safe condition.
6.2 Tailings Management Facility

Ongoing work on the TMF embankment will be completed to the extent that it remains in a stable and safe condition during any temporary suspension period. Depending on the period in which the suspension occurs, work on the TMF could continue to be performed to provide additional storage capacity.

The TMF and SCD will be monitored for physical integrity and remedial measures will be implemented as required. Water from the SCD pond will continue to be recycled to the TMF at the start of the temporary suspension period. Since reclaim water will not be drawn off the TMF pond during a temporary suspension, there will be a build-up of water within the TMF from the recycling of the water back from the secondary containment pond and direct precipitation. The TMF will be monitored for remaining capacity. In addition, the water quality of the SCD pond and the TMF Pond will be monitored for heavy metals and residual cyanide. If residual cyanide levels are reduced to or below surface water discharge standard, then waters could be pumped to the waste water treatment plant for treatment of metals, Sulphate and Calcium and then discharged in either the Roşia or Corna valley drainages, consistent with plant operations during ore processing. Alternatively the passive treatment system downstream of the SCD could be used to treat seepage water, if the system is already operational at the time of temporary suspension. This water will be discharged directly to the Corna Valley drainage provided that it meets water quality requirements.

6.3 Waste Rock Stockpiles

Ongoing work on the Cârnic and Cetate waste rock stockpile, including re-contouring, will be completed to the extent that the waste rock stockpiles remain in a stable and safe condition during any period of temporary suspension. If initiated, progressive rehabilitation on the lower lifts of the waste rock stockpile will be completed to the extent possible.

Run-off from the waste rock stockpiles will continue to be collected in their respective run-off collection ponds and pumped to the wastewater treatment plant. As the process plant demand for water will be curtailed, the plant outflow will be discharged to the Corna and Roşia creeks in accordance with the approved discharge permits.

6.4 Open Pits

During a period of temporary suspension, access to the open pits will be secured to prevent unauthorised access. Safety signs will be erected around the pit to warn trespassers of the potential danger. Internal pit roads will be blocked with lockable gates or by the placement of berms or other physical barriers. Water will continue to be pumped from each of the open pits and directed to the wastewater treatment plant to maintain the pits as a hydraulic sink for the area.

6.5 Cetate Water Catchment Dam and Pond
The Cetate Water Catchment Dam and pond will be maintained with any impounded water being directed to the wastewater treatment plant for treatment prior to release to the environment.

### 6.6 Wastewater Treatment

The wastewater treatment strategy during a period of temporary suspension will be to continue to operate the wastewater treatment plant to treat water from the open pits, run-off from the waste rock stockpiles, the plant site, the TMF/SCD and the Cetate Water Catchment Dam pond prior to release to the environment.

### 6.7 Sludge Management

Sludge generated by the wastewater treatment plant will be fluidised to the extent necessary to enable it to be pumped to the TMF Basin.

### 6.8 Miscellaneous Facilities

The miscellaneous facilities in the plant area, as well as the mining machinery and equipment, storage tanks, and other facilities will be maintained in a stable and safe condition.

### 6.9 Site Water Management

The site water management strategy during a period of temporary suspension will be to avoid build-up behind impoundments. This will be achieved through a system of collecting and treating impacted water prior to release to the environment, and collecting and releasing unimpacted directly to the environment. Specifically, diversion channels around the Cetate impoundment and the TMF will collect and route unimpacted surface water past these retention structures for discharge into the Roșia and Corna Valleys respectively. Water collected in the structures listed below will be pumped to the ARD treatment plant, processed and discharged:

- Cetate Waste and Mine Drainage impoundment;
- the TMF impoundment basin
- Secondary Containment Dam impoundment; and,
- Cârnic Wastewater Collection Pond.

Depending upon the phase of site development reached when the suspension occurs, water may be routed through the semi-passive treatment systems located downstream of the SCD and Cetate Dam.
7 Rehabilitation Measures during Periods of Inactivity Following Temporary Suspension of Operations

7.1 General measures

RMGC will take reasonable measures to protect public safety and minimise environmental impacts during periods of inactivity. "Inactivity" means the indefinite suspension of a project in accordance with a field closure plan where protective measures are in place and the site is being monitored continuously by the proponent. Typically, a period of inactivity is precipitated by an unfavourable and prolonged change in economic conditions that reduces the viability of mining operations over the long term.

All measures described in Section 6.1 are implemented. In addition, the following measures are taken:

- Mine workings will be assessed by a qualified engineer to determine their stability; any surface areas disturbed or likely to be disturbed by such mine workings will be stabilised or, if stabilisation is not practicable, will be protected against inadvertent access if such disturbance is likely to endanger the public or property;

- Essential electrical systems will be protected from inadvertent access and non-essential electrical systems will be de-energised;

- Tailings, rock stockpiles, overburden stockpiles, stockpiles, and waste management sites and systems will be monitored and maintained, or rehabilitated, this will include continued operation of the seepage collection system and pumping systems for the wastewater treatment plant;

- Petroleum products, chemicals and wastes will be removed, disposed of, isolated, or otherwise managed onsite. Sufficient stockpiles of these materials will be kept on site to maintain and service the equipment that will be required during periods of inactivity;

- Impoundment structures will be maintained in a stable and safe condition;

- Materials created as a result of mining, that produce or may produce acid rock drainage or metal leaching will be collected and treated to meet discharge standards.

7.2 Tailings Management Facility

Ongoing work on the TMF will be completed to the extent that it is left in a stable and safe condition during any extended period of inactivity.

All measures described in Section 7.2 are implemented.
7.3 Waste Rock Stockpiles

The measures described in Section 6.3 are implemented. In the event that the period of inactivity appears to be indefinite, discussions with the appropriate regulatory agencies will be ongoing to determine at what point additional measures for the rehabilitation of the waste rock stockpiles will be implemented as per the closure plan (see Section 5). There is a certain risk that valuable cover material could be consumed as a temporary rehabilitation measure and not be available for closure in the event that the mine becomes operational again in the future.

7.4 Open Pits

All measures described in Section 6.4 are implemented.

In the early years, the open pits may not be developed to the extent that the underground workings will serve as a conduit between the pits. Accordingly, barge mounted pumps may be required at more than one pit to maintain the pit water levels below the surrounding groundwater levels.

Prior to allowing the open pits to flood, other measures will be taken as per Section 5, including removal of equipment and the blocking off of internal pit roads.

7.5 Cetate Water Catchment Dam

The measures described in Section 6.5 are implemented.

7.6 Wastewater Treatment

The measures described in Section 6.6 are implemented.

7.7 Sludge Management

The measures described in Section 6.7 are implemented.

7.8 Miscellaneous Facilities

The measures described in Section 6.8 are implemented.

