CONCEPTUAL REHABILITATION PLAN FOR THE PROPOSED PLATREEF UNDERGROUND MINE

PLATREEF RESOURCES (PTY) LTD

OCTOBER 2013

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This document has been prepared by **Digby Wells Environmental**.

Report Title: **Conceptual Rehabilitation Plan for the proposed Platreef Underground Mine**

Project Number: **PLA1677**

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ABBREVIATIONS

Abbreviation	Description
AgIS	Agricultural Information System
Al	Aluminium
AMD	Acid Mine Drainage
C-Plan	Conservation Plan
CARA	Conservation of Agricultural Resources Act (Act 43 of 1983)
CITES	Conservation of International Trade in Endangered Species
DEA	Department of Environmental Affairs
Digby Wells	Digby Wells Environmental
DMR	Department of Mineral Resources
DWAF	Department of Water Affairs and Forestry
DWA	Department of Water Affairs
ECA	Environmental Conservation Act (Act 73 of 1989)
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
Fe	Iron
GIS	Geographic Information System
Ha	Hectares
ICS	Integrated Control Strategy
IEM	Integrated Environmental Management
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
LAN	Limestone Ammonium Nitrate

Abbreviation	Description
mamsl	Meters above mean sea level
MAP	Mean Annual Precipitation
MBCP	Mpumalanga Biodiversity Conservation Plan
MPRDA	Mineral and Petroleum Resources Development Act (Act 28 of 2002)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEM:AQA	National Environmental Management: Air Quality Act (Act 39 of 2004)
NEMBA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NFA	National Forest Act (Act 84 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NPAES	National Protected Areas Expansion Strategy
NWA	National Water Act (Act 36 of 1998)
WUL	Water Use Licence
Platreef	Platreef Resources (Pty) Ltd.
SSC	Species of Special Concern

1 INTRODUCTION

South Africa has a long history of mining and for a long part of this history there was a lack of legislation enacting proper rehabilitation and recovery of mine impacted land and natural resources. There now has been a paradigm shift, where the South African mining industry and mining companies now fully accept the concept and responsibility of mine site rehabilitation and decommissioning.

According to the Chamber of Mines Guidelines for the rehabilitation of mined land 'effective rehabilitation', is defined as *"rehabilitation that will be sustainable, in the long term, under normal land management practices*" (Chamber of Mines, 2007; Department of Minerals and Energy, 2008). Mine rehabilitation therefore must be considered as an on-going process aimed at restoring the physical, chemical and biological quality or potential of air, land and water regimes disturbed by mining to a state acceptable to the regulators and to post mining land users (Whitehorse Mining Initiative, 1994).

Platreef Resources (Pty) Ltd (Platreef) has proposed the development of the Platreef Platinum project. The project lies within the Limpopo Province, approximately 6 km outside of Mokopane. Digby Wells Environmental (Digby Wells) has been appointed by Platreef, as an independent consultant, to undertake an Environmental and Social Impact Assessment for the proposed project and in addition to this several specialist assessments.

Contained herein is the conceptual rehabilitation plan, which is one of the specialist studies that have been compiled for the Platreef project. The objective of the rehabilitation plan is to ensure activities associated with mine construction, operation and closure will be designed to prevent, minimise or mitigate adverse long-term environmental and social impacts and create a self-sustaining ecosystem.

The conceptual rehabilitation plan should be used to guide construction, operation and decommissioning phases of the Platreef project and guide the final rehabilitation of the project area. The report must be updated with the mine plan as often as needed to ensure that it is fully applicable to the activities associated with the proposed operations.

2 TERMS OF REFERENCE

2.1 Legal Requirements

Relevant legislation, governing mine rehabilitation, closure cost assessment (closure provision) and closure planning is described in the MRPDA. The definition for environmental management plan as stated in the MPRDA is '*means a plan to manage and rehabilitate the environmental impact as a result of prospecting, reconnaissance, exploration or mining operations conducted under the authority of a reconnaissance permission, prospecting right, reconnaissance permit, exploration right or mining permit, as the case may be*.' Specific sections include the following:

- Section 38 on 'Integrated environmental management and responsibility to remedy';

- Section 39 on 'Environmental management programme and environmental management plan'; and
- Section 41 'Financial provision for remediation of environmental damage'.

Supporting MPRDA Regulations include sections 53 – 57 and 60 – 62. There are several guideline documents which provide recommendations on how rehabilitation should be undertaken. For the purpose of the plan the following guideline documents will be considered:

- Guidelines for the Rehabilitation of Mined Land. Chamber of Mine of South Africa/Coaltech. November 2007;
- Guideline Document for the Evaluations of the Quantum of Closure-Related Financial Provision Provided by a Mine. Department of Minerals and Energy. January 2005; and
- Best Practice Guidelines (BPGs) series developed by the Department of Water Affairs (DWA).

In addition to the abovementioned guideline documents further regulations must be considered pertaining to mine closure and rehabilitation. These are as follows:

- Mineral and Petroleum Resources Development Act, 2002 (MPRDA): Mineral and Petroleum Resources Development Regulations (2004);
- International Finance Corporation (IFC) Environmental, Health and Safety (EHS);
- Amendment Bill of 2007;
- Constitution of the Republic of South Africa Act, 1996;
- National Environmental Management Act (NEMA);
- National Water Act (NWA);
- National Environmental Management: Waste Act 2008;
- Mine Health and Safety Act;
- National Environmental Management: Air Quality Act (NEMA:AQ);
- National Heritage Resources Act; and
- Conservation Agricultural Resources Act (CARA).

The abovementioned legislation and guidelines documents, not limited to, will be utilised to compile the rehabilitation plan with the objective of providing feasible and achievable rehabilitation objectives that can be met and that are in line with post closure requirements, such as land use. The legislative requirements are discussed in further detail in Section 7 below.

3 ASSUMPTIONS AND LIMITATIONS

For the compilation of the rehabilitation plan, it is assumed that:

- All relevant information will be made available, including designs for the waste rock facilities and tailings facility;
- All maps for the area will be made available, including the most up to date mine plan;
- All engineering inputs are Platreef's or their appointed contractor's responsibility and are thus not included in this report; and
- The rehabilitation guidelines and plan are dependent on the specialist studies done for the area by Digby Wells and other consultants, and the full mine plans from Platreef.

4 STUDY AREA AND DESCRIPTION

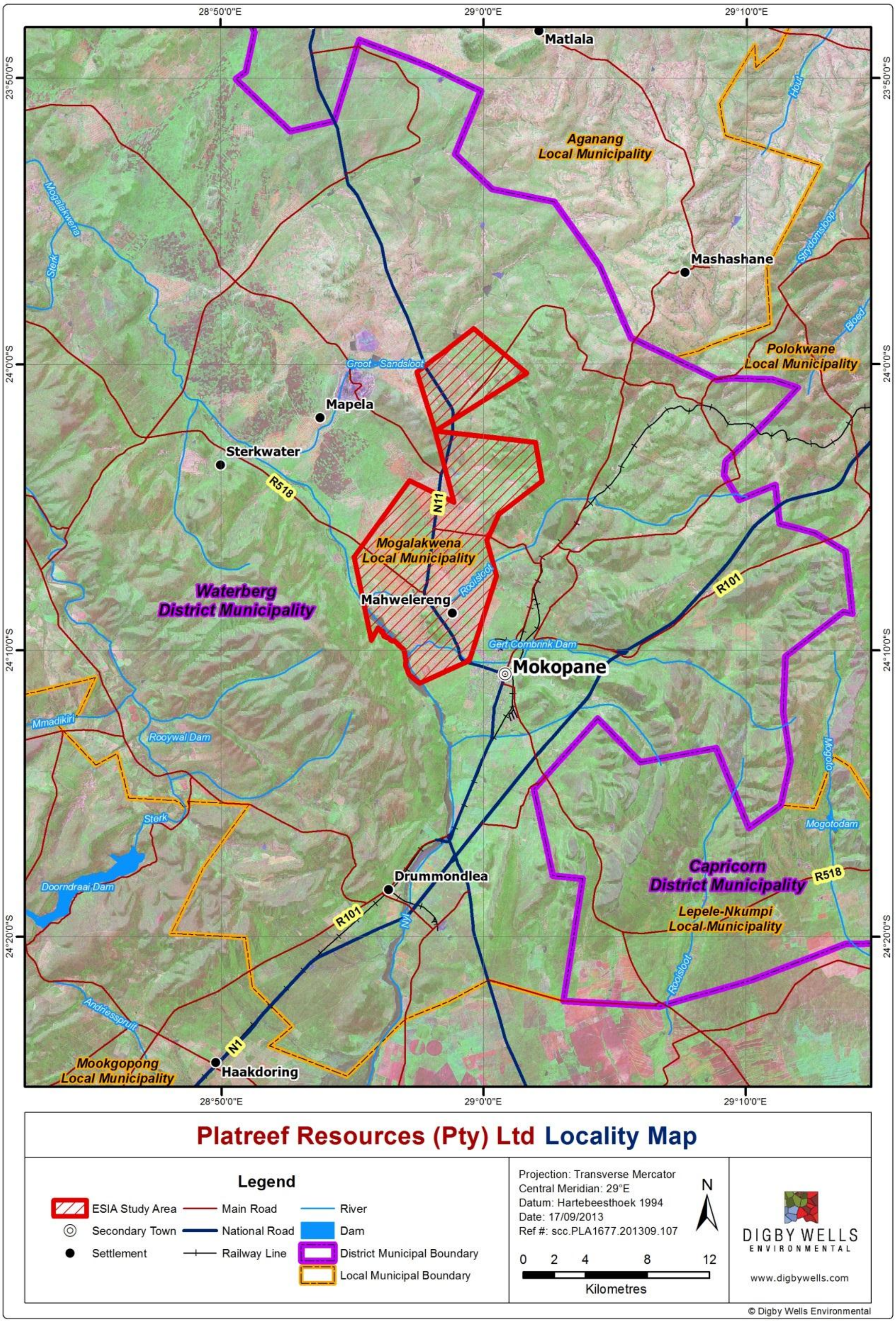
4.1 Project Area

The project is located within the Waterberg District Municipality (WDM) as represented in Plan 1. Platreef has obtained the exclusive prospecting rights for the base and precious metals on the farm properties Tufrspruit 241 KR, Macalacaskop 243 KR and Rietfontein 2 in the northern limb of the Bushveld complex, approximately 6km from Mokopane, Limpopo. The project area covers approximately 10 700 ha, of which a lot is existing settlements.

4.2 Infrastructure

Anticipated infrastructure relating to the proposed mine will include (but is not limited to):

- Workshops;
- Temporary offices;
- Pollution control facilities;
- Sewage treatment plant;
- Parking area;
- Hard park;
- Roads;
- Drainage systems;
- Bulk and potable water supply and storage infrastructure; and
- Fencing.



Plan 1: Locality Map

5 REHABILITATION OBJECTIVES

Internationally and in the South African context, the broad rehabilitation objectives include three schools of thought, explained below:

- Restoration of previous land capability and land use;
- No net loss of biodiversity; and
- What the affected community wants, the affected community gets.

Rehabilitation objectives need to be tailored to the project at hand and be aligned with the Environmental Management Programme (EMPr) and Mine Closure Plan. And thus, the overall rehabilitation objectives for the Platreef project are as follows:

- Re-establishment of the pre-mining land capability to allow for a suitable post mining land use;
- Maintain and minimise impacts to the functioning wetlands and water bodies within the area;
- Implement progressive rehabilitation measures where possible (i.e. contractors camps and areas used during the construction phase)
- Prevent soil, surface water and groundwater contamination;
- Comply with the relevant local and national regulatory requirements; and
- Maintain and monitor the rehabilitated areas.

6 BASELINE EVNIRONMENT

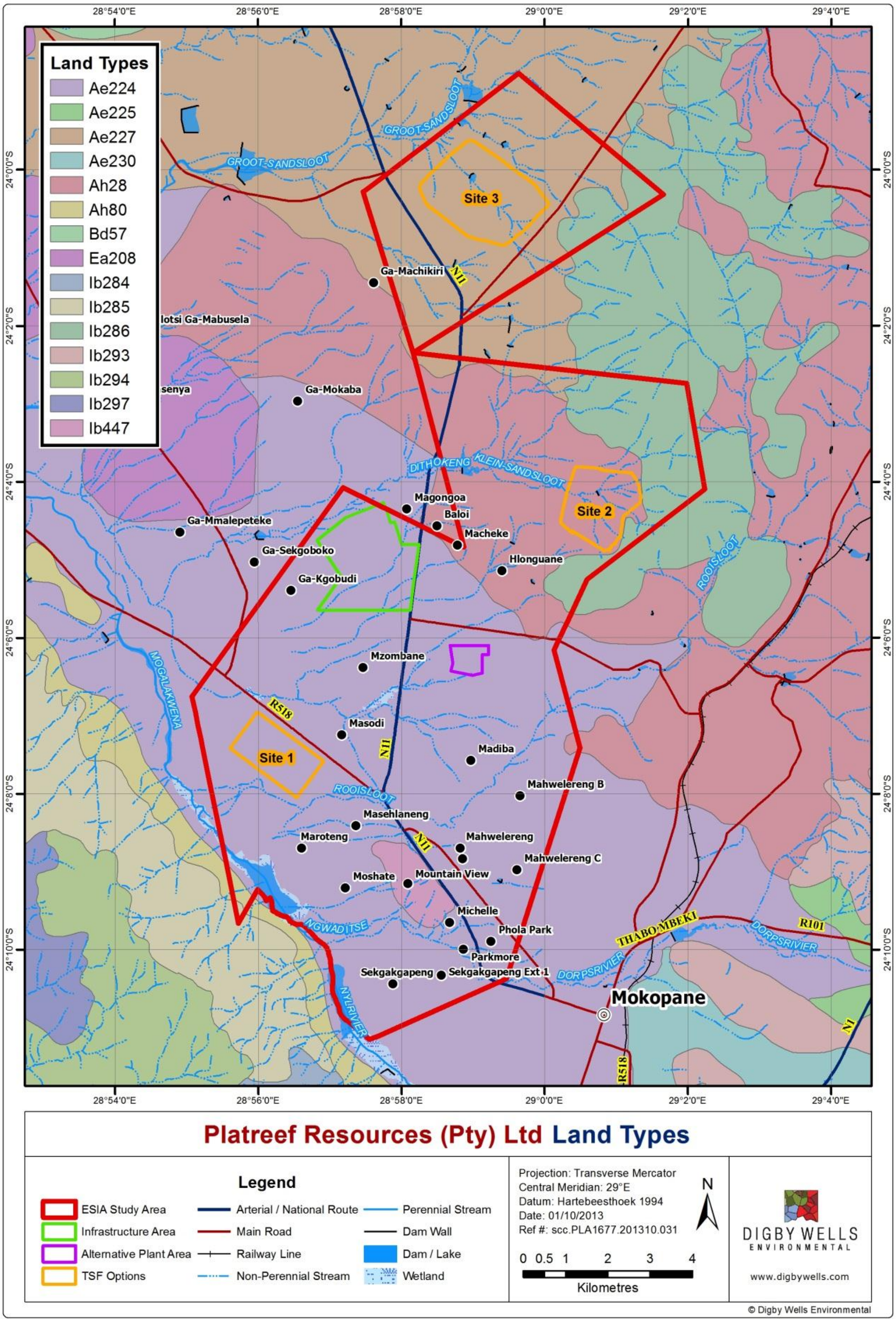
6.1 Soils and Land Capability

6.1.1 Land Type

The Platreef project site is undulating and is located within the dominant Ae, Ah and Ib land types of the 2328 Pietersburg and 2428 Nylstroom land type maps (Land Type Survey Staff, 1989). Land type information is depicted in Plan 2.