7.9 Site Water Management during a Period of Inactivity
The measures described in Section 6.9 are implemented.

Cyanide in the tailings decant pond water and TMF dam seepage must be removed prior to being discharged into the environment or being pumped into one of the open pits which may serve as an interim storage during longer periods of inactivity. This is achieved through the technologies described in Section 4.4.5.2 in order to achieve the cyanide limit of the NTPA 001/2005 standard.
8 Implementation Schedule of Closure

The proposed implementation schedule has been divided into five phases. These are described below and illustrated in Figure 5.18-1:

8.1 Early Years of Operations

Most importantly, the consultation process of the end-use of the various sites will start in the early years of operations. A process which is described in detail in the Sustainable Community Development Plan will involve all stakeholders and define the beneficial after-use of all facilities after closure and rehabilitation, according to BEP, BAT and specifically required by the Mine Waste Directive (Article 3, Subsection 20).clviii

Moreover, the following measures will start in the early years of operation:

- construct semi-passive treatment downstream of the Secondary Containment System and initial testing to determine effectiveness and treatment capacity;
- testing and trialling work on
  - cover systems performance and vegetation (see Section 4.5.4)
  - evaluation of Acid Base Accounting (ABA) testing and optimization of the waste segregation strategy to further minimize the ARD generation potential of waste rock facilities
  - establishment of vegetation cover establishment on pit walls

8.2 End of Year 5 to End of Year 10

- Reclamation of the Cetate waste rock facility
- Reclamation of the backfilled waste rock material on the southern rim of the Cetate pit
- start to placing the waste rock in Cârnic open pit;
- start reclamation of the Cârnic waste rock facility

8.3 End of Year 10 to End of Year 14

- end of consultation process to determine the end-use of various facilities
• evaluation of testing and trialling results and conclusion on design criteria for cover, revegetation, semi-passive water treatment, continuing testing and trialling phase if needed to reconfirm results

• construct safety berm around the Cârnic open pit;

• re-grade the Cârnic waste rock stockpile, install the evapotranspiration cover and construct the surface water collection ditch

• adding lime or other sources of alkalinity to tailings in order to enhance buffer capacity of tailings if lack of Calcite or Dolomite is confirmed;

• discharge tailings from the upstream end of the tailings impoundment; and

• place waste rock in Cârnic open pit;

• mining of all pits ends

• backfill of pits ends

• reclamation of Cârnic and Jig open pits starts,

• removal of Low Grade Ore stockpile begins

8.4 End of Year 14 to End of Year 16

• discontinue open pit dewatering;

• install bulkhead in 714 Adit (if not installed during operations);

• construct safety berms around the Jig, Orlea and Cetate open pits;

• ensure slope stability of pit walls;

• install trench system inside the Cetate pit to capture and drain low-pH water from the pit walls

• hydro-seeding of Cetate pit walls;

• reclamation of waste rock in Orlea pit begins

• reclamation of Orlea, Cârnic and Jig open pits complete

• regrading and revegetating of low-grade stockpile area begins
construct semi-passive treatment at the Cârnic Wastewater Pond

construct semi-passive treatment station downstream of the Cetate Water Catchment Dam;

modifications to tailings discharge to start to achieve final landform of TMF

regrading and covering of tailings TMF dam

8.5 End of Year 16 to End of Year 19

regrading and revegetating of low-grade stockpile area complete

modify detoxification plant to achieve the NTPA 001/2005 standard when pumping free water to Cetate pit;

install piping from TMF reclaim pond to Cetate pit, and pump final reclaim pond water to pit;

install surface water diversion channel on top surface of TMF basin;

construct evapotranspiration cover system construction for the tailings embankment and impoundment (if regrading and consolidation of the tailings are sufficient to support cover construction and facilitate surface water drainage);

conduct building and equipment demolition and salvage/materials recycling at process plant;

re-grade and revegetate process plant area;

install pumping and piping system to carry water from the Secondary Containment System to the wastewater treatment plant;

construct new or upgrade existing semi-passive treatment downstream of the Secondary Containment System at the TMF;

clean Secondary Containment Dam impoundment of sediments (if on-going seepage water quality is suitable to be treated in the semi-passive treatment cells);

breach the Secondary Containment System Dam and remove pumping and piping (if on-going seepage water quality is suitable to be treated in the semi-passive treatment cells); and

re-vegetate Secondary Containment System Dam and impoundment area;
- breaching the Cetate dam;
- construct safety berms and install signs around Piriul Porcului and Sulei pits

8.6 End of Year 19 to End of Year 21

- continue consultation on end-use, reporting progress with special emphasis on success and problems, check on earlier restoration work
- regrade and revegetate topsoil stockpile areas;
- possibly relocate Wastewater Treatment Plant at Cetate pit;
- construct pumpback system to Wastewater Treatment Plant downstream of the Cetate Water Catchment Dam;
- decommission Wastewater Treatment Plant at Plant Site;
- remove pumps and pipes from TMF to open pits;
- dismantling of the Temporary Hazardous Waste Storage Facility (THWSF) and cleanup of the site;

The closure activities listed above are shown graphically in figure 8.1. This is an indicative schedule and the actual duration’s and sequence of events will be refined and developed further during operations and finalised ahead of closure implementation.
## Implementation Schedule of Closure

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<td>Low Grade Ore Horniman</td>
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<td>Seedling slopes</td>
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<td>Seedling slopes</td>
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9 Closure Monitoring

The EU Mine Waste Directive (Preamble, Paragraph 22) states that "it is necessary to establish monitoring procedures during the operation and after-closure of waste facilities."

The environmental monitoring program described in the RMGC Environmental and Social Monitoring Plan will be an essential component of maintaining the currency and accuracy of the Mine Rehabilitation and Closure Management Plan, and, through the management review process described in the Environmental and Social Management Plan, will provide a feedback mechanism for managing the known and potential impacts resulting from construction, operation, and closure of the mine facility. The following objectives are considered during the development of the monitoring program for the Roșia Montană Project:

- development of supplemental baseline data;
- ensuring that construction, operation and closure activities proceed as required and environmental data are current;
- determining and maintaining the effectiveness of mitigation measures;
- evaluating the accuracy of the impact predictions for residual impacts;
- comparing changes in the environment against existing baseline (pre-development) conditions and distinguishing Project-related impacts from natural events, including seasonal changes;
- detecting any unacceptable impacts to enable the implementation of supplementary mitigation and/or contingency measures in a timely manner;
- providing Project-specific data on field performance of various cover materials, combinations and thickness, as well as revegetation species for closure;
- determining the effectiveness of proposed reclamation measures carried out as part of closure;
- ensuring compliance with applicable environmental regulations, and guidelines;
- ensuring compliance with permit/license requirements;
- ensuring accountability through a system of routine reporting to mine management, with summary reports being sent to applicable regulatory agencies;
- investigating environmental incidents and identifying follow-up requirements; and
- documenting and responding to public or regulatory agencies’ concerns.
This program is described in greater detail in the Roșia Montană Project Environmental and Social Management Plan and in the Environmental and Social Monitoring Plan.

9.1 Overview of Closure Monitoring

Environmental monitoring (consisting of physical stability monitoring, chemical stability monitoring, and biological monitoring) will be conducted during the construction, operations, and decommissioning and closure phases of the Roșia Montană Project. An overview of the monitoring during the closure phase is provided below.

Environmental monitoring during closure will be required to confirm that the remediation measures have been properly implemented and are effective. Closure monitoring will be performed under the guidance of the RMGC Managing Director and key operations personnel and will include the following:

- environmental inspections during active periods of closure; and
- the collection/analysis and reporting of monitoring data.

Mine personnel will regularly visit the site to inspect the property during periods of inactivity and will be trained to understand the objectives for the monitoring program. Personnel will be trained to identify areas of concern (e.g., areas where revegetation has not taken place, signs of physical stress, erosion or instability) which may arise between regularly scheduled monitoring periods. Following final closure, the property will be inspected by a qualified individual on an annual basis in accordance with procedures cited in the Environmental and Social Management Plan until it can be determined that the closure objectives have been met.

According to table 2-1, the Environmental Superintendent is responsible for the Monitoring Program.

9.2 Details of Closure Monitoring Program

During closure, the monitoring program will include specific monitoring for physical stability, chemical stability, and biological conditions.

The ground and surface water parameters of the standard NTPA 001/2005 are sampled monthly at the points indicated in table 9-1. If necessary, both the number of sampling points and the frequency of sampling will be increased.

Other parameters such as physical and biological stability are indicated in the corresponding Management Plans.

9.3 Quality Assurance/Quality Control

The monitoring program described in the RMGC Environmental and Social Monitoring Plan will include the following measures to ensure a high degree of confidence in the data:
strict adherence will be kept to standard sampling protocols (for groundwater and surface water) that were established during the environmental baseline study for collection, preservation, storage, handling and shipping of samples and for in situ sampling; documentation of the sampling program will include documentation of any unusual conditions or deviation from the protocols;

- a field quality control program will be performed, including submission of blank and duplicate samples, testing of chemical preservatives, checking contamination of sample bottles, and other equipment used in sample collection or handling, in order to detect other systematic or random errors that may be introduced between the time of sampling and analyses;

- a quality control program will be maintained for the laboratory analyses, including ensuring the certification status or quality capabilities of the contract laboratory;

- a timely review of analytical results will be performed to identify areas of concern (including methodology and potential impacts); and,

- regular monitoring reports will be prepared (at least annually for ongoing monitoring and monthly during construction) that describe the objectives for each of the components of the monitoring program, describe the methodology including deviations from protocols, present the results (tabulated and summarised) and make recommendations regarding the monitoring program and/or the approach to the development, operation or closure of the mine.

### 9.4 Reporting During Closure

A reporting system for monitoring results is described in the *Environmental and Social Monitoring Plan* that invokes the use of the inspection, performance verification, and management review processes described in the *Environmental and Social Management Plan* for the purpose of early detection of conditions that may require mitigation or changes in operating practices, as well as to provide performance data on the environmental control measures in place. The results of the monitoring activities will also provide data required by governmental and regulatory agencies to assess Project impacts and compliance with applicable laws and regulations.

As noted in the *Environmental and Social Monitoring Plan*, reports summarising the various components of the monitoring activities will be prepared on at least an annual basis that address the following:

- waste management;

- mine water effluent monitoring programs;

- dust controls;

- spill incidents (e.g., oil, gas, tailings);

- special studies; and
environmental effects monitoring.

Reporting to regulatory agencies will be dependent on specific regulations and the mining permit. With the exception of accidents, spills, and other malfunctions, reporting to regulatory agencies will typically be on an annual basis. An annual reclamation and rehabilitation report will also be submitted to appropriate Romanian regulatory officials. This report will detail the reclamation work carried out over the past year and any proposed work for the coming year. Any Project changes that may result in revisions to the Mine Rehabilitation and Closure Management Plan or proposed rehabilitation work; and the results of any progressive rehabilitation work will be included in the report.

9.5 List of monitoring activities

In general terms, the monitoring program of the Roşia Montană Project will be carried out according to the Best Practice described in the IPPC Reference Document "General Principle of Monitoring".

The period of time in which monitoring is required differs from object to object (pits, waste dumps, TMF etc.), and depends on the physical and chemical processes which may release contaminants into the environment (such as seepage transport mechanisms in the TMF), may affect the physical or structural stability (such as TMF dam stability) or may require corrective action (such as vegetation on cover systems). As a general rule, monitoring is required as long as a negative impact on the environment cannot be safely precluded and the situation has not yet reached a final steady state which is unlikely to deteriorate in the foreseeable future.

An after-closure period for monitoring and control of Category A waste facilities will be laid down proportionate to the risk posed by the individual waste facility, in a fashion similar to the requirements of the EU Landfill Directive (although the landfill directive does not apply here, it is a good guideline on monitoring waste facilities).
## Table 9-1. Roșia Montană Project Closure Monitoring Requirements