These land types indicate that the underlying geology consist mainly of hornfels, shale, quartzite, conglomerate, granite and biotite granite. The Ae land type covers most of the southern part of the project site while land types Ah and Ib cover the northern part of the project site.

The Ae land type is flat with slopes of 1 – 5 % while the Ah and Ib land types are undulating containing slopes of 5 – 10 % and 10 – 100 % respectively. The Ib land type is easily recognised as rocky outcrops within the Platreef area.



Plan 2: Land Types

6.1.2 Soils Forms

The soil types occupying the Platreef project site are indicated in Plan 3 below. The steep crest landscape positions are generally occupied by shallow rocky soil. Lower lying mid slope areas on the old flood plain, are dominated by well drained red and yellow soil such as Hutton, Oakleaf and sandy Clovelly soil types.

Hutton soils consist of an orthic A horizon overlying a red brown B horizon. The Clovelly soil consists of an orthic A horizon overlying a yellow brown B horizon while the Oakleaf soil consists of an orthic A horizon, overlying a neocutanic brown apedal B horizon. The A and B horizons have good internal drainage properties, and therefore well drained.

The lower lying areas in the foot slope and valley bottom positions are dominated by heavy clay soils such as the Valsrivier and Arcadia soil forms. The Valsrivier soil consists of an orthic A horizon overlying a structured pedocutanic B horizon. The Arcadia soil consists of a vertic A horizon.

The Katspruit (Ks) soil is a true wetland soil and is permanently wet. This soil type is found at the lowest landscape positions such as in the valley bottom landscape position. The Ks soil consists of an orthic A horizon overlying a G horizon. The G horizon is characterised high clay content and green and grey colours due to the anaerobic soil conditions caused by waterlogging.

The agricultural potential of the dominant well drained soils, for example Oakleaf and Hutton soils in the surveyed area are determined by the combination of soil depth and favourable climatic conditions. The average rainfall in the area is medium to high (650 mm per annum) and in combination with good soil, results in high arable agricultural potential as indicated in Table 6-1.

Table 6-1: Dominant cultivated soil forms found in the Platreef project area during the soil survey.

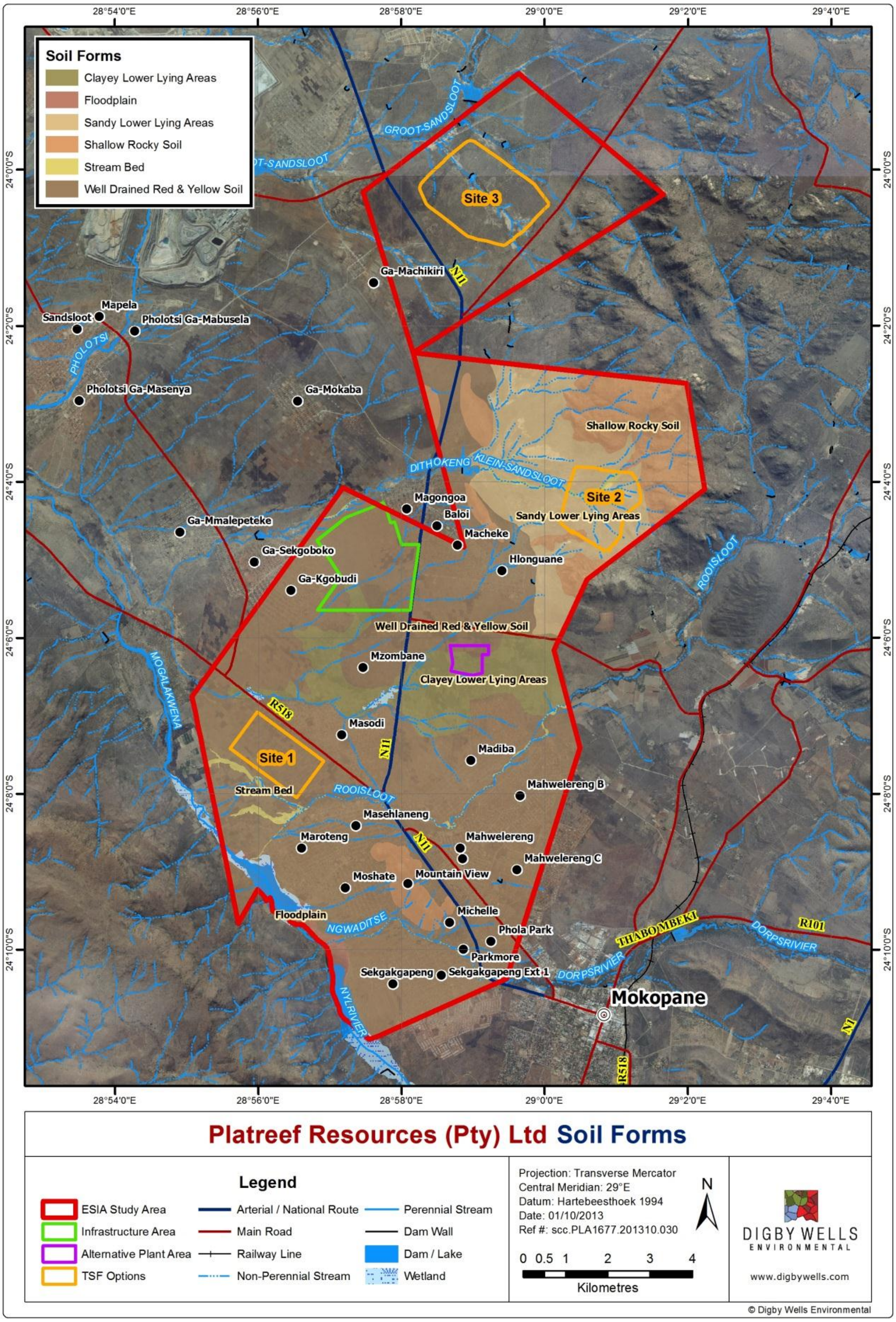
Soil Form	Average Depth (m)	General Characteristics	Agricultural Potential
Clovelly (Found near stream bed cultivated crop is maize)	1.5	Orthic topsoil A horizon overlying a deep, red, well drained, structureless, B horizon underlain by hard or weathered rock.	Low due to very sandy nature and low soil fertility conditions.
Oakleaf	0.8 – 1.5	Orthic topsoil A horizon overlying a deep, neocutanic, brown, well drained, structured B horizon.	High due to high rainfall in the region well drained status and high water holding capacity of the soil.
Hutton	0.8 – 1.5	Orthic topsoil A horizon	High due to medium to

Soil Form	Average Depth (m)	General Characteristics	Agricultural Potential
		overlying a deep, red, well drained, structureless, B horizon underlain by hard or weathered rock.	high rainfall in the region well drained status and high water holding capacity of the soil.
Valsrivier	0.75	Orthic topsoil A horison overlying a pedocutanic B horison underlain by unspecified material.	Low due to clayey nature and potential water logging conditions.

6.1.3 Land Capability and Land Use

Land capability is determined by a combination of soil, terrain and climatic features. Land capability is defined by the most intensive long term sustainable use of land under rain-fed conditions. Simultaneously an indication is included in the definition about the permanent limitations associated with the different land use classes (Schoeman *et a.l*, 2000).

The present land use is limited to subsistence crop farming and grazing. Underground mining will have a temporary influence on land capability changing the subsistence agricultural use to mining land use. Subsidence due to the underground mining might occur and is potentially very serious. Subsidence can cause changes in drainage lines, waterlogging of land and changes in land capability and land use.



Plan 3: Soil Forms

Underground mining will have an influence on land capability during mining operations. Access will be restricted to mine areas effectively preventing any agricultural activities to continue. This restriction causes pressure on the resources used for agriculture because smaller areas are available for arable and grazing in close proximity of the underground mining land.

6.2 Fauna and Flora

6.2.1 Flora

The study site is part of the Limpopo Bushveld, occupied by the Savanna Biome. According to Mucina and Rutherford three vegetation types are found within the project area namely Makhado Sweet Bushveld, Waterberg Mountain Bushveld, and Mamabolo Mountain Bushveld.

The field vegetation surveys identified six vegetation communities (Plan 4 and Table 6-2), namely

- Ridge Bushveld;
- Impacted Ridge Bushveld;
- Degraded Mixed Bushveld;
- Secondary Grassland and Agricultural Fields;
- Wetland vegetation; and
- Residential areas.

Table 6-2: Broad communities identified in the study area

Plant Community	Area (ha)	Percentage of total (%)
Community 1: Ridge Bushveld	795.4	7.44
Community 2: Impacted Ridge Bushveld	259.75	2.43
Community 3: Degraded Mixed Bushveld	2007.7	18.79
Community 4: Secondary Grassland and Agricultural fields	3516.3	32.91
Community 5: Wetland vegetation/Dam	338.5	3.17
Community 6: Residential areas.	3767.9	35.26

6.2.1.1 Ridge Bushveld

This vegetation type was defined as vegetation unique to the ecological system of a ridge and was found to be different in comparison to the environment that directly surrounds it. It consisted of a grassy layer and a tree/shrub layer which is characteristic of the Bushveld. The grass layer included species such as *Panicum natalense, Eragrostis rigidior, Brachiaria serrate* and *Schizachyrium sanguineum* along the channels within the ridge area. On the mid and higher slopes the grassy layer diminishes while the tree/shrub layer consists of *Acacia caffra, Combretum heroerense, Commiphora neglecta, Diospyrus villosa, Dombeya rotundifolia, Ficus sycamorus, Ficus glumosa* and *Cussonia paniculata increases*. A high level of indigenous well establishes bushveld species were abundant and prominent. This can also be due to the fact that these ridges form part of the Witvinger Nature Reserve ridge range.

6.2.1.2 Impacted Ridge Bushveld

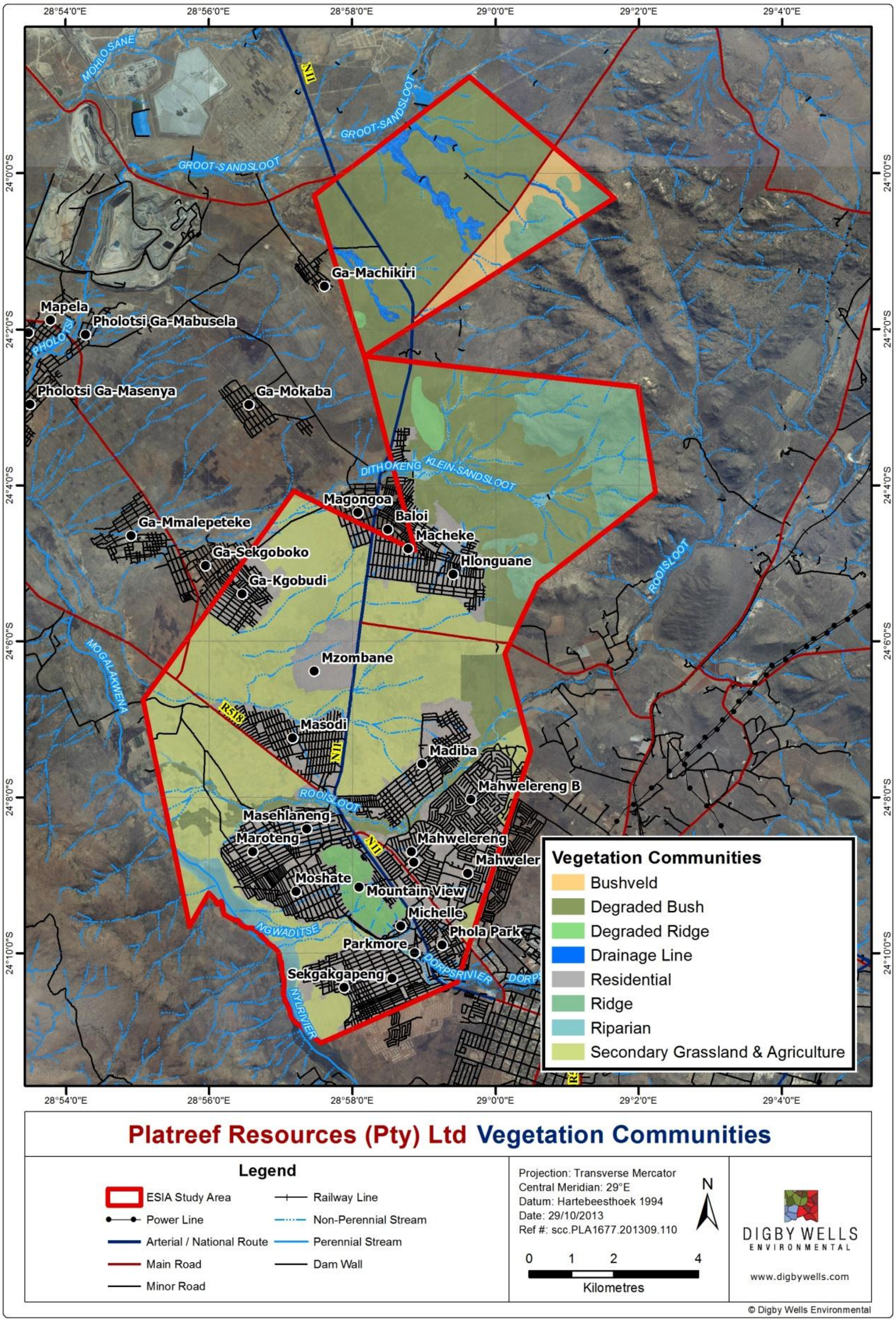
The Impacted Ridge Bushveld vegetation community forms part of the ridges that are close to settlements. For this reason the ridges are constantly exposed to the cutting down of trees for firewood and the grazing of cattle. If compared to the Ridge Bushveld vegetation community, the impacts are apparent as the amount of indigenous trees is significantly reduced. The reason for this is that indigenous species such as *Dombeya rotundifolia* are targeted first for the purpose of firewood and species such as *Dichrostachys cinerea* remain. The grassy layer consisted of species such as *Themeda triandra, Hyparrhenia hirta, Aristida congesta, Eragrostis curvula, Eragrostis rigidior, Melinis repens* and *Sporobolus centrifugus.* The tree/shrub layer comprised of *Aloe cryptopoda, Grewia bicolor, Grewia flava, Ruellia cordata, Gymnosporia buxifolia, Kirkia wilmsii* and *Dichrostachys cinerea*.

6.2.1.3 Degraded Mixed Bushveld

This vegetation community was found in between the base of ridges and residential areas/settlements, which was interrupted in certain sections by agricultural/secondary grasslands. This was also significantly impacted by removal of vegetation for firewood, grazing and dumping of domestic waste. Mining activities for sand mining were also found within this community with informal gravel roads that are used for this purpose. The grassy layer was dominated by *Melinis repens, Eragrostis plana* and *Eragrostis rigidior*. The tree/shrub layer includes *Acacia karroo, Acacia garrarrdii, Ziziphus mucronata, Aloe greatheadii, Aloe marlothii, Euphorbia ingens* and *Dichrostachys cinerea.*

6.2.1.4 Secondary grasslands/Agricultural fields

Secondary grasslands and agricultural fields have been grouped together, due to the fact that secondary grasslands persists were previous agricultural activities ceased. Where agricultural activities are still current, *Zea mays* (maize/mielies) is found. The secondary grasslands consist predominantly of secondary/pioneer grasses such as *Eragrostis curvula, Melinis repens, Urochloa panicoides, Cynodon dactylon, Hyparrhenia hirta, Aristida congesta, Pogonarthria squarrosa, Dactyloctenium aegyptium* and exotic species such as *Tagetes minuta, Senecio latifolius, Xanthium strumarium**, *Bidens pillosa, Solanum panduriform* and *Ricinus communis**. Secondary grassland and agricultural fields are also intermixed in-between each other, there is no distinct pattern as secondary growth is determined by activity or non-activity. Legally protected large Leadwood trees (*Combretum imberbe*) were found in large numbers in the secondary grassland vegetation type as remnant vegetation of the previous dominating bushveld vegetation of this region.



Plan 4: Vegetation Communities

6.2.1.5 Wetland Vegetation

The wetland regions are indicated by wetland indicators and aquatic plant species. Wetland regions are usually seen as sensitive areas due to its unique ecological cycles and the species that are dependent on it or inhabit it for both fauna and flora. Wetland vegetation species include *Ammania baccifera, Imperata cylindrica, Phragmites australis, Centella asiatica, Kyllinga erecta* and other Cyperaceae species.

6.2.1.6 Residential Areas

Although not identified as an official vegetation community, Residential areas form part of a large section of the project area. Although developed, this area still has vegetation species within it and due to the large extent of the Residential area within the project area; it is mentioned as a community. Species found within developed areas include *Mangifera indica, Carica papaya, Bouganvillea spinosa, Persea americana, Ceiba pentandra, Bauhinia variegate, Euphorbia milii, Senna pendula var. glabrata* and *Melia azedarach.*

6.2.2 Fauna

Fauna expected to occur on site include assemblages within terrestrial and wetland ecosystems: mammals, birds, reptiles, amphibians and invertebrates. Each of these assemblages occurs within unique habitats, the ecological state of these habitats directly relates to the number of species found within them. The main habitats occurring in the project area are bushveld plains and pans with little altitudinal variation.

A total of 11 mammals were observed, including two species protected by the Limpopo Environmental Management Act (2003). A total of 13 bird species were recorded, of which seven are Vulnerable and six Near Threatened. No Red Data status reptiles were found during the surveys, although there is a probability matrix calculated in the Fauna and Flora report based on the distribution and habitat requirements. Refer to the Flora and Fauna Report for further information related to fauna.

6.2.3 Sensitivity of the Area

Owing to the ecological function of the Bushveld habitat on the Platreef site and the presence or likelihood of occurrence of floral and faunal Species of Special Concern (SSC), the overall Sensitivity of the site was regarded as High.

The following areas were regarded as Highly Sensitive:

- Ridge Bushveld, and
- Riparian Areas (Wetland vegetation/Dam).

The following areas were regarded as Moderately to High Sensitive:

- *Impacted Ridge Bushveld*;

The following areas were regarded as Moderately Sensitive

- *Degraded Mixed Bushveld*

6.3 Surface Water and Aquatics

The aquatic ecosystems associated with the study areas located within the Limpopo Water Management Area (WMA1). The effected aquatic ecosystems are located in quaternary catchments A61F and A61G. The rivers systems under investigation form part of the upper reaches of the Limpopo River catchment, which is water stressed tributary.

Water quality data is very limited and not very reliable; however a first round of water quality sampling and testing took place in September 2011. The results show that the water has a high Total Dissolved Solids largely due to evaporation from the pools. The water quality results does show high concentrations of dissolved manganese, aluminium and iron as well as fluoride. This will be confirmed as more water quality data becomes available.

6.4 Groundwater

6.4.1 Hydrogeology

Two main aquifer types are present, i.e. primary and secondary. The two farms Turfspruit and Macalacaskop are mainly underlain by intergranular and fractured aquifers, associated with the Rustenburg Layered Suite. Rietfontein to the north is underlain by sedimentary rocks of the Transvaal Sequence (sandstone, shale and dolomite) and basement granite, forming the hills of the northern boundary.

6.4.2 Primary Aquifer

The primary aquifer is mostly restricted to the alluvium in the Mogalakwena river where alluvial thicknesses of up to 20 metres occurs and borehole yields in excess of 10 l/s have been established. Minor alluvium occurrences are associated with the Rooisloot River drainage.

Boreholes in the Rooisloot Alluvial Aquifer are drilled to depths between 35 and 45 metres. Water levels as shallow as 2m are present. Calculated aquifer transmissivity values range between 315 and 404 m^2/day. The aquifer storage coefficient (S) for both the alluvial and weathered bedrock aquifer is 2.7×10^{-3}.

6.4.3 Secondary Aquifer

The intergranular and fractured aquifers within the Platreef prospecting area are associated with the Rustenburg Layered Suite (RLS).

The main secondary aquifer occurs at a shallow depth of less than 45 m. Water level depths vary from 3 to 25m below ground level. Water strike depths in the weathered bedrock range from 12 to 20m, with strike yields between 0.1 to 1.0 l/s. Water interceptions in the shallow fractured bedrock occur at 20 to 42 m with strike yields between 1.0 to 10.0 l/s.

Calculated aquifer transmissivity values range between 17 and 113 m^2/day. The aquifer storativity (S) is in the order of 5×10^{-3}. The average saturated thickness of the main aquifer zone is 17.6 metres. The base of the main aquifer zones is shallow and varies from 12 to 42 m.

Seasonal water level fluctuations due to direct rainfall recharge are expected. Intrusive dykes may act as boundaries to lateral groundwater flow.

A minor fractured aquifer is present at depth (>45 m) with strike depths varying from 45 to 156m and yields between 0.1 and 0.2 l/s. Slug testing of six deep core holes indicate very low hydraulic conductivities, between 1 x 10^{-4} m/d and 1 x 10^{-5} m/d, considered representative of the igneous rock matrix. Inspection of core samples indicate minor fracturing at the mineralized contact zone at a depth of some 800 m.

Dolomite and granite underlie sections of Rietfontein. The study has confirmed that groundwater within these formations is limited.

6.4.4 Groundwater Flow

Groundwater flow generally follows surface drainage with flow occurring from northeast to southwest and eventually northwest following the Mogalakwena River. Groundwater elevations are highest (1 220 mamsl) on the farm Rietfontein underlain by granite and lowest (1 030 mamsl) on the farm Turfspruit associated with the Rooisloot Alluvial Aquifer. This represents a hydraulic head of 190m across the study area.

6.4.5 Groundwater Use

Zones of steep gradients indicate the presence of less permeable areas. Water is currently being abstracted from groundwater sources to supply the various rural communities on the 3 farms. Dispersed boreholes are in use throughout the area, with the highest volume abstracted for domestic water supply from the Rooisloot alluvial aquifer on the farm Turfspruit. The WARMS data base indicates no registered water use for the three farms.

The total current abstraction from groundwater supplied from governmental boreholes located within these three farms is estimated at 5 270 m^3/day, (76 boreholes). Abstraction from 43 private boreholes is estimated at 86 m^3/day.

6.4.6 Groundwater Quality

The average concentrations of the major cations and anions are within the maximum allowable SANS standards, except for nitrate. The average nitrate as N content in the study area is 31 mg/l, significantly exceeding the SANS limit of 11 mg/l as N with a high health risk when used as drinking water. The baseline groundwater quality is summarised in the table below. The impact of the large rural communities in the study area generally dominates changes in water quality relative to changes in geological formations.

7 STATUTORY REQUIREMENTS

South Africa's legislation unambiguously places the responsibility of mitigating environmental damage as a result of mining operations on mining companies. The liability exists throughout the life of the mine, and beyond in terms of residual impacts. It includes commitments for remediation and/or rehabilitation.

The key legislation governing the requirements for legislation for rehabilitation is contained in the following acts:

- The Constitution of the Republic of South Africa (Act 108 of 1996) ("The Constitution");
- The National Environmental Management Act (Act 107 of 1998, NEMA);
- The Mineral and Petroleum Resources Development Act (Act 28 of 2002, MPRDA); and
- The National Water Act (Act of 1998, NWA).

Other legislation that is applicable includes:

- The Environment Conservation Act (Act 73 of 1989, ECA);
- The National Environmental Management: Biodiversity Act (Act No. 10 of 2004, NEMBA);
- Conservation of Agricultural Resources Act (Act 43 of 1983, CARA);
- National Forests Act (Act 84 of 1998, NFA);
- Mine Health and Safety Act (Act 29 of 1996);
- National Heritage Resources Act (Act 25 of 1999);
- Occupational Health and Safety Act of 1994;
- Atmospheric Pollution Prevention Act (Act 45 of 1965);
- Hazardous Substances Act (Act 15 of 1973);
- National Environmental Management: Air Quality (Act 39 of 2004, NEM:AQA);
- National Environmental Management: Waste Management (Act 50 of 2008);
- National Veld and Forest Fire Act (Act 101 of 1998);
- Promotion of Access to Information Act (Act 2 of 2000); and
- The Promotion of Administrative Justice Act (Act 3 of 2000).

7.1 The Constitution

The Constitution, whilst it does not contain specific provisions for rehabilitation, does enshrine the right of every citizen to an environment that is not harmful to health or wellbeing (Section 24). The inclusion of environmental rights as part of fundamental human rights ensures that environmental considerations are recognised and respected during the administrative and legal processes implemented during the closure and rehabilitation of mined land.

The Bill of Rights, which is an aspect of the Constitution, also provides for rights pertaining to administrative justice, capacity or standing to institute legal proceedings and access to information. These all become relevant within the context of protection and management of the environment during all stages of the mine's life cycle.

7.2 The National Environmental Management Act (Act 107 of 1998)

NEMA aims to establish overarching general guidelines and principles to facilitate environmental management. It promotes Integrated Environmental Management (IEM) (Sections 23 and 24), which aims to integrate environmental management with development.

The concept of rehabilitation has become an imperative part of South African environmental law. Section 28 of NEMA imposes a duty of care to prevent, or where authorised, to minimise environmental degradation. It also provides examples of steps that should be taken to prevent environmental degradation, including the provision for rehabilitation in Section 28 (3) (f), which states that the measures may include measures to "remedy the effects of pollution and degradation".

Section 2 of the Act lists a set of principles, with which environmental management must comply and to which Section 37 (1) of the MPRDA refers directly as follows: "The principles set out in Section 2 of the National Environmental Management Act, 1998 (Act No.107 of 1998)

(a) apply to all prospecting and mining operations, as the case may be, and any matter relating to such operation; and

(b) serve as guidelines for the interpretation, administration and implementation of the environmental requirements of this Act."

Section 2 (b) of NEMA states that they "serve as the general framework within which environmental management and implementation plans must be formulated".

The principles of Section 2 of NEMA that are particularly applicable to rehabilitation are:

- The precautionary principle (2 (4) (a) (vii)), which lays the onus on the developer or operator to take a risk averse and cautious approach during decision making, that recognises the "limits of current knowledge about the consequences of decisions and actions". Where uncertainty exists , action must be taken to limit the risk;
- The cradle-to-grave (or lifecycle responsibility) principle (2 (4) (e)) states that "responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.";
- The polluter-pays principle (2 (4) (p)) is generally regarded as an important guiding principle for environmental management. The White Paper A Minerals and Mining Policy for South Africa October 1998 state that mining must internalise its external

costs. In Paragraph 4.4 (ii) it states that "The mining entrepreneur will be responsible for all costs pertaining to the impact of the operation on the environment."; and

- The project must comply with the requirements for sustainable development (2 (3)), which requires consideration of all relevant factors (2 (4) (a)). A holistic, integrated approach must be followed and the "best practicable environmental option", (defined as being "the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as in the short term") must be selected.