<table>
<thead>
<tr>
<th>Component</th>
<th>Location</th>
<th>Parameters</th>
<th>Methods</th>
<th>Frequency</th>
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<tr>
<td>PHYSICAL STABILITY</td>
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<td>Cetate, Cârnic, Jig, and Orlea open pits</td>
<td>Ditches / berms / fences / signs around pits</td>
<td>Access</td>
<td>Visual inspection of condition</td>
<td>Routine inspection frequency during construction. Weekly inspection during operations, annually during post closure. Frequency subject to review based on inspection results.</td>
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<td>Within open pits</td>
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<td>Slope stability</td>
<td>Visual inspection for tension cracks, signs of failure, gully erosion; survey slope movement and water levels</td>
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<tr>
<td>Cetate and Cârnic waste rock stockpiles and site waste disposal area</td>
<td>Ditches / berms / fences / signs</td>
<td>Access</td>
<td>Visual inspection of condition of stockpile and waste disposal areas</td>
<td>Annual visual inspection and surveys of slope movement. Frequency may be increased based on inspection results.</td>
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<tr>
<td>Stockpiles and waste disposal areas</td>
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<td>Slope stability</td>
<td>Visual inspection for tension cracks, signs of failure, gully erosion, revegetation progress</td>
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<tr>
<td>Stockpile and waste disposal areas</td>
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<td>Cover stability</td>
<td>Visual inspection for sheet and gully erosion, alluvial fans, revegetation progress</td>
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<tr>
<td>Tailings impoundment and water management structures</td>
<td>Ditches / berms / fences / signs</td>
<td>Access</td>
<td>Visual inspection of condition.</td>
<td>Routine inspections (weekly). Frequency may potentially be decreased in closure based on inspection results.</td>
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<td>Consolidation behaviour, differential settlements</td>
<td>Standard surveying techniques</td>
<td>Annually. Frequency may potentially be decreased in closure based on inspection results.</td>
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<td>Component</td>
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<td></td>
<td>Physical stability</td>
<td>Visual inspection for tension cracks, signs of failure, gully erosion, wind erosion, slope deformation, revegetation progress, seepage stains, survey rates of settlement; piezometers for monitoring water levels in impoundment area; weirs sampling and volumetric measurements for monitoring surface water discharge and water quality; well sampling for monitoring groundwater elevations and groundwater quality</td>
<td>Yearly visual inspections, with quarterly sampling/measurement of weirs, and groundwater wells. Frequency may potentially be increased or decreased based on monitoring results</td>
</tr>
<tr>
<td>TMF Dam</td>
<td>Tailings Management Facility</td>
<td>Physical stability</td>
<td>Instrumentation (vibrating wire piezometers, survey monuments and slope indicators) installed to determine phreatic head and signs of lateral movement settlement</td>
<td>Monthly measurements of embankment piezometers. Frequency may potentially be increased or decreased based on monitoring results</td>
</tr>
<tr>
<td>Surface Water Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>All fourteen (14) established operational phase baseline water quality stations</td>
<td>General physical / chemical parameters used during the operational phase.</td>
<td>Grab samples</td>
<td>Seasonal (excluding winter) with the numbers of stations, parameters and frequency modified in accordance with pit flooding and tailings area results.</td>
</tr>
<tr>
<td>Tailings management area discharge</td>
<td>Secondary containment pond outlet.</td>
<td>As per operational phase evolving to selected general phy/chem and metal parameters as area is rehabilitated</td>
<td>Grab samples</td>
<td>As per operational phase with reduced frequency (seasonal or annual) as area becomes rehabilitated.</td>
</tr>
<tr>
<td>Waste rock stockpile and plant site runoff ponds</td>
<td>Sediment pond outlet (or drainage ditch when pond removed)</td>
<td>General phy/chem parameters plus metals scan (or as appropriated based on operational phase dam)</td>
<td>Grab samples</td>
<td>Seasonal assuming progressive rehabilitation has been successful.</td>
</tr>
<tr>
<td>Component</td>
<td>Location</td>
<td>Parameters</td>
<td>Methods</td>
<td>Frequency</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Flooded pit</td>
<td>Flooded pit lake</td>
<td>General phys./chem. parameters plus metals scan (or as appropriate based on operational phase data)</td>
<td>Depth integrated composites, deep grabs</td>
<td>Seasonal with frequency and parameters reduced as pit lakes water quality stabilises.</td>
</tr>
<tr>
<td>Hydrogeology:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater flow patterns</td>
<td>Groundwater monitors adjacent to pit areas</td>
<td>Groundwater levels</td>
<td>Depth to water level measurement.</td>
<td>Seasonal, subject to review based on water level recovery in relation to all aspects of site operation.</td>
</tr>
<tr>
<td>Groundwater quality downgradient of waste rock stock piles</td>
<td>As per operational phase</td>
<td>General chemistry, metals scan and total phosphorus or as appropriate based on operational phase data.</td>
<td>Sampling of selected monitoring wells following current protocols.</td>
<td>Will be subject to review annually based on data results.</td>
</tr>
<tr>
<td>Groundwater quality downgradient of tailings dam</td>
<td>As per operational phase</td>
<td>General chemistry and metals scan or as appropriate based on operational phase data.</td>
<td>Sampling of selected monitoring wells following current protocols.</td>
<td>Will be subject to review annually based on data results.</td>
</tr>
<tr>
<td>Air quality (during remediation works):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust, carcinogens, toxic particulates, NOx</td>
<td>Around objects under remediation</td>
<td>Concentrations of dust, carcinogens, toxic particulates, NOx in air</td>
<td>Air and dust samplers</td>
<td>Weekly during remediation works</td>
</tr>
<tr>
<td>Dust, carcinogens, toxic particulates, NOx</td>
<td>Downwind of uncovered waste dumps and TMF tailings beaches</td>
<td>Concentrations of dust, carcinogens, toxic particulates in air</td>
<td>Air and dust samplers</td>
<td>Weekly until cover has been placed on wastes</td>
</tr>
<tr>
<td>Noise (during remediation works):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise from remediation works</td>
<td>Around objects under remediation</td>
<td>Loudness, frequency distribution</td>
<td>Noise meters</td>
<td>Weekly during remediation works, under typical working conditions</td>
</tr>
<tr>
<td>Biological stability:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetation on covers and other revegetated areas</td>
<td>All sites with revegetation (waste rock dumps, TMF cover, revegetated plant sites etc.)</td>
<td>Vegetation health, dominance of species, occurrence of weeds or unwanted species</td>
<td>Visual assessment</td>
<td>3 times during vegetation period (spring, summer, autumn)</td>
</tr>
</tbody>
</table>

Section 9: Closure Monitoring
<table>
<thead>
<tr>
<th>Component</th>
<th>Location</th>
<th>Parameters</th>
<th>Methods</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fauna, flora</td>
<td>General survey, possibly in areas with special ecological niches</td>
<td>General floristic and faunistic survey, Occurrence and/or abundance of rare and endangered species</td>
<td>Animals: visual observation, traps or collector systems Plants: Visual observation</td>
<td>Animals: depending on living habits of targeted species Plants: during vegetation period (spring-autumn)</td>
</tr>
</tbody>
</table>
The water samples are analysed for the parameters of the standard NTPA 001/2005 at the points indicated in table 9-1, as well as the physical parameters temperature, redox potential, conductivity, turbidity and flow rate. If necessary, both the number of sampling points and the frequency of sampling will be modified. The time frame over which the monitoring will be necessary has been estimated in Section 4.7.1.4.

Any water treatment facility in operation (i.e., semi-passive lagoons, conventional backup treatment plants) will be sampled at the inflow and outflow. If the performance of the semi-passive treatment system critically depends on the parameters within the aerobic or anaerobic cells (such as nutrient concentrations, redox potential etc.), chemical and physical water parameters will also be sampled for the process-relevant parameters.
10 Health and Safety

Standard procedures for workplace health and safety are invoked as part of the implementation of the RMGC Occupational Health and Safety Plan. All RMGC and contractor activities addressed by this plan are subject to the requirements of the RMGC Occupational and Health and Safety Plan, as applicable to the hazards associated with specific project assignments. Any personnel observing unsafe conditions shall notify their supervisors or RMGC Health and Safety staff for initiation of appropriate corrective and preventive action, as noted therein.
11 Provisions for Climatic Change

The mine closure and post-closure period coincides with a period of time for which substantial changes of the climatic conditions cannot be excluded, as noted in Section 4.1 of the EIA report.