7.3 The Minerals and Petroleum Resources Development Act (Act 28 of 2002)

The MPRDA is the principal legislation governing the mining industry and along with its regulations (GN R.527) has several provisions relating to rehabilitation. The objectives of the act in terms of rehabilitation are to give effect to environmental rights as outlined in the constitution. The cradle-to-grave principle (described above) is applied by means of the above-mentioned provisions, which cover the various stages of the project that apply from the period prior to mining through the construction, operation to closure and beyond.

7.4 Integrated Environmental Management and Responsibility to Remedy (Sections 38 and 39, Regulations 51 and 55 of GN R527)

The mining right holder must give effect to the principles of IEM as laid down in Chapter 5 of NEMA. An annual review for financial provision and a biennial review (or as stipulated in the EMP, or as agreed to in writing by the Minister of Minerals and Energy) for auditing to ensure that the requirements of IEM are being met, are required (Regulation 55 (2) of GN R.527).

7.4.1 Rehabilitation

Furthermore, Section 38 (1) (d) states that the environment that has been affected by prospecting or mining operations must be rehabilitated to its natural or predetermined state or land use according to the principle of sustainable development (cf. Sections 2 (3) and 2 (4) (a) of NEMA as discussed above as well as Regulation 56, GN R.527 of the MPRDA).

7.4.2 Responsibility for and Management of Adverse Impacts

Section 38 (1) (e) of the MPRDA states that the holder of the mining right is responsible for any adverse environmental impact resulting from the mining operations, "which may occur inside and outside the boundaries of the area to which such right, permit or permission relates." In addition Section 39 (3) (d) provides for a description in the EMP of the manner whereby remediation of adverse environmental impacts and compliance with prescribed waste management standards are to be implemented.

This along with the provisions in Section 28 (1) of NEMA regarding care of duty and Regulation 56 of GN R527, which also provides for the land being rehabilitated, as far as is practicable, to its natural state, or to a predetermined and agreed standard of land use which conforms with the concept of sustainable development means that the land use at Platreef must be restored to its previous state where appropriate, pending stakeholder approval.

7.5 Financial Provision (Sections 23 and 41 and Regulations 10, 52 – 54 of GN R527)

The applicant for a mining right must make financial provision for the prevention, management or rehabilitation of adverse environmental impacts before mining commences. In terms of Section 23 a mining right is granted only if a number of conditions are met including the requirement that mining will not result in unacceptable pollution, ecological degradation or damage to the environment. Regulation 10 requires that detailed documentary proof must be submitted to show that the applicant for a mining right has the technical ability or access thereto to conduct the mining activities and to mitigate and rehabilitate relevant environmental impacts.

Section 41 stipulates that approval of an EMP can only be granted once financial provision for rehabilitation or management of negative environmental impacts has been made.

The obligation for financial provision encompasses the entire life cycle of the mining operation from the stage prior to prospecting and/or mining operations through the various phases to closure and beyond as per the cradle-to-grave principle of NEMA. It remains in force until the Minister issues a closure certificate in terms of Section 43. Once the closure certificate has been issued the Minister “may” return the remaining portion of the financial provision. In the event that rehabilitation and closure are not done properly, the Minister may seize assets of the mineral rights holder to defray costs. In the event that this cannot be done then the cost of fixing the problem has to be paid from the Government fund. As a result this is why there is such a strong focus on rehabilitation and closure plans and the financial provision for closure.

Regulation 54 deals with the quantum of financial provision and stipulates that it must be updated and reviewed annually. It must include, amongst others, a detailed breakdown of the cost required for post-closure management of residual and latent environmental impacts.

7.6 Mine Closure

7.6.1 Principles of Mine Closure

Regulation 56 of the Regulations provides that the holder of a prospecting right, mining right, retention permit or mining permit must ensure (amongst others) that:

- The land is rehabilitated, as far as is practicable, to its natural state, or to a predetermined and agreed standard of land use which conforms with the concept of sustainable development; and
- Prospecting or mining operations are closed efficiently and cost effectively.

7.7 The National Water Act (Act 36 of 1998)

The NWA aims to regulate the protection, use, development, conservation, integrated management and control of water resources in the Republic of South Africa in an equitable, sustainable and efficient manner (a full description is given in Section 2 of the Act). An important principle of the Act is that water belongs to the state, which holds it in trust for the nation.

Section 19 of the NWA which imposes a duty of care on the holder of the mining right in a similar way to Section 28 of NEMA, states that "An owner of land, a person in control of land or a person who occupies or uses the land on which any activity or process is or was performed or undertaken; or any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.". This implies that before any mining or related activity is opened, or closed, whether temporarily or permanently, the necessary pollution control measures should be in place.

The regulations contained in GN R704 published in terms of the NWA consist of regulations on the "use of water for mining and related activities" and are "aimed at the protection of water resources". GN R704 acknowledges the principle of co-operative governance and the respective roles for the DMR, the Department of Environmental Affairs (DEA) and the DWA in regulating pollution from mining activities.

Regulation 9 of GN R704 promulgated in terms of the NWA, which deals with temporary or permanent mine closure, provides that any person in control of a mine or related activity must at the cessation of mining operations and its related activities, ensure that all pollution control measures have been designed, modified, constructed and maintained so as to comply with the regulations contained in GN R 704. Furthermore, the in-stream and riparian habitat of any water resource, which may have been affected or altered by the mine or activity, must be rehabilitated in accordance with the regulations contained in GN R. 704.

Further applicable regulations in terms of GN 704 are discussed below.

7.7.1 Regulation 5 – Restrictions on Use of Material

The regulation provides that material that could potentially impact on a water resource should not be used for the construction of any feature. Consideration should also be given to the influence on pollution potential by the manner in which certain materials are used. The person in control of the mining activity will be responsible for proving that material used will have no impact.

7.7.2 Regulation 7 – Protection of Water Resources

Regulation 7 (b) applies to the prevention of pollution of any water resource by residue deposits near a water body (such as a pan) or a water course and the provision in Regulation 10(2) (b) provides that stockpiles or sand dumps established on the bank of any watercourse or estuary must be stockpiled or dumped outside of the 1:50 year flood-line or more than a horizontal distance of 100 metres from any watercourse or estuary.

Regulation 7 (f) states that: “Every person in control of a mine or activity must take reasonable measures to- ensure that water used in any process at a mine or activity is recycled as far as practicable, and any facility, sump, pumping installation, catchment dam or other impoundment used for recycling water, is of adequate design and capacity to prevent the spillage, seepage or release of water containing waste at any time.”

8 CONCEPTUAL REHABILITATION PLAN

The rehabilitation of the Platreef project area is simultaneously a continuous and time-framed operation. In order to gain the best possible rehabilitation outcomes from the mining processes in the relatively sensitive area, different actions are required to occur at different times within the life of the project from prospecting to closure. Similarly, there are management and monitoring actions that will be required throughout the life of the mine project and for years after the project has been closed.

Traditional mining phases include Construction, Operational and Closure phases. Prior to construction and preparation of the land for mining, best practises need to be implemented and compliance to legislation needs to be adhered to.

The Platreef project is no exception and outlined below are the actions to occur through the three phases that are needed to ensure successful rehabilitation, see
Figure 8-1.

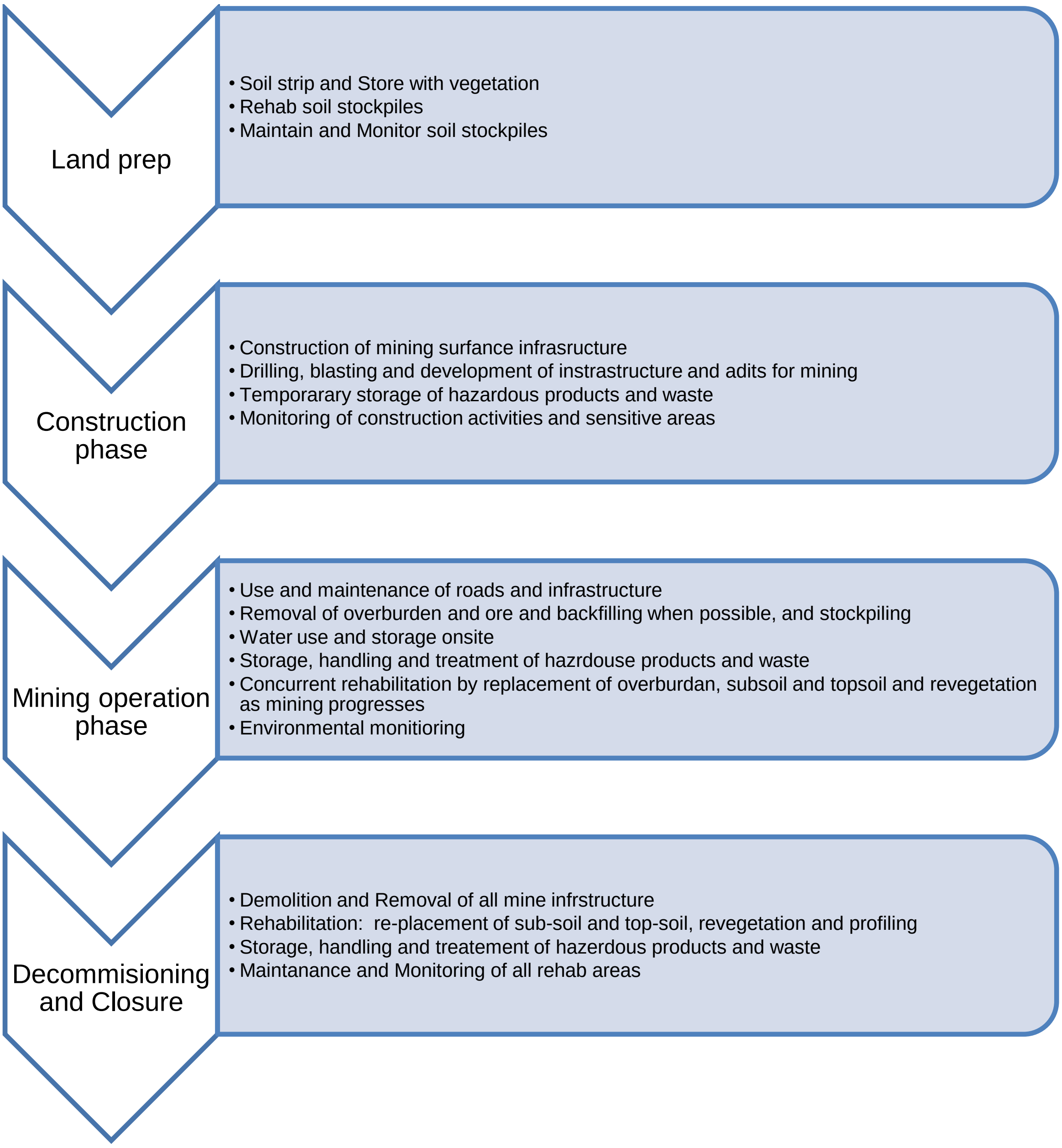


Figure 8-1: Actions to occur through the Life of Mine, summary figure.

8.1 Land Preparation

The most important factors to bear in mind when preparing for mining are; to limit the areas that will be affected by the development, minimise potential future contact of toxic or polluting materials with the environment and maximise the recovery and effective storage of those mining profile materials that could be most useful during the rehabilitation process after mining has been completed (Chamber of Mines, 2007; Department of Minerals and Energy, 2008).

The following points should be considered during the construction phase of the project:

- Mine planning should minimise the area to be occupied by mine infrastructure. The affected area should be kept as small as practically possible and should be clearly defined and demarcated;
- Care should be taken around sensitive landscapes e.g. wetlands to ensure that impacts to them are none to minimal and that the buffer zones around these sensitive landscapes are taken into account;
- Construction crews should restrict their activities to planned areas. Clear instructions and control systems should be in place and compliance to the instructions should be policed;
- All stockpiles should be located in areas where they will not have to be removed prior to final placement. Materials should thus be placed in their final closure location or as close as practicable to it;
- Soils which cannot be replaced directly onto rehabilitated land should be stockpiled. All stockpiles should be clearly and permanently demarcated and located in defined no-go areas, re-vegetated and monitored on an annual basis;
- Infrastructure should be designed with closure in mind. Infrastructure should either have a clearly defined dual purpose or should be easy to demolish. This aspect of rehabilitation should be considered if changes in the mine design are made;
- Soil stripping is a very important process which determines rehabilitation effectiveness. It should be done in strict compliance with the soil stripping guidelines, which should define the soil horizons to be removed; and
- If rock quarries or borrow pits are required include them into the environmental plans, however it is suggested that other material could be utilised to avoid further impacts to soils.

8.2 Soil Management Plan

8.2.1 Soil Stripping

This section explains the correct measures that should be followed during the stripping of soil. This is a key rehabilitation activity as soils lost cannot be regenerated in the lifetime of the mine. Correct stripping of soils will firstly ensure that enough soils are available for rehabilitation and secondly, that the soils are of adequate quality to support vegetation growth and thus ensure successful rehabilitation.

Confirmed sites within the project area that require soil stripping in preparation for mining activity included the infrastructure areas, the landfill area and the TSF area. All these areas constitute a dominant soil type, namely Oakleaf soil.

The soil depth to be stripped where the Oakleaf soil occurs is generally 1 m or deeper, see Table 8-1. This depth includes both the topsoil (depth where plant roots are most active) and the subsoil. It is recommended that a 1m soil layer is stripped and stored in a stockpile with slopes of 1:5 to 1:7 (mainly for erosion protection).

The positions of the soil stockpiles should be indicated on a map and the soil stockpiles should be protected using a fence because soil loss due to unauthorised use can and will occur. The topsoil stockpile should be re-vegetated to protect the soil from water and wind erosion.

Restrictive stockpile heights are usually recommended because soil quality is affected negatively by anaerobic conditions occurring in large stockpiles. The stockpile height in the case of the Platreef Project can be adjusted according to the space needed because the soil will be stored for a long time before used for rehabilitation purposes.

The remainder of material excavated deeper than 1 meter should be stored in a separate stockpile for later use such as to fill up the borrow pits.

Table 8-1: Proposed Soil Stripping Depths

Areas to be stripped	Soil Form	Average Soil Profile Depth (m)	General Characteristics	Agricultural Potential	Recommended stripping depth (m)
Infrastructure area; **TSF;** **Landfill; and** **Sub-soil stockpile**	Oakleaf	0.8 – 1.5	Orthic topsoil A horizon overlying a deep, neocutanic, brown, well drained, structured B horizon.	High: Due to high rainfall in the region, well drained deep soil.	1

Heavier soil types occurring in the drainage lines are not as deep as the Oakleaf soil. These should be stripped of the top 0.3 – 0.5 m only, and stockpiled separately due to the different soil properties present in these soils compared to the red Oakleaf soil.

The steps that should be taken during soil stripping are as follows:

1 A soil plan of the mining area is compiled and soils should be stripped making use of this;

2 Removal of hydromorphic soils should be avoided where possible. In the event wetlands have to be impacted upon, then hydromorphic soils should be stripped to a depth defined by the pre-mining soil survey. Typically, 0.3 m to 0.5 m of usable soil material can be stripped from wetland areas;

3 Well-drained soils should be stripped to a depth of 1 m;

4 Demarcate the boundaries of the different soil types;

5 Define the cut-off horizons in simple terms that they are clear to the stripping operator (avoid mixing of different horizons and try to ensure horizons and soil types are stockpiled separately);

6 Stripping should be supervised to ensure that the various soils are not mixed;

7 Soils should only be stripped when the moisture content will minimise the compaction risk (i.e. when they are dry);

8 The subsoil clay layers which can be found under certain hydromorphic soils need to be stripped and stockpiled separately. This clay material can be used as a compacted clay cap over rehabilitated areas that will become wetlands post-rehabilitation (stripping of wetland soils should be avoided, however if stripping does occur the above is recommended for stripping and stockpiling);

9 Where possible, minimise soil handling, i.e. soils should only be handled once instead of moving it around two or more times. However it is paramount that the correct soil types are replaced at the correct locations in the post-mining topography and accordingly there will always be a need to stockpile some soil; and

10 Truck and shovel should preferably be used as a means of moving soil, instead of bowlscrapers.

Some of the points listed above are discussed in more detail below (Chamber of Mines, 2007; Department of Minerals and Energy, 2008).

8.3 Soil Plan

A soil assessment was conducted during the EIA phase of the project. The information from the soils report was used to provide information regarding the recommended depth of soil stripping. This plan should be used to map and peg out the various soil types prior to the commencement of construction activities.

The soil, land use and land capability assessment report by Digby Wells (2013) describes the baseline soil conditions, the physical and chemical characteristics, land capability and current land uses of the mining area. This report should be consulted before areas are cleared in preparation for the placement of infrastructure.

8.3.1 Soil Stripping Guidelines

The soil survey that was conducted for the proposed project must be utilised to generate the soil stripping guideline. The boundaries of the different soil types should be demarcated and each soil horizon (within each soil type's suitability for rehabilitation) should be defined. If possible, the stripped soils should be replaced immediately in a similar location in the topographical slope to their natural location (for the proposed project soil will be stripped and used to construct a berm and the unused balance stockpiled. After vegetation has been stripped, soil types need to be pegged out accurately (pegging out soils types ahead of stripping). The topsoil and subsoil should also be removed from the areas associated with the proposed mine infrastructure and dumps. Table 8-2 provides measures that should be considered during the stripping of soil during the construction phase of the project.

Table 8-2: Soil stripping measures during construction and operation

Construction (including site preparation)
■ **Plan site clearance and alteration activities for the dry season (May to October);**
■ **Restrict extent of disturbance within the Plat Reef project site and minimise activity within designated areas of disturbance;**
■ **Minimise the period of exposure of soil surfaces through dedicated planning;**
■ **Stripping operations should only be executed when soil moisture content will minimise the risk of compaction (during dry season);**
■ **During stockpiling, preferably use the 'end-tipping' method to keep the stockpiled soils loose;**
■ **Ensure stockpiles are placed on a free draining location to limit waterlogging; and**
■ **Limit stockpile height – a safe height can be regarded as the height at which material can be placed without repeated traffic over already placed material.**
Operation
■ **Preserve looseness of stockpiled soil by executing fertilisation and seeding operations by hand; and**
■ **Soil stockpiles should be monitored for fertility via sampling and testing; and**
■ **Monitoring of the condition of all unpaved roads is necessary due to the high rainfall and potential water runoff and erosion of the soils present in the Plat Reef project site. Water runoff from compacted road surfaces may cause erosion of road shoulders degrading the road surface. Weekly inspections need to be carried out of all unpaved roads especially during the rainy season.**

8.3.2 Supervision

A very important aspect is the supervision and monitoring during the stripping process. Close supervision will ensure that soils are being stripped from the correct areas and to the correct depths, and placed on the correct stockpiles with a minimum of compaction. Monitoring requires an assessment of the depth of the soil, the degree of mixing of soil materials and the volumes of soils that are being replaced directly or being placed on stockpiles.

Contracts for the stripping of soils should not only be awarded on the volumes being stripped but also on the capability to strip and place soil accurately.

A soil balance sheet needs to be developed to record all soil types and stripping volumes transported to the stockpiles. This soil balance sheet will aid in the management of the soil stockpiles in addition to keeping record of available soil volumes for rehabilitation.

8.3.3 Moisture Content

Soils are most susceptible to compaction when the moisture content is high. The dry winter months (April - August) are thus more suitable for the stripping and replacement of soils. If soils have to be moved during wet months then special care should be taken to adopt methods that cause minimum compaction.

8.3.4 Stripping Method

Soils should be stripped and replaced using the truck and shovel method as far as possible. This method will limit the compaction of soils. If bowl scrapers are used then the soils must be dry during stripping to minimise compaction (it is recommended that bowl scrapers are not used).

8.3.5 Stockpiling

This section explains the correct measures to be followed during the stockpiling of soil. Stockpiling should be minimised as far as possible since it increases compaction and decreases the viability of the seed bank.

The steps that should be taken during soil stockpiling are as follows:

1. Mark stockpile locations accurately on a plan to ensure that re-handling is minimised (i.e. soils will not have to be moved a second or third time);
2. Ensure that the location is free draining to minimise erosion loss and waterlogging;
3. Minimise compaction during stockpile formation. The soils should be kept loose by, preferably, tipping at the edge of the stockpile not driving over the stockpile (avoid end-tipping as this causes compaction).
4. The positions of the soil stockpiles should be indicated on a map and the soil stockpiles should be protected using a fence because soil loss due to unauthorised use can and will occur.
5. Restrictive stockpile heights are usually recommended because soil quality is affected negatively by anaerobic conditions occurring in large stockpiles. The stockpile height in the case of the Platreef Project can be adjusted according to the space needed because the soil will be stored for a long time before used for rehabilitation purposes. Limit the stockpile height so as to prevent internal compaction (soil stockpiles should be <2 m in height);
6. Re-vegetate with a seed mixture similar to the final rehabilitation seed mixture; and
7. Ensure that the stockpiled soil is only used for the intended purposes.

Some of the points listed above are discussed in more detail below (Chamber of Mines, 2007; Department of Minerals and Energy, 2008).

8.3.6 Stockpile Location

The materials that will be removed from the areas where infrastructure will be placed should be placed as close as possible to where it will be placed in the final landscape.

Appropriate mitigation measures for the management of topsoil stockpiles needs to be implemented to ensure that wetlands and drainage paths are not affected and that the loss of topsoil is mitigated against. Progressive monitoring of stockpiles and replacing of topsoil will ensure successful post-mining land and soil reclamation. Assessing post-mining soil characteristics and associated land capability and land uses is necessary to ensure that the end land uses goals can be met. The following information needs to be recorded when stripping and stockpiling of soils:

- Location of soil types than can be stripped and stockpiled together;
- Stripping depths of different soil types; and
- The location, dimensions and volume of planned stockpiles for different soil types.

Soil stripped from the tailings facility will be stored near the facility. Soil stripped from the remaining infrastructure areas will need to be stockpiled for use during rehabilitation. This includes soil that will be removed to construct the access shafts and vents. It is envisaged that a berm (screening berm) will be constructed around the plant area. This berm will be constructed from waste material removed from the underground workings. Once the berm has been constructed, soil will be placed on the berm and vegetated. It is envisaged that the berm will remain post closure.

It has been assumed that an additional stockpile will be required for the excess topsoil that will not be placed on the berm. This area will be 200 m by 200 m and should not exceed 2 m in height. Refer to Plan 5 for the proposed location of the soil stockpile (two locations have been provided).

8.3.7 Free Draining Locations

Soils should normally be replaced in the landscape positions it was stripped from. Well drained soil should therefore be replaced in high landscape positions while the wet soil is replaced in lower lying landscape positions.

The locations of the soil stockpiles should be on a topographical crest to ensure free drainage in all directions. If this is not possible then an alternative is a side-slope location with suitable cut-off berms constructed upslope.

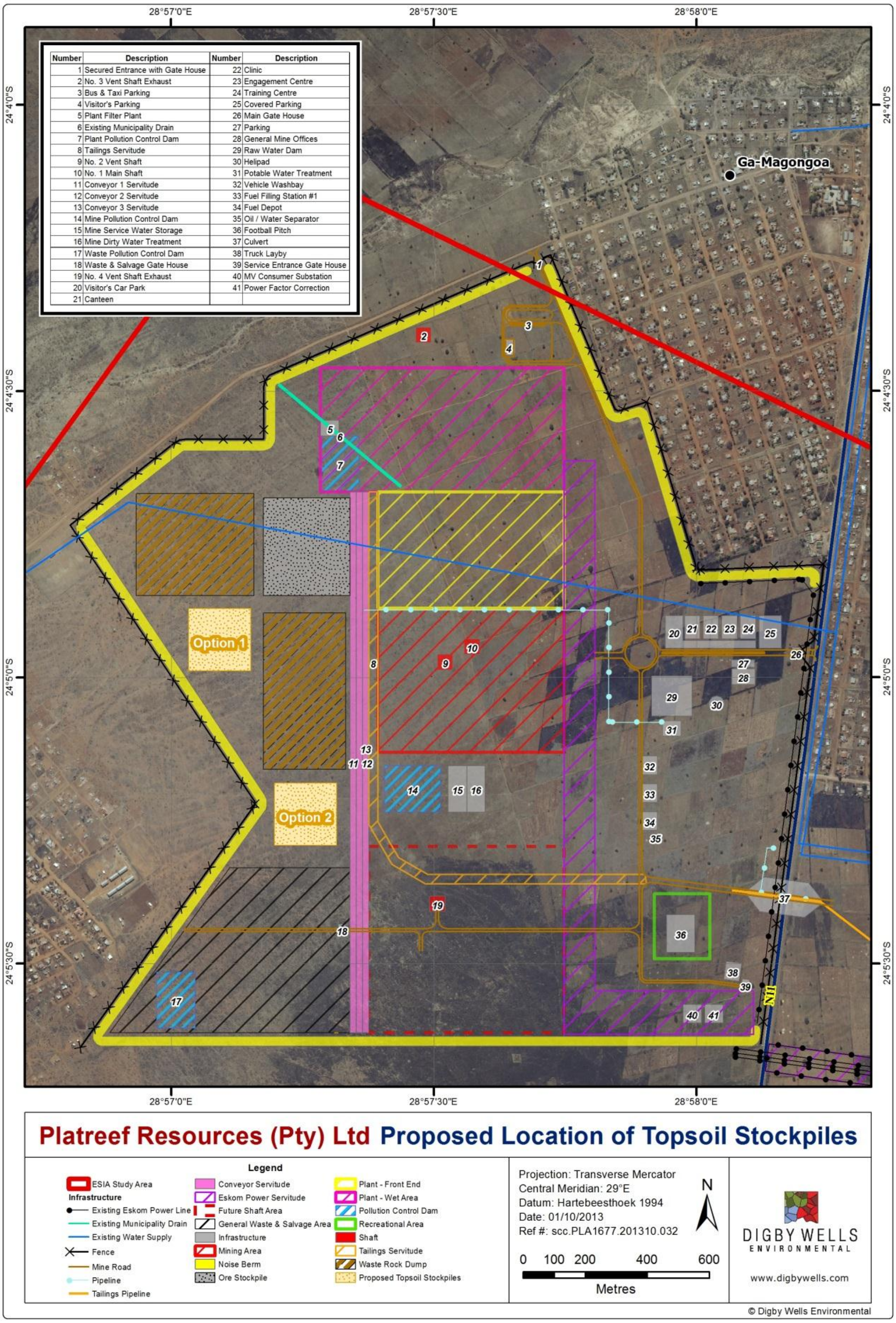
Stockpiles that are placed in drainage lines result in soils becoming water logged and a loss of desirable physical and chemical characteristics. Such situations also result in a loss of soils due to erosion. If stockpiles need to be placed in drainage lines, hydromorphic soils should be stockpiled in the wetter sections.

8.3.8 Soil Reclamation

Rehabilitation and soil reclamation of the farms affected by the placement of infrastructure mining should take into consideration that during stockpiling soil's natural carbon content deteriorates over time. The stripping and stockpiling of topsoil should be handled in a responsible way. Organic material should be retained in the topsoil by stripping and stockpiling the topsoil with the vegetation. Shallow rooted vegetation will not pose any problem but deeper rooted vegetation like shrubs and trees should be chipped first then incorporated into the topsoil through the stripping and stockpiling process.

It is recommended that rehabilitated land should be reconstructed to pre-mining grazing and arable land capabilities within the areas where surface infrastructure will be. The topsoil and subsoil materials should not be mixed during stockpiling or reclamation. Compaction by vehicle traffic should be avoided when reclamation takes place. Soil physical problems are of real concern as impacts, such as compaction, on reclaimed vegetation are severe due to restricted root growth, low water penetration and low water holding capacity.