The implications of climate change and its influence on the design and impacts of the Rosia Montana project need to be taken into account to provide further reassurance that the planned mitigation measures remain appropriate (or can be easily modified if necessary). Furthermore, given that understanding of climate change is inevitably going to increase through the operational life and post-closure period of the project, relevant Management This Mine Closure and Rehabilitation Management Plan incorporates procedures to continually review the state of knowledge and current predictions as the project proceeds (see table 2-1 for responsibilities).

In Section 4.1 of the EIA, the impact of climatic change is discussed in more detail, including the assumptions and models used in the predictions made. For the purpose of mine closure and the post-closure period, the main results are summarised below:

- Predicted changes compare the 1961-1990 period as a baseline, referenced forward 110 years to the period 2071-2100. The Rosia Montana project (operational, closure and early post-closure phase) falls approximately 25-50% through that interval; later post-closure phases are >50% through that interval;

- General climatic changes between 1961-1990 and 2071-2100 are predicted as:
  - Temperature increases of up to 6°C with respect to annual mean and in winter;
  - Temperature increases of up to 9°C in summer;
  - Winter rainfall increases of 10-30;
  - Summer rainfall decreases of 20-60%;
  - Possible increases of maximum annual daily rainfall by up to 30% (with a corresponding increase in extreme 24-hour events);
  - Reductions in snow fraction of precipitation by 10-40 percentage points;

- To assess the potential impact of these predictions, the rainfall record and rain data used for the water balance model (see Site Water Balance Report) can be reviewed in the context of an average rainfall adjusted for climate change predictions. For this purpose it is assumed that the predictions for 2071-2100 are halved in magnitude since the project main activity takes place at the end of the first half of the timespan between climate change baseline and prediction period (see diagram at beginning of this section). In other words, the predicted ‘normal’ conditions relevant to the project are assumed to be:
  - Winter precipitation (December-February) - increase by 5-15% (50% of mean predicted increase to 2071-2100);
  - Spring precipitation (March-May) - no change;
  - Summer precipitation (June-August) - decrease by 10-30% (50% of mean predicted decrease to 2071-2100);
- Autumn precipitation (September-November) - decrease by 5% (-2.9% per °C global change, 3-4 °C nominal global change by 2071-2100, 50% of that figure);

- Extreme events increase in magnitude by 0-15% (50% of predicted increase of up to 30%).

Monitoring of rainfall and temperature before and during the project (and active post-closure) is a conventional and routine activity. To account for climate change and improvements in knowledge and predictive ability as data availability and modeling techniques improve, the project Water Management and Erosion Protection Plan includes a provision for continual review of climate change knowledge status so that any design or management implications can be identified as soon as possible and acted upon in a timely manner.
12 Records

All records specified by this Plan and the other management plans and Standard Operating Procedures cited herein shall be forwarded to the RMGC Environmental Management office and retained in accordance with MP-11, “Management of Environmental and Social Management System Records.”
13 Major Uncertainties of the Estimates

According to Annex 3 of MO 863\textsuperscript{clx}, the uncertainty attached to estimates of residues and emissions must be discussed. Where there have been difficulties in compiling the data needed to predict or evaluate effects, these difficulties should be acknowledged and implications for the results described. Where there is uncertainty about the precise details of the Project and its impact on the environment, worst case predictions should be described.

The main uncertainties in the Mine Closure and Rehabilitation Plan, the consequences for the estimates presented in this Plan, and the conservative assumptions that have been made to satisfy the above requirement, are summarized in table 13-1.

Table 13-1. Summary of main uncertainties

<table>
<thead>
<tr>
<th>Parameters, processes</th>
<th>Consequences for estimates</th>
<th>Conservative assumptions made to account for uncertainties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit hydrology, groundwater dynamics, hydraulic conductivity of host rock and historic underground mine workings towards Roșiția valley</td>
<td>Time required for flooding the Cetate pit is uncertain.</td>
<td>Maximum flow rate collected at Cetate dam needs to be treated.</td>
</tr>
<tr>
<td>ARD generating surface (percentage of ARD generating parts) and reaction kinetics of pit walls</td>
<td>Pit water quality is uncertain, especially pH, metals, SO\textsubscript{4}. Requirements to seal pit walls and time estimates for treatment need depend on oxidation kinetics.</td>
<td>low-pH, highly mineralized pit water quality is assumed, based on ARD samples</td>
</tr>
<tr>
<td>Content of buffer material (Calcite, Dolomite) in tailings bears some uncertainty</td>
<td>Modeling shows that acidification (low pH) will be effectively prevented due to oxygen-barrier in cover system and siderite buffer. Elevated iron concentrations may appear, however.</td>
<td>Addition of lime, limestone in later phases of tailings deposition, disposal of alkaline concrete rubble during demolition phase, ashes from thermopower plants is foreseen to provide enough buffer capacity in case lack of Calcite is confirmed</td>
</tr>
<tr>
<td>Tailings seepage quality</td>
<td>Retardation processes within tailings body and embankment can significantly attenuate contaminant concentrations in tailings water seepage (especially metals, cyanide)</td>
<td>Tailings seepage water quality assumed to be the same as decant pond water during production.</td>
</tr>
<tr>
<td></td>
<td>Content of buffer material (Calcite) could not be unambiguously determined</td>
<td></td>
</tr>
<tr>
<td>Tailings seepage rate</td>
<td>Cover system design, properties of cover material, long-term stability of soil properties (including compaction), and vegetation strongly impact infiltration rate through cover system</td>
<td>Design parameters for seepage treatment (Semi-passive lagoons) based on predictions for uncovered TMF. Assumptions for covered TMF span a wide range of infiltration rate, based on international experience.</td>
</tr>
<tr>
<td>Cyanide content in tailings decant pond water, decrease with time</td>
<td>Time needed to wait for sufficient CN degradation before decant pond water can be pumped into Cetate pit.</td>
<td>Modified detoxification plant will be retained as contingency variant</td>
</tr>
<tr>
<td>Tailings surface consolidation behaviour</td>
<td>Time needed to place TMF cover.</td>
<td>Conservative assumptions for TMF closure time</td>
</tr>
<tr>
<td>Choice of water treatment technology</td>
<td>Amount and composition of wastes generated by water treatment.</td>
<td>Gypsum/Ettringite precipitation for ARD with conservative specific waste generation</td>
</tr>
</tbody>
</table>
14 ANNEX 1  RMP’s ENVIRONMENTAL FINANCE GUARANTEE

The RMP’s Environmental Finance Guarantees (EFGs) are the principle means of ensuring that funds are available for closure and rehabilitation in the event that RMGC cannot fulfill its financial obligations. In so doing confidence is provided to governments, communities and the general public that appropriate environmental rehabilitation will be achieved.