Soil fertility and acidity status should be established through representative soil sampling and analyses to ensure optimal post reclamation vegetative growth. Any nutritional problems should be corrected prior to any vegetation establishment on reclaimed soil.



Plan 5: Proposed locations of the 200 m by 200m soil stockpile

8.3.9 Compaction

Soils should be stockpiled loosely. Achieving this will depend on the equipment being used during the stripping and stockpiling process.

Soils should be dumped in a single lift if truck and shovel methods are used. If the dumps are too low, then the height could be increased by using a dozer blade or back actor bucket to raise the materials.

The use of heavy machinery should be avoided as it results in the compaction of soils and destruction of the soil structure. It is not recommended that a bowl scraper or grader be used to level and shape the stockpiles. If heavy machinery must be used, then compaction can be reduced by stripping and dumping as thick a cut as possible. Deposition of soils in a single track line may also reduce the compaction of the dumped or replaced soil.

8.3.10 Stockpile Management

Established stockpiles should be managed to ensure that soil losses are minimised and that additional damage to the physical, chemical or biotic content is minimised. Stockpile soil health, volume and biotic integrity can potentially be harmed by factors including erosion, 'borrowing' for other purposes, contamination and water logging.

Stockpiles should be re-vegetated to avoid soil loss due to erosion and weed colonisation if stockpiles remain in the same location for more than one growing season and have not re-vegetated naturally. A similar seed mixture to the final mixture recommended for rehabilitation should be used. The looseness of the soil in stockpiles should be preserved (assuming stripping and construction of the stockpiles are done correctly) by fertilising and seeding by hand, hydroseeding (is the norm in the industry) or seeding aerially to minimise the introduction of compaction. If stockpiles are already compacted, standard agricultural equipment can be used to establish grass cover. Weed infestation should also be controlled on the stockpiles by approved methods and herbicides (e.g. Roundup).

It is very important that soils are only used for the intended purposes. The dumping of waste materials next to or on stockpiles and the pumping out of contaminated water from infrastructure areas are hazards to stockpiles. Employees must be made aware of these hazards and a detailed management and monitoring programme should be put in place.

8.3.11 Soil Replacement

Soils should be replaced in similar locations on the re-created slope to those that they occupied in the original slope. This means that the red and yellow soils should be placed at the crest and upslope areas, the grey soils that display hydromorphic characteristics and the hydromorphic clays should be placed in the bottom lands. Soils should be replaced in this way so that soils encounter the moisture conditions that are similar to their natural physical conditions. Clay subsoils should be replaced in any "valley bottom" locations, in order to replicate the impermeable layers that were previously naturally present in such locations.

8.3.12 Compaction and Equipment

Compaction limits the effectiveness of replaced soils. The equipment used during the replacement of the soils has a major impact on the compaction levels. Ideally heavy machinery should not be used to spread and level soils during replacement. The truck and shovel method should be used since it causes less compaction than, for example, a bowl scraper.

When using trucks to deposit soils, the full thickness of the soil required can be placed in one lift. This does, however, require careful management to ensure that the correct volumes of soil are replaced. The soil piles deposited by the trucks will have to be smoothed before re-vegetating the area.

8.3.13 Compaction and Soil Moisture

The soil moisture content is a determining factor in the degree to which the soils are subject to compaction. Each soil type has a moisture content at which the compactability is maximised. The aim during the replacement (and removal) of soils should be to avoid the moisture content of maximum compaction when moving soils. The best time for stripping and replacement of soils is thus when soil moisture content is lowest which will be during the dry season.

8.3.14 Multi-Layer Soil Profiles

Replacing soils in the same sequence as how they occur in nature (and have been removed) would result in considerable benefits in the re-establishment of the natural processes (provided that the soil is fertilised and re-vegetated using the correct seed mixes to represent local species) since this will result in the organic-enriched, chemically fertile, soil zone being located in the zone of maximum plant root exploitation.

Multi-layer replacement of soils is not, however, ideal from a compaction point of view because each layer needs to be deposited and levelled before the next is replaced. Compaction of the re-created profile can be reduced, provided the correct equipment is used. Soils should also be dry when it is replaced in layers. In any event, ripping through all layers of the re-created multi-layer profile will be essential.

8.3.15 Smoothing Equipment

The soils that are deposited with trucks need to be smoothed before re-vegetation can take place. A dozer (rather than a grader) should preferably be used to smooth the soils since it exerts a lower bearing pressure and thus compacts less than wheeled systems.

If the top- and sub-soils have been mixed during the stripping process then the seed-bank has been diluted excessively and the creation of a seed-bed for planting purposes will be required. For stockpiles that have stood for several years will need to be seeded and thus the preparation of the seed bed is important to the success of re-vegetation.

8.4 Amelioration

The steps that should be taken during the amelioration of soils are as follows:

1 The deposited soils must be ripped to ensure reduced compaction;

2 An acceptable seed bed should be produced by surface tillage;

3 Restore soil fertility (if top and sub-soils have been mixed) using the soil analytical data as a guideline;

4 Incorporate the immobile fertilisers in to the plant rooting zone before ripping; and

5 Apply maintenance dressing of fertilisers on an annual basis until the soil fertility cycle has been restored.

The sections below provide more detail on the above mentioned points.

8.4.1 Soil Ripping

Deep ripping should be applied to loosen compacted soils (if they occur), preferably done in areas where hard compaction has occurred, to a depth of at least 1 m (this should be limited to sections occurring out of the wetlands, for example along haul roads).

The soil moisture content for maximum disturbance and the desired spacing between the rip lines must be established before ripping starts. In general terms, ripping effectiveness is greatest when soils are slightly moist throughout, and not too wet or dry. The ripping process normally requires the use of a dozer with one or two (maximum) ripper tines that operate to a depth of at least 1 m. The desired rip pattern will be determined by the breakout pattern of the disturbance caused by each ripper tine. Usually, this breakout pattern is at 45 degrees to the tine tip, so if spacing between lines is 1 m, then shattering effect between tines is only to 500 mm. Note that standard agricultural equipment has proved to be ineffective for this task. Soil bulk density should be measured to establish the degree of compaction in the rehabilitation areas, and ripping should be carried out accordingly.

8.4.2 Surface Tillage

Rehabilitated land that requires re-vegetation using improved pastures will require tillage to produce a suitable tilth. The equipment that can be used to establish the appropriate tilth includes spring-tine harrows and disc harrows. Harrows are especially useful for breaking up coarse soil clods. Standard agricultural equipment and techniques can be used for this. Larger tractor tyre surface area will reduce compaction.

Where the natural surface horizons have been returned in the correct sequence and the surface layer stripped and returned directly (i.e. no stockpiling), there may be no need to generate a seedbed tilth since vegetation may grow naturally.

8.5 Infrastructure Removal

After mining has stopped the processing facilities, administration, mining, transport and storage facilities should be removed in order to meet the requirements of the post closure land use (grazing). In some cases portions of the existing infrastructure can be used by land users after closure. These structures should be identified and protected prior to commencement of decommissioning.

Attention should be paid to managing safety risks during the removal of infrastructure since is it a dangerous occupation.

The following steps should be followed during infrastructure removal (Tanner *et. al.,* 2007):

- Identify infrastructure items that may be of use to the future land users;
- In association with those users and the authorities, define what could be left, how it would be used and how sustainable that use would be;
- The remaining infrastructure should be assessed for its suitability for re-use/recycling;
- The re-usable items should be removed from the site;
- Hazardous material locations and deposits require specialised assessment and analysis to determine how these materials should be decontaminated and to ensure that all residual hazardous materials are deposited in officially-sanctioned hazardous waste deposit sites;
- Mining infrastructure that will be left on site must be rendered safe;
- Remaining structures should be demolished and the demolition rubble removed;
- The final landform agreed for the infrastructure areas should be created; and
- Soil should be replaced on the disturbed area and revegetated.

8.5.1 Infrastructure for Future Use

All the structures on site should be assessed in conjunction with the ultimate land users, and the authorities, to determine which items could be used in future. Care should be taken when this assessment is undertaken to ensure that the infrastructure left behind will not become abandoned due to unsuccessful enterprises.

In cases where the retention of services (e.g. roads, electricity supply, and sewage plants) is requested, the ability of the land users to maintain the various structures should be assessed.

8.5.2 Decontamination of Hazardous Material Locations

The storage and use of hazardous materials such as degreasers and hydrocarbons could result in the contamination of the environment during the life of the operation. During the life of the mine these substances will be off loaded and stored in bunded concrete lined facilities with oil/water traps for storm water management. Care should always be taken when handling and storing hazardous materials and spillages should be cleaned up and remediated immediately. Products similar to Enertech1 or Supazorb can be used. It is important to monitor the efficiency of this.

During closure the mine site should be assessed for contaminated areas. These areas should then be cleaned up by removing the contaminated soil and overburden materials and disposing of it in an officially registered hazardous waste site.

In the event that large areas have become contaminated, the required authorisations and permits must be obtained for the disposal of this waste as a registered/authorised landfill site. Cognisance must be taken that the decommissioning of hazardous storage areas (such as the Hydrocarbon Storage Areas).

In addition to this the following should be undertaken during the decommissioning of these facilities:

- The effluent/waste be classified based on the Minimum Requirements for Handling, Classification and Disposal of Hazardous Waste compiled by the Department of Water Affairs and Forestry, Second Edition 1998;
- Risk assessment and a contamination assessment study be conducted to evaluate and identify risks associated with the removal of the these facilities to determine if any significant contamination to the soils surrounding these facilities has occurred; and
- Based on the findings of the classification assessment and risk assessment, it can then be determined if authorisation is required for the decommissioning of these facilities, the appropriate decommissioning and disposal methods to be undertaken and identification of remediation measures if required.

8.5.3 Removal of Infrastructure

Infrastructure that will be demolished should be assessed for its suitability to be re-used or recycled. Items such as cladding, roofing, electrical components and equipment should be removed from the site before demolition of the structures starts. All foundations should be removed to a depth of 1 m. The hard surfaces of roads should also be ripped to a depth of 1 m.

Concrete structures contaminated with hazardous materials should be isolated and disposed of at hazardous waste disposal sites. All other inert material can be disposed of in the shafts during the decommissioning phase of the proposed project.

8.5.4 Vertical Shafts

Where underground mining has been done, the key issue is the sealing and making safe of mine shafts, adits, ventilation tunnels and any other routes to the underground workings. In all cases, all the access routes must be sealed.

It is recommended that for the access or vertical shafts, the procedure involves the filling of the shaft, as far as practically possible with inert rouble from demolition, or waste materials. The shaft must be sealed with concrete seals, designed by a professional engineer and approved by the DMR and should be positioned in unweathered rock to ensure that they are permanent.

In addition it will be a requirement to install "breather" pipes for gas release, or for water release systems where the ultimate re-establishment of the water table will result in water decant from the shaft position. Finally, the seals should be covered with inert material and topsoil and then re-vegetated.

8.5.5 Tailings Storage Facility

The closure recommendations for the Tailings Storage Facility (TSF) have been extracted from the Scoping study compiled by GeoTail (Pty) Ltd (GeoTail, March 2013).

The minimum objectives for the rehabilitation of the TSF must be to prevent air and water pollution in accordance with the requirements of the relevant regulations and with good international practice. The intended end-use should take into consideration the prior land-use and the location with respect to current and potential future socio-economic development.

The closure plan for the TSF will be developed during the life of the facility. The purpose of preparing a closure plan is to ensure that the TSF design, construction and operation procedures are compatible with the achievement of final closure and rehabilitation to acceptable environmental standards and at a reasonable cost. It is anticipated that the closure plan will be updated periodically before the preparation of the final closure plan. The closure plan will be prepared in accordance with "best practice" and the requirements of the environment.

In view of the above, the closure considerations can be summarised as follows:

- The segregated fine tailings material is expected to have a low permeability with the result that seepage from rainwater infiltration will be very limited;
- The required final side slope and top surface geometries will be achieved during the operation phase. The final top surface will either be divided into smaller compartments and/or the water will be allowed to drain in a controlled fashion to the historical pool area from where the runoff will be allowed to evaporate;
- The side slopes and the final top surface will be covered with a vegetated engineered layer. The purpose of the cover is to stabilise the tailings surface (erosion and dust generation) and to minimize the infiltration of water and oxygen;
- An emergency spillway will be included in the final closure design;
- The water storage dams will remain in place; and
- Generally all surface structures (i.e. pumps, pipelines, power lines etc.) will be removed.

The following measures will need to be implemented for the preparation of the TSF area in order to conserve as much topsoil as possible that will be utilised for rehabilitation and closure:

- The design should conserve all resources as far as possible i.e. land area, water, airspace, topsoil, mineralization and energy;

- During stripping operations, topsoil will be separated from trees and brush and placed in a dedicated stockpile for future rehabilitation purposes. Topsoil is defined as unconsolidated soil with sufficient organic content and moisture retaining capacity to sustain vegetation growth;
- Topsoil will be harvested from the TSF footprint for re-use in the rehabilitation and closure phases;
- Implement erosion control measures around the topsoil stockpiles located at the TSF to minimise and limit soil erosion; and
- Avoid the use of chemicals in and round the stockpiles to be located at the TSF to avoid contamination.

It must be noted that the engineered cover must be designed by a qualified specialist. Normally store and release covers are designed to manage rainwater on TSF facilities. This should include slope lengths and steepness.

8.5.6 Waste Rock Dump

Topsoil and subsoil from the proposed waste rock dump footprint should be stripped and stockpiled with the initial purpose of delimiting the perimeter of the dump prior to placing the waste rock on site. It has been assumed that a proportion of the waste rock will be utilised (assumed to be inert) during the construction phase.

It is proposed that some of the waste rock be used for backfilling of the underground sections of the mine. In addition to this a paste will be utilised to backfill to construct pillars underground in order to allow for total abstraction of the mineral. Taking this into account the rehabilitation of the waste rock dump will occur during the closure phase,

It is proposed that three waste rock dumps will remain post closure that will need to be shaped, soil placed on them and vegetated. The waste rock dumps that will remain post closure can be rehabilitated by placing subsoil and topsoil back and vegetating it. This will minimise the potential for erosion on the side slopes of the dump. To further limit the erosion potential of the soils, indigenous vegetation should be seeded prior to the onset of the wet season.

When deposition of waste rock occurs it is recommended that that during the deposition phase a minimum slope of 1:3 slope be constructed. In the event that this is no possible then shaping of the waste rock dumps will need to occur during the rehabilitation phase of the mine. The slopes of the waste rock should also be terraced or benched to minimise the erosion potential.

Maintenance of the vegetation and topsoil on the waste rock dump must take place after closure with the areas of erosion being rehabilitated and re-vegetated.

8.5.7 Subsidence

It is proposed that waste rock material will be utilised to fill the bords and that the pillars will be removed. This is being undertaken to allow for complete extraction of the mineral from the underground workings. It is important to note that when pillar extraction "robbing" is undertaken that there is a potential risk for subsidence to occur. This is as a result of the back areas being left unsupported and are allowed to collapse. This collapse will continue until the resistance to compaction of the collapsed material equals the weight of the overlying material. The rate of collapse can be slow and it is anticipated that the rate of collapse will take several weeks for 90% of the total subsidence to occur, the remainder subsidence will occur over several years.

To mitigate against the potential of subsidence occurring Platreef will use a paste material to fill the bords left and then remove the pillars. This is being done to avoid the risk of subsidence occurring as the roof of the underground workings will be supported by the constructed pillars from waste material. In order to mitigate against the possibility of subsidence occurring a Rock Mechanic should be consulted during the process to ensure the correct safety factors are put into place.

8.5.8 Final Landform

Once the mine site has been cleared of all infrastructure and rubble the exposed underlying materials should be reshaped to create a gently sloping, free-draining topography. The topsoil that was removed during the construction phase should be replaced, fertilised and ripped.

In cases where the foundations of the structures are impractical to remove, the foundations should be covered with a combination of soft overburden or B horizon material topped with a layer of topsoil. This layer should be at least 1 m thick.

After these tasks have been completed the infrastructure sites can be included in the rehabilitation process for the rest of the mining area for re-vegetation, monitoring and maintenance.

8.5.9 Reshaping

During the reshaping of the disturbed areas the overburden (waste rock) material, which is being replaced should be compacted by the action of the trucks running repeatedly over the replaced materials. This will compact the surface to a certain degree.

The soft overburden material should be placed on top of the overburden material to a depth of at least 1 m and shaped to produce the final landform. Compaction that will occur during the placement of this soft material will be sufficient. Compaction of the topsoil layer (or top- and sub- soils, where soil is stripped in layers) should be avoided by using the truck and shovel method. The slopes, where present, should be designed to minimise erosion potential.

8.5.10 Monitoring of the Waste Rock Dump

The waste rock volumes moved in relation to the mining work programme should be monitored on a monthly basis. Where post-rehabilitation survey results are available, these should be used, with volumes moved and removed, to correct bulking factors that were employed in the original conceptual planning exercise.

Site assessments should ensure that waste rock deposition and reshaping are being done according to plan and specifications.

8.5.11 Landform Design

Areas where specific land capabilities need to be achieved should be considered when the final landform is designed. The topography and soils are two of the most important factors which will determine the land capability classification. The final land capability should be in accordance with the commitments made in the approved EIA/EMP.

The maximum ideal slope to achieve grazing should be between 1:5 or 1:7, if grazing is the pre–determined end land use. When determining the final slope factors such as regional rainfall intensity and soil type should be considered since they will affect the erodibility rate. Excessively steep slopes will also reduce the land capability class. A general rule of thumb is not to have diagonal slopes of more than 5 m. Contour drains or log pegging can be used to break erosional force of runoff water.

Rehabilitation to Arable Land

The question is raised time and time again, can impacted mine land be rehabilitated back to the pre-mining land use and will there be a reduction in the land capability post mining (impacts to crop yields pre and post mining). The answer to this question is dependent on several factors, such as the capability of the mine to undertake rehabilitation successfully, soil stripping and stockpiling during mining, placement of soil during rehabilitation, progressive monitoring of both topsoil stockpiles and rehabilitated areas and nutrients available in the soil post rehabilitation.

Consideration must be taken that rehabilitation is much more difficult during opencast mining and that underground mines impact on smaller areas and are easier to rehab so the impacts are smaller.

To determine the success of rehabilitation post mining it is important to understand the current land use and the land capability of the area in question prior to mining. For this it is recommended that pre-mining land capability is proportionally emulated by post mining rehabilitation.

Land Capability as defined in South Africa can be classified using two approaches. The first approach is used in agriculture and is recommended by Schoeman *et al*. (2000).The second approach is contained in the Coaltech Research Association and the Chamber of Mines of South Africa Guidelines for the Rehabilitation of Mined Land, 2007.

Schoeman *et al.* (2000) defined land capability to be determined by the collective effects of soil, terrain and climatic features. The defined land capability shows the most intensive long-term use of land for rain-fed agriculture and at the same time indicates the permanent limitations associated with the different land-use classes. The classification system is made up of four orders and eight classes namely:

- Order A: Arable land – high potential land with few limitations (Classes I and II);
- Order B: Arable land – moderate to severe limitations (Classes III and IV);
- Order C: Grazing and forestry land (Classes V, VI and VII) – applicable land use; and
- Order D: Land not suitable for agriculture (Class VIII).

The 2007 Guidelines for the Rehabilitation of Mined Land recommend the classification criteria for post mining rehabilitated land to be arable, grazing, wilderness and wetland. The following criteria are used for rehabilitated land capabilities mentioned above:

- ARABLE: The soil depth exceeds 0.6 m, the soil material must not be saline or sodic and the slope (%) will be such that when multiplied by the soil erodibility factor K, the product will not exceed 2.0;
- GRAZING: The soil depth will be at least 0.25 m – applicable for the location of site infrastructure;
- WILDERNESS: The soil depth is less than 0.25 m but more than 0.15 m; and
- WETLAND: The soil depths as for grazing are used but wetland soils must be used for the construction of wetlands. These wetland soils should have been separately stockpiled.

Based on the criteria stipulated above the evaluation of the post mining land capability is based on the rehabilitation guidelines published in 2007. Based on the soil depths of the study area there is a correlation between the depth of the soil and the land capability assessed prior to mining. Based on the land capability assessment conducted by Digby Wells in 2013, typically deeper soils have an arable land capability and these soils are prime soils for the use of agriculture in the form of planting crops. Taking this into account it is recommended that areas that currently have an arable land capability need to be rehabilitated back to the pre-mining land capability by using the criteria as stipulated in the rehabilitation guidelines.

8.5.12 Drainage Channel Designs

The construction of erosion control channels on the rehabilitated areas should be avoided as far as possible. This can be done if reshaping and soil replacement are done during the dry months, the slopes are short and stabilising vegetation cover establishes in the first rains. In areas where surface water drainage systems are unavoidable, care must be taken that these structures do not make erosion worse.

The consolidation of mine spoils takes many years to complete and once mining stops the water table re-establishes and the wetting-up of the overburden materials may result in further settlement. This can be countered by constructing slopes in the contour banks that are significantly steeper than their equivalents on un-mined land and by making sure that the batters are higher. The steeper slopes might result in scouring within the channel but the risk of contour banks or drains breaking will be greatly reduced.

All drainage channels, if needed, should be designed by a "competent person" (usually an engineer), who has experience in designing such structures on rehabilitated ground.

8.6 Vegetation and Fertiliser Management Plan

8.6.1 Vegetation Management

8.6.1.1 Vegetation Establishment

This section explains the procedure that should be followed during the re-vegetation of rehabilitated areas.

The main aim when re-vegetating the areas where infrastructure is placed is to restore the areas back to the pre-mining environment (grazing capacity) and that is self-sustaining with a natural nutrient cycle in place and with ecological succession initiated.

Although the rehabilitated land may have variable land capability, including arable land capability for some areas, the main aim of this re-vegetation process is to establish a stable, sustainable grass cover.

The objectives for the re-vegetation of reshaped and top-soiled land are to:

- Prevent erosion;
- Re-establish eco-system processes to ensure that a sustainable land use can be established without requiring fertilizer additions; and
- Restore the biodiversity of the area as far as possible.

8.6.1.2 Re-vegetation Steps

1 Ensure that the soils have been replaced correctly according to the soil replacement guideline;

2 All soils are to be ripped to full potential rooting depth to correct compaction induced by the soil replacement activity;

3 Analyse the topsoil to determine the lime and fertilizers requirements;

4 Prepare the soil by adding lime and fertilizer and ploughing the area, followed by tillage to prepare the seed bed;

5 Plant a grass seed mixture consisting of a range of indigenous or non-invasive naturalised species. For wetland areas, *Imperata cylindrica* (Cotton Wool Grass) can be hand planted and hydrophilic species can be worked into the seed mix. Recommendations regarding the seed mixtures for both grassland areas and wetland areas is provided further on in the report (Where good quality grazing land or wilderness land soil is replaced by direct transfer – this will be avoid the need to plant grass mixtures. The majority of plant species present in the un-mined areas will re-establish naturally, provided the soils are replaced correctly and the tillage is done correctly;

6 Inspect the area after a good rainfall event;

7 Control and remove weeds where necessary;

8 Repeat the procedure for the next growing season;

9 Application of fertilisers is crop and site specific, analysis of the soils and stockpiles should be undertaken to determine the appropriate fertilisers to be used, if required;

10 Define and establish the long-term land management system (grass needs regular defoliation if it is to be sustainable);

11 Leave pasture to allow natural grasses to become re-established;

12 Conduct annual monitoring (repeatable demarcated transect surveys); and

13 Steps 9 to12 will apply for areas that were previously under crops, or where significant infestations of alien species were present. Initial establishment of improved pastures will result in a more ecologically satisfactory end product.

8.6.1.3 Species Selection

Some of the criteria that should be considered during the selection of the appropriate species for rehabilitation include:

- Use species which are perennial and well adapted to the area namely:
  - *Digitaria eriantha* (Fingergrass);
  - *Chloris gayana* (Rhodes grass);
  - *Eragrostis tef* (Teff); and
  - *Cynodon dactylon* (Kweek);
- The species should be tolerant of adverse soil conditions;
- Species should have a large biomass and prolific root system; and
- As areas of rehabilitation expand, maintenance costs increase, so species selected should be those with minimal maintenance cost, or with production and financial returns that exceed the cost.

The proposed seed mixture for final rehabilitation and for soil stockpiles is provided in the tables below. Note that the seed mixture can be adapted as required to meet the rehabilitation objectives. The amount of seed mixture could also very and would be site specific.

Table 8-3: Rehabilitation seed mixture (final)

Species	Rate(kg/ha)
Chloris gayana (Rhodes grass)	4
Digitaria eriantha (Fingergrass)	8
*Cenchrus ciliaris (*Blue Buffalo Grass*)*	1

Species	Rate(kg/ha)
Cynodon dactylon (Kweek)	5
Eragrostis teff (Teff)	2
TOTAL	**19**

Table 8-4: Rehabilitation seed mixture (stockpiles)

Species	Rate(kg/ha)
Chloris gayana (Rhodes grass)	4
*Cenchrus ciliaris (*Blue Buffalo Grass*)*	1
Digitaria eriantha (Fingergrass)	4
Cynodon dactylon (Kweek)	3
Eragrostis teff (Teff)	1
TOTAL	**12**

The seeding rates given are approximations only; with highly efficient planters, e.g. gel planters, these rates may be significantly reduced. Please note that in sensitive areas like wetlands and riparian areas, *Chloris gayana* should be excluded from the mix and that *Cynodon dactylon* is increased.

8.6.1.4 Re-vegetation Methods

The common methods used to establish vegetation include seeding and hydroseeding. Flat areas should be seeded using tractor implements and slopes too steep for tractors should be hydroseeded.

In the event where soils are stripped and returned directly (i.e. no stockpiling) and the areas stripped have good vegetation cover with suitable species present, natural re-colonisation may occur and there will be no need for re-seeding. In this case, it may be best to simply replace the stripped soils, lightly level and rip thoroughly, and leave for one growing season to assess the extent and suitability of the natural re-vegetation, however, this method is not suitable for any areas previously infested with alien invader species such as wattle.

Mulching with locally cut grass will also enhance the seed bank and ecological succession.

8.6.1.5 Climatic Conditions

Planting will be most successful when it is done after the first rains and into freshly prepared fine-tilled seedbeds (provided the soil material is not prone to crusting). Water retention in the seed zone will stimulate germination and can be supported by the application of light vegetation mulches.

8.6.1.6 Maintenance

Established vegetation requires regular maintenance. If the growth medium consists of low-fertility soils (i.e. topsoil and subsoil mixed) and overburden material, then regular application of plant nutrients will be required until the natural fertility cycle has been restored. Annual fertiliser application should continue for three to five years.

The grasses should be defoliated initially through grazing for the first three years and then mowing to prevent it from becoming moribund which will increase soil erosion risk. Some ecosystems might require fire at strictly defined intervals for their propagation and perpetuation. Mowing generally requires less supervision than grazing but this results in large quantities of plant nutrient (especially potassium) being removed through the hay (this will only occur if the hay is removed, then the nutrients will be lost). Larger dressing of fertiliser will have to be applied to maintain the soil fertility status quo. Grazing requires more management but it ensures nutrient recycling and that organic matter returns to the soil. Close supervision will be required for land that is hired out to ensure that overgrazing does not take place.

8.6.1.7 Vegetation Conservation

Control and management of alien vegetation will contribute to the conservation of the natural vegetation. The alien species should, therefore, be removed from site and control measures must be implemented to ensure spreading of these species does not occur to other parts of the project area or the surrounding lands.

8.6.2 Fertiliser Management

8.6.2.1 Soil Fertilisation

Deterioration of the fertility regime of soils could be minimised if the surface soils have been stripped separately from the sub-soils and have been replaced at the surface during the replacement process, however, when surface soil has been mixed with sub-soil in the stripping and replacement process, the end product is a soil with low fertility.