As required by the new EU Directive on Mine Waste, an EFG should ensure fulfillment of the following obligations:

- Prevention of pollution of soil, air, groundwater or surface water, taking into account especially Directives 76/464/EEC(1), 80/68/EEC(2) and 2000/60/EC,
- Evaluation of the water balance and leachate generation potential of waste backfilled to voids, including contaminant content of the leachate, of the deposited waste after closure of the waste facility,
- Efficient collection & treatment of contaminated water and leachate as and when required by the permit,
- Treatment of contaminated water & leachate from the waste facility to fulfill obligations set by the authorities or the appropriate standard required for discharge where these exist,
- Reduction of erosion caused by water or wind as far as it is technically possible and economically viable,
- Physical & chemical stability of the waste facility and/or backfilled waste,
- Maintenance of overflow channels & spillways so that they are kept clean and free,
- Minimization as far as possible of damage to the landscape,
- Adequate measures to reduce dust & gas emissions,
- Suitable arrangements for the maintenance, monitoring & control of the waste facility after closure as well as any necessary corrective measures, including monitoring of waste backfilled to voids, until such times as the competent authority decides to take over such tasks from the operator.
- Suitable arrangements for the rehabilitation of the land and the closure of the waste facility.

The RMP EFG provides the financial assurance that reclamation will return the site to a safe and stable condition, free of safety hazards. It provides the means to address and prevent ongoing pollution from the site. Given this, however, it will not return the site to its original condition before mining started in Rosia Montana 2000 years ago nor to a condition permitting all conceivable land uses.

The environmental financial guarantee required by the Romanian law has two components.
- one to cover the reclamation cost relation to the operator’s next-year operations – referred to as the “next-year operations EFG component”, and
• one to cover the designated post-closure period – referred to as the “post-closure EFG component”.

The EFG to be established by the RMP is therefore:

1. The “next-year operations EFG component” in accordance with art. 2-8 of the National Agency for Mineral Resource (NAMR)’s Technical Instructions of 25.02.2004, is established based on the collective commitments made in the Mine Rehabilitation and Closure Plan (Plan J of the EIA report) relating to reclamation of the RMP, adjusted for current costs.

2. The “post-closure EFG component” in accordance with art. 15-16 of NAMR’s Technical Instructions of 25.02.2004, is established based on the collective commitments made in the Mine Rehabilitation and Closure Plan (Plan J of the EIA report) relating to post-closure reclamation of the RMP, adjusted for current costs.

However, as projects can and do vary in ways that the law cannot always anticipate, it is necessary to take a broader approach to the EFG provision in the case of the RMP to ensure not only compliance with Romanian law, but with the general principle – consistent with the new EU Mine Waste Directive – that there be in place at all times in the Project’s life adequate financial guarantees to provide reclamation.

In specific, Romanian law rests on an assumption that reclamation proceeds on an annual schedule; in the case of a long-life project like RMP, however, reclamation takes place in phases. The result is that reclamation activity in any given year is not an indicator of the level of reclamation in the year prior, or in the year to follow. The only way, therefore, to ensure an adequate EFG at every moment in the life of the mine is to reassess and recalculate the required amount on an annual basis.

RMP’s EFG calculation will be updated annually by independent experts – as required by Article 14 par. 2 (b) of the EU Directive on Mine Waste; the Company will be required to adjust its EFG accordingly.

The annual update will consider the following four criteria:

- Assessment of the physical impact of the project
- Technology review/update for Best Available Techniques
- Unit price assessment (possible escalation)
- Changes in relevant law

These four criteria ensure that – at every moment in the mine life – the EFG will not only be adequate to the costs of reclamation, but will accommodate changes in public law, developments of new technologies that improve the science and practice of reclamation, changing prices for key goods and services associated with reclamation, and any changes in the project that impact reclamation objectives.

This calculation is inherently conservative, for two reasons:

1. It assumes the profit-margin a 3rd Party contractor would charge to accomplish the reclamation (on the assumption that the environmental financial guarantee would be triggered only by the bankruptcy or dissolution of the Company).

2. Regardless of the calculation outlined above, the environmental financial guarantee will always adjust upward by no less than 1.5% of the current year’s work commitment, as legally stipulated in the Company’s Exploitation License. That increase is carried forward on a cumulative basis into each new year’s calculation. The environmental financial guarantee declines only as the Romanian Government progressively releases the Company for liability as reclamation work is completed.
The net effect is that the environmental financial guarantee for the Rosia Montana Project will be larger than would otherwise be the case under a calculation taking notice solely of Romanian law.

The design of the RMP calls for the costs presented in table 1 to be covered by RMGC in order to achieve the aims set out in the above discussion.

**Table 1 Rosia Montana Closure Cost Estimate**

<table>
<thead>
<tr>
<th>Years from start of mine operation</th>
<th>Cost of rehabilitation</th>
<th>Annual Operating Costs (water treatment, monitoring, etc)</th>
<th>Main area where rehabilitation activities are focused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 5-6</td>
<td>$ 2,613,321</td>
<td></td>
<td>Cetate Waste Rock dump</td>
</tr>
<tr>
<td>Years 10-12</td>
<td>$ 8,951,780</td>
<td></td>
<td>Cirnic Waste Rock dump and Cetate pit</td>
</tr>
<tr>
<td>Years 13-14</td>
<td>$ 4,126,659</td>
<td></td>
<td>Backfilling Cirnic pit and Jig pit</td>
</tr>
<tr>
<td>Years 14-16</td>
<td>$10,787,459</td>
<td></td>
<td>TMF Dam, partially backfilling Cetate Pit and backfilling Orlea pit</td>
</tr>
<tr>
<td>Year 16</td>
<td>$ 39,196,375</td>
<td>$ 1,252,000</td>
<td>Low Grade Ore Stockpile, TMF Basin, Plant Site, roads, Cetate Dam, Secondary Catchment Dam and Quarries</td>
</tr>
<tr>
<td>Year 19</td>
<td>$ 4,934,920</td>
<td>$ 1,252,000</td>
<td></td>
</tr>
<tr>
<td>Year 21</td>
<td>$ 179,372</td>
<td>$ 1,252,000</td>
<td></td>
</tr>
<tr>
<td>Operating Costs (annual) going forward</td>
<td></td>
<td>$ 1,252,000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$70,789,884</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Numbers Based on Dec 2005 USD*
15 References

15.1 RMGC Environmental and Social Management System references

Roşia Montană Project Environmental and Social Management Plan
Cyanide Management Plan
Emergency Preparedness and Spill Contingency Plan
Environmental and Social Monitoring Plan
RMGC Occupational Health and Safety Plan
Community Sustainable Development Plan
Public Consultation and Disclosure Plan
Waste Management Plan
RMGC Standard Operating Procedures Manual

15.2 External references

1 MWH, 2005; Engineering Review Report, Appendix R – Rehabilitation and Closure Management Plan

2 Roşia Montană Gold Corporation 2006; Roşia Montană Project Environmental Impact Assessment


6 Province of Ontario (Canada), Rehabilitation of Mines – Guidelines for Proponents


8 http://www.minind.ro/Pagina_noua_ump/Pagina_noua_eng/pag_princ_e_modif.html

5 Note: all documents listed are controlled documents per Section 4.5 of the Roşia Montană Project Environmental and Social Management Plan; current approved versions will be assumed to apply in all cases.

x Province of Ontario (Canada), Rehabilitation of Mines – Guidelines for Proponents

xi Republic of Romania, Mining Law 85/2003


 xv. Government of Romania, op. cit.

xvi Province of Ontario (Canada), op. cit.

xvii COUNCIL DIRECTIVE 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control. EU Commission, 1996, Section 20 of the Preamble

xviii MWH Engineering Review Report

xix Legea nr.85/2003: Legea Minelor – M.Of.nr. 197/27.03.2003

xx Government of Romania, op. cit.

xxi S.C. Ipromin S.A. 2005, Closure Technical Project for Roşia Montană Mine and Environmental Plan

xxii MWH Engineering Review Report

xxiii S.C. Ipromin S.A. 2005, Closure Technical Project for Roşia Montană Mine and Environmental Plan


xxviii CONVENTION ON ACCESS TO INFORMATION, PUBLIC PARTICIPATION IN DECISION-MAKING AND ACCESS TO JUSTICE IN ENVIRONMENTAL MATTERS, done at Aarhus, Denmark, on 25 June 1998

xxix CONVENTION ON ENVIRONMENTAL IMPACT ASSESSMENT IN A TRANSBOUNDARY CONTEXT done at Espoo (Finland), on 25 February 1991


xxxi HELCOM RECOMMENDATION 13/6: DEFINITION OF BEST ENVIRONMENTAL PRACTICE, adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention

xxii HELCOM RECOMMENDATION 12/3: DEFINITION OF BEST AVAILABLE TECHNOLOGY, adopted 20 February 1991, having regard to Article 13, Paragraph b) of the Helsinki Convention


xxviii MANAGEMENT OF MINING, QUARRYING AND ORE-PROCESSING WASTE IN THE EUROPEAN UNION". Study made for DG Environment, European Commission, BRGM, December 2001

xxix HELCOM RECOMMENDATION 25/2: REDUCTION OF EMISSIONS AND DISCHARGES FROM INDUSTRY BY EFFECTIVE USE OF BAT, adopted 2 March 2004 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention 1992
xi HELCOM RECOMMENDATION 24/5: PROPER HANDLING OF WASTE/LANDFILLING, adopted 25 June 2003 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention


xiii Province of Ontario (Canada), Rehabilitation of Mines – Guidelines for Proponents

xiv http://www.clotadam.com/


xvii www.inap.com.au


lix ESG Stantec et al, 2005, op. cit.

lix Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. EUROPEAN COMMISSION, DIRECTORATE-GENERAL JRC JOINT RESEARCH CENTRE, Institute for Prospective Technological Studies, Technologies for Sustainable Development, European IPPC Bureau, Final Report, July 2004 (http://eippcb.jrc.es/pages/FActivities.htm), Section 4.3.1.2.8

lix MWH, 2006; Technical Memorandum "PROCEDURE FOR PAG IDENTIFICATION FOR WASTE ROCK SEGREGATION". 10 February 2006

lix MWH, 2006; Technical Memorandum "PROCEDURE FOR PAG IDENTIFICATION FOR WASTE ROCK SEGREGATION". 10 February 2006

lxiv Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. EUROPEAN COMMISSION, DIRECTORATE-GENERAL JRC JOINT RESEARCH CENTRE, Institute for Prospective Technological Studies, Technologies for Sustainable

iv Province of Ontario (Canada), Rehabilitation of Mines – Guidelines for Proponents


lxii Lu, Ming, 2004: Pit lakes from sulphide ore mining. Geochemical and Limnological Characterisation before Treatment, after Liming and Sewage Sludge Treatment. PhD Thesis, Luleå University of Technology, Department of Chemical Engineering and Geosciences, Division of Applied Geology, 2004

lxiv Federal Landscape Architecture Exhibition BUGA 2007 Gera-Ronneburg (Thuringia). The landscape of a former mining area will be remodelled with wetlands etc. cultural and mining heritage, including a strong educational aspect. Similar examples exist in Lower Lusitania (Saxony, Brandenburg) where a Federal Landscape Architecture Exhibition was held in 2001 in a former lignite mine area with dozens of flooded pits. Other EU and international examples include Lousal Sulphide Mines (Portugal), Castlecomer Mine (UK), Butte Mine (Montana/USA), Waihi Gold Mine (Australia), Kennecott Ridgeway Mine (South Carolina/USA), San Manuel copper mine (Arizona/USA), see also Reference lvii.


lxvi Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. EUROPEAN COMMISSION, DIRECTORATE-GENERAL JRC JOINT RESEARCH CENTRE, Institute for Prospective Technological Studies, Technologies for Sustainable Development, European IPPC Bureau, Final Report, July 2004 (http://eippcb.jrc.es/pages/FActivities.htm), Section 5.4.2


Numerous conferences are held on this topic, updating the mining community on the most recent research, such as the "Pit Lakes" conferences held by the US EPA in 2000 and 2004.

Lu, Ming, 2004: Pit lakes from sulphide ore mining. Geochemical and Limnological Characterisation before Treatment, after Liming and Sewage Sludge Treatment. PhD Thesis, Luleå University of Technology, Department of Chemical Engineering and Geosciences, Division of Applied Geology, 2004

B.C.Aube, B.Arseneault: In-Pit Mine Drainage Treatment System in a Northern Climate. Mining and the Environment Conference, Sudbury (Canada) 2003


S.McCullough: "Why we filled a pit lake with dead plants and poo." Centre of Excellence for Sustainable Mine Lakes. Edith Cowan University.