Surface soil fertility should be reinstated in order to establish and maintain good plant growth.

The soil should be sampled and analysed to determine the soil nutrient content as this varies from site to site. Variables to be considered for analysis include pH, P, K, Zn, Al, Ca and Mg and organic carbon. Fertiliser should then be applied to raise the soil nutrient content to the desired levels. Nitrogen is a macro nutrient and needs to be applied. Usually topdressing is required during a growing season as Nitrogen is mobile and will not last if all Nitrogen is provided in the beginning of the season.

8.6.2.2 Immobile Nutrients in Fertilisers

Immobile fertilisers such as lime (containing calcium and magnesium) and phosphorus should be incorporated deep into the plant rooting zone. This should be done by application prior to the deep ripping, which should be followed by deep ploughing, as this is the only way to get these nutrients deep into the soil. These nutrients may be replaced in a single application.

8.6.2.3 Mobile Nutrients in Fertilisers, and Maintenance Fertiliser Dressings

Potassium and nitrogen are mobile nutrients (as present in most fertilisers) and are subject to loss by leaching and volatilisation. Mobile nutrients will need to be provided for rehabilitation of new areas and because they are mobile repeat applications, may be needed. Fertiliser applications are crop and site specific and depending on the soil analysis prior to planting or seeding. The fertiliser mixture will need to be determined during rehabilitation and may vary from site to site. It is recommended that soil analysis is conducted to determine the appropriate application of fertilisers.

The success of re-establishment of vegetation on rehabilitated areas is not only a function of just adding fertiliser. Other factors play a role in determining the success of rehabilitation, such as appropriate management, climatic conditions and microbes present within the soil. Fertility can be reclaimed by adding inorganic fertilisers, however good soil fertility does not provide a warranty that vegetation will grow and the other factors involved need to be considered during rehabilitation.

Normally when fertilisers are applied, the first couple of years good vegetation cover can be established as a result of the high fertility, however as time passes there is the risk that the grass cover starts to deteriorate because of mismanagement and lack of nutrients. It may be an option to consider the introduction of legumes into the seed mixture as an option to fix Nitrogen, which allows for a higher Carbon/Nitrogen ratio, thus maintaining the existing soil fertility help build up the biological activity within the soil. However it must be noted that the management of legumes is crucial to their success.

8.7 Weed Control

Alien invasive species tend to out-compete the indigenous vegetation; this is due to the fact that they are vigorous growers that are adaptable and able to invade a wide range of ecological niches (Bromilow, 1995). They are tough, can withstand unfavourable conditions and are easily spread.

The table below (Table 7-4) shows the alien invasive and weed species that were recorded on the project area during the fauna and flora surveys for the EIA/EMP report.

Table 8-5: Alien invasive and weed species recorded (Digby Wells, 2013)

Family	Species Name	Common Name	Category
Agavaceae	*Agave Americana*	Century plant	-
Apocynaceae	*Catharanthus roseus*	Periwinkle	-
Asparagaceae	*Asparagus laricinus*	Wild asapragus	-

Family	Species Name	Common Name	Category
Asteraceae	*Bidens pilosa*	Black Jack	-
Asteraceae	*Mantisalca salmantica*	Mantisalca	-
Asteraceae	*Schkuhria pinnata*	Dwarf marigold	-
Asteraceae	*Senecio latifolius*	Ragwort	-
Asteraceae	*Tagetes minuta*	Tall khakhi weed	-
Asteraceae	*Xanthium strumarium*	Spiny cocklebur	1
Asteraceae	*Zinnia peruviana*	Redstar zinnia	-
Cactaceae	*Opuntia ficus-indica*	Prickley pear	1
Caesalpiniaceae	*Senna pendula var. glabrata*	Easter Cassia	3
Euphorbiaceae	*Ricinus communis*	Castor oil plant	2
Fabaceae	*Bauhinia variegate*	Orchid tree	3
Fabaceae	*Indigofera heterotricha*	Hairy indigo	-
Meliaceae	*Melia azedarach*	Chinaberry	3
Papaveraceae	*Argemone ochrolauca*	Mexican poppy	1
Poacea	*Melinis repens*	Natal red top	-
Solanaceae	*Solanum incanum*	Thorn Apple	-
Solanaceae	*Solanum panduriform*	Bitterappel	-

Alien invasion for the Platreef study area was not regarded as severe and is not regarded as a major hindrance to biodiversity.

Alien species in South Africa are categorised according to CARA and NEMBA.

Declared alien and invasive species have been divided according to CARA into three categories:

- Category 1: Declared weeds that are prohibited on any land or water surface in South Africa. These species must be controlled, or eradicated where possible;
- Category 2: Declared invader species that are only allowed in demarcated areas under controlled conditions and prohibited within 30m of the 1:50 year flood line of any watercourse or wetland; and
- Category 3: Declared invader species that may remain, but must be prevented from spreading. No further planting of these species are allowed.

In addition, Draft NEMBA Regulations (Government Gazette Vol. 526, No. 32090) were issued on the 3rd of April 2009. Although these regulations are yet to be promulgated as law, they are useful and relevant for categorising alien plant species found on site in this study. The draft NEMBA categories for invasive species according to Section 21 are as follows:

- Category 1a: Species requiring compulsory control;
- Category 1b: Invasive species controlled by an invasive species management programme;
- Category 2: Invasive species controlled by area, and;
- Category 3: Invasive species controlled by activity.

8.8 Alien Invasive Control Plan

Alien invasive species tend to out-compete the indigenous vegetation; this is due to the fact that they are vigorous growers that are adaptable and able to invade a wide range of ecological niches (Bromilow, 1995). They are tough, can withstand unfavourable conditions and are easily spread.

8.8.1 Alien Species Control

Invasive alien plant species (as noted in Table 8-5 above) are difficult to control. Methods should be used that are appropriate for the species concerned, as well as to the ecosystem in which they occur.

When controlling weeds and invaders, damage to the environment must be limited to a minimum.

There are four basic methods by which encroachers or weeds are controlled:

- Physical (mechanical):
  - Uprooting (hand pulling);
  - Cutting back;
  - Chopping, slashing and felling; and
  - Ring-barking (girdling).
- Chemical:
  - Foliar application;
  - Stem notching and application;
  - Stump treatment; and
- Soil treatment.
  - Biological treatment which involves the use of host-specific natural enemies of weeds or invaders from the plant's country of origin, to either kill or remove the invasive potential of these plants; and
  - Specific care needs to be taken to treat the Category 1 species (Scotch Thistle and Pampas Grass) with the correct chemicals and dye, as prescribed and approved by authorities, using trained personnel.

8.8.2 Integrated Control Strategies

The satisfactory control of weeds and other invasive species is usually only achieved when several complementary methods, including biological control, improved land management practices, herbicides and mechanical methods, are carefully integrated. Such a strategy is termed an Integrated Control Strategy (ICS).

Follow-up control of alien plant seedlings, saplings and coppice regrowth is essential to maintain the progress made with initial control work, and to prevent suppression of planted or colonizing grasses. Before starting new control operations on new infestations, all required follow-up control and rehabilitation work must be completed in areas that are originally prioritized for clearing and rehabilitation.

8.8.3 Additional Measures

The following additional measures are recommended in order to prevent the future introduction or spread of alien species, and to ensure the rehabilitation of transformed areas:

- There must be no planting of alien plants (e.g. black wattle, eucalyptus and pampas grass) anywhere within the mining area;
- Annual surveys, aimed at updating the alien plant list and establishing and updating the invasive status of each of the alien species, should be carried out (can be done by Platreef staff);
- The transportation of soils or other substrates infested with alien species should be strictly controlled;
- Benefits to local communities as a result of the alien plant control programme should be maximised by not only ensuring that local labour is employed, but by also ensuring that cleared alien trees are treated as a valuable wood resource that can be utilised;
- It is considered essential that appropriate veld management (particularly appropriate grazing levels and burning frequencies) should be applied to areas of secondary indigenous vegetation (e.g. secondary grassland of historically cultivated areas), and especially the grassland and wetland vegetation of untransformed habitats. Appropriate grazing levels and burning frequencies will not only ensure that good vegetation condition and biodiversity levels are maintained, but will also serve to control the spread and increase in cover of palatable alien species such as *Paspalum dilatatum*.

8.9 Monitoring and Maintenance

The purpose of monitoring is to ensure that the objectives of rehabilitation are met and that the rehabilitation process is followed. The physical aspects of rehabilitation should be carefully monitored as well as during the progress of establishment of desired final ecosystems.

The following items should be monitored continuously:

- Alignment of actual final topography to agreed planned landform;
- Depth of topsoil stripped and placed;
- Chemical, physical and biological status of replaced soil;
- Erosion status;
- Surface drainage systems and surface water quality;
- Groundwater quality at agreed locations;

- Vegetation basal cover;
- Vegetation species diversity;
- Faunal re-colonisation (Sherman and pitfall trapping); and
- Proportion of mined land that has been fully rehabilitated.

Monitoring of surface and groundwater resources as well as air quality (dust sampling) should take place on a monthly basis for the first 12 months after rehabilitation has been completed. Aquatic ecosystems should be monitored bi-annually i.e. once during the wet season and once during the dry season. After the first 12 months of monitoring the frequency of sampling should be adjusted to quarterly monitoring for the surface and groundwater resources. Aquatic ecosystems should still be monitored on a bi-annual basis and dust sampling should be undertaken on a monthly basis. This monitoring should continue for an additional 36 months.

8.9.1 Final Topography

The topography that is achieved during rehabilitation should be monitored and compared to the planned topography. The final profile achieved should be acceptable in terms of the surface water drainage requirements and the end land use objectives. The survey department should do an assessment of the reshaping carried out on the site and signoff should be obtained from the rehabilitation specialist before the topsoil is replaced.

8.9.2 Depth of Topsoil Stripped and Replaced

The recovery and effective use of the usable topsoil available is very important. It is also important to undertake regular reconciliation of the volumes stripped, stockpiled and returned to the rehabilitated areas. A topsoil balance can be used to keep track of soil resources on the mine.

A final post-mining rehabilitation performance assessment should be done and information should be adequate for closure applications that involve:

- Assessment of rehabilitated soil thickness and soil characteristics by means of auger observations using a detailed grid;
- A post-mining land capability map based on soil thickness and characteristics;
- A proposed post-mining land use map;
- Erosion occurrences;
- Fertility analysis and soil analysis;
- Representative bulk density analysis.

8.9.3 Chemical, Physical and Biological Status of Replaced Soils

Assess the depth of the replaced soils using a soil auger in a regular grid pattern. The standard spacing of auger holes is 100 m by 100 m which results in one hole per hectare.

Ensure that each auger hole is geo-referenced and that the results are plotted. The auger points can be used to identify compact soil layers, the degree of disturbance of the soil and the plant rooting pattern.

Undertake soil fertility sampling independently of the auger survey. The land should be split into logical land use units and should not be bigger than 100 ha.

These assessments should be conducted pre-establishment to ensure that immobile nutrients can be applied and incorporated deep into the plant rooting zone during the initial tillage process.

8.9.4 Erosion

Continuous erosion monitoring of rehabilitated areas should be undertaken and zones with excessive erosion should be identified. Erosion can either be quantified or the occurrence there-of simply recorded for the particular location.

8.9.5 Surface Water

8.9.5.1 Drainage systems

The functionality of the surface water drainage systems should be assessed on an annual basis. This should preferably be done after the first major rains of the season and then after any major storm. An assessment of these structures will ensure that the drainage on the recreated profile matches the rehabilitation plan as well as to detect early on when any drainage structures are not functioning efficiently. These can then be repaired or replaced before it causes significant erosion damage.

8.9.5.2 Water quality

The quality of all water leaving the property should be monitored on a regular basis (as per the EMP) to ensure compliance of the various constituents with the standards approved by the DWA. Samples should be analysed for particulate and soluble contaminants as well as biological.

Additional monitoring should include aquatic biomonitoring (invertebrates, habitat, water quality and fish) on a bi-annual basis (high and low flow) to determine the ecological functioning and health of the rivers and streams, in and around the rehabilitated areas. The ecological functioning of the wetlands should similarly be assessed on an annual basis.

8.9.6 Groundwater

The groundwater levels and quality should be measured and monitored in a similar way to the surface water to determine the impact of the mining activities on the groundwater resources. A hydrogeologist, together with the relevant authorities, should determine the locations of the monitoring boreholes. The monitoring frequency will be determined by the regulator.

8.9.7 Vegetation Basal Cover

Basal cover refers to the proportion of ground at root level which is covered by vegetation and by the rooting portion of the cover plants. The line-transect (or the quadrat bridge) method can be used to establish sampling positions. A target of 15% basal cover should be set for fully established vegetation

8.9.8 Vegetation Species

Biodiversity assessments and surveys should be undertaken by external experts to establish the full range of plants that have become established. Summer and winter samplings should be done during these assessments.

8.9.9 Crop and Pasture Growth and Yield

The growth and yield of pastures grown on rehabilitated land should be recorded in relation to climatic conditions. This should be done in order to gather evidence of the relative capability of the new profile to support the pastures in relation to unmined conditions. This can be done by recording the number of grazing days, hay bales produced, their average weight and the amount crops as an average yield per hectare can be recorded.

9 RECOMMENDATIONS

The following recommendations regarding rehabilitation of the Platreef mine site are applicable:

- It is recommended that the financial provision for closure and rehabilitation be annually updated as per the requirements of the MPRDA;
- Ensure that all water users have been identified and that the applicable authorisations are obtained in terms of the NWA (obtain WUL before construction or operation of the mine is undertaken);
- Site infrastructure:
  - Long term management of the rehabilitated areas will be required via contractual agreements with land owners in the area;
  - Rehabilitation should also be undertaken to best practise;
- Regular audits should be undertaken to monitor the progress of areas that have been rehabilitated;
- Regular audits should be undertaken by a soil scientist during the soil stripping process. This will guarantee that soil are stripped and stockpiled correctly; and
- Surface water monitoring of the pans and associated wetlands surrounding the project area is to be undertaken to determine the impacts associated with operations of the proposed mine.

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