CN degradation models

Government of Romania, GD 188/2002, Annex 3 regarding the establishment of pollutants charging limits for industrial and city waste waters on the evacuation into natural receivers, amended by GD 352/2005 (NTPA 001/2005),

MWH, 2005; Engineering Review Report, Appendix R – Closure Plan, Annex B: Pit Lake Hydrology and Hydrochemistry, Table 2.3

MWH, 2005; Engineering Review Report, Appendix R – Closure Plan, Annex B: Pit Lake Hydrology and Hydrochemistry, Section 2.3

MWH, 2005; Engineering Review Report, Appendix B – Geochemistry Characterisation Study, Table 4.1

MWH, 2005; Engineering Review Report, Appendix B – Geochemistry Characterisation Study, Table 4.2


MWH 2005: Engineering Review Report, Appendix F - Tailings Management Facility Geochemistry and Water Quality Report. Table 4.3

MWH, 2005; Engineering Review Report, Appendix O, Contaminant Transport Modelling. Memorandum: "RMGC Contaminant Modelling Results".

Water and Oxygen Transport Modelling for Cover Systems on Waste Rock Facilities and Tailings Pond at Roșia Montană. WISUTEC/WISMUT, March 2006


Evaluation of Sulphate Discharges with Effluents from Mining and Milling Operations (Work Package 1). WISUTEC Wismut Umwelttechnik GmbH, Chemnitz, October 2004

Evaluation of Sulphate Discharges with Effluents from Mining and Milling Operations (Work Package 1). WISUTEC Wismut Umwelttechnik GmbH, Chemnitz, October 2004

Evaluation of Sulphate Discharges with Effluents from Mining and Milling Operations (Work Package 1). WISUTEC Wismut Umwelttechnik GmbH, Chemnitz, October 2004


C. Kunze, G. Kießig, A. Küchler: Management of passive biological water treatment systems for mine effluents. Lecture held on the NATO ASI Summer School by the University of Parma (Italy) and by the Zhitomir State Technological University (Ukraine), August 17-28, 2005 at Zhitomir, Ukraine. To be published by Springer Verlag Berlin, Heidelberg, New York, 2006, http://www.dsa.unipr.it/phytonet/NATO/ASIhome.htm


S. McCutcheon: Experience with passive water treatment systems in the US. Lecture held on the NATO ASI Summer School by the University of Parma (Italy) and by the Zhitomir State Technological University (Ukraine), August 17-28, 2005 at Zhitomir, Ukraine. To be published by Springer Verlag Berlin, Heidelberg, New York, 2006, http://www.dsa.unipr.it/phytonet/NATO/ASIhome.htm


See, for example, the website of the German Fraunhofer Institute on this issue: www.igb.fraunhofer.de/WWW/GF/Bioremediation/dt/GFBU_24_Cyanid.dt.html


Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. EUROPEAN COMMISSION, DIRECTORATE-GENERAL JRC JOINT RESEARCH
CENTRE, Institute for Prospective Technological Studies, Technologies for Sustainable Development, European IPPC Bureau, Final Report, July 2004
(http://eippcb.jrc.es/pages/FActivities.htm), Section 4.3.1.2.2


(http://eippcb.jrc.es/pages/FActivities.htm), Section 4.3.1.2.2


(http://eippcb.jrc.es/pages/FActivities.htm), Table 4.7


ET Cover Design Approach. GeoSlope International, 2005

Water and Oxygen Transport Modelling for Cover Systems on Waste Rock Facilities and Tailings Pond at Roşia Montană. WISUTEC/WISMUT, March 2006


Robertson, A.Mac; Clifton, A.W.: Design consideration for the long term containment of tailings.


Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. EUROPEAN COMMISSION, DIRECTORATE-GENERAL JRC JOINT RESEARCH CENTRE, Institute for Prospective Technological Studies, Technologies for Sustainable Development
Development, European IPPC Bureau, Final Report, July 2004
(http://eippcb.jrc.es/pages/FActivities.htm), Section 5

cxxix MWH, 2005; Engineering Review Report, Appendix F– Tailings Management Facility Geochemistry and Water Quality Report, Section 3

cxx MWH, 2005; Engineering Review Report, Appendix R – Rehabilitation and Closure Management Plan, Annex C (Cover Systems Test Sections)


cxxiv MWH, 2006; Summary of Changes and REsults for Site Water Balance Revision 14.0, March 7, 2006

cxxv MWH, 2006; Summary of Changes and REsults for Site Water Balance Revision 14.0, March 7, 2006, Attachment 1


cxxvii MWH, 2005; Engineering Review Report, Appendix F– Tailings Management Facility Geochemistry and Water Quality Report, Cyanide Modelling Report 2b, Figure 2


cxxi Memo by MWH of 01 February 2006, updating the "Engineering Review Report, Appendix R, Annex B - Pit Lake Closure Hydrology and Chemistry Report", as Orlea and Jig pits are backfilled

Section 15: References


Cxxxv HELCOM RECOMMENDATION 12/3: DEFINITION OF BEST AVAILABLE TECHNOLOGY, adopted 20 February 1991, having regard to Article 13, Paragraph b) of the Helsinki Convention


Cxxxix Evaluation of Sulphate Discharges with Effluents from Mining and Milling Operations (Work Package 1). WISUTEC Wismut Umwelttechnik GmbH, Chemnitz, October 2004

Cxl B.C.Aube, B.Arseneault: In-Pit Mine Drainage Treatment System in a Northern Climate. Mining and the Environment Conference, Sudbury (Canada) 2003

Cxi Environmental Protection Agency, 2003 "EPA proposes action on North Potato Creek" Copper Basin Mining District Site Polk County, Tennessee, Region 4 Fact Sheet. February 2003 (http://www.epa.gov/region4/waste/copper/npotateeca.pdf)


Cxiii MWH 2006: Summary of Changes and Results for Site Water Balance Revision 14.0, Memo of 7 March 2006


Cxvi MWH, 2005; Engineering Review Report, Appendix R – Rehabilitation and Closure Management Plan, Appendix C

Cxvii MWH, 2005; Engineering Review Report, Appendix F, Tailings Management Facility Geochemistry and Water Quality

Cxviii MWH, 2005; Engineering Review Report, Appendix A (A2: Rainfall Runoff Routing)
PIRAMID Consortium, 2003, op. cit


Memo by MWH of 01 February 2006, updating the "Engineering Review Report, Appendix R, Annex B - Pit Lake Closure Hydrology and Chemistry Report", as Orlea and Jig pits are backfilled

Horka Pit Lake Diving Resort (Germany): [http://www.die-aquanauten.de/horka.htm](http://www.die-aquanauten.de/horka.htm)

Messinghausen Pit Lake Diving Resort (Germany): [http://www.sauerland-tauchen.de/ausbildung/mess.htm](http://www.sauerland-tauchen.de/ausbildung/mess.htm)


COUNCIL DIRECTIVE 1999/31/EC ON THE LANDFILL OF WASTE (EU Landfill Directive) 1999/31/EC
